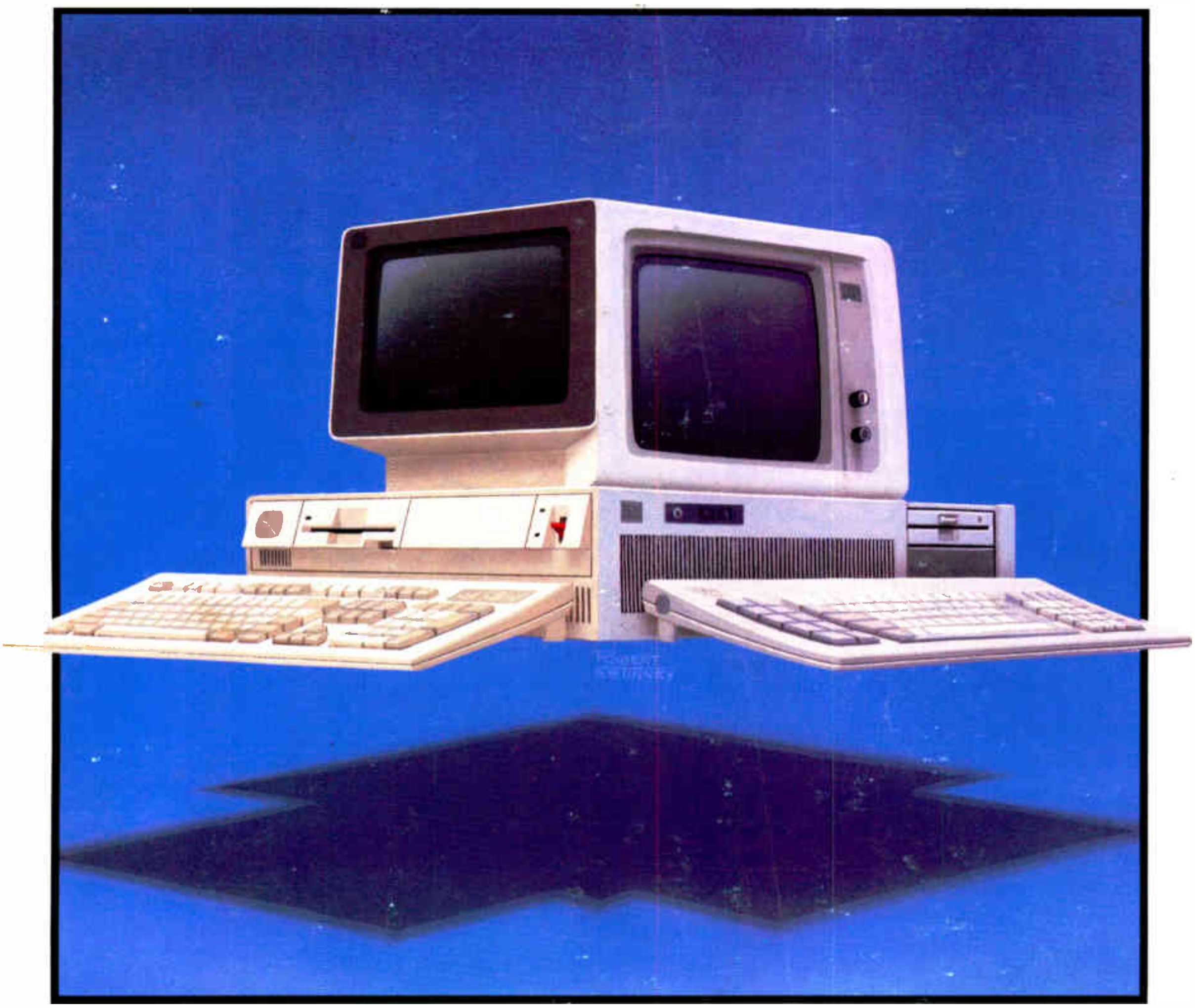
Fifth Annual Extra All-IBM Issue

BYTE

IBM Special Edition



Battle of the Boards: Micro Channel vs. AT Bus
State of the Art in PC Graphics
Multitasking with DOS

Plus Unix • DOS 4.0 • OS/2
Communications • Memory Technology
Best of BIX • Expert Columnists

ebugger, Turbo Pascal 5.0

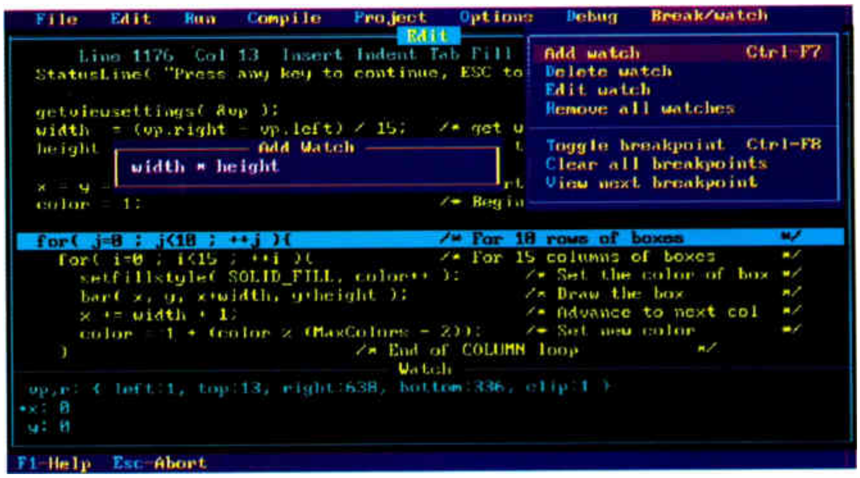
New! Turbo C® 2.0 with integrated source-level debugger

New Turbo C 2.0 is the *one* C compiler that does it all; nothing is half done or not done at all—instead, your every programming need is met. We wrote our best-selling word processor Sprint® with Turbo C; now you can write your own best seller with Turbo C 2.0.

At better than 16,000 lines a minute,* Turbo C 2.0 compiles your code 20-30% faster than its predecessor Turbo C 1.5 which was already faster than any other C compiler.

Make bugs bug off

Nice bugs are dead bugs, and Turbo C 2.0's integrated source-level debugger lets you find them and flatten them in a flash. You can set multiple breakpoints, watch variables and evaluate expressions—all from inside your integrated C environment.



Debugging in the Turbo environment: shown here an expression is being added to the Watch window in Turbo C. The Execution Bar highlights the next line the debugger will execute.

TURBO C 2.0

HEAPSORT BENCHMARK	TURBO C 2.0	Microsoft® C 5.1
.OBJ size (bytes)	843	945
.EXE size (bytes)	6896	7731
Execution time (seconds)	8.1	12.2
FEATURE COMPARISON		
Integrated debugger	Yes	No*
Inline assembly	Yes	No
Auto dependency checking	Yes	No
EMS support for edit buffer	Yes	No
Device-independent graphics	Yes	No
Number of memory models	6	5
Price	$149.95	$450.00

Heapsort compiled with full optimization. Benchmark run on an IBM PS/2 Model 60.
*Integrated debugger included with Quick C.

Minimum system requirements: For the IBM PS/2™ and the IBM® family of personal computers and all 100% compatibles. PC-DOS (MS-DOS) 2.0 or later. Turbo Debugger minumum 384K. Turbo Assembler minimum 256K. Turbo C and Turbo Pascal minimum 448K (256K comment line version).

*Customer satisfaction is our main concern, if within 60 days of purchase this product does not perform in accordance with our claims, call our customer service department, and we will arrange a refund

Prices and specifications subject to change without notice

Turbo C and Turbo Pascal owners, upgrade now! CALL (800) 543-7543

If you're a registered Turbo C and/or Turbo Pascal owner, you can upgrade and get the latest version of your favorite language, plus both Turbo Assembler and Turbo Debugger, all at special upgrade prices. Whether you order by phone or mail, be sure to include your old Turbo Pascal and/or Turbo C serial numbers and the code PL02.

Mail coupon to: Borland, Attn: Dept. PL02, 1800 Green Hills Road, P.O. Box 660005, Scotts Valley, CA 95066-0005.

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Turbo Pascal Serial Number ______

Turbo C Serial Number ______

Upgrades for registered Turbo C and Turbo Pascal owners	Suggested Retail	Upgrade Price
Please check box(es)		
1 ☐ Turbo C 2.0 Professional (Includes both Turbo Assembler and Turbo Debugger)	250.00	99.95
2 ☐ Turbo Pascal 5.0 Professional (Includes both Turbo Assembler and Turbo Debugger)	250.00	99.95
3 ☐ Turbo Pascal with 5.0 upgrade manual and disks	N/A	49.95
4 ☐ Turbo C with 2.0 upgrade manual and disks	N/A	49.95

Please specify diskette size: Either ☐ 5¼" OR ☐ 3½"

Total product amount $ ______

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In US please add $5 shipping/handling for each product $ ______

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Total amount enclosed $ ______

Payment: ☐ VISA ☐ MC ☐ Check ☐ Bank Draft Credit card expiration date: ____/____

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*If you have not registered your Turbo Pascal or Turbo C, you may qualify for the special price by including your completed registration card with this coupon and payment. Offer good September 1 through November 30, 1988. Coupon must be postmarked before December 15, 1988. Offer good in U.S. and Canada only. This offer limited to one upgrade per valid product serial number. Not good with any other offer from Borland. CODs and purchase orders will not be accepted by Borland

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Turbo Assembler, Turbo D

What started modestly enough in November of 1983 with the launch of Borland's first program, Turbo Pascal® 1.0, became a revolution and it's been going like a rocket ever since.

We've changed the way you program.

We invented integrated environments with Turbo Pascal and we brought them to all our languages. Borland continues to bring you the best programming tools in the world.

New! Turbo Assembler & Turbo Debugger

Two state-of-the-art development tools in one package for only $149.95.

New Turbo Debugger® debugs all sizes

With EMS support, remote debugging, and 386 virtual machine debugging, there's no limit to the size of program you can debug. In fact with 386 virtual machine mode, debugging takes *zero*, bytes of conventional memory!

See what's happening

Overlapping windows give you multiple views of the program you're debugging: source code, variables, CPU registers, call stack, watches, breakpoints, memory dump, and more. And a new "session-logging" feature tracks and records your every move.

You're in control

Our breakpoints give you more control than anyone else's. Ordinary debuggers only get you to a stop, then they stop. When our breakpoints are triggered you can simply stop, or you can print expressions, run code, send messages to the session log, or even evaluate an expression with user-defined function calls. And *all* our breakpoints are conditional.

Shown here are views of source code, CPU registers, watch expressions, and a session log.

Unique Data Debugging

Plain Vanilla debuggers can only give you *code* debugging. Our new Turbo Debugger give you *data* debugging too. You can browse through your data from the simplest byte to the hairiest data structure, inspect arrays, and walk through linked lists. All by point and shoot.

Feature highlights

Breakpoints

- Actions: stop, run code, log expression
- Break on condition, memory changed
- Software ICE capabilites
- 386 debug register support
- Support for hardware debuggers

Debug any program

- Turbo Pascal, Turbo C, Turbo Assembler
- EMS support
- 386 virtual machine and remote machine debugging
- Supports CodeView® and .MAP-compatible programs

Data Debugger

- Follow pointers through linked lists
- Browse through arrays and data structures
- Change data values

New Turbo Assembler® lets you write the tightest, fastest code

Turbo Assembler is faster than other assemblers, and you can use it on your existing code. It's fully MASM compatible, 4.0, 5.0, and 5.1; even MASM can't say that. Turbo Assembler takes you beyond MASM, with significant new Assembly language extensions, more complete error checking, and full 386 support.

Turbo Assembler is designed for easy interfacing with high-level languages like Turbo Pascal and Turbo C. We use Turbo Assembler on Quattro,® our best-selling spreadsheet program; now you can write your own best-seller with Turbo Assembler!

Feature highlights

- Faster than other assemblers
- MASM compatible (4.0, 5.0, and 5.1)
- Significant new assembly language extensions
- Easy interfacing with high-level languages including Turbo C and Turbo Pascal
- Full 386 support

TURBO DEBUGGER

FEATURE COMPARISON	TURBO DEBUGGER	CodeView®
Multiple overlapping views	Yes	No
386 virtual-86 mode debugging	Yes	No
Remote debugging	Yes	No
Data debugging	Yes	Partial
Generalized breakpoints	Yes	No
Session logging	Yes	No
Conventional memory used—80386	Zero K	230K
Conventional memory used—remote	15K	N/A

Turbo Debugger version 1.0, Microsoft CodeView version 2.2.

TURBO ASSEMBLER

BGIDEMO BENCHMARK	TURBO ASSEMBLER	Microsoft® Assembler
Assembly time (seconds)	9.34	27.46
Link time (seconds)	4.15	10.51
FEATURE COMPARISON		
MASM compatible (4.0, 5.0, 5.1)	Yes	No
Thorough type checking	Yes	No
Nested structures and unions	Yes	No
Multimodule cross reference	Yes	No
Assemble multiple files	Yes	No

Run on IBM PS/2 model 60 using Turbo Assembler version 1.0, Turbo Linker version 2.0, Microsoft Macro Assembler version 5.10, Microsoft Overlay Linker version 3.64.


The Revolution continues with our new . . .
TURBO C
TURBO C PROFESSIONAL
TURBO ASSEMBLER/ DEBUGGER
TURBO PASCAL PROFESSIONAL
TURBO PASCAL
BORLAND

and Turbo C 2.0!

Turbo C 2.0 has the best of everything

- Includes the compiler, editor, and debugger, all rolled into one
- Integrated source-level debugger lets you step code, watch variables, and set breakpoints
- Develop and debug production-quality code in all six memory models
- Inline assembler support
- Support for Turbo Assembler and Turbo Debugger
- Make facility with automatic dependency checking
- Over 430 library functions, including a complete graphics library
- Only $149.95

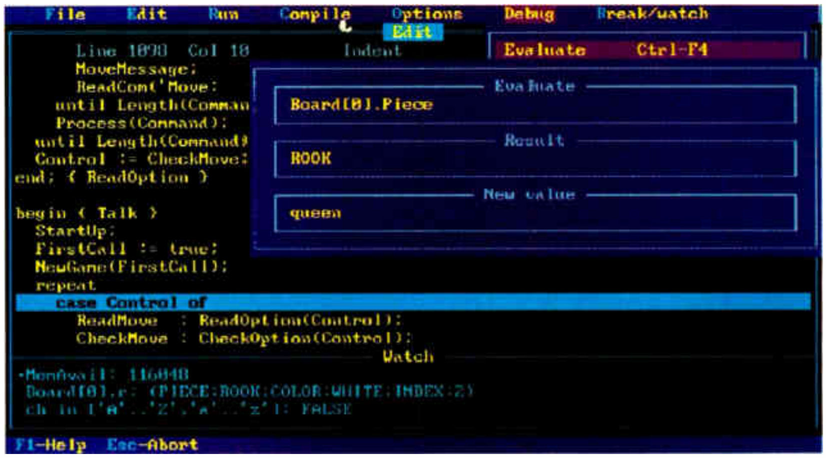
New Turbo C Professional

Turbo C 2.0 plus *both* Turbo Assembler & Turbo Debugger: all three programs rolled into one—the *one* C package that has everything. A complete set of tools that caters to every level of programming expertise. Turbo C Professional: $250. Includes coupon for free T-shirt (while supplies last).

New! Turbo Pascal® 5.0 with integrated source-level debugger

Turbo Pascal, the worldwide favorite with over a million copies in use, just got even smarter. The best got better. Meet Version 5.0. In a word, it's revolutionary.

Not only do you go code-racing at more than 34,000 lines a minute,* you also now go into a sophisticated debugging environment—right at source level.



Shown here is the Evaluate/Modify window of Turbo Pascal: look at expressions, examine structured data types, change variables on the fly.

It's completely integrated and bullet-fast.

Turbo Pascal's new integrated debugger takes you inside your code for fast fixes. You step, trace, set multiple breakpoints. You modify variables as you debug and watch full expressions at runtime.

Separate Compilation

Break your code into units. Your separately compiled units can be shared by multiple programs and linked in a flash with Turbo Pascal's built-in Make utility and smart linker. We give you a powerful library of standard units including the spectacular Borland Graphic Interface and our state-of-the-art overlay manager.

TURBO PASCAL 5.0	TURBO PASCAL 5.0	Turbo Pascal 4.0
SIEVE BENCHMARK		
.EXE size (bytes)	1440	1504
Execution time (seconds)	6.15	7.25
FEATURE COMPARISON		
Integrated debugger	Yes	No
Overlays, including EMS support	Yes	No
8087 floating-point emulation	Yes	No
Turbo Debugger support	Yes	No
Procedural types, variables, parameters	Yes	No
Smart linking of code and data	Yes	No
Constant expressions	Yes	No
EMS support for editor	Yes	No

Benchmark (25 iterations) run on an IBM PS/2 Model 60.

Feature highlights

- Includes the compiler, editor, and debugger, all rolled into one
- Integrated source-level debugger lets you step code, watch variables, and set breakpoints
- Overlays, including EMS support
- 8087 floating-point emulation
- Support for Turbo Assembler and Turbo Debugger
- Procedural types, variables, and parameters
- Smaller, tighter programs: Smart Linker strips both unused code and data
- Constant expressions
- EMS support for editor
- Only $149.95

Debugging: The inside story

Turbo Pascal's new integrated source-level debugger takes you inside your code to fix errors fast. Don't worry about errors, everyone makes them; but with the right debugger, this one, it's a fast fix.

Turbo Pascal Professional®

Turbo Pascal 5.0 plus *both* Turbo Assembler & Turbo Debugger: all three programs rolled into one—the *one* Pascal package that has everything. A complete set of tools that caters to every level of programming expertise. Turbo Pascal Professional: $250. Includes coupon for free T-shirt (while supplies last).

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VOLUME 13, NUMBER 11, 1988

BYTE

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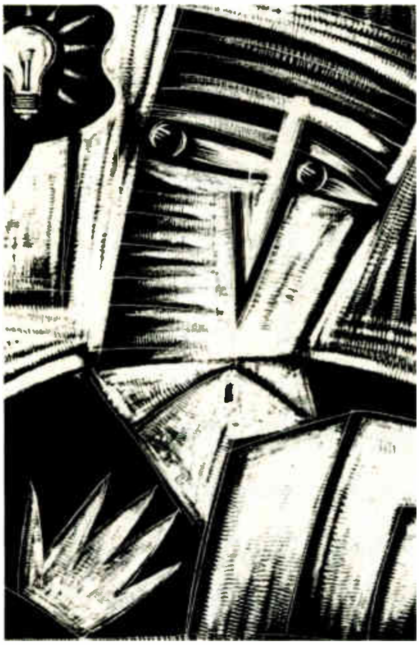

BYTE (ISSN 0360-5280) is published monthly with an additional issue in October by McGraw-Hill, Inc. Founder: James H. McGraw (1860-1948). Executive, editorial, circulation, and advertising offices: One Phoenix Mill Lane, Peterborough, NH 03458, phone (603) 924-9281. Office hours: Monday through Thursday 8:30 AM-4:30 PM, Friday 8:30 AM-1:00 PM, Eastern Time. Address subscriptions to BYTE Subscriptions, P.O. Box 7643, Teaneck, NJ 07666-9866. Postmaster: Send address changes, USPS Form 3579, undeliverable copies, and fulfillment questions to BYTE Subscriptions, P.O. Box 7643, Teaneck, NJ 07666-9866. Second-class postage paid at Peterborough, NH 03458 and additional mailing offices. Postage paid at Winnipeg, Manitoba. Registration number 9321. Subscriptions are $22.95 for one year, $39.95 for two years, and $55.95 for three years in the U.S. and its possessions. In Canada and Mexico, $25.95 for one year, $45.95 for two years, $64.95 for three years. $75 for one-year air delivery to Europe. ¥28,800 for one-year air delivery to Japan, ¥14,400 for one-year surface delivery to Japan, $40 surface delivery elsewhere. Air delivery to selected areas at additional rates upon request. Single copy price is $3.50 in the U.S. and its possessions, $3.95 in Canada, $4.50 in Europe, and $5 elsewhere. Foreign subscriptions and sales should be remitted in U.S. funds drawn on a U.S. bank. Please allow six to eight weeks for delivery of first issue. Printed in the United States of America.

Address editorial correspondence to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Unacceptable manuscripts will be returned if accompanied by sufficient postage. Not responsible for lost manuscripts or photos. Opinions expressed by the authors are not necessarily those of BYTE.

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COVER ILLUSTRATION: ROBERT TINNEY

The Dell System 220. Once again the critics stole the words right out of our mouth.

"The Dell System 220 runs most PC Labs system benchmark tests at speeds that would make you think you're running a 386."
—PC MAGAZINE

"the Dell machine is renewed evidence that the price of 286-based desktop equipment continues to drop rapidly, making such machines very attractive for daily work under MS-DOS even as they hold out the promise of running OS/2 in the future."
—WILL FASTIE, PC WEEK

"...includes a year's on-site support...in the price of the computer. This is the sweetest support deal offered by any computer vendor in the industry."
—ERIC KNORR, PC WORLD

"The hot item from a technical point of view is the System 220. This machine runs a 286 processor at 20 MHz, which is its major claim to fame."
—WILL FASTIE, PC WEEK

"the System 220 has more going for it than just speed."
—PC WORLD

The reviews are beginning to pour in.

And they read like a wish list for every power user looking to exceed the ordinary limitations of a 286 computer.

The computer everyone is praising in such glowing terms is the Dell System 220.

The first 286 computer with a clock speed of 20 MHz.

It's totally MS-DOS® and MS® OS/2 compatible. Yet it sells for much less than you may pay for a 386 computer.

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This optional service contract is available in over 95% of the United States, with over 1,000 engineers in 198 service locations.

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THE NEW 20 MHz 386† SYSTEM 310.

The top of the line. It's our highest performance computer available, faster than the IBM† PS/2† Model 80 and the Compaq† 386/20. It runs at 20 MHz with the latest 32-bit architecture. Since it also has Intel's Advanced 82385 Cache Memory Controller, and high performance disk drives, the System 310 is ideal for intensive database management, complex spreadsheet development, CAD/CAM, desktop publishing or performance as a network file server.

Standard Features:

- Intel† 80386 microprocessor running at 20 MHz.
- 1 MB of RAM (640K usable) expandable to 16 MB without using an expansion slot.
- Advanced Intel 82385 Memory Controller with 32 KB of high speed static RAM.
- Socket for 20 MHz 80387 or Weitek 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 expansion slots (6 available).

Performance Enhancements (Systems 310 and 220):

- 384 KB of dedicated RAM is used by portions of the system software for increased performance.

***Lease for as low as $148/Month.*

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Hard Disk Drives	VGA Mono	VGA Color Plus
40 MB – 28 ms	$4,099	$4,399
90 MB – 18 ms ESDI	$4,899	$5,199
150 MB – 18 ms ESDI	$5,399	$5,699
322 MB – 18 ms ESDI	$7,399	$7,699

THE NEW 20 MHz 286 SYSTEM 220.

As fast as most 386 computers, at less than half the price—more power for the money than any other system. An 80286 system that runs at 20 MHz, with less than one wait state. Completely compatible for both MS-DOS® and MS® OS/2 applications (it runs faster than IBM PS/2 Model 80), and with a remarkably small footprint, the System 220 is the ideal executive workstation.

Standard Features:

- 80286 microprocessor running at 20 MHz.
- 1 MB of RAM (640K usable) expandable to 16 MB (8 MB* on system board).
- Page mode interleaved memory.
- Integrated diskette and VGA video controller on system board.
- 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.
- LIM 4.0 support for memory over 1 MB.
- Three full-sized AT† compatible expansion slots available.
- Socket for 80287 coprocessor.

Options:

- External 5.25" 1.2 MB diskette drive.
- 3.5" 1.44 MB diskette drive.
- Intel 80287 coprocessor.
- 1 MB RAM upgrade kit.

***Lease for as low as $85/Month.*

System 220	With Monitor		
	VGA Mono	VGA Color	VGA Color Plus
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40 MB – 29 ms Hard Disk	$2,999	$3,199	$3,299
100 MB – 29 ms Hard Disk	$3,799	$3,999	$4,099

THE 12.5 MHz SYSTEM 200.

A great value in a full-featured AT compatible. An 80286 computer running at 12.5 MHz, this computer is completely MS-DOS and MS OS/2 compatible. The System 200 offers high speed drive options, industry standard compatible BIOS and on-site service. As Executive Computing said of this computer's predecessor, "If faster processing speed and low cost are two key issues affecting your purchase decision, this machine might be the ideal choice for your office."

Standard Features:

- Intel 80286 microprocessor running at 12.5 MHz.
- 640 KB of RAM expandable to 16 MB (4.6 MB* on system board).
- 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.
- Real-time clock.
- 6 expansion slots. (4 available with hard disk drive controller and video adaptor installed).
- Socket for 8 MHz 80287 coprocessor.

Options:

- 512 KB RAM upgrade kit.
- 8 MHz Intel 80287 coprocessor.

***Lease for as low as $78/Month.*

System 200	With Monitor & Adapter	
Hard Disk Drives	VGA Mono	VGA Color Plus
40 MB – 28 ms	$2,699	$2,999
90 MB – 18 ms ESDI	$3,499	$3,799
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322 MB – 18 ms ESDI	$5,999	$6,299

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Near-letter quality at 60 cps.
Standard parallel interface.
Wide carriage.

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Near-letter quality at 36 cps.
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Paper parking.
Standard parallel interface.

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DOS system running Lotus 1-2-3

SCO XENIX system running SCO Professional

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**Cost comparisons are based on most recently published U.S. domestic suggested list prices. Cost model: Base machine. IBM PS/2 Model 80, 70Mb disk, 1Mb RAM, IBM 8512 color monitor, 1Mb additional IBM RAM, IBM ProPrinter XL.® 1-user DOS system: Base machine, plus DOS 3.3, WordPerfect 4.2, Lotus® 1-2-3,® dBASE III PLUS.® 1-user OS/2 system: 1 user DOS system, substitute OS/2 for DOS. 1-user SCO XENIX system: Base machine, plus SCO XENIX 386 for PS/2, SCO VP/ix, SCO Lyrix® (word processing), SCO FoxBASE+™ (dBASE III PLUS workalike), SCO Professional™ (1-2-3 workalike). 9-user SCO XENIX system: 1-user SCO XENIX system, plus intelligent 8-user multiport card, 8 IBM 3151 ASCII terminals. 33-user SCO XENIX system: 9-user SCO XENIX System, plus 3 more intelligent 8 user multiport cards, 24 more IBM 3151 ASCII terminals, 4 Mb additional RAM, additional 70Mb disk.

TWO ROADS

These days, there's more than one path to PC power

Recently, I was driving on Route 128 in Boston, the heart of Silicon Valley East. Several large semitrailers passed me, with other trucks and passenger cars following in their wake. The other vehicles were "drafting"—letting the first big truck cut a path for them and taking advantage of lowered wind resistance and improved mileage. It's a dangerous habit, especially if the truck in the lead decides to make a sudden stop or turn.

For the last several years, IBM has been the "lead truck" in the computer industry, barreling down the PC highway with a host of PC-compatible manufacturers trailing behind. The rest of us have been following somewhere further back in the distance. As we've traveled along, the road has been continuously upgraded and improved, from PC Road to the XT Expressway and then to the AT Highway—no dramatic twists and turns, but the ride hasn't been too bumpy, and we've been getting increasingly better mileage.

Then, in 1987, IBM took a sudden detour onto a new superhighway, Route PS/2. The clone manufacturers, not used to high-speed turns, gulped and continued on down the AT Highway, led by Compaq.

IBM, looking in its rearview mirror, figured that it had finally shaken the other entries from its tail. A year later, however, Big Blue may be getting a little nervous: If hardly *anybody* follows you, maybe you've taken a wrong turn.

Meanwhile, Compaq and the rest of the compatible convoy have found that the AT Highway (which has merged with Route 386) continues to be broad and well paved, and stretches toward the horizon with no distinct end in sight.

Move on Down the Road

So, along come the rest of us, with a choice to make: Do we follow IBM down Route PS/2, or do we stay on Route AT/386 and hope that the clone makers know where they're going? Of course, the front-runners aren't making things any easier for us, what with companies like Tandy and Dell selling both AT- and PS/2-style machines.

Even IBM, disappointed with sales of the PS/2, seems ready to plant a foot firmly in each path and attempt to bridge the gap Colossus-style; by the time you read this, IBM will have announced a new AT-based PS/2. Even the title of this *IBM Special Edition* is an indicator of the current situation; for the first four years, we called our annual IBM issue *Inside the IBM PCs*. Times have changed.

At the same time, other computing avenues are opening up. Unix, long the silent player in the microcomputer world, suddenly looks like a serious contender for the operating system of the future. The Macintosh and its heirs continue to make inroads into the market for "serious" heavy-duty applications. Steve Jobs' powerful NeXT machine—with its 68030 processor, 1120- by 832-pixel resolution, and read/write optical drive—could give the Mac and PS/2 a run for their money in the workstation race. And Amiga and Atari machines are far from running on empty. All this makes the computer industry a lot more volatile—and a lot more exciting.

All the Difference

The articles in this *IBM Special Edition* reflect the dual-road nature of IBM and compatible computing. You'll find articles that deal with the PS/2 and OS/2 alongside those that discuss DOS, the AT bus, and software alternatives to OS/2. We're not taking anything for granted. Neither should you.

Robert Frost took "the road less traveled," and that made all the difference in his journey. Whether you take the PS/2 route or the AT route, you'll find yourself in plenty of traffic, so you probably can't go wrong—and at the speed we're moving these days, that's no small comfort.

—Kenneth M. Sheldon
Senior Technical Editor
(BIX name "ksheldon")

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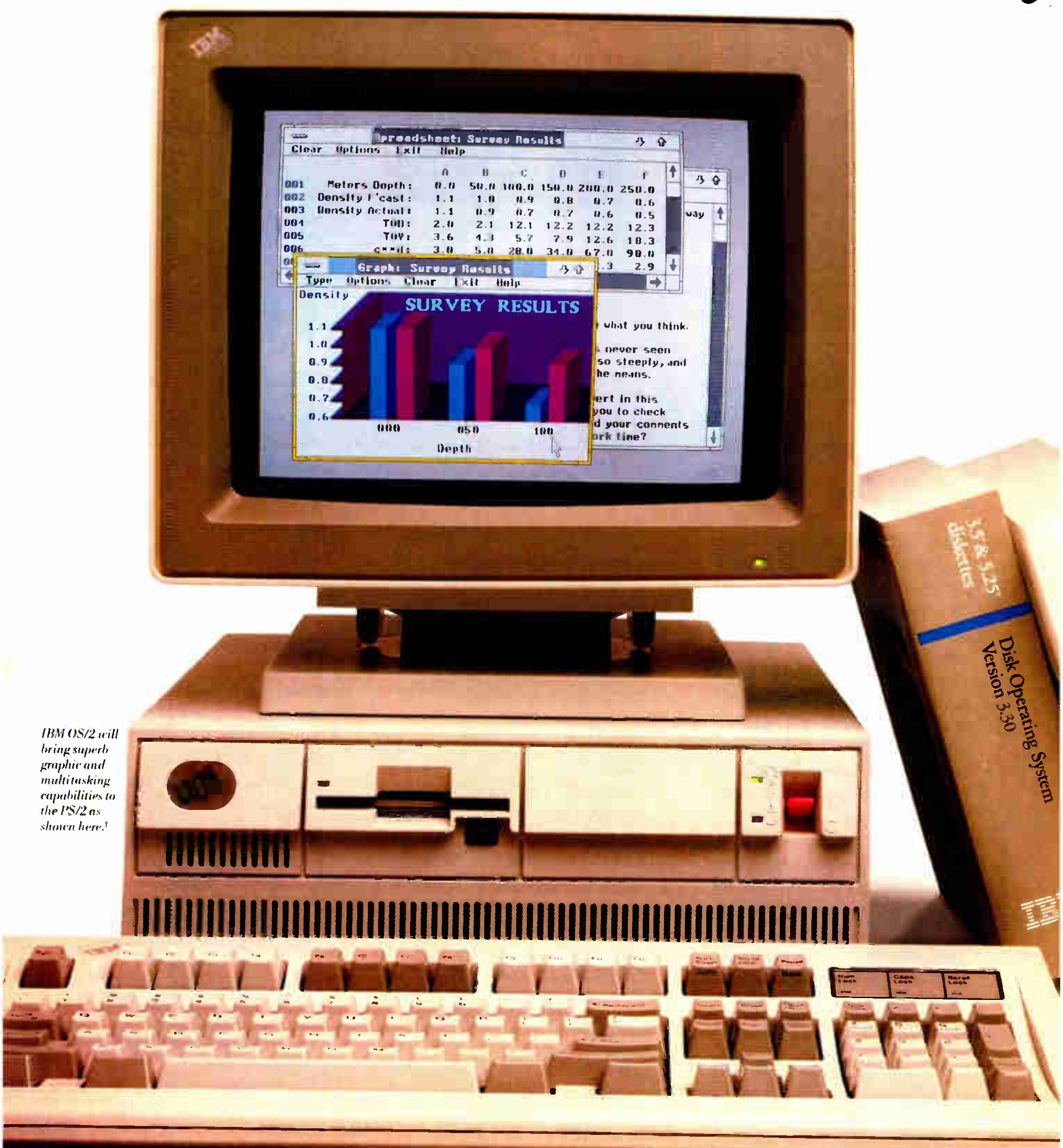

IBM OS/2 will bring superb graphic and multitasking capabilities to the PS/2 as shown here.†

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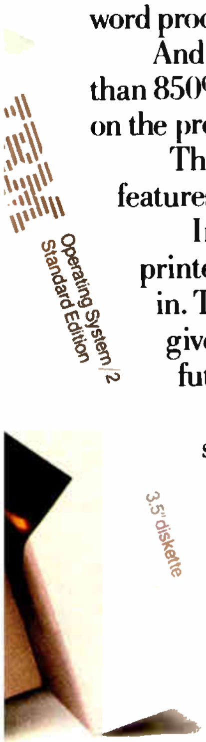

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*Based on performance test results published in the April, 1987 and January, 1988 issues of *PC Digest*, comparing the PS/2 Models 30, 50, 60 and 80 to the IBM PC XT-089, running Lotus 1-2-3 and DisplayWrite 4. Actual results may vary. †This simulated screen shown was developed using the IBM Storyboard Plus program. IBM, Personal System/2 and PS/2 are registered trademarks; PC XT, Operating System/2, OS/2, Micro Channel and DisplayWrite are trademarks of IBM Corporation. Lotus and 1-2-3 are registered trademarks of Lotus Development Corporation. © IBM 1988.

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PROBING THE STATE OF THE ART

Jerry teaches his scanner a few tricks, and he gets a new mouse and a wonderful printer

Special supplements are supposed to provide a good opportunity to talk about the state of the art. I've got only one problem: I don't know what the state of the PC art is.

The PC world is in a thorough state of flux just now. We don't even know what bus will be used in the future. IBM is very disappointed in PS/2 sales, particularly sales of machines using the new Micro Channel bus. The company makes a big thing about having shipped 2 million PS/2 systems, but "shipped" isn't sold. Many of those machines are sitting in warehouses. It's impossible to get the real sales figures, but they're a long way shy of 2 million. So it goes. Meanwhile, no other major company has done anything with the Micro Channel. We sure can't call the PS/2 the state of the art. It may be, but it may also be a dead end.

On the other hand, while no important third party has adopted the Micro Channel bus, there's no standard 32-bit bus either. Zenith went one way, Compaq another, and Intel yet another. Cheetah, a relative newcomer, has developed a motherboard and bus that many, including me, consider the best of the lot. My Cheetah 386 runs at 20 MHz, but it would run at 25 MHz and possibly at 30 MHz if I had the higher-rated chips. There are also about a dozen other advanced 80386 systems.

The point is that although I consider the 80386/80387 the real state-of-the-art chip set, we're still left with a very real problem: whose 80386 bus? No one company is going to do everything well. The microcomputer industry makes its biggest advances through small companies developing add-ons to standard systems. Until someone's bus becomes a standard, we're not going to see too many real advances in 32-bit add-on boards.

I don't want to be an alarmist. Except for the Micro Channel, all 32-bit 80386 systems use the standard IBM PC AT (16-bit) bus as a starting point. The AT bus is a subset of all the 32-bit 80386 machines, and they'll all run 16-bit add-on boards. There's no shortage of developers of 16-bit boards. Moreover, at the moment, the main use of 32-bit boards is for 32-bit memory, and the various companies that make 32-bit 80386 machines all sell memory cards to go with their systems. There's no crisis. But until we do get some standards, there won't be the incentive for small start-ups to develop innovative 32-bit hardware applications.

Operating-System Wars

We're also unsure about the operating system of the future. IBM recently revised sharply downward the sales estimates of OS/2 penetration: instead of predicting 75 percent acceptance among AT and PS/2 users, they're now expecting no more than 25 percent to 30 percent. This can affect the amount of hype and promotion IBM puts into OS/2. As a result, not even IBM knows what the operating system of the future will be.

For the moment, the contenders are OS/2, OS/3 (which works only on 80386-compatible machines), one or another brand of Unix, and good old DOS itself. Note that even if IBM goes for Unix, there will still be divisions within the microcomputer community. The Unix faction within IBM wants to promote AIX, Big Blue's own brand of Unix, rather than AT&T's. There's even a real question of whether this is serious marketing or merely a ploy to distract attention from AT&T's "real" Unix.

Assuming IBM seriously turns from OS/2 to Unix, it's still not clear what will happen. By developing their own brand of Unix, IBM will be going head to head with AT&T. AT&T has the most experience with Unix and thus presumably has a head start. AT&T has great resources, including Bell Labs and lots of money. On the other hand, IBM has terrific marketing, while AT&T's present team couldn't market eternal life.

The dark horse on our list is OS/3. Acceptance of that will depend almost entirely on the timely appearance of the 80386SX chip, formerly known as the P9; the chip (well, actually it's a little daughterboard, but you can think of it as a chip) goes in the 80286's socket and turns all those AT machines out there into 80386s. Of course, it doesn't *really* do that, since 80286 machines have only a 16-bit bus, while real 80386s can work with 32 bits; but the 80386SX will let 80286 machines execute 80386 code, meaning that an operating system designed to use the 80386's many advances over the 80286 is easier to write and more useful than one that must work with all the different steps and revisions of the 80286.

I can't draw any conclusions from all this. I can say that for me, the current state of the art is an 80386 machine using Quarterdeck's DESQview under DOS. It's what I'm running; if I decide to change, it will be from DESQview to Microsoft Windows/386. I haven't seen anything that tempts me to make any other changes.

Scanners Live in Vain

When I began using microcomputers, I'd been writing for some time and had many books in print. I've since had two of them keyed into machine-readable form, but many more exist only in printed form. My books generally stay in print, but once in a while one gets sufficiently dated that it ought to be revised before reissue. That can be a problem. I'm used to working with computers now, and I don't

continued

much like doing pen-and-ink revisions on photocopies of typeset books. Rekeying the whole book is usually impractical. By the time I can get it done, the deadline for turning in the revisions is past. What I need is a gizmo that will read a printed copy of the book itself.

That kind of scanning system is called an optical character reader, or OCR, and I recently got a state-of-the-art system.

The hardware is the Hewlett-Packard ScanJet. It looks like a small copy machine, complete with a glass scanning plate, where you put documents up to legal size. (I think larger-size machines are available.) You can also get an automatic document feeder attachment. The ScanJet comes with an 8-bit (short slot) interface card you install in your PC, and software to let the computer know how to find the device.

The ScanJet installation documents are remarkably clear and concise. Of course, there's also the standard legalese that informs you that Hewlett-Packard doesn't warrant the documents to contain ink on paper, much less useful information.

Once it's set up, you can use the ScanJet's Scanning Gallery software to capture images into disk files. For that matter, you can use the ScanJet as a rather odd sort of copier. We connected the AT to a Kyocera F-3010 laser printer emulating a Hewlett-Packard LaserJet Series II, put a picture (actually a page of the ScanJet manual) in the ScanJet, and presto! Out came quite a good copy of the manual page, complete with diagrams.

Scanning Gallery works under Microsoft Windows. You don't need Windows to make it work; a run-time Windows program comes with Scanning Gallery. The program is nifty. You can get a preview scan of your document, then show the program just what part you want to clip out and put into a file. You can also dither around with the image, making it lighter or darker. You can paste it into some other document. Scanning Gallery images can be converted into PC Paintbrush and Microsoft Paint file formats.

Of course, all you have is an *image* of your document. The computer hasn't *read* it, and it doesn't understand that this particular image contains words and ASCII characters. It's just an image.

Still, if all you want is to get images into files so you can paste them into black-and-white documents, the ScanJet and Scanning Gallery will do the job quickly and painlessly. The ScanJet works fine with PageMaker, Ventura Publisher, and, I have no doubt, other desktop publishing systems. If you're seriously into desktop publishing, you will sooner or later want a scanner, and I can heartily recommend the ScanJet.

Here, Spot

We'll probably use the ScanJet to build up a library of images I can use as "visual rewards" when I put together the final version of Mrs. Pournelle's reading instruction program; but that isn't why we wanted it. I got the ScanJet because I understood that Flagstaff Engineering had software that would let me use it as an OCR to read in my books. Indeed, the ScanJet came on loan from Flagstaff. An OCR program doesn't just bring in *images* of text; it actually *reads* the document and puts it into a file you can then transfer to your word processor.

Flagstaff's Spot is a "trainable" OCR program, which means that you can teach it to recognize the letters in different type fonts. As Spot learns, it builds a

continued

font file for that particular type font; once that file is built, you can load it in at any time. Since it takes anywhere from a few minutes to several hours to train Spot to recognize a font, you should be careful to make *frequent* backups of the font file while the educational work is in progress; I managed to crash the system (my fault entirely) and lose an hour of work during my tests.

To use Spot, you must have some kind of scanner. Flagstaff's documents list the Canon IX-12 (with or without the Tall Tree Systems JRAM/JLaser board), the ScanJet, Panasonic FX-RS505 and FX-RS506, and Microtek MSF-300C and MSF-300G scanners as being acceptable. The PC you use must have either CGA (or EGA in CGA emulation) or Hercules-compatible monochrome graphics. Our generic AT clone has a genuine Hercules card running an Imtec 12-inch amber-screen monochrome monitor and works fine. You'll need at least 512K bytes of main memory. If your machine has a megabyte or more of Lotus/Intel/Microsoft Expanded Memory Specification 4.0 memory, Spot will know how to make use of it and can do some fancier tricks, but you don't need any expanded memory.

You'll also need a hard disk drive. Spot will run on a floppy disk drive-only system, but Flagstaff warns against doing that, since everything will be terribly slow.

Spot is quite easy to install, provided that you ignore the silly directions given in the manual. For reasons not clear to me, Flagstaff has built a complex Setup batch file to do a very simple job. In theory, Setup will copy the Spot disk files from disk A to your hard disk. In practice, it won't do it that easily; you're much better off creating a subdirectory and using DOS's COPY command to move the files. Then you can run Setup directly off the hard disk.

Spot comes with about a dozen font files. It's menu-driven, and while the manual sucks rocks, it really isn't hard to figure out how to do what you want. As a test, we loaded in the Letter Gothic 12-pitch Selectric font and put a test page written in that into the ScanJet.

The ScanJet lights came on (Spot controls the whole process), the AT clone thought to itself, and quickly there appeared, line by line, long lines of utter garbage. I stood there ruefully shaking my head. Mrs. Pournelle was more practical. She looked at how I'd put the paper into the ScanJet and turned it over. When we tried again, Spot read every letter.

The test page is laid out in multiple columns. There are ways to tell Spot how to store those columns in sequence so that the text file you're building reads continuously. Once we'd read the text image, I stored it all as an ASCII file, exited Spot, and read the file into a text editor. Voilà! Everything worked fine.

I changed test sheets and fonts, and fired it up again. Same result, perfect score again. On the third test sheet, Spot missed one letter, replacing it with the wrong character. When we looked at the original, we couldn't see anything different about the letter it missed—an *a*—but what the heck, missing one letter in three pages is plenty good enough. I was beginning to get excited.

Teaching Spot Tricks

It was clear that Spot could read just about any typescript ever devised. The acid test would be whether I could teach it to read my printed books. Could it read kerned text? (Kerning is the typesetting technique of squeezing letters together so that their spacing overlaps, for example, *WA*.)

I got out *Exiles to Glory*, a science fiction adventure novel published by Ace Books in 1978. The book is theoretically still in print, but it's about time for a reissue. The book has stood up well, but if I had a machine-readable copy, I'd probably make a few revisions.

The first problem was how to lay the book into the scanner. Should I make a photocopy first, so that I'd have one page on each sheet, or should I open the book and lay it flat? The Spot manual said that I could tell the program to treat the two pages as columns, so I decided to use the book laid flat.

The next problem was headers. The book has running heads—my name on the left side, and *Exiles to Glory* on the right—and they're not in the same typeface as the rest of the text. I solved that problem by putting a narrow strip of tape across the top of the scanner's glass. That way, I could square off the top of the book to the top of the scanner window, but the scanner wouldn't be able to see that header at all.

It's easy to invoke Spot's teaching function. I did that and told it to save what it learned in a font file named Exile, laid the book on the scanner screen, and told Spot to have at it. The scan light came on. Spot reads the entire page image at one gulp; once the scan light goes off, you can remove the text from the scanner. Then the computer thinks for a while and shows you what it has seen.

The first thing it had seen were some tiny spots, clearly garbage. Once we were past those, Spot put up a magnified graphic image of the first line of text, with the first letter surrounded by a little box. I typed in what the letter was—as it happens, a *T*—and Spot went on to the next letter, and the next. Feeding Spot while it's learning a new alphabet can be tedious, but it's also exciting. Spot shows each new character (uppercase and lowercase letters, numerals, and punctuation marks) that it has learned in a little table at the bottom of the page, so you can tell which ones you still have to show it.

At first all Spot saw was single letters, but then it began to show two-letter combinations. It does that by expanding the little on-screen box; what Spot is saying is that it can't see any gaps between these letters, so it thinks this is just a single character. I typed in the two letters (*fi*, as I recall) and told Spot to continue.

After a while, Spot had learned most of the letters and a number of two-letter and even three-letter combinations. At this point, I set the Spot "guessing level" so that the program would skip over all the letters it was confident it knew and show only those it was uncertain about. Now the work went even faster.

I saved my work and scanned another page—and disaster struck.

Spot doesn't understand about lines. Spot's little box showing me what the program was looking at enclosed the lower chunk of a letter on one line and the upper half of another letter on the line below. This sure wasn't anything I wanted Spot to learn, so I told it to skip it. No good. It was obsessed with the notion that the "center of gravity" of my text was between the lines.

I decided maybe the book wasn't prop-

continued

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erly squared up in the reader, adjusted it, and scanned it again. This time, I didn't get that odd result until further down on the page, but it still happened.

There was another problem. In 1979, Ace didn't print on what you'd call high-quality paper. Sometimes the ink would run so that two letters not usually kerned would be ever so slightly run together. For example, the right-hand serif of the *a* in the combination *as* might barely touch the left serif of the *s*. Spot asks about this special case (as indeed it should and must), and then you have a dilemma.

Spot can learn only 250 characters. That's a lot, but it may not be enough. Consider that in all fonts there will be 52 uppercase and lowercase letters; 10 numerals; a dozen symbols, such as $, %, ^, &, and *; and another dozen punctuation marks. This uses up well over a hundred of your symbols before you can teach the program a single combination pair. There are another 75 or so common kerning pairs that have to be learned, so now we're up to 200, leaving no more than 50 we can waste on stuff like the *as* in my example above. How many ink-run cases could I afford to teach the program? I just had to guess which ones would be common.

I also kept getting the "multiple line" phenomenon I described above. Whenever it happened, it could be fixed only by moving the book around on the scanning plate and rescanning that page. Finally, we figured out what was happening: because the book was laid flat on the screen, the lines on each page weren't precisely in adjustment to each other. Get everything really square, and the problem goes away. Another remedy would be to define each page as a separate zone; I didn't do that, but it probably would have worked.

Eventually, I taught Spot the entire font that *Exiles to Glory* was printed in, plus all the kerning pairs and triplets I could find. Now we were ready to read in the book.

Alas, that was a disaster. Spot didn't recognize half the letters on the page. There would be a fair number of correct words and letters, then something like a group of squiggles, where each squiggle stood for from one to several letters. Recentering the page and scanning it again improved matters slightly, but the percentage recognized was still far too low. Spot lets you correct the page before you save it, but in the time it would take to make all those corrections, a good typist could have copied the whole page in the first place.

Well, all right, I thought. *Exiles to Glory* wasn't printed on very good paper. I'll take *Birth of Fire*, recently reprinted by Baen Books, and try that.

Alas, that produced just about the same result.

Finally, I took out a quality art book printed on slick paper and taught Spot that font. This time, things worked pretty well. There weren't many ink-run characters for the program to learn. After Spot had learned the font, we began to scan the book, and it got well over 90 percent correct; if that had been a book I wanted my computer to read, I'd have been able to use Spot to do it.

Actually, I wouldn't have used Spot on the art book, because the big art book had lots of graphics. Spot has a system for dealing with this. You can define zones in the scanned image: some areas will be text and should be scanned with

continued

the OCR function, while other areas are graphics and ought to be either ignored or simply read in as image files. This works, too, but it's pretty tedious to use on a big book that has a different layout for every page.

I'm willing to believe that Spot is the state of the art regarding character scanning of printed text; I've seen nothing better, and I've been looking. However, before I use Spot to read in old paperbacks, I sure wish they'd make some improvements.

The most obvious would be to greatly increase the number of characters you can teach the program. This would let you deal with many more ink-run pairs. It would also slow the program down, of course. Maybe what's needed is an optional increase.

More critical, though, is the need to teach the program some elementary rules about *size*. You should be able to define the period as the minimum-size object the program should pay attention to. Anything smaller just gets ignored. That alone would greatly cut down on the time required to teach Spot a new font. Even more important, though, would be rules about the *maximum* size a letter can have *in each dimension*. No single letter will ever be taller than the distance between two lines. Spot should know this, so that if it ever tries to look at something longer, it will understand that it's looking at two lines.

Third, Spot does know what a line is, but it doesn't automatically look to see whether lines are properly in adjustment. You can do that by defining zones, but I don't think it would be hard to make Spot do that automatically. Then it wouldn't get confused enough to try to take the top part of one line and combine it with the bottom part of the one above it.

Despite all my criticisms, I'm quite impressed with Flagstaff Engineering's Spot. The program won't read my cheap paperback books very well, but it does read them; and they're already working on improvements. I suspect that by the time you read this, I'll have been able to read those old books. Meanwhile, it's near perfect on typescript, and it does fine on most business and financial documents, like the Xerox Annual Report we aimed it at. Given that you understand its limits, I can recommend the program. If you need something like this, you need it bad.

LANtastic

Artisoft offers the state of the art in low-cost PC networks. Other networks are faster and have more features, but none has more bang for the buck. For about $200 a station, you get full networking features and 2-megabit transmission rates over a four-wire cable system. This little wonder is called LANtastic, and despite the terminally cute name, I really like it.

Installing LANtastic is either complicated or a snap, depending on what kind of machine you have. For generic PCs, XTs, and ATs (real or clones), you simply drop in the card, connect the cable, and follow the installation instructions in a remarkably well done manual. Setting up the network with all the options you want can be confusing—and sometimes tedious—but it isn't difficult. Just follow instructions.

As soon as you get away from generic machines or add features to one, installing LANtastic gets tougher. No tougher than installing anything else—we had at least as much difficulty with the CompuPro ARCNET PC system—but tough enough to be discouraging.

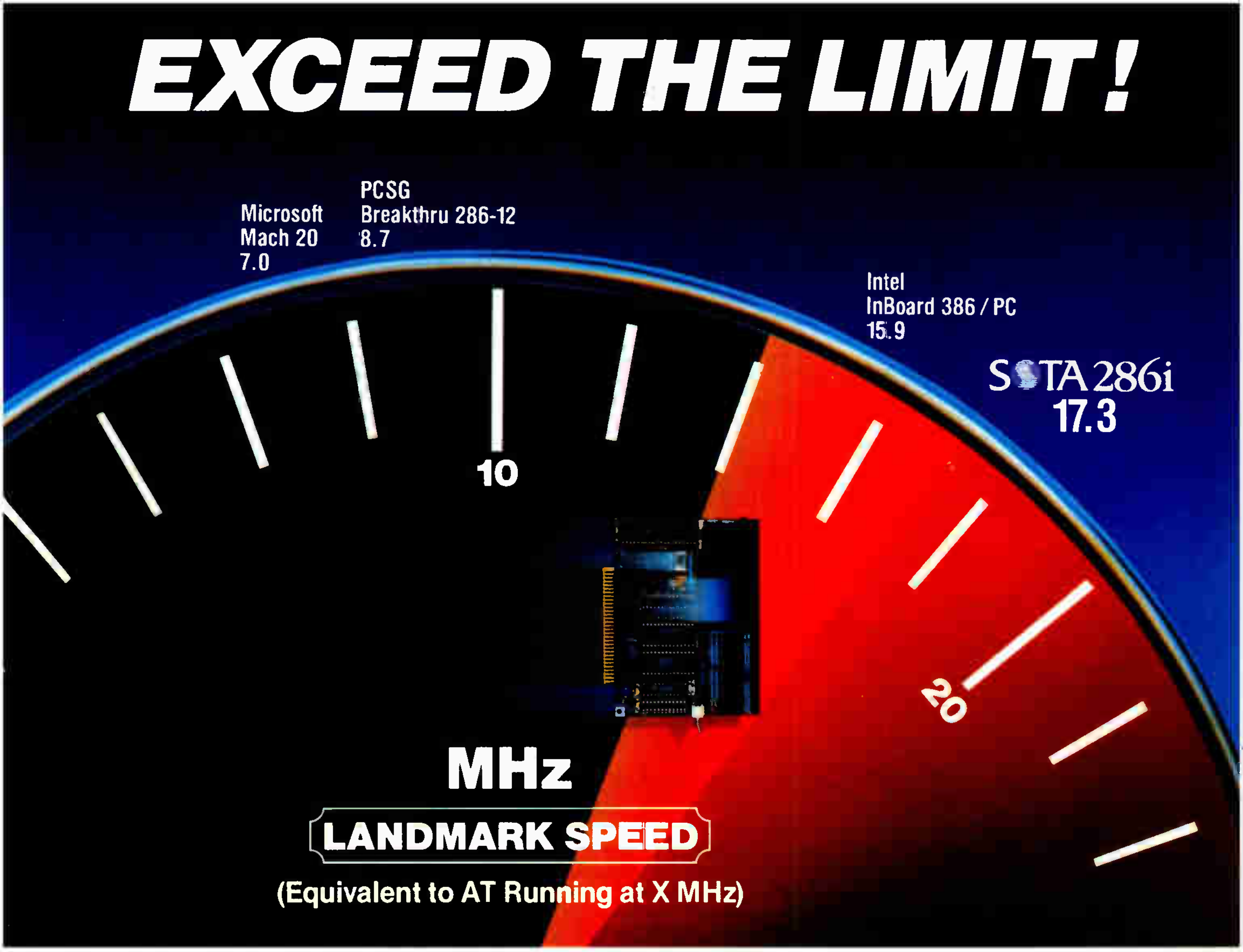
The reason for this is clear enough. Any communications network needs ports to talk through and some means for getting the computer's attention. LANtastic doesn't, but some networks want more, including a direct-memory-access channel.

There are, alas, a limited number of available interrupt requests (IRQs) on your PC. Your XT's hard disk drive needs one. Serial ports need another. Other add-on cards use interrupts. To make it even worse, some brands of AT clones use different IRQs for different purposes.

If that wasn't enough, networks will also need a block of memory. LANtastic doesn't actually need memory, since each LANtastic network card has 32K bytes of memory (and a Z80 processor) on-board; but it does need a place to address that memory. Like the IRQ, you change the LANtastic's memory address by moving little jumpers on the card, and it's explained quite adequately in the manuals. The LANtastic card offers you eight choices of address, all of them in the area above 640K bytes and below 1 megabyte. These areas were reserved in the original IBM PC design for just this sort of purpose. Alas, many of those areas are also in use by other processes.

We have a lot of different computers here at Chaos Manor. Every blankety-blank one of those machines seems to require a different IRQ and memory-address setting on its LANtastic card. For example, the Zenith Z-386 (running at 16 MHz) worked fine with the default

continued



Supports the IBM PS/2 Model 30, PC, XT—Compaq DeskPro, Portable—AT&T 6300—Tandy 1200—Zenith PC's and most 8088 or 8086 machines operating at clock speeds up to 10 MHz.

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Most Compatible

In fact, speed is just the beginning. The SOTA 286i is the only turbo board to earn the title ***Universal Accelerator.*** The same board that works in the IBM PC will also work in the Compaq DeskPro, AT&T 6300, PS/2 Model 30 and the list goes on. Not only that, the SOTA 286i is compatible with every add-on board in your system. Networks, video adapters, 3270 emulation boards all function flawlessly. And, the SOTA 286i fully supports the new EMS 4.0 memory standard. No other manufacturer offers this level of compatibility. No one!

OS/2 Upgradeable

Included on the SOTA 286i is a 16-bit expansion connector for attaching such options as the Memory/16i. With its on-board RAM configurable as either EMS 4.0 or extended memory the Memory/16i is ideally suited for those new memory intensive programs. You can even run *AT* specific programs such as ***IBM OS/2*** and Professional ORACLE. A second feature connector is provided for the Floppy I/O Plus. This multimedia disk controller supports both 3½" and 5¼" disk drives. It also contains both a parallel and serial port. A complete solution to your computing needs.

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SOTA Technology has been acclaimed as a pioneer in the field of OS/2 compatibility. SOTA's first accelerator, the MotherCard 5.0, was the first and up until now—only product to run IBM OS/2 on a PC. It was nominated for product of the year 1987 in the field of technical excellence. The SOTA 286i is the next generation of accelerators from SOTA Technology. So why buy a product from our competitors that offers half a solution, when you can buy the **fastest,** most **compatible,** most **expandable** accelerator available. ***The complete solution–the SOTA 286i!*** Suggested retail: 12.5 MHz—$595.

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SOTA 286i benchmark was run on IBM PS/2 Model 30.

Circle 214 on Reader Service Card

Items Discussed

HiREZ Mouse $149
Logitech
6505 Kaiser Dr.
Fremont, CA 94555
(415) 795-8500
Inquiry 435.

Kyocera F-3010 .... $8395
Kyocera Unison, Inc.
3165 Adeline St.
Berkeley, CA 94703
(415) 848-6680
Inquiry 436.

LANtastic $399
Artisoft, Inc.
3550 North First Ave., Suite 330
Tucson, AZ 85719
(602) 293-6363
Inquiry 437.

ScanJet............................. $1495
Hewlett-Packard
3000 Hanover St.
Palo Alto, CA 94304
(415) 857-1501
Inquiry 438.

Spot...................................$995
Flagstaff Engineering
1120 Kaibab Lane
Flagstaff, AZ 86001
(602) 779-3341
Inquiry 439.

settings of the LANtastic board. The Tandon AT needs quite different settings of both IRQ and memory address. The Cheetah 386 (20 MHz) needs yet another combination. They all work fine once you get the boards set right. The only way to get the right settings, alas, is trial and error.

The Kaypro 386 with its 512K-byte Intel motherboard needs something else again, and indeed I ran out of time before I found a combination that would work right with the Kaypro; it looks like we can't use Quarterdeck's Expanded Memory Manager and LANtastic at the same time, because QEMM fills that area from 640K bytes to 1 megabyte with 32-bit extended memory. I've got the Artisoft people talking to Quarterdeck about this. Note that the network does work with the Kaypro 386; it's just that when you set up the Kaypro to run the network, the Kaypro has only 512K bytes of memory available. Let me repeat that this is a problem peculiar to the *old* Kaypro 386 with the Intel 512K-byte motherboard. They don't make that machine any longer.

Remote WORM and CD-ROM

LANtastic does all the things you expect a network to do. Technically, it's a peer network: you can't do anything to my machine without my permission. Each machine can define which users will be allowed to log on to it and which of its resources it will make available to the other network stations.

The good news is that those resources can include *anything*. Printers, modems, and disk drives, of course; but much more than that.

You can also access WORM (write once, read many) and CD-ROM drives through the network. To the best of my knowledge, LANtastic is the only local-area network that lets you do remote access to a CD-ROM drive.

Better yet, you don't have to install DOS extensions and device drivers on any machines except those that physically have the CD-ROM readers. You can also access multiple CD-ROM systems. For example, we've set up one CD-ROM device on the Z-386 and another on the Cheetah. LANtastic gives each machine access to the other's CD-ROM, while two more machines have access to both. We can be doing word processing—or even communications—on the Cheetah while simultaneously reading data off the Cheetah's CD-ROM onto a generic AT located 50 feet away.

The notion is that I'll set up a generic AT clone as a service machine. It will have modems, a connection to the Kyocera F-3010, a WORM drive, and several CD-ROM readers. All those resources will be available to all the other machines on the network, and the other machines won't even need to have CD-ROM and WORM device drivers installed. I haven't actually done this yet, but I've experimented enough with LANtastic to know it's possible. This is sufficiently intriguing that I would be tempted to do it even if I had only two machines.

Fair warning: remotely accessing CD-ROM drives is slower than accessing them directly. Of course, "slow" is a relative term. If you're using generic XTs running at a Norton System Index of 2 or 3, it won't slow things a bit. It's only when you get to really fast machines like my Z-386 that you notice CD-ROM access takes longer than you expect.

The disadvantages of LANtastic are endemic with any network. As an example, it's a bit disconcerting to be told that I can't do CHKDSK on any machine set up as a network server. On the other hand, I don't have to set up my one machine as a *server* at all. If I tell the network that my machine is a *workstation*, I can do anything I ever did; it's only servers that have restrictions on their devices. Workstations can access anything on the network; it's just that their own resources aren't remotely available. Thus, my Cheetah as a workstation can get at the remote CD-ROM and WORM drives, but no one can use my Cheetah. If at another time I want to give remote access to the Cheetah, that takes one DOS command. (To go back from server to workstation requires rebooting, though.)

LANtastic really lives up to its name. Highly recommended.

HiREZ Mouse

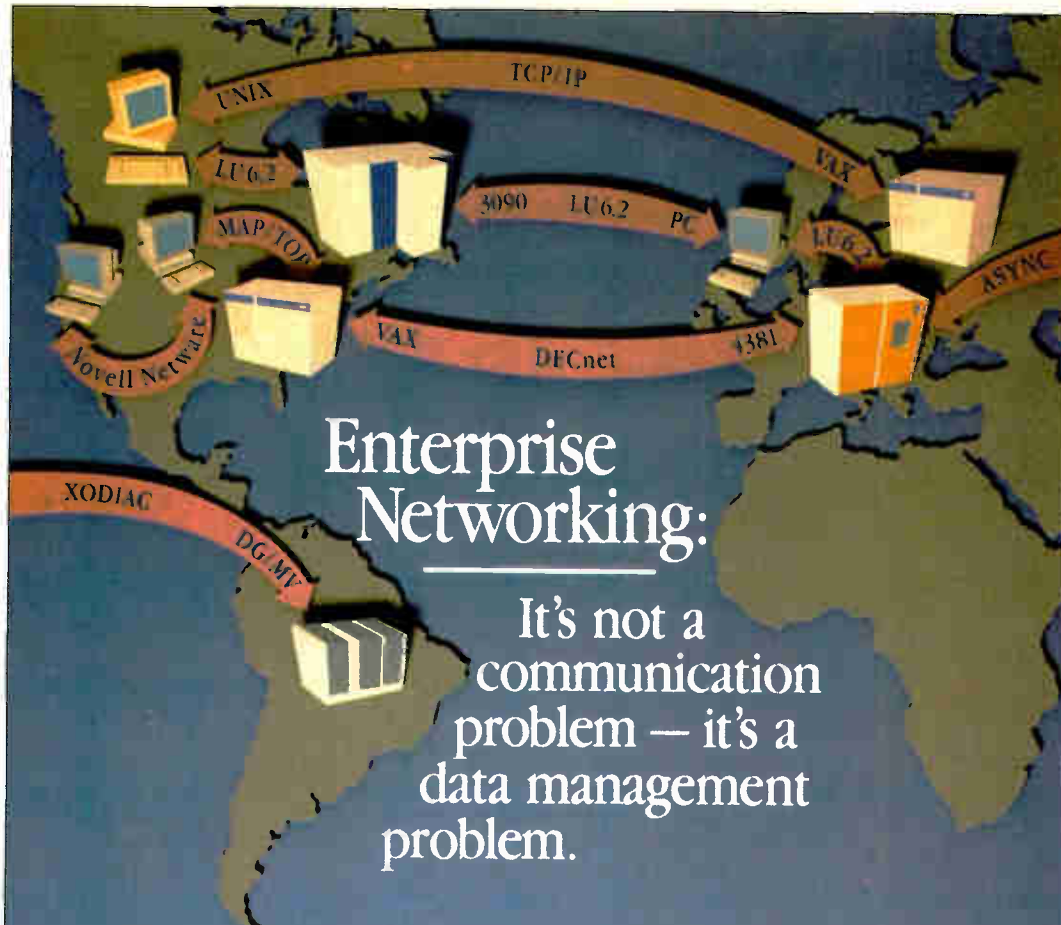
I don't suppose anyone will ever settle the mouse wars: which is best, two buttons or three? Maybe only one?

The two big players in the PC mouse game are Microsoft, with two buttons, and Logitech, with three. The mice are both very good, both widely supported, and each can emulate the other (push both Microsoft buttons at the same time and you get the equivalent of a third button), so at bottom it's just a matter of taking a view.

I've always preferred the Logitech mouse, but I'll be the first to admit it's as much due to background and history as anything else. My first mouse-driven machine was the Lilith, which came out well before Apple's Lisa, much less the Macintosh. The Lilith used an operating system devised by Niklaus Wirth of ETH (the Swiss equivalent of MIT), and it employed a three-button mouse. Indeed, Logitech got its start marketing that mouse both overseas and in the U.S. I've been using Logitech three-button mice ever since.

One reason I'm not tempted to change is the support software Logitech provides with its mouse. Point has always been my favorite editor for quick changes in AUTOEXEC.BAT and CONFIG.SYS

continued



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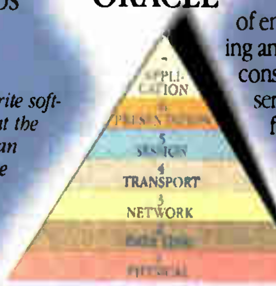

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BYTE

files, breaking big ASCII files up into smaller ones, and even as a substitute for the DOS TYPE command. Point is fast, intuitive to use, and configurable. The newest version of Point can, in an emergency, even be used without a mouse, although I sure wouldn't want to do that very often; but since one of the first things I always do when I set up a new machine is install a mouse on it, that doesn't present a problem.

Logitech also provides support with its Logimenu and Click packages. These are memory-resident programs that can glue in mouse support, complete with pull-down menus, for any application that doesn't have it. As an example, I used the Logitech software to add mouse support to Borland's new Sprint editor, as well as to my old standby, Q&A Write. My mouse implementations aren't very clever because I haven't had much time to develop them; but you can set up your mouse to do almost anything.

Logitech's latest mouse is the HiREZ. This is a bus mouse only, meaning that it takes up a slot but doesn't use up a port. The advantage is that it can be used on a tiny desk since it works at 320 dots per inch (compared to 200 dpi for the usual mouse). The result is that you can control operations on high resolution (EGA and VGA displays) much more easily. We installed the HiREZ on the Z-386, and it really is easier to use—more precision with less motion—than the mouse it replaced.

My only complaint about the HiREZ is that they haven't (so far as I know) combined the HiREZ mouse with an EGA or VGA video board; the Logitech EGA&Mouse board works fine (we have one in the Zenith Z-248 80286 system), but that supports only the standard 200-dpi Logitech mouse. I make no doubt they'll have a VGA/HiREZ board soon.

Logitech is one of those companies that's always going right out to the edge of the state of the art. I have yet to see a Logitech product that I don't like.

Kyocera F-3010 Compact Laser Printer

Let me confess straight off that I've got no business with a printer as good as this one. Having said that, let me add that they'll get it back over my bruised and broken body. This printer is *wonderful.* If there's a better 300-dpi printer available, I don't know about it.

The Kyocera F-3010 is built around the Kyocera engine; a similar but slower engine is used in a Mannesmann Tally printer. The F-3010 has all the features of that engine, including two output bins (face-down and curled, and face-up and flat), two input bins (put letterhead in one and plain paper in the other), plus a manual feed capability. Unlike the Mannesmann Tally printer, the F-3010 does *not* have cartridge slots. That's because it doesn't need them. Instead, it has two IC card slots. The cards can control the F-3010's programming language. There are three resident fonts, and the printer also has enough memory to hold 48 downloadable fonts.

There's more. The Prescribe printer-control language is built in. Prescribe lets you do almost anything you'd like, including draw complicated pictures. You can do about anything in the programming language that you can do from the keyboard. Prescribe commands are fed to the F-3010 as ASCII strings; you can do that from BASIC or simply send them out the printer port from your console.

Prescribe can also be used as a built-in font editor, with a font-generation capability. You can change the point size or rotate the resident fonts. If you don't like the fonts you have, you can play games with them.

I confess I'm still learning about this printer. It isn't that the machine is hard to use. It just has so many features that I haven't learned them all.

The control panel is extraordinarily complete. Instead of little message numbers, the F-3010 has a liquid crystal display that tells you things. It will, for instance, tell you which printer it is emulating: there's a wide choice, including Hewlett-Packard's LaserJet Series II, the IBM PC Graphics Printer, the Epson FX-80, and even the old standby, the Diablo 630. You can switch emulations in software or from the control panel. You can also use the control panel to make the F-3010 print out a list, with samples, of all the fonts it's currently aware of. That's three resident fonts when you first turn it on; you can add more by downloading them off disks.

The optional font disk that came with the F-3010 was Microsoft's Z font package. These fonts are the same as those in the cartridge that permanently resides on my Hewlett-Packard LaserJet Plus, so it seemed a good thing to use for a test of the F-3010.

I connected the F-3010 to the serial output port of the Printer Optimizer; this is where the LaserJet Plus is usually connected. The F-3010 has both serial and parallel input ports; the parallel port is of the Centronics variety.

Downloading the Z fonts took about 2 minutes. Once that was done, I went into

continued

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Q&A Write and told it to print on a LaserJet Series II, and I fed my last column to the F-3010.

It printed blazingly fast, 18 pages a minute (as advertised), but the top and bottom margins were wrong. I couldn't figure this out. That file had printed perfectly on the LaserJet Plus. After stewing for a while, I went back in and told Q&A Write that it was going to print on a LaserJet Plus, not a II, and tried again. Voilà! Then I tried another word processing program instructed to print to a LaserJet Series II, and that worked. It turns out that I was using an older version of Q&A Write that didn't properly know about interfacing with a LaserJet Series II.

The F-3010 is a heavy-duty printer, designed to be used a lot more than I ever will need it. I'm still learning about it, but by me it's state of the art for a 300-dpi printer. If you need that kind of capability, you ought to look at this one. I'll definitely have more to say about it in future columns.

Winding Down

I'm about out of space, and there's still a lot to cover. I guess the bottom line is that the state of the art in PCs changes rapidly; what used to be the outer edge of the envelope becomes the "standard" for serious users, and the old "standard" systems drop behind or die.

For me, "serious user" state of the art is an 80386 at 16 MHz or more; at least 4 megabytes of 32-bit memory; at least 80 megabytes of hard disk space, but better would be Priam's 330-megabyte hard disk drive; a good WORM drive for backup; and a 9600-bit-per-second modem (we routinely run at 2400 bps over Tymnet).

EGA remains the business graphics standard, but VGA is catching up fast. The Zenith Flat Technology Monitor (which runs nicely off a good VGA card like Video Seven's VEGA) is far and away the most impressive standard-size monitor available. Keyboards have improved greatly; both Northgate (which puts the function keys on the left side, as they were on the older PCs) and DataDesk make wonderful add-on keyboards that are in general much better than the ones you get with your machine, and they don't even cost much.

CD-ROM systems are coming along also. Microsoft has a number of new CD-ROM products coming out, including a Programmer's Library that puts everything you ever needed to know about C, Windows, and OS/2 onto one CD-ROM disk. This year, we'll see CD-ROM drives that run off small-computer-system-interface ports; since Priam already makes a SCSI 330-megabyte hard disk drive, and it will be no great trick to make a WORM drive interface through SCSI, by this time next year that will be state of the art as well.

I love the way they keep expanding the envelope. It's like I have all those bright people working to keep me happy. ■

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

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Source: Power Meter MIPS Version 1.3. The Database Group, Inc.

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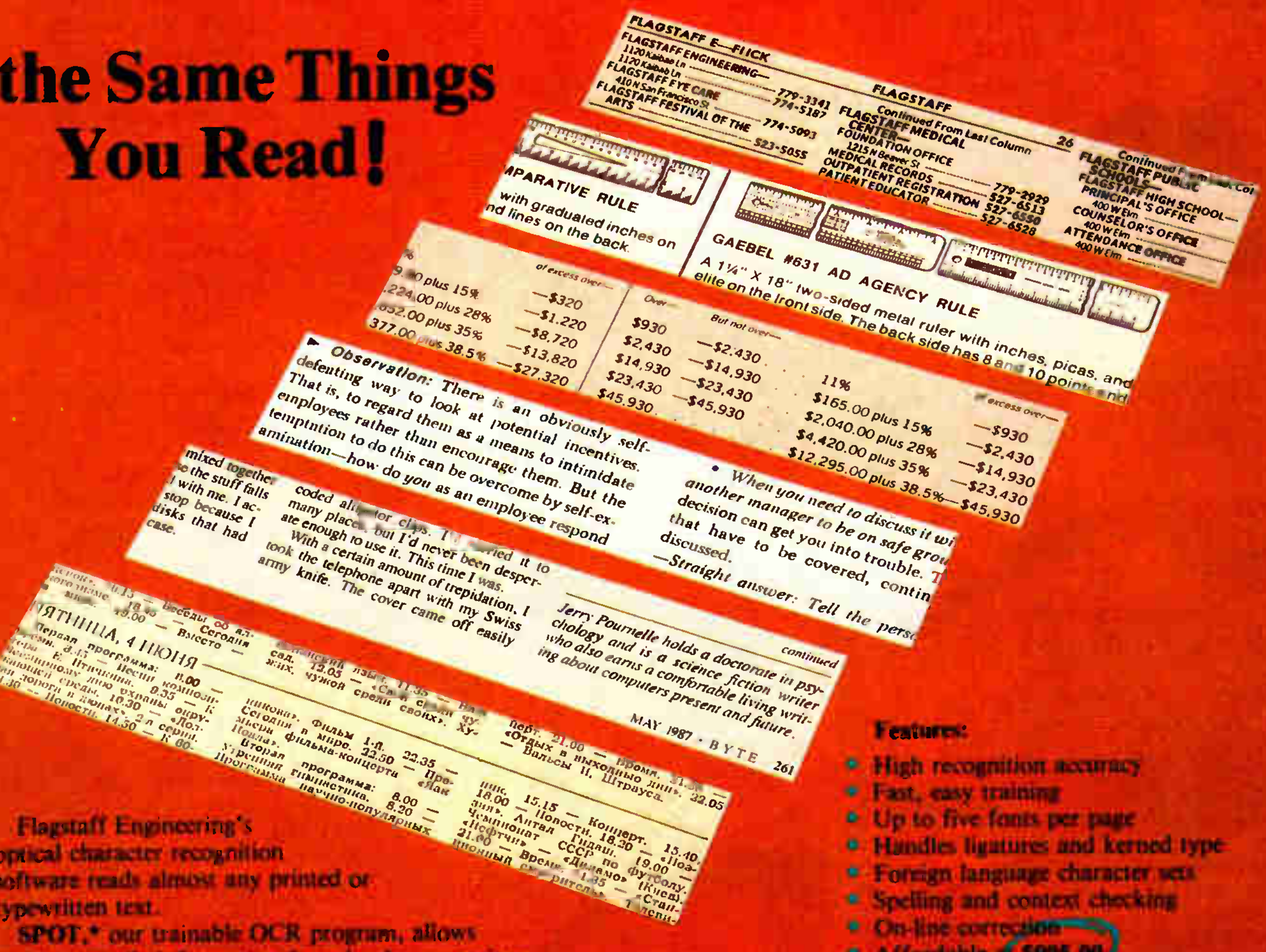

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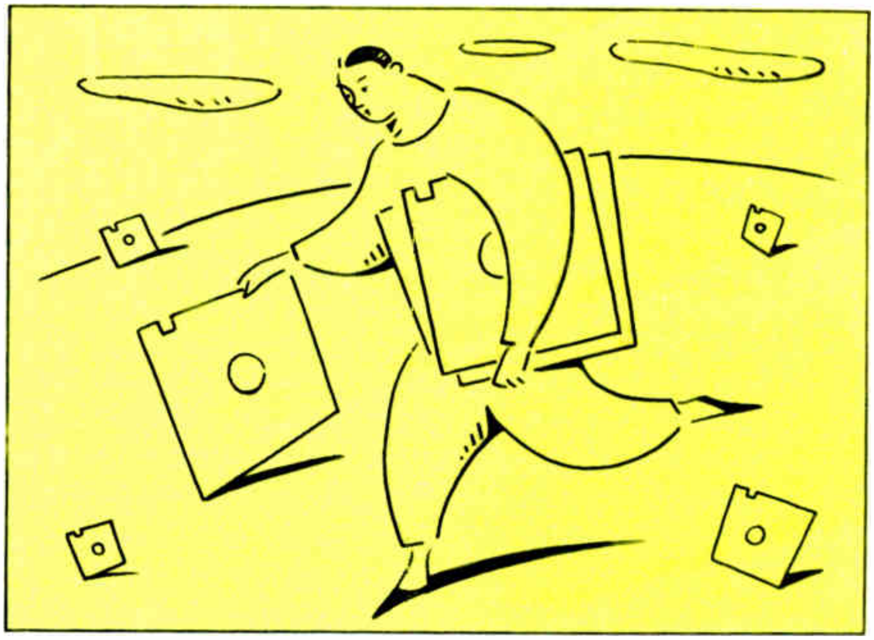
MAPPING THE SOFTWARE WORLD

In a world of great software, what you need is what you use



When I recently lost the contents of my hard disk during a long-distance move, I reacted with an emotion that surprised me. Rather than feeling panic and despair, I felt euphoria and freedom. All the stuff I'd been keeping on the disk but never using was gone! I could start over with a clean slate.

I knew I'd have to salvage my documents, utility programs, and a couple of essential applications from the backup floppies, but I'd been forced to do some long-overdue housecleaning. I imagine my delight in this situation is similar to what people feel when an airline reimburses them for lost luggage: You miss the old clothing, but hey—it's time to go shopping for a new wardrobe.

I'm slowly filling the hard disk with new software. Old friends—programs I've used for years—are being left quietly on the shelf. I'm going for new programs, new habits, and new ways of doing things. I'm not willing to admit that I was stuck in a rut, but running my Tandon IBM PC AT clone is suddenly more invigorating than it was before the disk got trashed. I realize that this is going to be a long undertaking, and it's nowhere near complete.

One side benefit of this has been a thorough reexamination of applications software from the point of view of a user, rather than from that of a columnist. When you write about software for a living, you begin to classify those programs you don't despise into three categories: programs you use, programs you like, and programs you'd recommend.

Though the boundaries between these groups are often blurry and there's quite a bit of overlap, the distinctions are real. When your bookshelves are filled with every package imaginable (and some that are beyond imagining), you must develop some sort of mental algorithm for assessing programs outside the traditional constraints of cost and availability, which are not germane because you get the stuff free, whether you want it or not.

What I use is dictated mostly by habit and convenience rather than by any intelligent scheme of analysis. As an example, I use WordStar because I've used it for a long time and its commands are second nature to me, not because it's the best word processor, or even the best word processor for my needs. Right now, I'm trying to tailor my personal software choices more closely to what I do. When I'm done, I'll be much more efficient and (I hope) happier.

How does this differ from what I like? Well, there are tons of programs I like that I don't use. I mean, there are quite a few good database managers on the market, but I don't need to use five at a time. I'm bound by the same limitations as anybody else; I don't have room in my head for more than a few programs' command sets. And some programs that I love, I just don't use on a day-to-day basis, like VP-Expert from Paperback Software; my work doesn't really require that I develop expert systems.

What's right for a novice user in a business environment is not necessarily right for a sophisticated software hacker who's writing a technical encyclopedia. I usually recommend programs that I use and like, but I recognize that there is no universal collection of programs that can be deemed "the best." The MS-DOS universe is such a smorgasbord of top-quality products that even people in the same line of work can choose different packages based on personal whim with no worry of losing functionality.

I'm developing a new map of the software world. I thought I'd pass on what

continued

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I'm discovering about the geography. Bear in mind that I'm only one explorer; I haven't visited every city and town on every continent.

Integrated Software

The rule for integrated software used to be that you couldn't compare it to stand-alone products. Integrated packages always seemed to lack critical features. That's not true today. The state of the art has advanced to the point where you can do quite well with most of the combination products on the market.

I'd recommend integrated software to almost anyone now, with this caveat: Be prepared to buy a stand-alone product for your primary application area and use the integrated package for everything else. You may not have to do this, but it's more likely that you'll need the truly obscure features in your area of concentration. If your primary application lies outside the big four (i.e., word processing, spreadsheet, database, and telecommunications), don't worry about missing out on power features; you'll get enough of them to keep you humming along.

One of the first things I put on my clean hard disk was Microsoft Works, in place of Framework II. I'm developing an increasing affection for the product, largely due to my fondness for Works on the Macintosh. Like its Mac cousin, Works on the PC can handle 80 percent to 90 percent of what any mortal needs to do on a computer. The program is intelligently if simply designed. It's not the fastest around, but it's no slug. The word processor module is nearly as powerful as Microsoft Word's, but it's friendlier and easier to master. Good spelling checking. The spreadsheet and database sections are adequate for all but the heaviest use.

I have not reinstalled Framework II because I'm awaiting delivery of Framework III (any day now). I have always liked Framework II, but I found myself avoiding it as time went on, largely because I found myself forgetting how to do things. And its built-in programming language, FRED, is incredibly tough. But this is one slick product, and I hear Framework III has considerably improved database and spreadsheet modules. I'll see how I feel about this program after I get the new version.

So I'm using Works, I like Framework II, but do I recommend them? Nope; I'm more prone to tell people to check out the Smart Series from Informix Software. The individual application modules can run just fine as stand-alone programs, and the integrating shell is better for quickly developing multifunctional applications for users than anything else out there. Also, the development/macro language is as readable as BASIC, and the Smart Series will follow your actions and generate code automatically. This was one of the first microcomputer packages to be rewritten for network use, and it's rock solid.

Word Processing

There are so many fine programs, it's tough to choose. I've substituted Professional Write 2.0 from Software Publishing, the descendant of PFS:Write, for my old standby WordStar. It's speedy, reliable, and absolutely effortless to use. You won't need a manual for this one, unless you plan to do something extremely arcane, but it doesn't skimp on features. My favorite aspect of the program is its ability to read and write files in most major formats. Conversion is painless and invisible. I also recommend

continued

this one to anyone with midrange word processing requirements.

I'm also installing a copy of XyWrite III Plus, which I regard as the killer program in the category. It's difficult, ornery, and an ordeal to learn, but once you feel comfortable with it, you can do anything. It's nicely programmable, and the fastest word processor I've seen in a while. Don't give this to your fumble-fingered friend, though; it should have a warning label. I like this program, I use it, but I don't recommend it to anyone who isn't willing to be devoted to it.

Desktop Publishing

I use PageMaker because I can also use the identical program on the Macintosh, but here I give the nod to Ventura Publisher by a tiny margin. I like the way Ventura Publisher allows you to position artwork with the mouse, then fine-tune locations by adjusting actual measurements in a dialog box. This makes up for the imprecision of current screen resolution. PageMaker is not a bad second choice, however, especially now that it uses style sheets and can automatically lay out long documents.

As far as I'm concerned, there are no other contenders in this category.

Spreadsheets

A category brimming with quality. I don't think I've seen a truly bad spreadsheet in years; the technology has been thoroughly assimilated by the industry. What you have to judge is not so much how functions are implemented as which functions are missing. Even the most meager spreadsheet will calculate numeric results, but you'd better know before buying a product whether you need fancy charting or database capacity.

I'm still using VP-Planner Plus. I'm comfortable with it, and Paperback Software treats its customers like royalty. The newest version has speeded up recalculation, the multidimensional database paradigm lets you build sophisticated projections without the need of a huge fenced-off worksheet, and much of the command interface is borrowed from Lotus 1-2-3. A nice product, at a reasonable price.

I keep meaning to learn how to make Microsoft's Excel for the PC jump through a hoop. Though it doesn't have full macro compatibility with 1-2-3, it has the richest environment available for turning a spreadsheet into a job-specific customized application, so I'll be loading Excel onto my fresh hard disk.

But I recommend two other programs. SuperCalc4 is the umpteenth revision of a classic program, fully compatible with 1-2-3, time-tested, quick, and as good a pure spreadsheet as you'll ever find. For most users, though, I actually recommend plain old 1-2-3. Although it has been overshadowed by its imitators, it's still an excellent product. And because of a brilliant design decision by the manufacturer, it's far more than a simple spreadsheet. Its add-in capability makes 1-2-3 a truly special shell for software integration. You can add word processing, dBASE database management, spelling checking, utilities—just about anything. At this point, 1-2-3 has more going for it as an operating system than OS/2.

Database Management

Here, I stick with three favorites I've used before. On the high end, my choice is Paradox (now a Borland product), a fully programmable relational engine

continued

Items Discussed

AskSam $295
AskSam Systems
119 South Washington St.
P.O. Box 31
Perry, FL 32347
(904) 584-6590
Inquiry 934.

AutoCAD Release 10 .... $3000
Autodesk, Inc.
2320 Marinship Way
Sausalito, CA 94965
(415) 332-2344
Inquiry 935.

Framework III $695
Ashton-Tate
20101 Hamilton Ave.
Torrance, CA 90502
(213) 329-8000
Inquiry 936.

KeepTrack Plus 2.0 .... $99
The Finot Group
2680 Bayshore Pkwy., Suite 101
Mountain View, CA 94043
(800) 628-2828 ext. 700
(415) 966-1900
Inquiry 937.

Lotus 1-2-3 .... $495
Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500
Inquiry 938.

MemoryMate $69.95
Broderbund Software
17 Paul Dr.
San Rafael, CA 94903
(415) 492-3200
Inquiry 939.

Microsoft Excel $495
Microsoft Works $149
Microsoft Corp.
16011 Northeast 36th Way
P.O. Box 97017
Redmond, WA 98073
(206) 882-8080
Inquiry 940.

Mirror II $69.95
SoftKlone Distributing Corp.
336 Office Plaza Dr.
Tallahassee, FL 32301
(904) 878-8564
Inquiry 941.

PageMaker $495
Aldus Corp.
411 First Ave. S, Suite 200
Seattle, WA 98104
(206) 622-5500
Inquiry 942.

Paradox $725
Reflex $149.95
SideKick $84.95
Borland International, Inc.
1800 Green Hills Rd.
P.O. Box 60001
Scotts Valley, CA 95066
(408) 438-8400
Inquiry 943.

Procomm Plus $75
Datastorm Technologies, Inc.
1621 Towne Dr., Suite G
P.O. Box 1471
Columbia, MO 65205
(314) 474-8461
Inquiry 944.

Professional Write 2.0 .... $199
Software Publishing Corp.
1901 Landings Dr.
P.O. Box 7210
Mountain View, CA 94039
(415) 962-8910
Inquiry 945.

Q&A $349
Symantec
10201 Torre Ave.
Cupertino, CA 95014
(408) 253-9600
Inquiry 946.

Ready! $99.95
Symantec Corp.
Living Videotext Division
117 Easy St.
Mountain View, CA 94043
(415) 964-6300
Inquiry 947.

Smart Series $895
Informix Software, Inc.
16011 College Blvd.
Lenexa, KS 66219
(913) 492-3800
Inquiry 948.

SuperCalc4 .... $495
Computer Associates International, Inc.
1240 McKay Dr.
San Jose, CA 95131
(408) 432-1727
Inquiry 949.

TopDOS $69.95
FrontRunner Development Corp.
14656 Oxnard St.
Van Nuys, CA 91411
(818) 376-1322
Inquiry 950.

Ventura Publisher 2.0 .... $895
Xerox Corp.
U.S. Marketing Group
P.O. Box 24
Rochester, NY 14692
(800) 832-6979
Inquiry 951.

VP-Planner Plus $249
Paperback Software International
2830 Ninth St.
Berkeley, CA 94710
(415) 644-2116
Inquiry 952.

XyWrite III Plus $445
XyQuest, Inc.
44 Manning Rd.
Billerica, MA 01821
(508) 671-0888
Inquiry 953.

with a solid application generator and a comprehensive language. Queries are easy to write, and file manipulation is as good as anything competing. Although all the other database development packages I've looked at are pretty amazing, Paradox is to my eye the most consistent and logical. It's not cheap, but it's good.

For smaller projects that don't demand the ultimate in development capability, either Reflex (also from Borland) or Symantec's Q&A are excellent selections. Reflex is the most Macintosh-like product going that doesn't use Microsoft Windows. Designing entry forms and reports is unintimidating, and the program's mathematical and cross-tabula-

continued

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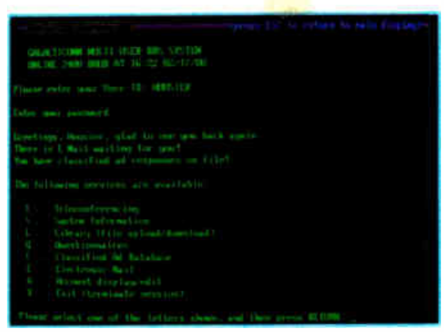

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tion tools make it ideal for financial analysis. Q&A is the perfect low-stress database product, combining powerful flat-file operation, natural language queries, and even a good word processor for mailing-list management.

I use all three. With products like these, who needs SQL?

Also worth noting is AskSam, a free-form text database product. Although I disliked earlier versions, which seemed to be overly complicated, AskSam Systems has just bolted on a new, simpler interface. I haven't had enough time with it yet to decide how I feel about it, but I'm beginning to think that it has at last achieved star status.

Telecommunications

There are very few bad products for telecommunications; almost anything you can name will get the job done, unless you've got exceptionally demanding criteria. I like and use both Mirror II and Procomm Plus. Mirror II operates in the background, and its script language has steadily improved to become absolutely amazing. Want to write a bulletin board system (BBS) with a high-level language geared to telecommunications and run it in the background while you work on your spreadsheet? You got it. Impressive. Procomm Plus is just a top-notch all-around package. Supports every protocol you ever imagined. Effortless to use.

Recommendations? Anything that isn't Microsoft Access.

Drafting

Simple. AutoCAD.

Painting

I haven't seen a single PC program that comes close to what's available on the Mac. Sorry.

Utilities

Were I starting to populate my hard disk without benefit of backup disks, I'd begin by picking up the necessary public domain utilities from a users group, a BBS, or a friend. I'm particularly fond of one that's a handy substitute for the `DIR` command. Modeled after Unix's `LS` command, it displays file directories in lowercase (much more readable than MS-DOS's all-caps format) and accepts a whole bunch of parameters that let me sort by name, size, or date; list programs and batch files only; show the status of read/write, system, and archive flags; and so on.

I'm now so used to typing `LS` instead of `DIR` that I feel lost without the program. There is also a number of shareware command stack editors that let me use the keyboard to retrieve and edit the DOS commands I've used recently (convenient for repetitive operations).

If you want a commercial product to handle DOS operations, I'd recommend FrontRunner's TopDOS, a memory-resident utility that provides both directory display and command history features, as well as a built-in editor that beats EDLIN by a mile, facilities for mass copying and deletion of files, command aliasing, and shortcuts for anything else you want to do at the DOS level. I use KeepTrack Plus from The Finot Group for hard disk maintenance and backup; it's neither as fast nor as slick as some of its competitors, but it backs up files as pure DOS rather than any proprietary format, and it doesn't crash.

Picking utilities is the most personal aspect of personal computing. Your choice in these little programs is what gives your system its flavor. I avoid suggesting utilities; it's like commenting on haircuts—you can't win.

Pop-Ups

Memory-resident programs on a PC system are a nightmare that's been well documented in this column and elsewhere. I try to keep my use of the contentious little devils to a bare minimum, and I'm staying with MemoryMate and Ready!. MemoryMate is a bare-bones text database program that lets you store 60-line records and dig them up by searching on any string. Not fancy, but it's a great way to keep your random jottings under control. When I need outlining, I'll switch to Ready!.

However, I recommend the original SideKick (if you can still find a copy). It's the program that started the whole pop-up trend, and its elegant design for note taking and scheduling makes it an absolute classic.

Final Thought

There you have it. The products I've mentioned all represent sound programs that do what they're supposed to do. It's not a "10 Best" list, but it's what I tell people who ask. And I'm beginning to listen to my own advice at last. ■

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.


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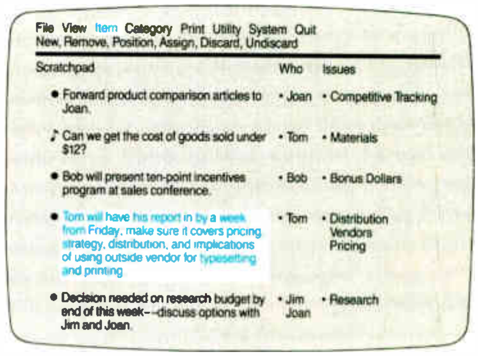

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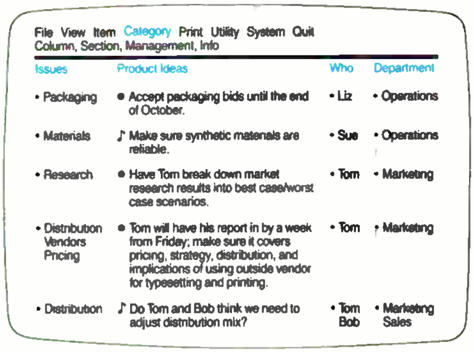

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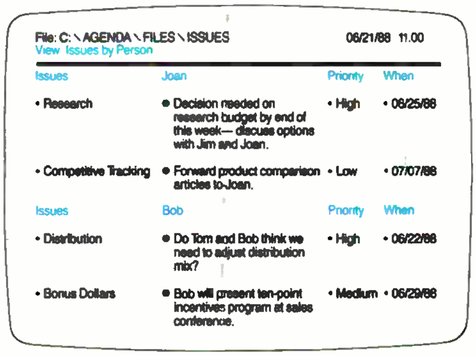
• Distribution	♪ Do Tom and Bob think we need to adjust distribution mix?	• Tom Bob	• Marketing Sales

Categories. Agenda files items in all relevant categories so you can always find the information you need.



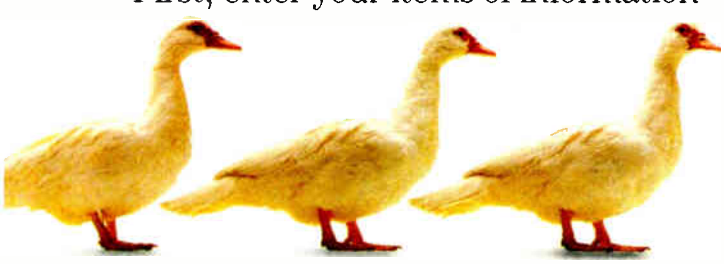
File: C: \ AGENDA \ FILES \ ISSUES View Issues by Person			06/21/88 11.00
Issues	Joan	Priority	When
• Research	● Decision needed on research budget by end of this week— discuss options with Jim and Joan.	• High	• 06/25/88
• Competitive Tracking	● Forward product comparison articles to Joan.	• Low	• 07/07/88
Issues	Bob	Priority	When
• Distribution	● Do Tom and Bob think we need to adjust distribution mix?	• High	• 06/22/88
• Bonus Dollars	● Bob will present ten-point incentives program at sales conference.	• Medium	• 06/29/88

Views. Looking at the same information through different views gives you a more informed perspective.

more on using and acting on your information. And less on processing it.

How does Agenda work?

First, enter your items of information



The whole idea behind Agenda is to get them all in a row.

into your PC and assign them to categories that you create.

Then Agenda will do all of your filing automatically. And thanks to Agenda's *multiple filing capabilities*, if the information is relevant in more than one place, Agenda will take it and put it in several categories at once.

This makes it easy to view your data in different ways so you can pinpoint information that's important to you. Or discover new relationships you hadn't considered before. And anytime you change an item in a view, Agenda will automatically update all other categories where the item has been assigned.

In fact, you could say that Agenda recalculates your text the way a spreadsheet program recalculates numbers.

All of which means, from now on you'll be able to come in every morning, check your Agenda, and get right to work.

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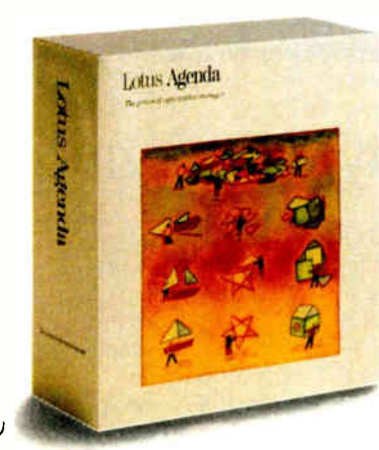
For $15, we'll send you an Agenda demo kit or videotape. Call 1-800-345-1043 and ask for demo kit AGU-3058 for the 3.5″ version or AGU-3053 for the 5.25″ version. Or ask for videotape AGU-3063.



Introducing Lotus Agenda

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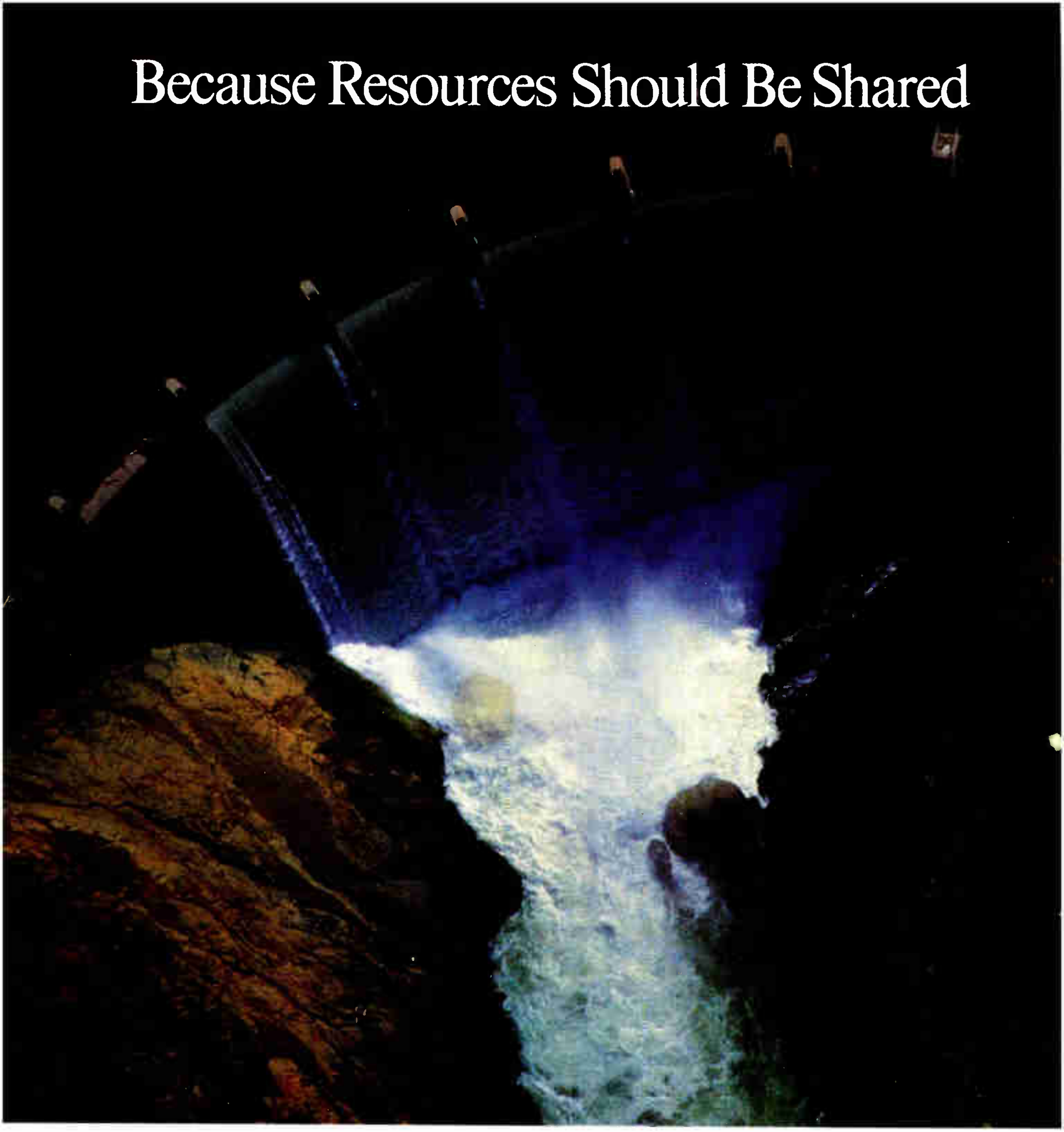
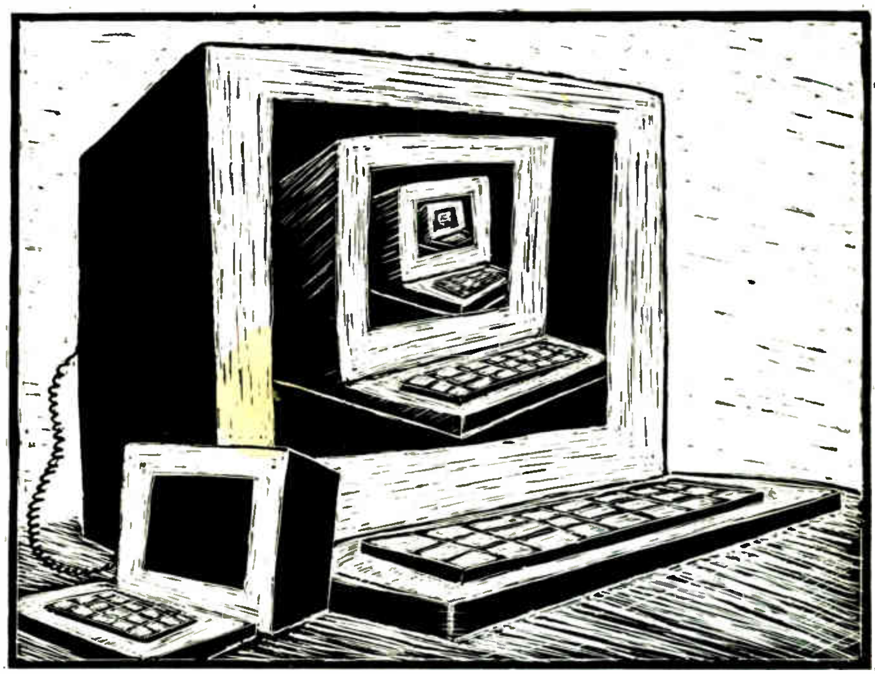

Because Resources Should Be Shared

COM1: ■ Brock N. Meeks

BEEFED-UP BULLETIN BOARDS



The offspring of yesterday's bulletin boards are sophisticated, powerful systems with plenty to offer PC users

The Dark Ages of microcomputer-based communication stretch back 6 years, tops. Back then, all bulletin board systems (BBSes) looked alike. They were single-line, dual-floppy, unstable, kludgy electronic beasts. For sysops, they were a challenge requiring the dedication of an unrequited love affair. For users, they were electronic labyrinths, the next best thing to an interactive adventure game. Not any more.

Today, the garden-variety BBS is as rare as a Susan B. Anthony silver dollar. The BBS has been constantly evolving ever since Ward Christensen and Randy Suess first used their homegrown BBS to squirt binary files back and forth. Their system evolved as a way to overcome the nightmarish logistics of traveling some 50 miles between their homes just to trade updates of the software they were both working on. And nowhere is that evolution more evident than in today's "power BBSes."

These power BBSes often sport multiple dial-up lines capable of handling up to 50 users at a time. Their on-line storage capacity is mind-boggling. And sysops have even carved out full-time careers (and $50,000 or $60,000 incomes) simply from charging modest subscriber fees.

Most of the boards I'll profile here belong to this power category. The remainder aren't quite beefed-up to such power levels, but they are important boards for their software libraries. All are powerful grass-roots communications tools that have helped define that slippery moniker, the information age.

All these boards should be on your "check in regularly" list. Further, most are accessible via Telenet's all-you-can-eat $25 per month, flat-fee, packet-switched service, PC Pursuit. This network gives you access to any computer service in 24 major metropolitan areas in the U.S. (For more information about PC Pursuit, call (800) 835-3001.)

Exec-PC

How important is the Exec-PC BBS? To borrow a line from a famous hamburger chain, I was the 1,282,770th caller served. And I do mean "served." Exec-PC is perhaps the premier BBS in the nation for exchanging software.

For starters, Exec-PC has some 54 dial-up lines. My first log-on saw me in the company of 30 other users hailing from 10 different states. I discovered this fact only after I became suspicious of the board's speed. I thought I was the only one on-line. Wrong. A single-key command told me the total number of other users on-line, who they were, and where they were calling from.

The board contains the complete, fully accessible, PC-SIG (special-interest group) software library on CD-ROM. Hard disk storage space is 1.48 gigabytes. Over 700 files are dedicated to Unix and Xenix. In all, there are more than 50,000 individual software files (most of them in .ARC format) for you to peruse and download. First-time users are allowed 30 minutes on the system in what the board calls "demo mode." This mode is for unregistered users; registered users have unlimited access.

During your first sign-on, you can

- Download files from the free file area.
- Leave comments to the sysop at log-off.
- Read messages only in the main IBM conference.

continued

ILLUSTRATION: CLAUDIA TANTILLO © 1988

Items Discussed

Exec-PC
Operation: 24 hours a day, 365 days a year
Phone: (414) 964-5160
Sysop: Bob Mahoney
PC Pursuit Access: Yes
Audience: IBM only
Access: Free, 30 minutes; subscriber fee for full access
Communications requirements: 300/1200/2400 bps; full duplex, no parity, 8 bits, 1 stop bit
Inquiry 862.

Invention Factory
Operation: 24 hours a day, 365 days a year
Phone: (212) 431-1194 (free-access line)
Sysop: Mike Sussel
PC Pursuit Access: Yes
Audience: IBM only
Access: Free-access line with full download privileges; subscriber fees for unlimited access
Communications requirements: 300–9600 bps; full duplex, no parity, 8 bits, 1 stop bit
Inquiry 863.

Thousand Oaks Technical Database
Operation: 24 hours a day, 365 days a year
Phone: (805) 493-1495
Sysop: Trevor Marshall
PC Pursuit Access: No
Audience: IBM only
Access: No subscriber fees
Communications requirements: 300–2400 bps; full duplex, no parity, 8 bits, 1 stop bit
Inquiry 864.

Utilities Exchange
Operation: 24 hours a day, 365 days a year
Phone: (614) 488-3991
Sysop: Mike Koehler
PC Pursuit Access: No
Audience: IBM only—anyone needing any type of software utility program
Access: Limited free access, subscriber fee for unlimited access
Communications requirements: 300–2400 bps; up to 9600 bps for owners of USRobotics HST modems; full duplex, no parity, 8 bits, 1 stop bit
Inquiry 865.

- List the directories of files available for transfer.
- Use the Barndt database search system to find files.

For the uninitiated, the Barndt database search system is a proposed standard for naming files. Anyone who has spent even a small amount of time banging around a hard disk looking for specific types of files will appreciate the Barndt system. Many of the BBSes across the land now employ this system. You can read all about it in a text file under the extensive on-line help section. The file explains the theory behind the system and the indexing system. It's required reading if you're serious about making your on-line life more efficient.

Invention Factory

The Invention Factory is one of the true survivors of the BBS community, given the high fatality rate of BBSes in general. According to sysop Mike Sussel, the board has been on-line for 5 years and has been down only once. It comes in a close second for the most power-packed board in the nation, the first being the Exec-PC.

The board allows you 30 free minutes a day for downloading. However, for every minute you spend uploading a program, your downloading credit increases by a factor of 2. There are no fees for this privilege. A yearly fee of $100 ($8.33 a month) gives you unlimited access every day. Sussel says that paid subscribers are guaranteed never to get a busy signal.

The Invention Factory has 24 dial-up lines (2 free and 22 subscriber). There are over 8000 files available, representing over 41,000 individual files. The system also has 1.2 gigabytes of hard disk storage.

The free-access lines operate at data rates of 300 or 1200 bits per second; subscribers can access the system at data rates of up to 9600 bps if they have a Hayes V-series modem. Sussel says that data transfer rates of up to 19.2K bps are possible for V-series owners using the ZMODEM transfer protocol.

The board contains 76 different file areas that encompass such diverse topics as amateur radio, OS/2, and local-area networks (LANs).

The board also supports "doors" or special programs that you can execute while on-line. One of these doors, called Qwikmail, lets you automatically scan

continued

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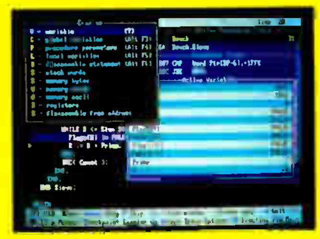
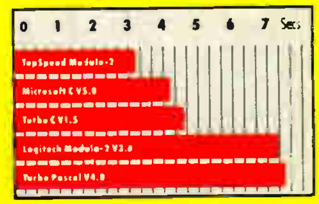


VID (Visual Interactive Debugger): power without complexity.



Sieve benchmark measured by the British Standards Institution (BSI)—25 iterations on an 8MHz AT.

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The Compiler Kit includes: High-speed optimizing compiler (3,000-5,000 lines/min. on a PC AT 8MHz), integrated menu-driven environment with multi-window/multi-file editor, automatic *make*, fast smart linker. All Modula-2 sources to libraries included. BONUS: Complete high-speed window management module included with source. 258-page User's Manual and 190-page Language Tutorial.

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each of the message bases for any messages left since your last log-on. Qwikmail then compiles all those messages (including any electronic mail you have waiting) into one .ARC file that you can then download using your choice of protocol, including YMODEM BATCH or ZMODEM.

Sussel and two assistant sysops spend an average of 100 hours a week combing the several BBSes from coast to coast looking for the newest and best software available. This process ensures that the file database is always up to date.

Thousand Oaks Technical Database

The Thousand Oaks board will be familiar to "old-timers" because it is modeled on the venerable RCP/M (remote CP/M) system, a BBS program for the CP/M operating system. Under RCP/M software, you essentially sit at your computer keyboard and issue the same commands you would if you were controlling DOS directly. This means you type `DIR` to view the file directory and `TYPE` to read ASCII files. Obviously, any command that is potentially dangerous (e.g., `DELETE` and `FORMAT`) is locked out.

The system's primary drawing point is the PC-SIG CD-ROM that is fully accessible for downloading. You'll find the CD-ROM listed as drive 1. The hard disks are C, D, E, F, and G. They have a combined storage capacity of 160 megabytes. The CD-ROM is organized into subdirectories in a tree structure that tries to group like files in the same location. For instance, on drive C, if you choose the 68000 path, depending on your interests, you can then go to either Amiga, Atari, or CPM68K. These subdirectories are shown on the directory display as `68000/amiga/atari/cpm68k/`.

As the system warns, if you don't know how to use the `Change Disk` command, you should consult your MS-DOS manual before attempting an on-line session here. The best way to find out what software is available on this system is to transfer the file catalogs on drive E and read them on your machine.

To keep the system reasonably accessible, when accessing the CD-ROM, you are allowed only 15 minutes to download. I found this time more than adequate. The 15-minute limit lets you download what amounts to one entire PC-SIG floppy disk. If you get greedy, you'll have to wait 24 hours before coming back for a CD-ROM fix.

Utilities Exchange

True confessions time: I'm a utilities freak. I love all those little programs created under the adage "Necessity is the mother of invention." And the Utilities Exchange board is dedicated to utility programs—up to 117 megabytes of dedication, to be exact.

Sponsored in part by the Columbus (Ohio) Computer Society, this board offers limited free access to everyone. But those who choose to subscribe receive unlimited access for a fee of $25 per year.

Free-access users are allowed 45 minutes of time on the board and up to 256K bytes of downloads per day. You can view a full listing of the board's files offline by just downloading a file called UEFILES.ARC. This file is updated daily. And from my extensive romp through the board's files, you won't find a better selection of utility programs anywhere.

The board also runs a door called Prodoor, which has a handy feature called ARCM (which stands for arc mail) that allows you to archive all your messages into a single file for more efficient downloading.

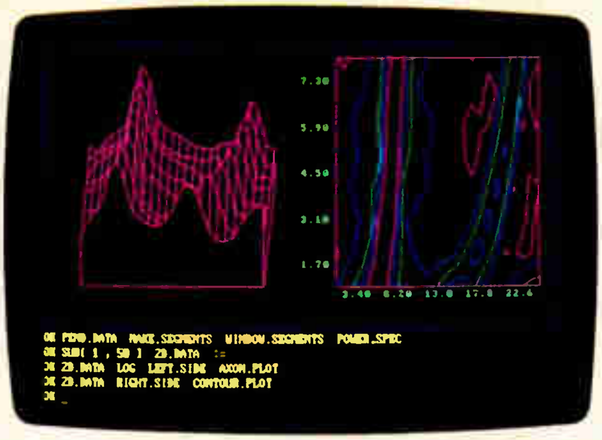
This program board's 117 megabytes of storage are divided into 28 separate categories of utilities. Here you'll find utilities for every possible application, from AT386 to diagnostics to LANS to word processors. A nice touch provided by the Utilities Exchange is an open software library that contains programs written by Columbus-area software authors. This idea should be adopted by every BBS that serves an active shareware author community.

Currently, there are an estimated 10,000 BBSes on-line across the nation. With this many boards up and running, there are BBSes providing formidable software libraries that rival those I've outlined. The ones I mention here are simply reference points—a clearinghouse, if you will. And even if you never venture beyond these boards, you'll not want for a steady diet of the most up-to-date and innovative software programs that are being written today.

Whether you call it the hacker ethic or the shareware spirit, these BBSes represent a basic element in the evolution of microcomputer-based telecommunications: powered up, pushing on. ■

Brock N. Meeks is a San Diego-based freelance writer who specializes in high technology. You can reach him on BIX as "brock."

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



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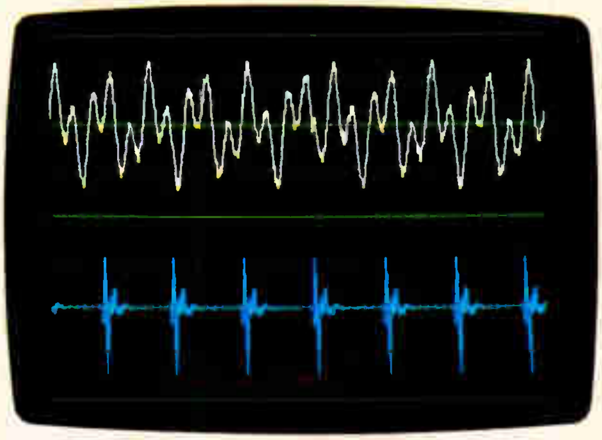

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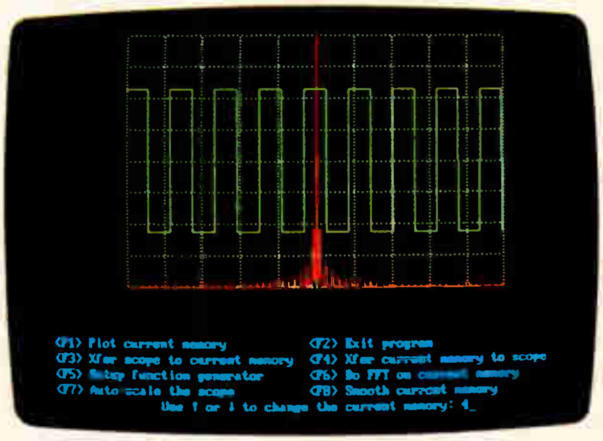

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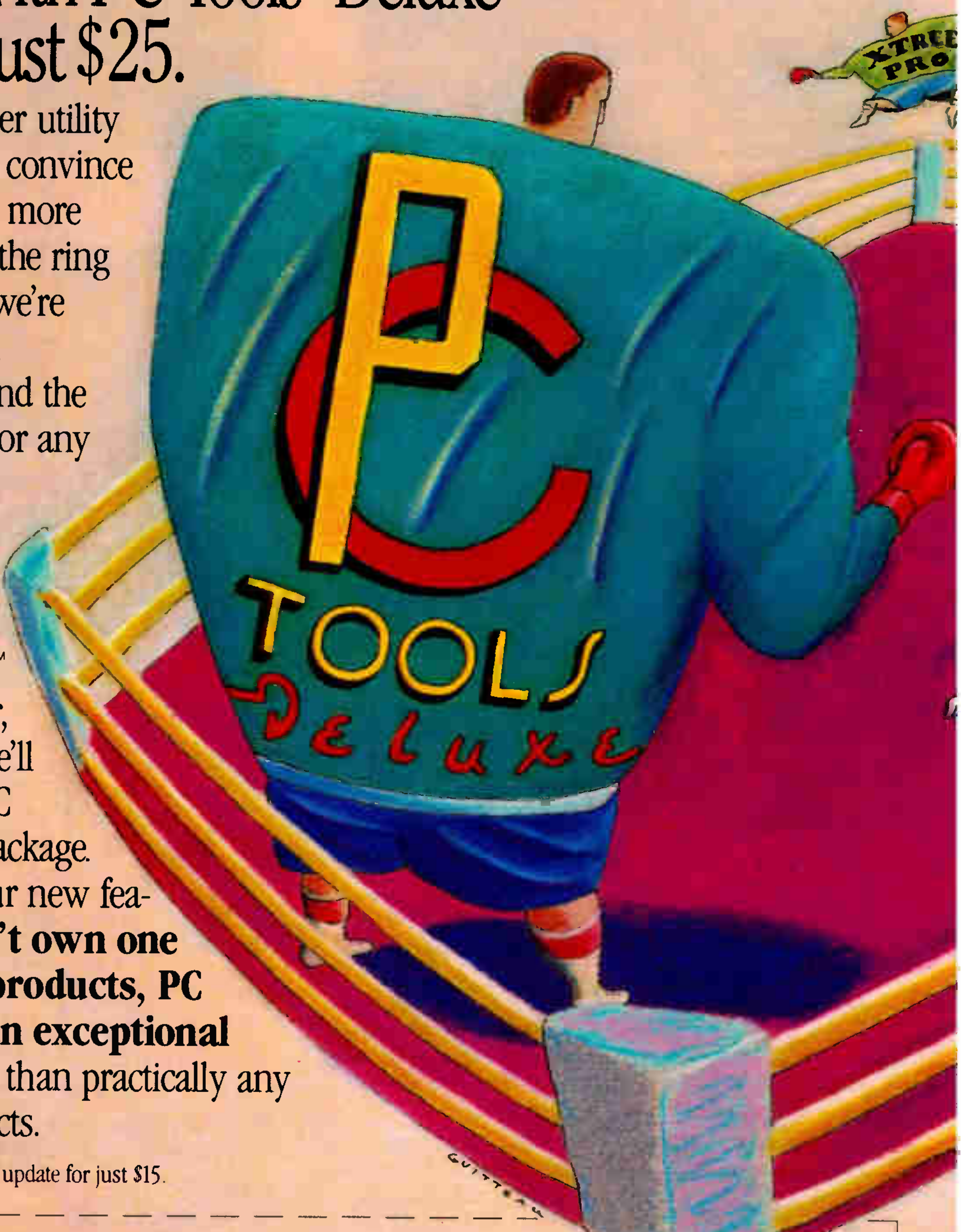

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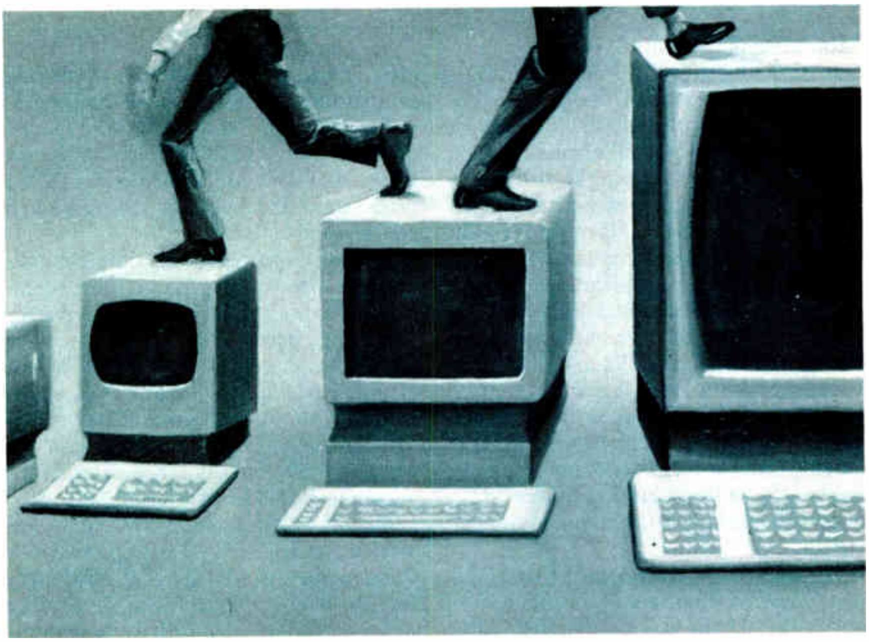
MIGRATING: UP OR DOWN?

Today's micros let you move some mainframe applications to your PC, but first you need to make some decisions



Conventional wisdom seems to be that during their lifetime, applications require a steady growth in the size and capacity of the computers on which they run. In other words, what starts out as a small, simple application written in something like dBASE eventually grows to require more and more computing power. This seems to be supported by the fact that users are getting bigger and bigger computers. If the computers are getting bigger, the applications must require bigger machines, right? Well, maybe not.

That's one of the problems with conventional wisdom. Many assumptions that become part of the culture don't really have a good reason to exist and are, in fact, invalid. Sure, you buy more computer capacity as time goes on. But that doesn't mean a particular application must necessarily grow through a series of incrementally larger machines until it's eventually on a mainframe. In fact, just the opposite may take place.

Part of the confusion is that there is an obvious drift among users to larger and faster machines. Where the IBM PC was once the standard in business, now it is the AT. Soon, machines based on the 80386 will be the norm. Does that mean that the individual applications demand larger machines? Let's take a look at the drift to larger machines, and then at the migration of applications.

Driving Forces for Migration

You may want to move to larger machines for a number of reasons. Not the least of these is the significant price reduction of the newer, faster machines. In addition, once you get used to having a computer, you want to do more with it, and you want to do things faster. This tendency, combined with the relatively low price of better machines, contributes greatly to user dissatisfaction with the status quo, and thus the urge to move up.

These same pressures have led software companies to write software that requires bigger machines. User demand for more features, combined with the availability of more powerful hardware, leads to software that is more capable but that also requires more in the way of resources. Where once programs worked well on computers that had only floppy disks, now some perform well only on hard disk machines.

Sadly, the user's desire for larger size is not due just to increased capability. To some extent, there is less incentive for software companies to spend the money to optimize their software for less-capable machines. Why bother, when nearly everybody has a hard disk drive and 640K bytes of memory?

All these factors, of course, give the impression that users want to migrate to larger machines. Whether there is a trend to a larger class of machines is another question. In many ways, a move from a microcomputer to a minicomputer or mainframe is a step backward.

One or Many Users?

To most users, a minicomputer or mainframe looks like a huge machine. When you visit a large computer room, you see row on row of CPU cabinets and more rows of disk drives. These appear to be large capable machines, and they are. That does not necessarily mean, however, that they will do more for your application.

Minicomputers and mainframes are designed to be shared by many users. For many applications, this is a primary ben-

continued

efit, but it may not be for you if you're the only one using the application. In fact, on a larger computer, you may have only a limited amount of CPU time and storage space. In addition, the fast response and sophisticated screens you are used to seeing on a microcomputer are unlikely to be available on the mainframe.

Almost everyone would agree that a mainframe computer is a powerful machine. But a mainframe or minicomputer has a different set of design criteria. It must deal concurrently with hundreds of users on a variety of terminals. Your microcomputer has to deal with just you.

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Migrating Downward

One of the most overlooked paths of migration, and yet one of the most potentially rewarding, is movement from a large machine to a smaller one. This is especially so when moving from a mainframe or a minicomputer to a microcomputer. Oddly enough, this move is rarely considered. For some reason, whether it makes sense or not, applications that are on a mainframe tend to stay there.

I suppose that the size of the hardware and support staff has a lot to do with this situation. Users look at a room full of equipment and programmers and wonder how they could handle any application requiring such a large machine with the computers on their desks. Physical size, of course, really has little to do with capability.

At one time, mainframes actually had less capacity than today's microcomputers do. There was a time when 64K bytes of memory (core memory in those days) was a lot. Disk space was either unavailable or hideously expensive. You used cards to load programs and data. Many of the programs our businesses currently depend on were written in those days. Some of them have remained relatively unchanged, while others have been updated, but many are still essentially batch systems written in COBOL.

Of course, we have changed the way we use mainframe computers. Some of the most important changes have occurred because programmers have developed some impressive database management systems. A surprising number of old programs hailing from the IBM 360 days still reside on today's mainframes. We still use them, and they still take up space and soak up CPU cycles. These are the applications to look at for possible migration to a microcomputer.

The Micro Move

The same factors that have led users to move to more capable machines have also opened up the possibility of moving mainframe applications to microcomputers. The most notable of these factors are the ready availability of hard disk drives, the wide use of 80286 and 80386 processors, and operating systems such as OS/2 and Unix.

While mainframes and minicomputers once started out with no more memory and mass storage than many microcomputers, most of these old machines have been phased out. Likewise, as the machines in the mainframe and minicomputer worlds have become larger, the software has grown. Now, it isn't always possible to fit a really large COBOL application into 640K bytes.

Fitting an application into 16 megabytes on an IBM PC AT-compatible machine is not as much of a challenge, though. With versions of Unix becoming widely available for microcomputers, and with a wider variety of compilers becoming available for OS/2, software conversion is no longer outside the realm of the possible.

Despite the current lack of commercial applications for OS/2, this is one area where the move from the mainframe to the microcomputer is becoming possible. When the operating system was introduced, a number of compilers were introduced with it. Microsoft already publishes a version of the C compiler, and Micro Focus is shipping an ANSI-standard COBOL compiler. While it isn't yet possible to simply recompile a program to have it run under OS/2, that goal isn't so far away. Already, a number of large mainframe COBOL systems are being moved to microcomputers under OS/2.

Factors to Help You Decide

So, you use a mainframe computer with several old COBOL programs. What's the best way to decide if they should be moved to a micro? Here are some ideas you should consider:

- Is yours essentially a single-user system? In other words, is it used by only one person at a time? Many older applications are limited to a single user, even though the computer they run on can handle hundreds.
- Are you having problems with response time? Because they are required to service hundreds of users, mainframes can sometimes keep you waiting. Often a microcomputer will be faster, mainly because there's only one user.
- Are you getting ready to perform a major rewrite? Major new development efforts on a mainframe can take years. If you really need it now, maybe a microcomputer is the only way it will happen.
- Is the application written in something standard? While most mainframe business applications are written in COBOL, FORTRAN, or another common language, many of these languages have no practical counterpart in the microcomputer world. This situation could be a showstopper, unless you're planning on doing a complete rewrite, in which case it wouldn't matter so much.
- Is the mainframe running out of space? It costs a lot less to buy a microcomputer than to upgrade a mainframe. Maybe there are programs that could migrate, given a reasonable level of effort.

There are as many reasons to migrate to microcomputers as there are individual circumstances. Likewise, there are any number of reasons not to move. The important thing to remember, however, is that sometimes you can move. Today's 80286- and 80386-driven personal computers will let you put a mainframe application on your desk.

Now on BIX

I've been granted my own BIX conference in which to conduct ongoing conversations about the subjects discussed in this column. I'd love to hear from you. Please feel free to join the conference (it's called "to.wayne") and ask questions, grind axes, or air your opinions. Fair warning: Contributing to BIX is akin to writing a letter to the editor, and I may quote you sometime. ■

Wayne Rash Jr. is a member of the professional staff of American Management Systems, Inc. (Arlington, Virginia), where he consults with the federal government on microcomputers. You can reach him on BIX as "waynerash."

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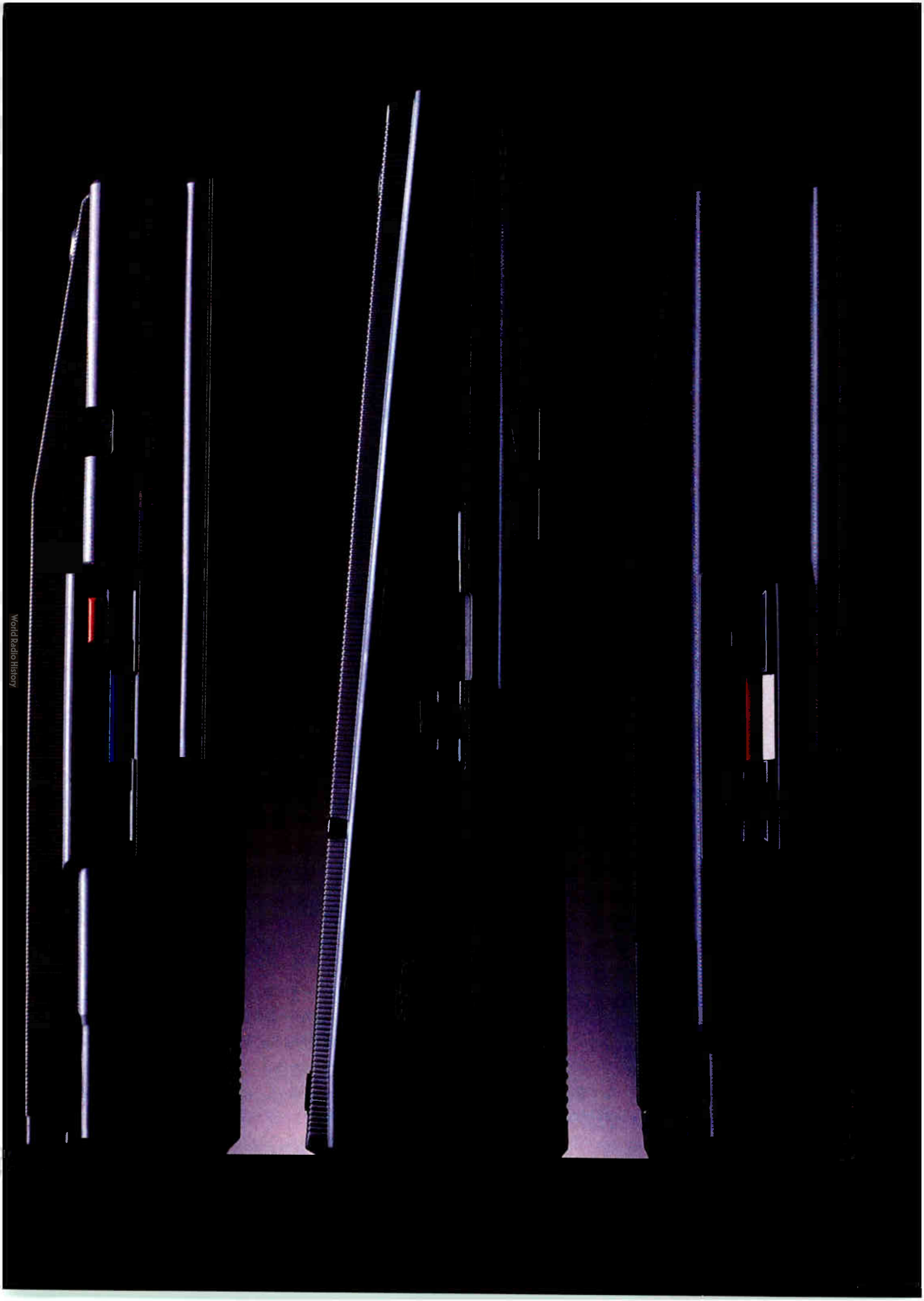

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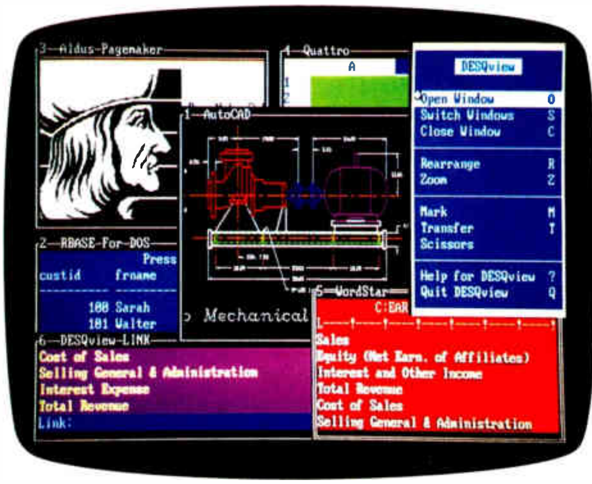

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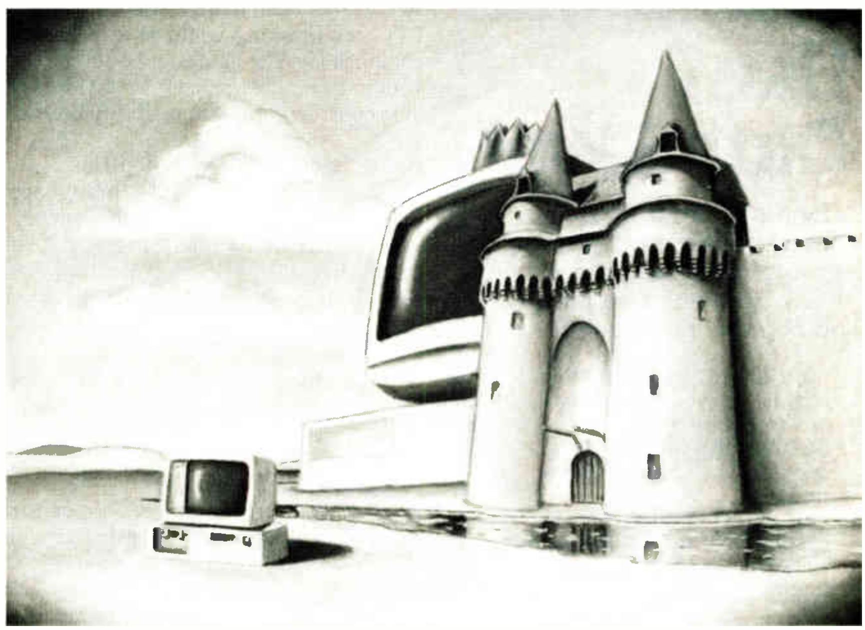
OS/2 DREAMS

I've got a few suggestions for the operating system that would be—could be—king



OS/2 has some neat features. And by the time you read this, IBM and Microsoft will have released the Presentation Manager, filling out OS/2 considerably. (I hope for your sake that they fixed it before they shipped it. The beta developer's version is very unstable.)

But OS/2 has some really fatal flaws. I'm not just talking about bugs here: Yes, OS/2 is buggy, but so is version 1.0 of any product. I'm talking about genuine design flaws.

OS/2 is important to IBM and Microsoft. It's either the operating system that will take us into the twenty-first century, or the operating system that will take Microsoft into Chapter 11. So I hope they'll fix these things.

Support the 80386, Not the 80286

OS/2 was written for the 80286 rather than the 80386 because the project first got under way in 1984, shortly before the announcement of the IBM PC AT. At that time, there *was* no 80386. For those of you with an 80286-based system, help is now available via the 80386SX, a chip that makes 80386 upgrades less expensive for 80286 owners.

Despite the larger base of 80286 machines than 80386 machines, there are several compelling reasons to bypass the 80286 altogether and release future versions of OS/2 to exploit 80386 features.

First, programmers would gain access to the 80386 protected mode, which is much more useful than the 80286 protected mode. (The 80386 chip can also run the 80286 mode, which is why it can run OS/2 now.) Intel chips address memory in a two-part manner: *segment* and *offset*. Think of the segment as the neighborhood and the offset as a particular street address within the neighborhood.

The 80286 protected mode won't allow a segment larger than 64K bytes. The effect of this on 80286 programs (and, it follows, OS/2 programs) is to impose a "nuisance barrier" of 64K bytes. Data structures or programs larger than 64K bytes require special handling, so many software vendors have not offered large program or data capabilities.

The 80386 has a protected mode that allows segments to be as large as 4 gigabytes. All the existing code written for mainframes and minicomputers—programs written in an environment without the 64K-byte shackles—could be more easily ported to machines running an 80386-based OS/2. Large segments would also help make converting code from the Motorola 680x0 family easier.

A second argument for the 80386 is mode switching. Recall that OS/2 operates in protected mode. DOS operates in real mode. An 80286 powers up in real mode. When OS/2 boots up, it switches the 80286 to protected mode. OS/2's compatibility box, as it runs DOS programs, must operate in real mode. The problem is that there is a command to switch the 80286 from real mode to protected mode, *but none to reverse the process*. How, then, does OS/2 switch to real mode to run the compatibility box?

Believe it or not, it resets the processor—reboots the system, in effect. Since the processor is reinitialized when in real mode, the compatibility box can run. The downside is that the 80286 is then deaf to external interrupts (e.g., communications and keyboard) for 30 milliseconds. The 80386 improves matters: Intel included a command to switch the 80386 from protected mode to real mode without going through the reboot sequence.

continued

This results in no dropped interrupts.

A third reason to build OS/2 for the 80386 is that the 80386 has a "DOS multitasking" mode, called the Virtual 8086 (V86) mode. In previous columns, I have discussed that, due to the way DOS programs are written, there's no way to write a bulletproof multitasking version of DOS for the 8088, 8086, or 80286. But the 80386's V86 mode provides the hardware support to make DOS multitasking possible. Products like IGC's VM/386 and Microsoft Windows/386 use V86 mode (see "Life After DOS" by Namir Clement Shammas on page 142). Had OS/2 been written for the 80386, DOS multitasking could have been accomplished. V86 is designed to coexist with protected mode, so it would be easy to support multiple compatibility boxes.

Bring Back the DOS Amenities

DOS, at about $100, includes a language interpreter (BASICA), a debugger/assembler (DEBUG), and an ASCII text editor (EDLIN). Microsoft Windows, at $99, includes a terminal emulator, notepad, word processor, paint program, calculator, analog clock, and reversi game.

OS/2 and the Presentation Manager provide none of these. Bring the goodies back.

Make It Less Expensive

At $325, OS/2 is over three times the price of DOS. But that's not all. The real costs of OS/2 are memory and video. The Presentation Manager takes up 2.6 megabytes of RAM just to boot up. As OS/2's disk performance is abysmal without a cache, you're forced to add more memory to accommodate a 1- to 2-megabyte cache (2 megabytes is significantly better than 1 megabyte). OS/2 is really most comfortable in a machine with 5 to 8 megabytes of RAM. To run the Presentation Manager, you'll need an EGA or VGA and a monitor. The Hercules board isn't supported by OS/2.

A megabyte costs about $400, so you're looking at $1600 to $2800 to add 4 to 7 megabytes. That's a lot of money to spend on each workstation. By comparison, VM/386 and DESQview can run on any kind of video board, require only 640K bytes of RAM (although, obviously, more memory is better), and cost $125 to $245, depending on the product and options.

Add DOS Multitasking Support via V86 Mode

I said this above under the 80286/80386 discussion, but there's an important point to make here. IBM and Microsoft misled us to believe that DOS 5.0 would be a multitasking DOS (i.e., it would run multiple existing DOS applications). Had we known in 1985 that we'd have to wait 3 years for a new, incompatible operating system requiring all software to be rewritten, we'd have gone to Unix and gotten it all over with quickly.

End Software Defenestration

"Defenestration" means to be forced through a window. Microsoft seems to want to force us to buy into Windows for everything. More and more of its DOS products need Windows. To get V86 multitasking (Windows/386), you have to buy into the Windows interface.

Perhaps the worst example of this is the Presentation Manager, which is really "Windows for OS/2." The Presentation Manager offers some really slick device-independent graphics routines to programmers. They are called GPI, which stands for graphic application program interface. Rather than writing a routine to draw a circle on the screen, the programmer need only invoke a GPI call, without worrying about what kind of video board the program will run on. The problem: Your program must run under the Presentation Manager to use GPI calls.

This wasn't necessary. Microsoft is just committed to the Windows interface, and GPI is enough bait to convince many developers to swallow the interface. GPI should be available in the text-based OS/2 interface also.

Support Disks Larger than 32 Megabytes

We have seen that disk I/O is considerably slower under OS/2 than under DOS. This is, I hope, only a temporary problem. But the 32-megabyte limitation is still with us. Why? MS-DOS 3.3 and PC-DOS 4.0 eliminate the 32-megabyte limitation on hard disk size, upping the maximum to 512 megabytes.

Why not OS/2? Microsoft talks about a new, incompatible, "protected" file system for OS/2 2.0. I remember how much fun it was convincing DOS 1.1 programs to read data in DOS 2.0 subdirectories. Keep the new file structure, guys, and just increase the disk size.

Offer a Text Mode Presentation Manager

Video boards often have two modes: text and graphics. In text mode, the screen can show only text—no graphics. It's a little limited, but it's faster than graphics mode. Graphics mode can display graph-

continued

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ics *and* text, but writing text is much slower in graphics mode.

Graphics mode is, then, more flexible than text mode but slower. The Presentation Manager operates *solely* in graphics mode. Software running in a window under the Presentation Manager always runs in graphics mode—even software originally written to operate in text mode. This means that a text application will run much more slowly under the Presentation Manager, as the screen I/O will be slowed down considerably. For example, I recently TYPEd a file to the screen 20 times, first in OS/2 text mode and then in a Presentation Manager window. The operation took 97 seconds in text mode and 298 seconds in a Presentation Manager window.

Most existing DOS applications are text mode only. It makes no sense to force existing applications to fit the graphics mold of the Presentation Manager. Why not offer a version of the Presentation Manager that does windowing in *text* mode? DESQview does this successfully already.

Provide a System Monitor Screen

Multitaskers usually have some way of monitoring and adjusting system performance. In VM/386, for example, a virtual machine manager lets you adjust priorities, assign devices to virtual machines, and the like. OS/2 has nothing like that. Instead, it requires a program that would (at a minimum) display active jobs, allow termination of a crashed job, and display and allow adjustment of job priorities.

Along these lines, I'm always a little worried by OS/2's reboot command. To reboot the system, you use the familiar Ctrl-Alt-Del combination. But, recall, you could have 10 jobs running simultaneously. OS/2 doesn't say "Are you sure?" or anything of the like. It doesn't inform you what files are open at the moment. It just reboots.

Open Up the Serial Ports

OS/2 supports nongraphics text-based applications through its VIO (video I/O) routines. These are a basic set of simple, nongraphics, teletypewriter-like system functions. Recall that OS/2 programs can't talk directly to the screen. They *must* use OS/2 to send output to the screen. Given that, it would be simple to offer an option whereby any OS/2 program's screen output and keyboard input could be redirected to the serial port. DOS tried this with the CTTY command, but so many DOS programs bypassed DOS for I/O that the command wasn't worth much.

This feature would allow simple remote access to your PC from the road via modem and easier remote software support from software vendors. It also would pave the way for multiuser capabilities.

Call Me a Dreamer

Don't get me wrong. In many ways, OS/2 is a really nice system. Microsoft and IBM have made a great first step. But I hope they take it further.

Are you listening, folks? ■

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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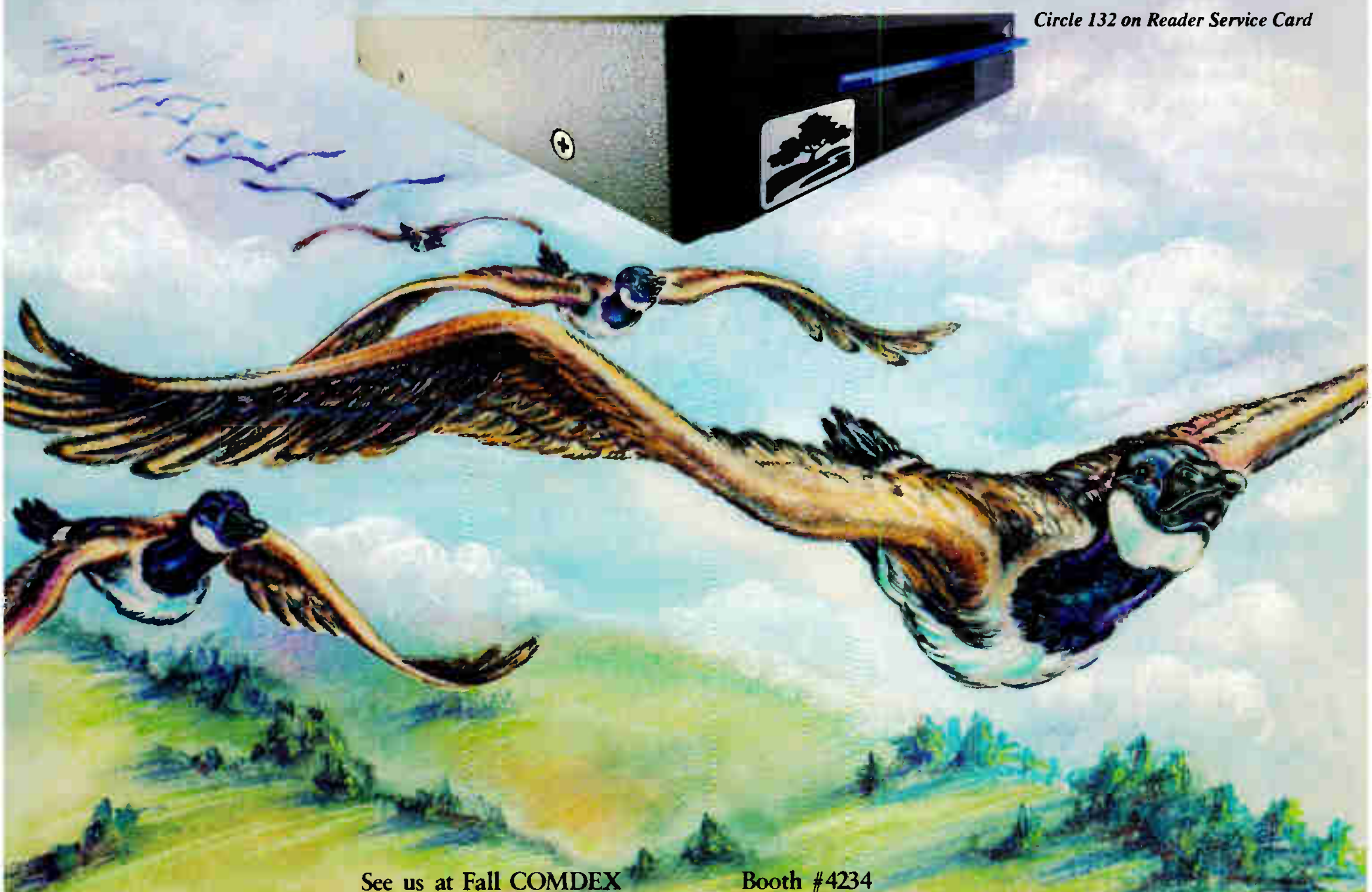

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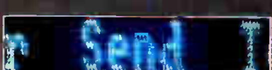

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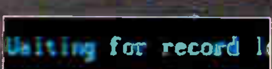

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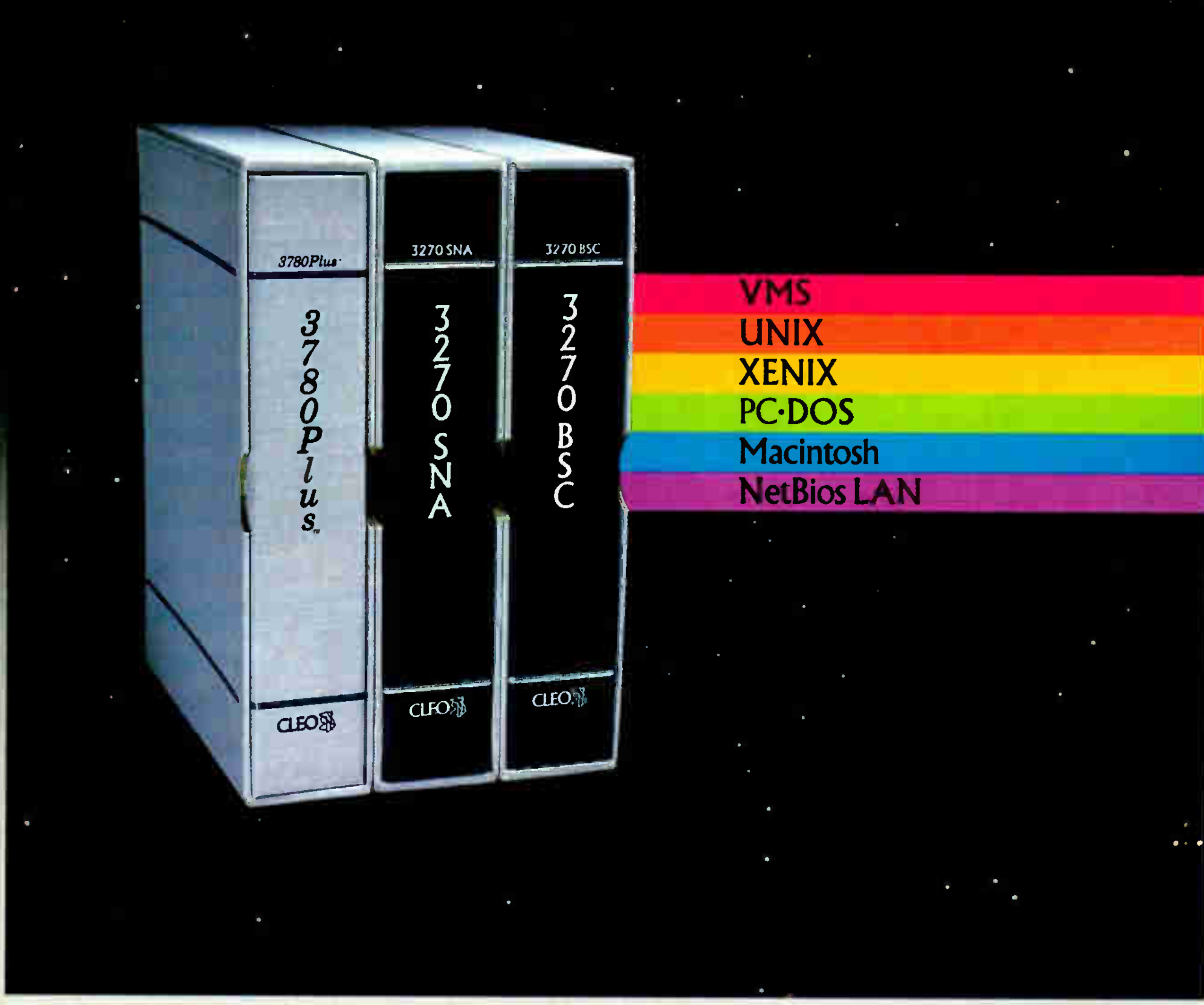

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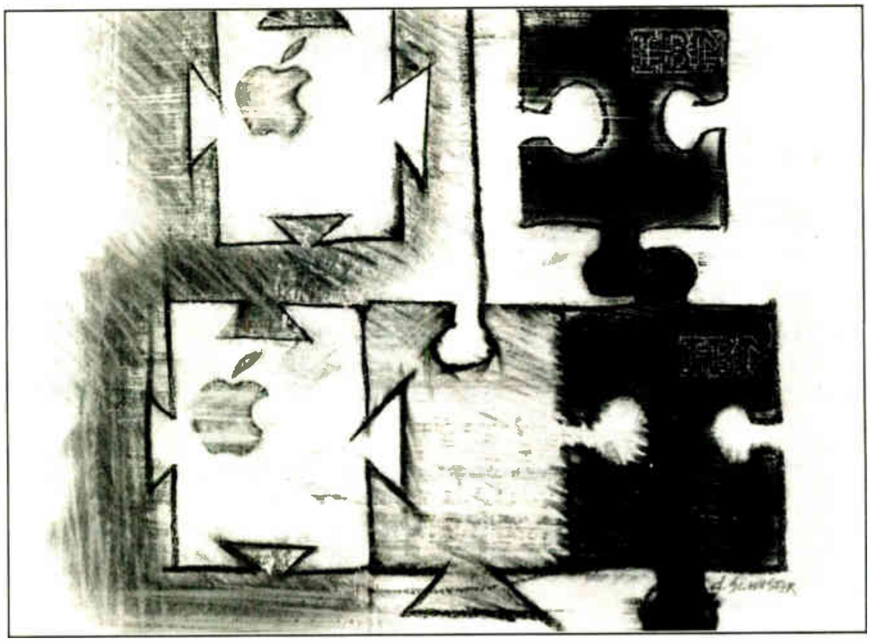

Like many of you, I have to deal with the problem of different operating systems. I have Unix workstations, Macintoshes, and IBM PC AT clones, which all have to share information. Fortunately, as far as Macs and ATs are concerned, the information-sharing possibilities are fairly well developed and can be had in a number of ways at a number of prices. Naturally, every solution isn't perfect, and every solution isn't cheap.

Since I'm more of a Mac user than a DOS user, I'll describe connections primarily from the Mac's point of view.

From the Mac, you can share information with DOS machines in several ways: direct serial connections between Macs and PCs, coprocessors that run DOS, coprocessors that run DOS or DOS emulations, disk drives that can read DOS and Mac files, and local area networks (LANs). Each method has its strengths and weaknesses.

Direct Serial and SCSI Connections

Direct serial connections offer the simplest solution. All you need is an RS-232C-compatible cable to connect the Mac's modem serial port to the COM1: serial port of the PC and some file-transfer software. Public domain terminal applications that support the Kermit and XMODEM file-transfer protocols are available for the PC and the Mac, so cost can be negligible.

The cable needed to make the connection will run you about $30 for a 12-foot length at most computer stores. Shorter cables, like the Apple Imagewriter I cable, can be purchased from authorized Apple dealers (about $30 for a 6-foot cable), although you'll also need a DB-9-to-mini DIN-8 adapter cable to use with it. Both the Mac's and the PC's serial port pin-outs are well documented, so it's easy to use some wire, parts from Radio Shack, and a soldering iron to roll your own for a lot less.

The Kermit and XMODEM protocols typically allow files to be transferred at up to 57.6K bits per second. Unless you have some special translation software or format filters, this kind of file exchange is typically limited to simple ASCII text files.

If you like your solutions prepackaged, you can buy a serial connection kit from the DataViz people. They make the popular MacLink Plus kit, which includes the necessary serial cable and software for both machines. The MacLink software works well and is a bit easier for novices to use than a public domain terminal application. It's also fairly fast at a maximum transfer rate of 57.6K bps.

But you pay for this convenience. The MacLink Plus package lists for $195, although I've seen it for as little as $130. Still, it's a good buy because the package includes a good manual and the software is nearly foolproof. Both the public domain terminal applications and MacLink Plus support modem connections for these file exchanges, in case the machines you want to connect are separated by a distance. The MacLink software will also translate the data format of many DOS data files into a format that the Mac can use, a big plus over a simple text-file transfer.

Besides direct serial connections, you can also connect your Macs and PCs using a small-computer-system-interface connection. The SCSI interface is much faster than serial ones, operating from about 1 megabit per second to 4 megabits per second. Macs already have a SCSI in-

continued

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Inquiry 824.

Apple PC drive and drive card ..$528
Apple Computer Inc.
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Cupertino, CA 95014
(408) 996-1010
Inquiry 820.

AST Mac286 1.1 .... $1599
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Irvine, CA 92714
(714) 863-1333
Inquiry 821.

DaynaFile
360K-byte 5¼-inch drive........$595
360K-byte 5¼-inch drive and
720K-byte 3½-inch drive $849
Dayna Communications, Inc.
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Salt Lake City, UT 84144
(801) 531-0600
Inquiry 822.

MacLink Plus $195
DataViz
35 Corporate Dr.
Trumbull, CT 06111
(203) 866-4944
Inquiry 823.

QuickShare $465
Compatible Systems Corp.
P.O. Drawer 17220
Boulder, CO 80308
(303) 444-9532
Inquiry 825.

SoftPC $595
Insignia Solutions, Inc.
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Suite 625
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Inquiry 826.

TOPS/Macintosh $249
TOPS/DOS
(requires Flashcard) $189
TOPS Flashcard $239
TOPS, a Sun Microsystems Co.
950 Marina Village Pkwy.
Alameda, CA 94501
(415) 769-9669
Inquiry 827.

terface built into them, so that end of the connection is taken care of. You'll need a SCSI card for each PC, though. A SCSI card will run you about $450, according to recent mail-order ads I've seen. You'll also need some special transfer software to work across the SCSI link. Compatible Systems makes QuickShare, a product that not only allows you to transfer files between the two machines, but lets you create and use a Mac Hierarchical File System volume on the PC's hard disk. It costs $465. Still, if you frequently exchange a number of large files between a Mac and a PC, the fast SCSI connection may be a good alternative, despite the high equipment cost.

DOS Coprocessing

If you're like me, you long for a single computer that will run software from a variety of operating systems and transparently share files among the different systems. I'm still waiting for this hybrid machine to be built at a cost I can afford. In the meantime, I minimally need to run DOS and Mac software, but still want to reduce the number of computers I have hogging my desk.

In the last year or so, DOS coprocessing on the Mac has become a reality, offering a solution to my space problem, and at the same time offering another way to share files.

The first coprocessor available, from AST, is a set of two boards that plug into slots on a Mac II. The AST Mac286 board gives you the processing power of an 8-MHz AT inside your Mac II. At $1599, though, the cost is high, and that doesn't include the price of a drive and NuBus board you'll need to read MS-DOS disks. I've owned two of them since they first came out last November, but only since June have I been able to use them as AST intended; it took that long for the company to issue a software update to the painfully slow video drivers that came with the first release (1.0).

The Mac286 1.1 is now a nice implementation, and one that you can use as a guide to other coprocessing solutions. Such solutions should be able to read DOS files from an attached PC drive (I use the Apple PC drive); partition the Mac's hard disk so it can store DOS files; emulate monochrome, CGA, and Hercules video; and exchange files between the DOS and Mac environments using Apple's File Exchange software. AST expects to release an SE version of this coprocessor sometime this year.

Besides hardware coprocessing, at least one company, Insignia Solutions, offers a software PC emulation for the Mac II, called SoftPC. I've used SoftPC 1.01 for several months now, and it's a good product. It's slower than AST's hardware product, working at about the speed of a 4.77-MHz XT. But its video emulation is excellent, and I have not yet found any DOS software it can't run. Cutting and pasting between DOS applications and Mac applications is also supported (as it is with the Mac286). SoftPC is less expensive than the Mac286, at $595. Still, if all you need is to exchange files between the two machines, any kind of coprocessing seems like costly overkill to me.

The Disk Drive Solution

Whether you are using a hardware or a software DOS coprocessor, you need some way to read DOS-formatted disks using your Mac. If all you need is data compatibility and interchange, a DOS drive for your Mac may be all the hardware you need. Apple and Dayna Communications make PC-compatible disk drives for the Mac. The Apple drive uses a supplied controller card that plugs into either the SE's Eurobus slot or a Mac II's NuBus slot. It reads and writes 360K-byte 5¼-inch floppy disks. The Apple drive is not under Finder control directly; it won't appear on the Desktop. Instead, you read and write to it using Apple's File Exchange utilities. The Apple PC drive costs $528, including the controller card.

The DaynaFile connects to any Mac's SCSI port and can be had in a variety of formats, including 360K-byte and 1.2-megabyte 5¼-inch, and 720K-byte and 1.44-megabyte 3½-inch. The DaynaFile does appear on the Desktop, and files on the drive can be manipulated directly by the Finder and other applications. Software for PC-to-Mac and Mac-to-PC file

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translations is included, a nice touch. The price of the DaynaFile varies according to the physical formats you select, ranging from $595 for a single-drive unit up to about $850 for a dual-drive box.

Networking Solutions

All the connection methods mentioned so far have one big drawback: They require you to think about the file-exchange process and what it entails. In other words, you have to actively keep the file-transfer process in mind. One way to get around that inconvenience is to set up a LAN of shared Macs and PCs. A properly set up LAN allows you to forget where files are stored and in what format, since the LAN takes care of the necessary access protocols and file translations or filters as required.

There are currently two LAN products available that allow Macs and PCs to be connected to one another transparently: TOPS from Sun Microsystems, and Novell's Advanced NetWare for the Mac. In both cases, once you have established the LAN, with its cable connections, adapter cards (used by the PCs, since the Mac's printer port serves as its physical AppleTalk connection), and so on, the LAN software takes care of the rest.

The software translates data files from a native DOS format to one that a Mac can read, and vice versa (depending on the applications software, of course). It also provides transparent access to printers (including PostScript devices), stores files as needed on any available network hard disk, and provides electronic mail services. In short, a complete LAN implemented across two different operating systems (DOS and Macintosh) provides a high level of interoperability that you just can't get with any of the other file-exchange methods I've listed.

A TOPS network will cost you about $250 per Mac, and about $430 per PC (including the necessary PC-AppleTalk card), plus the cost of LocalTalk cabling. A Novell LAN costs about $899 for the server software and another $300 for each of the PC adapter cards needed. The level of file integration and exchange, however, is the current state of the art. ■

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

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

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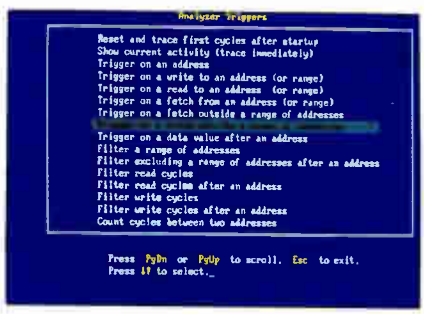

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DOS 4.0

The world's most widely used operating system finally gets a friendly interface

The familiar C> prompt of DOS is perhaps the most common sight in the computer world today. To first-time users, it is probably also the most intimidating. Many programs have sought to rectify this situation, and some have succeeded nicely. Now, in version 4.0, DOS can finally mask itself from users.

DOS 4.0, from IBM and Microsoft, has a number of new utilities and some minor improvements to existing utilities. It can also handle disk drives larger than 32 megabytes. But the most significant change for the new DOS is its DOS Shell, a graphics-based interface that features windows, pull-down menus, and mouse support.

Hiding the C> Prompt

Anyone who has looked at other personal computers and then glanced back at the C> prompt of DOS has realized that something was lacking. A number of software manufacturers, such as Executive Systems (manufacturer of XTree) and Peter Norton Computing (the Norton Commander) have created menu-based interfaces for DOS. These packages display a menu of programs or files in a directory and allow you to "point and shoot" to run the individual programs.

But despite all these developments, the underlying DOS retained much the same look and feel as it had back in 1981. Until this summer, that is, when IBM and Microsoft released DOS 4.0. The DOS Shell included with 4.0 is a clear first step toward user-friendliness. But, like many first steps, it does exhibit a certain amount of unsteadiness.

The New Shell Game

The DOS 4.0 Shell program (see photo 1) runs on a wide range of graphics display adapters. On a VGA, the program takes advantage of the 480- by 640-pixel resolution that is available and offers up an impressive image, complete with icons and windows. The program also runs effectively on other adapters, including EGA, CGA, and even the nongraphics MDA. Unfortunately, the program suffers from IBM's "not-invented-here" syndrome: It does not support the popular Hercules monochrome graphics adapter.

The DOS Shell basically consists of two parts: a front-end menu called simply "Start Programs" and a file-handling module called the File System. The Start Programs menu allows you to quickly select one of several "programs" or batch files. Each batch program can have a long descriptive name and its own help message, which you can call with the F1 key.

Think of the Start Programs menu as an enhancement of the batch-file capability of DOS. With the enhanced batch commands, you can write a batch program that will display a window and prompt the user for additional information. You can also set up the batch program to run only when the user enters the correct password.

For example, if you have trouble remembering how to use the Find utility in

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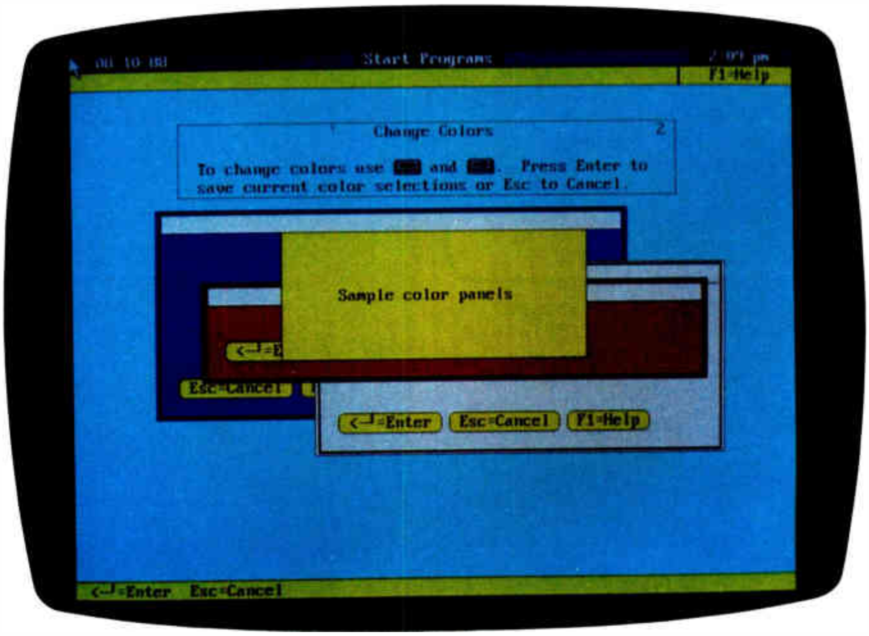

Photo 1: *The most striking feature of DOS 4.0 is its Shell program. The first part of the program, called "Start Programs," consists of a menu of possible batch programs to run. One of these programs allows the user to change the colors used by the Shell program.*

DOS, you can set up a batch program called "Find a Text String in a File." You can write the program so that it asks the user for the string to search for and the name of the file to look at. The batch program can then call the Find program and feed it the parameters in the correct order.

One problem with the batch programs is that you can edit them only through a small, horizontally scrolling window. Another possible deficiency is that, though most older batch commands are supported, GOTO is not.

Easy File Handling

The second interesting part of the DOS Shell is the File System module (see photo 2). This module, which you call from the Start Programs menu, starts up by showing two windows. On the left is a graphical representation of the subdirectory structure of a disk drive; on the right is a scrolling list of files from one of the directories.

You can use the File System to do many of the traditional DOS tasks. Once selected, files can be easily copied, deleted, or moved. The files can be viewed (in ASCII and hexadecimal code), and their attributes can be changed (read-only, hidden, or archived).

You can also associate a particular filename extension with a certain application. Then, when you select a filename with that extension, the associated application is executed with the filename as a parameter.

While the Shell does have some nice features, it seems to fall short in a couple of areas. One is size. All the files needed to run the Shell will almost completely fill a 360K-byte disk. The DOS Shell seems aimed at hard disk drive systems. On a floppy disk-based system with one disk each for the DOS Shell, applications, and data, you will find yourself doing a lot of disk swapping.

You may also be doing quite a bit of waiting. The DOS Shell seems to do a significant number of disk accesses. For example, despite its large size, the DOS Shell program has no DOS-like capabilities; if you select a simple DOS function, such as showing a directory, the Shell has to take the time to reload COMMAND.COM, list the directory, and then reload the Shell.

Of course, you can speed up the program by running it in "resident" mode, but then you run into memory problems. In its usual "transient" mode, the Shell will transfer control back to the operating system, leaving a small resident kernel of 10K bytes. The small kernel will

continued

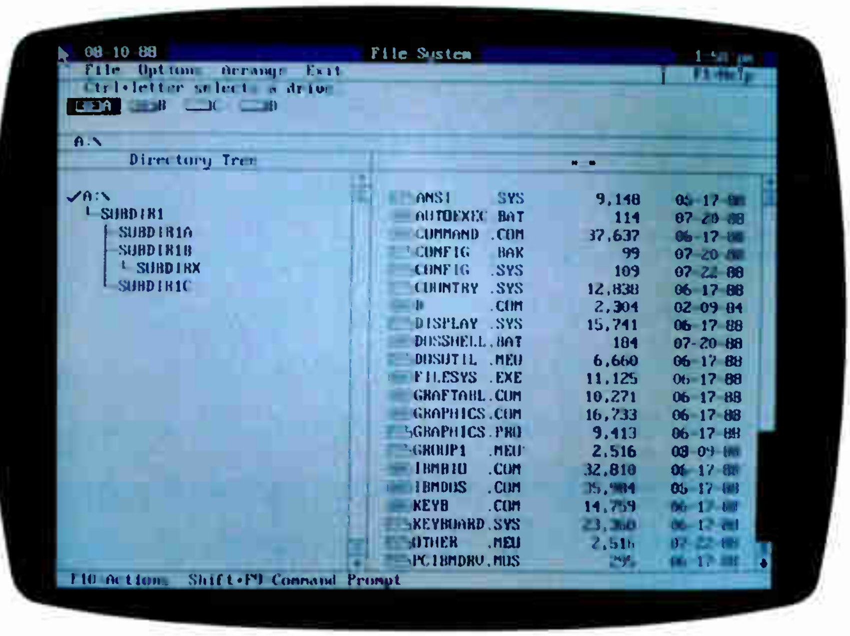

Photo 2: *The File System module of the DOS 4.0 Shell program allows easy access to individual files. In this representation of the File System menu, which was generated on a VGA display, there is a graphical representation of the subdirectory tree structure on the left and a scrolling list of filenames on the right. Along the top is a list of pull-down menus. The File System module allows you to copy, delete, move, and execute files easily.*

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While the DOS 4.0 Shell has a number of nice features, it seems to fall short in a couple of areas.

call back the rest of the Shell program when you type EXIT on the DOS command line.

In resident mode, however, the Shell stays completely in memory all the time. In fact, it leaves little room for anything else. The version I tested, which obviously had a bug, left only 65K bytes available for other programs. This was not even enough to run the CHKDSK utility. Curiously, the program always left 65K bytes, no matter how much memory it had available to begin with.

The program's support for mouseless systems is less than you might expect from a company that developed Windows and Excel. In fact, for keyboard-based users, there is enough of a difference between the Shell and Microsoft Windows to be somewhat annoying. For example, the Shell, like Windows, displays a horizontal row of menu names at the top of the screen. In Windows, you can call the pull-down menus associated with these names by using a simple Alt key combination. In the Shell, however, you must either hit the Tab key until the cursor moves up to the menu row or hit F10. You can eliminate this problem by using a mouse, but then another problem arises: speed. When I used a Microsoft mouse on a 6-MHz AT clone, there was a very noticeable delay each time I selected an item.

One other concern about the Shell involves copy protection. The new Shell is not exactly copy-protected, but it is not easily copied, either. IBM has provided a program, called SELECT, that helps you install the operating system on your hard disk or a set of floppy disks. Once you install the operating system, you can copy it to other floppy disks.

For some strange reason, however, IBM has decided to copy-protect the SELECT program. It will run only when you execute it from the original IBM floppy disk. In fact, IBM has employed an old but simple copy-protection trick: SELECT looks for a certain hidden file of length 0.

Another problem with SELECT is that it does not recognize certain non-IBM hard and floppy disk drives. You may be forced to install your system on floppy disks and then copy it over to your hard disk.

New DOS Utilities Keep Track of Memory

DOS 4.0 has an interesting new utility, MEM, that is designed to show how your system memory is allocated. If you invoke the program using the command MEM/PROGRAM, the program will display a memory map showing which program uses which areas of memory.

In addition, some of the existing commands have been enhanced. Many of the commands, such as BUFFERS and VDISK, can now make use of non-IBM expanded memory. I could not, however, get this feature to work with my Intel Expanded Memory Specification card.

The DEL or ERASE command now has a /P parameter. With this parameter set, the program will ask you to verify each program before it is erased.

Perhaps most important, the utility FDISK now allows you to create partitions on your hard disk that are larger than 32 megabytes.

Replace Your Old DOS?

The new version of DOS is significantly different from previous versions. But with a price of $150 for the IBM version ($90 for an upgrade), it is also significantly more expensive. Many users may opt to continue to use older versions of DOS with existing DOS shells. Others may choose environments such as Windows or DeskMate.

Of course, if you require support for very large hard disk drives, DOS 4.0 is almost a necessity. However, other users may prefer to stick with the old C> prompt. If nothing else, it rarely gets in the way.

One other hesitation you may have about the new DOS is that it is probably not compatible with many programs that directly access disk drives. For example, old versions of the Norton Utilities will crash with the new DOS. But, by the time you read this, new versions of these utilities will probably be available for DOS 4.0. ■

Rich Malloy is the associate managing editor of BYTE's news and technology section. He can be reached on BIX as "rmalloy."

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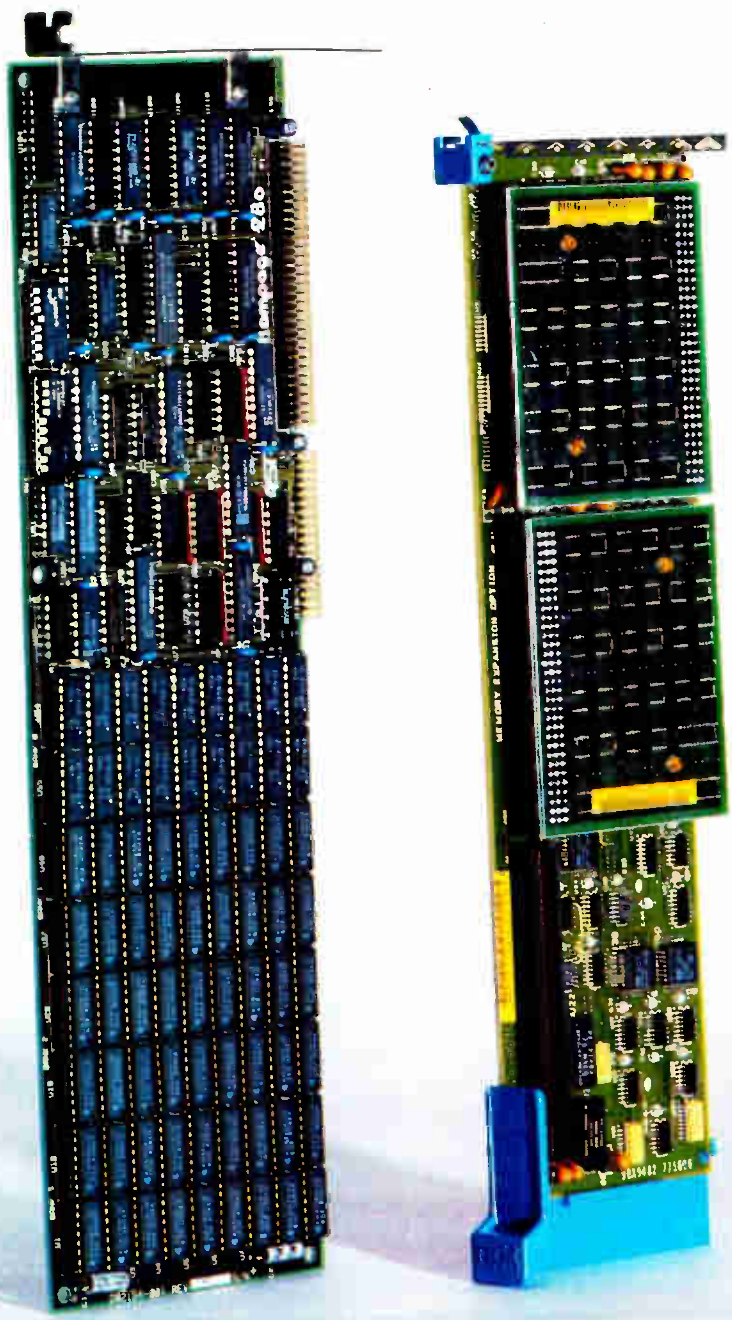
MEMORY BOARD ROUNDUP

How PS/2 memory boards stack up against those for the PC, XT, and AT systems



One of the first questions that comes to mind when you're trying to evaluate the IBM Micro Channel architecture (MCA) is: How many boards are available for it? That's a question we asked ourselves recently, and we figured that now is as good a time as any to find out.

Of course, if we wanted to count all types of boards, we'd probably have to devote a whole issue of the magazine to the task. Instead, we narrowed our search to one segment of the add-in board market. And for a control group, we looked at the corresponding group of boards avail-

continued

MEMORY BOARDS FOR THE PC/XT/AT SYSTEMS

Company	Board	Host system	Bus type (bits)	Standard memory (bytes)	Maximum memory (bytes)
American Micronics	Elephant-5	AT	16	0K	5M
AST Research	Advantage[1,3]	AT	16	128K	1.5M
	RAMpage 286	AT	16	512K	2M
	RAMpage Plus 286	AT	16	512K	8M
	RAMvantage!	AT	16	128K	3M
Boca Research	BocaRAM/AT	AT	16	0K	4M
	BocaRAM/XT	PC/XT/AT	8	0K	2M
	TophAT	AT	16	128K	128K
Cheetah International	Combo	AT	16	0K	1.5M
Club AT	Maxi-Magic EMS	PC/XT	8	0K	2M
Comark	CAT C-RAM	AT	16	0K	1M
	CAT D-RAM	AT	16	0K	4M
Computer Elektronik	XDrive	AT	16	1M	1M
DigiBoard	DigiRAM/3MB	AT	16	N/A	3M
Everex Systems	Magic Card 1[1,2]	PC/XT/AT	8	0K	384K
	RAM 10000	AT	16	0K	10M
	RAM 3000 Deluxe	AT	16	0K	3M
	Mini Magic Card	PC/XT/AT	8	0K	576K
IDEAssociates	IDEAmax 30	PC/XT/AT	8	0K	8M
	Supermax 30[1,3]	PC/XT/AT	8	0K	8M
	Supermax/EMS[1,3]	AT	16	0K	16M
Intel	Above Board 286	PC/XT/AT	16	512K	2M
Micron Technology	1-Mb EMS Board	AT	16	1M	4M
	2-/4-Mb Extended Memory DIP Board	AT	16	2M	4M
	2-Mb Expanded Memory Board	PC/XT/AT	8	2M	2M
	4-Mb Extended Memory ZIP Board	AT	16	4M	4M
	6-/16-Mb Extended Memory DIP Board	AT	16	6M	16M
	PC/AT & compatibles 2-/4-Mb EMS Board	AT	16	2M	4M
Monolithic Systems	JustRAM/AT16	AT	16	2M	16M
	JustRAM/ATX	AT	16	2M	16M
	JustRAM/ATZ	AT	16	2M	8M
Newer Technology	attention!	AT	16	0K	4M
PC Technologies	286 RAMRacer	PC/XT/AT	8	0K	2M
	RAMPartner	AT	16	0K	2M
Profit Systems	Elite 16[1,2]	AT	16	512K	16M
STB Systems	Memory Companion/PC	PC/XT/AT	8	2M	2M
	Rio Plus II[1,2]	PC/XT/AT	8	64K	576K
Suntek	MemoPlus AT	AT	N/A	0K	2M
Tall Tree Systems	JRAM AT2	AT	16	0K	2M
	JRAM AT4	AT	16	0K	8M
Tecmar	Captain 286[1,2]	AT	16	128K	16M
Veritek	Low Profile Mega Mem	AT	16	0K	2M

[1] Parallel port [2] Serial port [3] Two serial ports

Chip size (bits)	Chip speed (ns)	Memory Standard: Extended memory	EMS	EEMS	EMS 4.0	Price	Warranty period (years)	Comments
256K	60-120	●	●	○	○	$439	2	EMS 4.0 supported by software.
256K	120	●	○	○	○	$399	2	Optional piggyback board supports 3 megabytes.
256K	100, 120	●	●	●	○	$695	2	Includes software driver for EMS 4.0.
256K, 1M SIMMS	85, 100, 120	●	●	●	○	$895	2	Includes software driver for EMS 4.0.
64K, 256K	120	●	○	○	○	$445	2	
256K	120, 150	●	●	○	○	$225	2	Includes software driver for EMS 4.0.
256K	150	○	●	○	○	$175	2	Includes software for EMS 4.0.
64K	150	○	○	○	○	$165	2	
256K	60	●	○	○		$39		Runs at zero wait states in protected mode.
256K	100	●	●	○	●	$89	1	
256K	120	●	○	○	○	$235	1	Can support up to 1 megabyte of NMOS, CMOS, and EPROM devices; has on-board lithium cell rated at 2 amps.
256K	100	●	○	○	○	$310	1	
Static RAM CMOS	120	○	○	○	○	$1090	2	
64K	120	●	○	○	○	$319	1	
64K, 256K	150	○	○	○	○	$199	1	
256K	150	●	○	○	●	$399	1	
256K	150	●	○	○	●	$228	1	
64K, 256K	150	○	○	○	○	$99	N/A	
256K, 1M SIMMS	120	○	●	○	●	$275	1	
256K, 1M SIMMS	120	○	●	○	●	$395	1	
256K, 1M SIMMS	120	●	●	○	○	$425	1	
256K	120, 150	●	○	○	●	$645	5	Version of board available with serial and parallel ports.
256K	100	●	●	●	●	$895	2	Full 16-bit data transfers at all speeds; mappable backfill for multitasking; RAM disk and print spooler software included.
256K	100	●	○	○	○	$1345	2	Includes RAM disk and print spooler software.
256K	150	●	○	○	○	N/A	2	Includes diagnostics, RAM disk, and print spooler.
N/A	N/A	●	○	○	○	N/A	2	Includes diagnostics, RAM disk, and print spooler.
1M	100	●	○	○	○	N/A	2	Includes diagnostics, RAM disk, and print spooler.
256K	N/A	○	●	○	○	N/A	2	Mappable back to support multitasking applications; full 16-bit data transfers at all speeds; includes RAM disk and print spooler.
1M	100	●	●	○	○	$1888	5	Includes software for EMS 4.0.
1M	100	●	○	○	○	$1885	5	Includes disk-cache software.
1M	100	●	●	○	○	$1721	5	Includes software drivers for EMS, RAM disk, and disk cache.
256K	120	●	○	○	○	$250	1	Includes software drivers for RAM disk and print spooler; optional EMS in software.
256K	150	○	●	●	○	$595	2	Includes 512K-byte daughtercard; optional 80287 math coprocessor.
256K	150	○	●	●	○	$250	2	
256K, 1M SIMMS	120	●	○	○	●	$695	5	
64K, 256K	120	○	●	○	○	$1595	2	
64K, 256K	120	○	○	○	○	$269	2	
256K	120	●	●	○	○	$135	1	Includes software for EMS 4.0, RAM disk, and print spooler.
256K	120	●	●	○	○	$349	N/A	
1M	120	●	●	○	○	$399	1	
1M SIMMS	100	●	●	○	○	$57	2	
256K	150	●	○	○	○	$279	2	

● Yes ○ No N/A=Not available

MEMORY BOARDS FOR THE PS/2 MCA SYSTEMS

Company	Board	PS/2 model	Bus type (bits)	Standard memory (bytes)	Maximum memory (megabytes)
AST Research	Advantage 2/386	70, 80	32	1M	8
	Advantage/2	50, 60	16	0K	8
	RAMpage Plus/MC	50, 60	16	0K	8
	RAMpage/2-286	50, 60	16	0K	2
Boca Research	BocaRAM 50/60	50, 60	16	0K	4
Chrislin Industries	CI-SYS2-56	50, 60	16	2M	8
CMS Enhancements	MC-8000	50, 60	16	0K	8
Computer Elektronik	Micro Four	50, 60	16	0K	4
Everex Systems	RAM II 2000	50, 60	16	0K	2
	RAM II 4000	50, 60	16	0K	4
IBM	80286 Expanded Memory Adapter/A	50, 60	16	2M	2
	80286 Memory Expansion Kit	50, 60	16	512K	2
	80386 Memory Expansion Option	70, 80	32	2M	6
IDEAssociates	IDEAmax/MC	50, 60	16	0K	12
	IDEA Supermax/MC[1]	50, 60	16	0K	8
Intel	Above Board/2	50, 60	16	0K	2
Monolithic Systems	JustRAM/MC8	50, 60, 70, 80	16	2M	8
Orchid Technology	RamQuest Extra[1]	50, 60, 70, 80	16	0K	8
	RamQuest II	50, 60	16	1M	2
Profit Systems	Elite 16/2	50, 60, 70, 80	16	512K	16
Quadram	QuadMEG PS/Q	50, 60	16	512K	4
STB Systems	RapidRAM 2	50, 60	16	2M	2
	RapidRAM 2/8	50, 60	16	2M	8
Tecmar	MicroRAM 50/60	50, 60	16	0K	8
	MicroRAM AD	50, 60, 70, 80	16	0K	8

[1] Has two serial ports.

able for the industry-standard PC, XT, and AT systems.

Next, we had to decide which segment of the market to concentrate on. We could look at graphics boards, but since the PS/2s have graphics on the motherboard, there would naturally be a smaller number of graphics boards available for these systems. The same would apply to multifunction cards, since the PS/2s already have a parallel and serial port.

We could do a roundup of modems, but that's a rather specialized area. A much more basic need is memory, a resource that we never seem to have enough of. Unless you have one of the new systems that can accommodate up to 8 megabytes on the motherboard, chances are you'll need to buy a memory board at some point.

To get a more or less complete listing

Chip size (bits)	Chip speed (ns)	Memory Standard			Price	Warranty period (years)	Comments
		Extended memory	EMS	EMS 4.0			
256K, 1M SIMMS	85	●	○	○	$1395	2	
256K, 1M SIMMS	150	●	○	○	$345	2	
256K, 1M SIMMS	100	●	○	●	$595	2	Optional serial or serial/parallel port piggyback card available; includes software driver for EMS 4.0.
256K, SIMMS	120	●	○	○	$495	2	
1M	120	●	○	○	$295	2	Includes EMS-emulation software.
1M	100	●	○	●	$975	5	4K-byte user-programmable PROM.
256K, 1M SIMMS	120	●	○	●	$395	N/A	
1M	100, 120, 80	●	○	○	$399	2	
1M	120	●	○	●	$399	1	
1M	120	●	○	●	$499	1	
256K	120	●	○	○	$1460	1	Requires and supports device drivers resident within the 3270 workstation program and operates as contiguous memory with OS/2.
512K	150	●	○	○	$630	1	The $165 expansion kit includes 512K bytes to increase memory on option.
256K	80	●	○	○	$1695	1	The $1295 expansion kit includes 2 megabytes; two kits can be added to board to get maximum memory.
256K, 1M SIMMS	120	●	●	○	$395	1	
256K, 1M SIMMS	120	●	●	○	$545	1	
256K, SIMMS	100, 120	●	○	●	$445	5	Includes RAM disk and print spooler software.
1M	100	●	●	○	$1888	5	
256K, 1M	100, 120	●	●	○	$599	4	
256K	100, 120	●	●	○	$849	4	
256K, 1M SIMMS	120	●	○	●	$595	5	
256K, 1M	120	●	○	●	$545	1	Uses SIMM memory; includes RAM disk and print spooler software.
1M	100	●	○	●	$1595	2	10-MHz zero-wait state rapid MAP utility to increase software performance.
1M	100	●	●	○	$1695	2	
1M	100	●	○	●	$350	2	Optional dual serial/parallel adapter; uses SIMM chips.
1M	100	●	○	●	$445	N/A	Optional I/O modules with two serial ports or one parallel and one serial port.

● Yes ○ No N/A=Not available

of available memory cards for both PS/2 MCA systems and PC, XT, and AT systems, we enlisted the help of our McGraw-Hill sister company, Datapro Research. Datapro publishes the *Datapro Reports on Microcomputers*, which continuously keep track of microcomputer systems, peripherals, and software.

By combining our information resources with those of Datapro, we came up with a total of 25 boards available for the PS/2s and 42 memory boards for the PC, XT, and AT systems. As you might expect, there are more boards available for the PC, XT, and AT systems—but not that many more. ■

Rich Malloy is the associate managing editor of BYTE's news and technology section. He can be reached on BIX as "rmalloy."

Company Information

American Micronics, Inc.
17811 Skypark Cir., Suite H
Irvine, CA 92714
(714) 261-2428
Inquiry 866.

AST Research, Inc.
2121 Alton Ave.
Irvine, CA 92714
(714) 863-1333
Inquiry 867.

Boca Research, Inc.
6401 Congress Ave.
Boca Raton, FL 33487
(407) 997-6227
Inquiry 868.

Cheetah International, Inc.
107 Community Blvd., Suite 5
Longview, TX 75602
(800) 243-3824
Inquiry 869.

Chrislin Industries
P.O. Box FF
Canovanas, PR 00629
(800) 468-0736; in Puerto Rico,
(809) 876-5205
Inquiry 870.

Club AT, Inc.
46707 Fremont Blvd.
Fremont, CA 94539
(415) 490-2201
Inquiry 871.

CMS Enhancements, Inc.
1370 Valencia Ave.
Tustin, CA 92680
(714) 259-9555
Inquiry 872.

Comark Corp.
93 West St.
Medfield, MA 02052
(617) 359-8161
Inquiry 873.

Computer Elektronik Infosys
Trade Ventures International
512-A Herndon Pkwy.
Herndon, VA 22070
(703) 435-3800
Inquiry 874.

DigiBoard
6751 Oxford St.
St. Louis Park, MN 55426
(612) 922-8055
Inquiry 875.

Everex Systems, Inc.
48431 Milmont Dr.
Fremont, CA 94538
(415) 498-1111
Inquiry 876.

IBM Corp.
Old Orchard Rd.
Armonk, NY 10504
(800) 426-2468
Inquiry 877.

IDEAssociates, Inc.
29 Dunham Rd.
Billerica, MA 01821
(617) 663-6878
Inquiry 878.

Intel Corp.
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Elam Young Pkwy.
Portland, OR 97124
(800) 538-3373
Inquiry 879.

Micron Technology, Inc.
2805 East Columbia Rd.
Boise, ID 83706
(208) 383-4000
Inquiry 880.

Monolithic Systems Corp.
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Englewood, CO 80112
(303) 790-7400
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Orchid Technology
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(313) 996-9690
Inquiry 427.

Profit Systems, Inc.
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Inquiry 428.

Quadram Corp.
One Quad Way
Norcross, GA 30093
(404) 564-5566
Inquiry 429.

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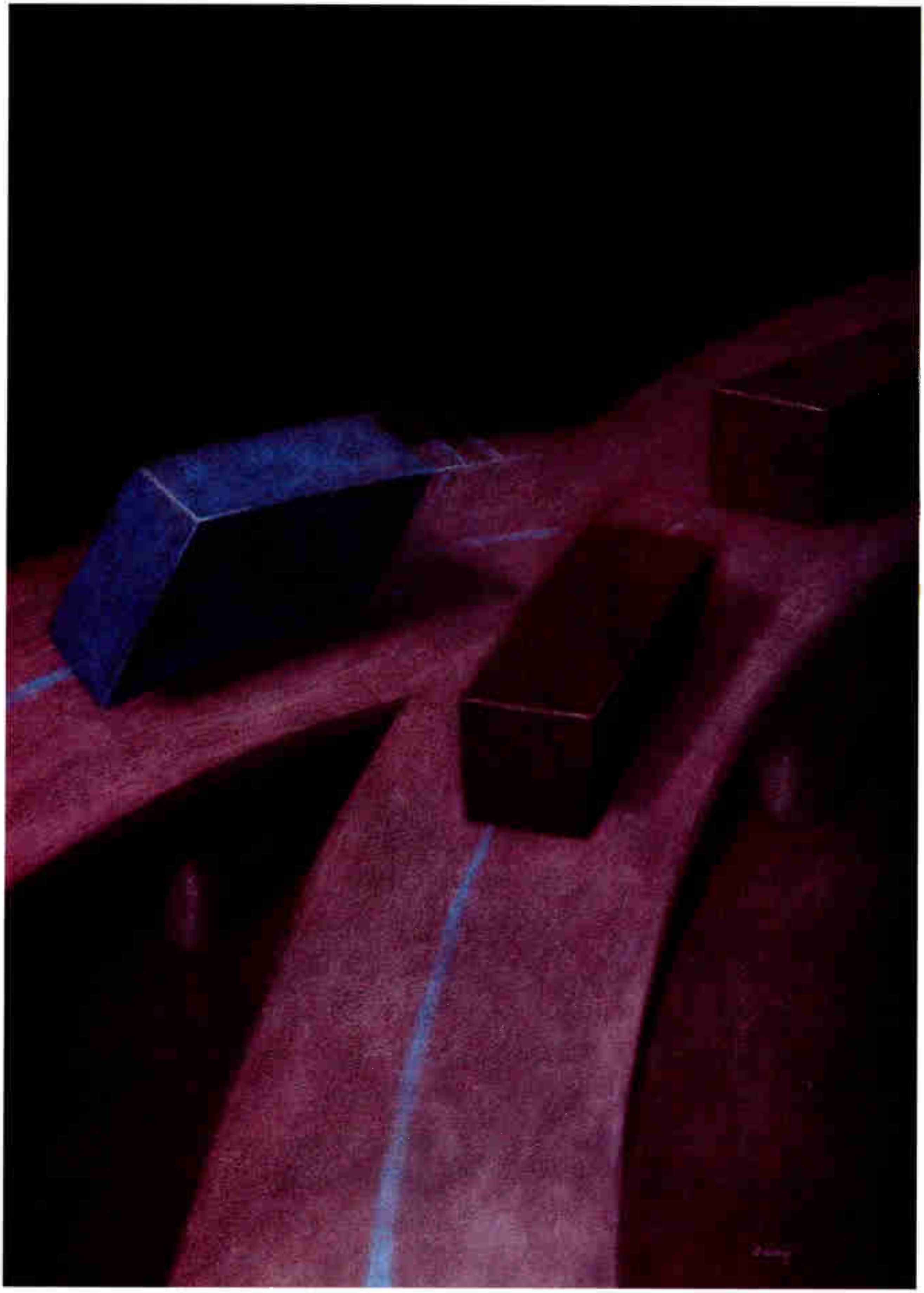

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The Micro Channel versus the AT Bus

IBM changed the rules with the PS/2's Micro Channel architecture, but a lot of AT fans aren't playing along. Should you?

Kerry Newcom

Shortly after IBM introduced the PS/2s in April 1987, it stopped making the IBM PC, XT, and all but one model of the AT. The PS/2 machines offered more performance and a new, modular design.

But the most radical change was the sharp break with the hardware bus standard for expansion cards that IBM had established in 1981. Except for the low-end PS/2 models, IBM's original PC bus design is gone, replaced by the Micro Channel architecture. The MCA offers the promise of better throughput and multiprocessing, though these features have taken longer to be exploited than was expected.

Had any other company introduced them, the PS/2s would have been hailed as innovative, clever, technically progressive, and destined to fail due to lack of IBM compatibility. But IBM's marketing muscle worked to ship more PS/2s in a shorter period than any other computer ever built. Other vendors are building MCA expansion boards or adopting the MCA bus in their latest computers. For example, Dell and Tandy recently announced computers featuring an MCA-compatible expansion bus.

Meanwhile, other vendors offer microcomputers using the AT bus, the industry standard established by IBM and now championed by industry giants like Compaq. A multitude of expansion cards are available for the AT bus, and clever designers have worked around some of its limitations while providing high-performance processing.

So which computer architecture is best for solving today's problems? The best way to answer that question is to tackle the technical merits of the AT bus and the Micro Channel head-on.

Where's the Standard?

If you want to compare the Micro Channel with the "industry-standard" AT bus, it's necessary to define the industry standard, and that's not as easy as it sounds. The original AT has evolved into several diverse high-end computers; to figure out where the industry standard is headed, it's best to look at its roots.

The Micro Channel and the AT bus are both extensions of the local processor bus; that is, they're processor-specific and defined by the processor's signals. The original PC bus resembled the 8088 processor. The AT bus expanded the capabilities of the PC bus, in the same way the 80286 processor expanded the capabilities of the 8088. If there ever was an industry-standard bus, it stopped with the IBM Model 339: This was IBM's last AT-bus machine and was based on an 8-MHz 80286 processor. The significant thing about this industry-standard bus is that timing and mechanical specifications were never published in the IBM AT *Technical Reference* manual.

When IBM failed to publish timing specifications for the AT, it forced every third-party manufacturer to derive the bus timing from the schematics—a design approach with some major pitfalls. The first pitfall is that there is no guarantee that what's in the schematics matches what's in the production units.

The second pitfall has to do with the fact that to remain competitive, every clone manufacturer wants its computer to have the highest performance. The easiest way to do this is to turn up the processor clock. As the clock speed increases, the design margin (i.e., the spare time that the bus has to complete an operation) decreases. If you increase the processor clock rate sufficiently, the design margin for cards built for the original AT disappears and the expansion cards begin to fail. Since the bus timings were derived from schematics, the exact margins are unknown.

At this point the manufacturer has a choice between a fast, low-cost product with potential reliability problems and a fast, costly product that will work reliably. The additional cost comes from the circuitry required to couple a high-speed processor with a slower system bus.

Most manufacturers opted for reliability and designed the AT bus to run at a slower speed than the processor. This approach maintains compatibility with existing third-party add-in cards. It also improves reliability but ignores the original need for speed. The only way to boost the computing power is to design a

continued

Table 1: *The signals for the AT bus and MCA bus compared. Note the additional signals for arbitration and control on the MCA bus.*

Signal type	AT bus	Micro Channel	Definition/comments
Processor	SA0 SA19 latched	A0-A31 unlatched	Address lines
	LA17 LA23 unlatched	MADE 24	
	D0-D15	D0-31	Data lines
	BALE	ADL	Address latch
		SBHE, S0, S1, M/-IO	Memory and I/O status
	SMEMW, MEMW		Memory and I/O enables
	SMEMR, MEMR		derived from processor signals
	IOR, IOW		
Memory	REFRESH	REFRESH	
	I/O CH CHCK	CHCK	Parity or serious system error
DMA/bus master control	DRQ0-3 5-7	-PREEMPT	DMA request
		ARB 0-3	
	DACK0-3 5-7	ARB/GNT	DMA acknowledge
	TC	TC	Terminal count
		BURST	
Interrupts	IRQ3-7, IRQ9-12, 14, 15	IRQ3-7, IRQ9-12, 14, 15	
	RESET	CHRESET	Reset
	MEM CS 16	CD DS 16	Control signals
	I/O CS 16	DS 16 RTN	for 16-bit transfers
Clock	OSC	OSC	14.3 MHz
AT-specific	0WS		Zero wait states
	CLK		8 MHz
	MASTER		Used to gain bus control
	AEN		Address enable
MCA-specific		CD SETUP(n)	
		CMD	
		CD SFDBK(n)	
		CD CHRDY(n)	
		CHRDYRTN	
		CD DS 32(n)	
		DS 32 RTN	
		TR 32	MC 32-bit bus masters
		BE0-3	Byte enable
Advanced memory		MMC	Matched memory cycle
		MMCR	
		MMC CMD	
Video		VSYNC, HSYNC, BLANK	
		P7-0, DCLK, ESYNC, EVIDEO,	
		ED CLK	
Audio		AUDIO	
		AUDIO GND	

high-speed local memory bus that can keep pace with the processor. Fast static RAM (SRAM) or interleaved memory addressing is used to satisfy the speed requirements of the processor without wait states. Exotic support chips for numeric processing and other functions are added for additional processing power.

Just when manufacturers got their 80286 machines cranked to the max, Intel introduced the 80386. IBM kept quiet about its plans for the 80386. With no one to define a standard, the manufacturers took the worst possible action—they formed a committee.

In 1986 a representative committee of several manufacturers set out to define a standard 32-bit bus for the 80386, the Personal Computer Extended Technology (PCET) bus. To keep their 80386 designs secret, none of the major players joined the committee. When the first 80386-based machines were announced in the fall of 1986, the committee disbanded and no standard was established.

Customers could always hope for a de facto standard: A standard based on largest sales or a system board that was designed into the widest variety of 80386-based machines. But no single standard has emerged. While Compaq has the largest market share for 80386 computers, Intel sells an 80386 board of its own design to a large number of system integrators. Other popular computers are based on proprietary designs different from those of both Compaq and Intel.

So what is the industry-standard AT bus that this multibillion-dollar industry is based on? It definitely isn't the old AT bus: The resemblance of this bus to the ones inside computers now blazing away at 20 MHz and 25 MHz is only superficial. As long as a computer works with most of the popular add-in cards, the industry standard is just about anything a manufacturer defines it to be. The bigger the manufacturer, the more "standard" its standard.

To reach valid conclusions, the comparisons in this article are limited to 80386-based computers. This narrows the field to the PS/2 Models 70 and 80 (which have no AT-compatible slots) and the current crop of 80386 AT-bus computers.

Basic Bus Components

An 80386-based AT-bus computer has a 20- or 25-MHz 80386 processor, an 8-MHz system bus, one or two 32-bit proprietary slots (usually for processor memory), three to six 16-bit AT-style slots, and perhaps up to three 8-bit PC-

continued

style slots. Table 1 shows the signals for a standard AT bus and the MCA bus.

The Micro Channel has 32 address and data lines, while the AT bus has 24 address and 16 data lines. AT-bus computers compensate for the smaller address range by using a local 32-bit address and data bus for processor memory. Both the Micro Channel and the proprietary 32-bit buses use fast SRAM to closely match the 80386's speed. This fast SRAM eliminates the need for processor wait states during operation; computers using it show dramatic speed improvements.

However, this type of memory is expensive. The compromise between performance versus price is that only high-end AT-bus computers (such as those from Compaq or Everex) and IBM's PS/2 Model 70 provide this type of RAM in a cache (32K to 256K bytes) that minimizes processor wait states. Despite the design differences, the performance of a top-end AT-bus PC and the top-end Micro Channel PC are quite similiar (see "IBM and Tandy: Same Channel, Same Plan for Growth," September BYTE).

That's the current situation. One thing to remember is that since there is a bigger market for the 32-bit Micro Channel than for the proprietary 32-bit buses, there should eventually be a larger choice of high-speed memory boards for the Micro Channel. With proprietary buses, the only choice of memory cards is what the manufacturer offers, and if you don't like that product you're out of luck. Proprietary or not, pricing will probably remain realistic, given the intense competition in the industry.

The MCA bus is unquestionably more difficult to design for than the AT bus. It takes more hardware to design an MCA card, because more features are required and card functions must be software-configurable. The AT bus has few requirements, and it provides decoded signals (e.g., MEMR/W, IOR/W) while the Micro Channel provides raw processor signals (e.g., S0, S1, SBHE, M/-IO).

Availability of decoded signals can simplify some of the card's logic, but you're limited by the speed of the bus decode circuitry. Raw processor signals give the add-in card designer more options: He can generate his own decode signals using expensive high-speed parts for performance or use slower, inexpensive parts to reduce costs in products where speed is not a factor. The flip side of this flexibility is that it increases the complexity of the design.

If it takes more logic to design a Micro Channel card, it's logical that MCA cards are going to cost more. How much more is probably a marketing question rather than a technical one. Current MCA add-in cards are priced 10 percent to 50 percent above their AT equivalents.

The Space Squeeze

One obvious difference between AT-bus cards and Micro Channel cards is size. MCA cards are 45 percent smaller than AT cards (see figure 1), and this real estate crunch poses all kinds of problems for designers. The smaller size of the MCA cards, combined with the required additional functions, means that most AT designs simply won't fit on an MCA card.

A few companies have designed application-specific ICs for the Micro Channel to reduce the number of ICs on an MCA card. Surface-mount ICs can also ease the space squeeze, but they increase manufacturing costs. Using similar technology, it will always be possible to cram more capabilities on an AT card than on an MCA card.

Improvements in design, competition, and market size should bring more designs to the Micro Channel and bring prices down. However, at this time, the AT bus still offers far more add-in card choices and configuration options. The additional circuitry required on an MCA card could keep the cost of simple functions higher on the Micro Channel than on the AT bus. The high-end AT cards already packed with circuits face an uphill battle in their migration to the Micro Channel, with the expected increase in cost.

Direct memory access is available on both buses, allowing high-speed data transfer between memory and I/O. However, it takes more hardware to support DMA on the MCA than on the AT bus. For example, the card must arbitrate for bus ownership, and the DMA levels are programmable in software. The benefits for the MCA can be significant.

The Micro Channel supports eight DMA devices, while the AT bus supports seven. In actual practice, DMA is usually limited to three channels on the AT bus because most DMA devices can't use four of the available channels. The reasons for this originate with the original PC bus design, which supports only three DMA channels (actually four, but one is used for memory refresh).

Most vendors design their cards to work with the PC bus, which lets them sell the card to both PC and AT owners. The problem here is that the card uses only a subset of the AT-bus functions and doesn't use the additional DMA channels at all. This crunch on DMA channels in the AT bus often leads to hardware conflicts and configuration problems. The MCA automatically resolves DMA conflicts and sets DMA priority in an elegant way through a combination of hardware and software. With eight DMA channels and a maximum of seven slots, it's unlikely that DMA conflicts will occur on the Micro Channel.

Burst-mode DMA is an idea borrowed from minicomputers and officially introduced to desktops through the MCA. It is available on the AT bus as block-mode DMA but is rarely used because it isn't well documented. Burst-mode DMA gives an I/O device uninterrupted access to the computer memory and results in a 16-bit transfer every 200 nanoseconds for data rates as high as 10 megabytes per second. In contrast, the maximum DMA rate on the AT bus is less than 1 megabyte per second. Burst-mode DMA is best used in an application where the I/O device has well-defined packets of information to transfer. It offers the potential

continued

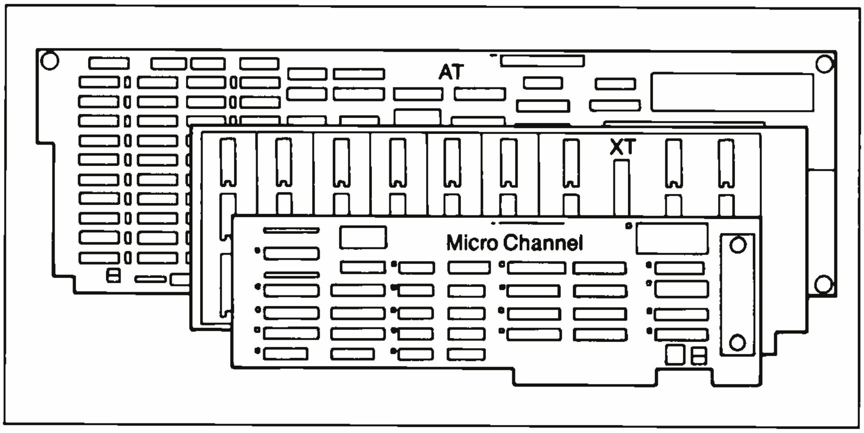

Figure 1: *The MCA card is smaller in area than either the XT or AT cards.*

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Interrupts, Multiple Processors, and Video

For AT-bus cards, there are two unsolvable interrupt problems. The first problem occurs when two cards share the same interrupt line. Because interrupt signals on an AT bus are edge-triggered, once the interrupt pulse goes away the processor has no idea which card signaled for service. So each card on an AT bus must have a unique interrupt line. The second problem occurs when a program recognizes only one interrupt level yet needs to control two different cards.

The Micro Channel solves both problems by using a signal level rather than a signal edge to send an interrupt to the processor. Because each card drives the interrupt line until it is serviced by the processor, level interrupts can be shared by two or more cards. This also solves the software problem in the same stroke and lets a designer save time by setting up and testing identically configured MCA cards with one program.

Multiple processors can be used on the AT bus and on the Micro Channel. The bus master signal (-MASTER) coupled with the DMA lines permit multiple masters on the AT bus, and the preempt signal (-PREEMPT) coupled with the DMA lines permit multiple masters on the Micro Channel. Multiple processors hold promise for a number of applications. But the lack of an independent timing specification for the AT bus makes designing a reliable multiprocessor system impossible. The MCA solves this with a set of well-defined timing specifications, but there are problems that restrict its use, including a low bus bandwidth and limited operating system.

OS/2 is a multitasking, but not a *multiprocessor*, operating system. OS/2 lets one processor do many tasks, but it has no provision to split tasks among processors. Without a multiprocessor operating system, system resources cannot be shared. This restricts a second processor to I/O tasks. The big gains that could be achieved through parallel processing will have to wait for the next generation of hardware and software.

The Micro Channel defines a video bus; the AT bus doesn't. The absence of a video bus has had no effect on the AT graphics card business, as witnessed by the large number and variety of cards on the market. However, the MCA video bus has the potential of lowering video card costs: It provides easy access to the PS/2's video D/A converter, and it also should help to standardize monitor cabling and interface circuitry.

Finally, the MCA provides an audio line and audio ground not provided on the AT bus. This line won't let you get high-fidelity sound from your computer, but it has potential for digitized voice and other analog applications.

Software Configuration

The Micro Channel's Programmable Option Select allows software configuration of the expansion cards; with the AT bus, you must set switches or move jumpers to configure the card. POS is supposed to eliminate the hassles caused by configuration switches on AT cards. The jury is still out on whether it's really an advantage or a disadvantage because of its awkward implementation.

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the Micro Channel requires software. A set of POS registers on Micro Channel cards eliminates the configuration switches but requires an adapter descriptor (.ADF) file that describes the card's characteristics to the POS software. Micro Channel boards can't be installed or removed without this .ADF file that defines their configuration. Installing a board takes about the same time on the AT as it does on the Micro Channel. With the AT card, you read the instructions, set the switches, and install the card. With the MCA card, you read the instructions, install the card, and run the configuration software. So far, so good.

Unfortunately, if you install and remove boards often, configuring a card for the Micro Channel can take much longer than for the AT. Consider the case where you want to share a card with someone. On an AT, you set the card up once, pop it out of your AT, place it in the other AT, and you're ready to run.

The same process on the Micro Channel is far more time-consuming. First, you configure your computer for the card when you install it, and then you configure the computer to forget the card when you remove it. Each time you reconfigure, you need to find your reference disk, and if you misplace the disk, you must reconfigure every board. If you don't reconfigure your Micro Channel computer after removing a card, the only error message is a decidedly unfriendly "165" code. No other message or instructions are provided. What's frustrating is that you know the computer knows what's missing, but it won't tell you anything or let you continue.

The configuration process gets even clumsier if a Micro Channel card has a hardware problem that causes a system board problem. On the AT bus, you simply pull out the questionable board and see if the problem goes away. When you pull the Micro Channel card out, you get the "165" error. You won't know if the problem went away until you reconfigure the computer. If the problem doesn't go away, you reinstall and reconfigure the board you just removed and start all over again with the next board. Software configuration is a good idea—IBM just fumbled the implementation.

Take Your Pick

So, which bus do you want for your next computer? The AT bus admittedly still enjoys a much wider selection of add-in cards. Most of the cards are priced lower than equivalent Micro Channel cards because they are simpler. Given equal technology, the larger AT-bus cards will always be able to carry more circuitry and therefore support more complex functions. The disadvantage of the AT bus is that it has run out of steam: It can't go any faster, and it has limited interrupt and DMA capability. AT-bus computers have managed to remain competitive, but at the expense of proprietary designs that lose some of the advantages of an open-architecture system.

The Micro Channel's main advantage is that it is a well-defined 32-bit standard. Mechanical, electrical, and timing parameters are carefully defined and readily available from IBM. This should lead to better, more reliable products. The Micro Channel was born a 32-bit standard, separate from the AT and free to break new ground. Unfortunately, AT hardware is not compatible with it.

Each bus offers a set of advantages and disadvantages. How you weigh them will determine which computer is best for you. If you own a lot of AT-bus cards, you have strong incentive to stick to an AT-bus computer. Aggravating the decision process is that while the MCA is a better design, it is not overwhelmingly better. Hopefully, IBM will clean up the POS software's act. The MCA has a lot of untapped potential, like high-speed DMA, video, and sound capabilities.

If you're just beginning to automate your office, there's not much risk in seeing if the MCA will live up to its promise. And if you plan to own your computers for the long haul, remember that the MCA offers a well-documented 32-bit bus standard—something AT-bus computers don't. ■

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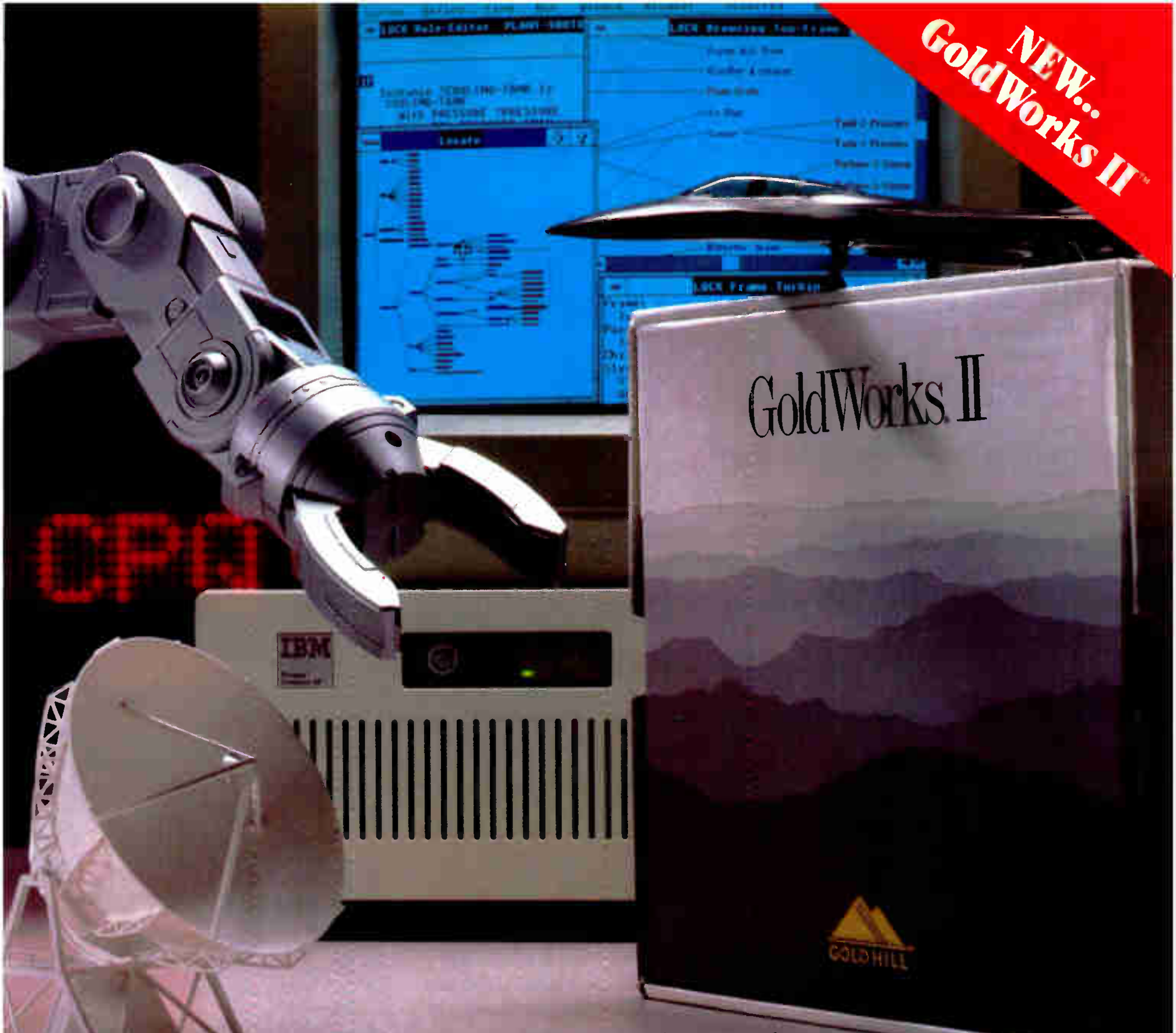

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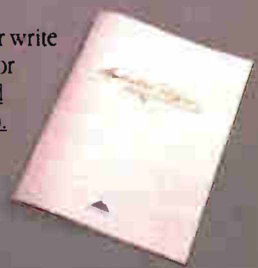

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KEEPING UP WITH THE CPU

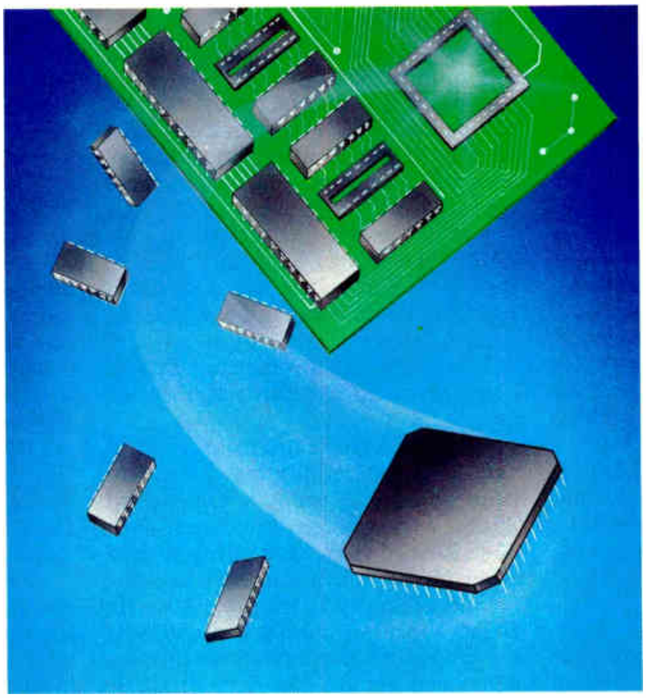
Today's microprocessors are so fast that they can overwhelm system memory

Mark L. Van Name

Most ads for personal computers based on Intel's 32-bit 80386 CPU trumpet the same two things: the price and the processor speed. First, such systems ran at 16 MHz, then at 20 MHz, and now the current performance leaders use 25-MHz 80386s. Unfortunately, as you can tell from a quick look at any table of benchmark times, processor speed is not the only thing that determines a system's overall performance. One other factor that is playing an increasingly important role in the performance of the new crop of high-speed 80386-based microcomputers is memory architecture.

As long as computers ran no faster than 8 or 10 MHz, their memory architecture was not an issue; normal dynamic RAM was fast enough. Most DRAM, however, cannot keep up with the newer, fast processors. While this problem is relatively new to microcomputers, minicomputer and mainframe designers have had to face it for some time.

The performance penalty for slow memory is similar to that for any other slow system component: Every time you use it, overall system performance suffers. Imagine that you were running an 80386-based system with only floppy disk drives; you would be fine as long as you didn't need any disk data, but when you had to hit the disk, you would pay with a long wait. The wait times for slow memory are obviously nowhere near as long as those for floppy disk accesses, but programs access memory almost constantly, so you pay the penalty almost all the time.



When it cannot get data from memory fast enough, the CPU has to stop working and sit idle until it gets the data it requires. To understand just how much overhead these waits can cost, you have to look at the timing of both processor and memory operations. You can apply this type of analysis to any processor, but I will stick with the 80386.

Processor Speed

For this discussion, the most important aspect of a processor's speed is its *cycle time*, the number of nanoseconds that it needs to complete its fastest instruction. You can compute a processor's cycle time by dividing 1 by the CPU's MHz rating; for example, a 16-MHz 80386 has a cycle time of 62.5 ns.

The cycle time alone is still not enough to determine how fast an 80386 can complete an operation. While some instructions, such as NOP, can complete in one cycle, most take two or more cycles. Simple register-to-register instructions, such as CMP (compare) and ADD, require two cycles. Some of the more complex instructions can take

continued

ILLUSTRATION: ROBERT PASTERNAK © 1988

much longer, like the nine cycles that MUL (multiply), requires.

These times assume that the instructions are working on data that is entirely in registers. That is rarely the case in real applications. Usually, the input data has to come from memory, and often the processor has to send the result back to memory. When you add memory accesses, instructions take more cycles. An ADD instruction that has to get its input from memory goes from two cycles to either six cycles (if the answer goes into a register) or seven cycles (if the answer must go back to memory).

Also, those numbers assume that the system's memory can supply the required data fast enough to keep up with the processor. If it cannot, then the processor must wait for the data. Every cycle that the processor must wait is a *wait state*.

Memory Speed

So, when the 80386 needs to read or write to memory, how much time does the memory have to fulfill that request? Since typical 80386 memory accesses take two cycles, memory needs to respond in two times the processor's cycle time, or, for a 16-MHz 80386, 2 × 62.5 ns, or 125 ns. That number suggests that 100-ns DRAM or even 120-ns DRAM should do the job with no wait states.

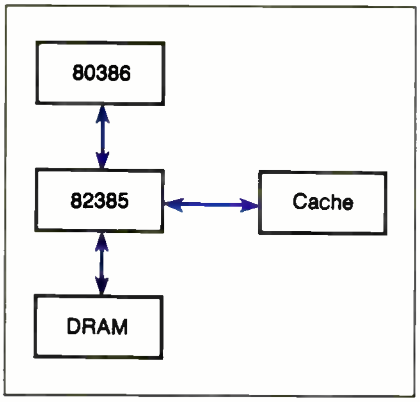
Unfortunately, that's not how it works out. Memory manufacturers rate their chips by what they call *access time*. Access time is the time it takes those chips to supply information, assuming that they are ready to go. Each time the processor accesses DRAM, however, the memory has to recharge before the processor can use it again. While there is no simple formula for computing recharge time, for most DRAM chips it is only slightly less than the access time. For example, 100-ns DRAMs have a recharge time of about 90 ns.

This is still not quite the whole story in memory timing. DRAM has the disadvantage that systems periodically need to refresh it or lose the data it contains. While there seems to be no single fixed overhead for DRAM refresh, on most systems it adds a performance overhead of between 6 percent and 12 percent.

So, the actual speed of DRAM memory is its cycle time, the access time plus the recharge time; 100-ns DRAM has a cycle time of about 190 ns. In addition, there is the periodic refresh overhead.

The Problem

When you compare the cycle times of the DRAM in most personal computers to



The Intel 82385 cache controller lets the 80386 run out of a small high-speed cache whenever possible; it accesses slower DRAM only when the memory the 80386 needs is not in the cache.

the cycle times of a 16-MHz 80386 (125 ns), you see the problem: 100-ns DRAM cannot keep up with the processor, and you have to pay the overhead of wait states. The situation only gets worse for 20-MHz and 25-MHz 80386s.

This is the heart of the major problem that the designers of today's high-speed microcomputers must face. The commercially available systems that have hit the market so far have tried to address this problem in one of the following six ways: live with it, or use faster DRAM, static RAM (SRAM), interleaved memory, paged memory, or caching.

What To Do?

The simplest answer is just to design the system to accommodate the wait states that accompany the commonly available 100-ns to 120-ns access time DRAMs. This technique is simple and inexpensive, but most system builders consider the speed loss prohibitive.

Another simple alternative is to use DRAM memory that can keep up with the 80386. This is as simple as the previous answer, and it avoids the wait states, but there are a few problems.

The first problem is the cost: DRAM chips get more expensive as they get faster.

The second problem is more severe: It would take incredibly fast DRAM to keep pace with today's high-speed 80386s without adding wait states. Even 80-ns DRAM chips have a cycle time of about 140 ns, which is already too slow for the 125-ns cycle time of a 16-MHz 80386. When you move to faster 80386s, the processor's memory-access time requirements become even more stringent: A 20-MHz 80386 has a cycle time of 100 ns, while a 25-MHz 80386 clocks an 80-ns cycle time. To support these chips, a system's DRAM would need access times of better than 60 ns and 50 ns, respectively. DRAM chips that can handle these speeds are not readily available in quantity—at any cost.

Even if you could get these chips, the system would still lose time for the periodic refreshes that DRAM requires.

Another way to get around the slow cycle time of DRAM is to use SRAM instead. The cycle time for SRAM is basically the same as the access time, so SRAM chips run faster than DRAM chips with the same rating. For example, the Intel 80386 hardware reference manual says that a 16-MHz 80386 can run with no wait states with 100-ns SRAM, while 100-ns DRAM would not be fast enough.

SRAM has one other advantage over DRAM: It does not need to be refreshed. By removing the approximately 6 percent to 12 percent DRAM refresh overhead, SRAM improves the overall system performance.

Dell Computer used SRAM in its first 80386-based system, the 16-MHz PC's Limited 386^{16}. Because of the 125-ns cycle time of the 16-MHz 80386, Dell was able to avoid wait states with 100-ns SRAM. Even with 100-ns SRAM, however, Dell's engineers found that the system could run with no wait states for only about the first megabyte of memory. After that, the system timing changed with the load on the bus, so that the 100-ns SRAM chips proved to be about 7 ns too slow. Dell employed some proprietary technology to work around this difficulty and gain a buffer of 10 ns so the system could stay with 100-ns SRAM and still have no wait states.

When you try to buy SRAM memory, however, you run into the major disadvantage of this approach: cost. SRAM chips generally cost much more than comparably rated DRAM chips. The cost is high enough that none of the current high-end 80386-based systems are using SRAM for their main memory.

Playing the Odds

All three of the above methods yield systems with a guaranteed level of performance. Systems that use them pay a fixed number of wait states—zero or more—essentially all the time.

If you feel like playing the odds, there are other options. As they execute, computer programs follow common patterns most of the time. Programs tend to work in relatively small areas of code and data for a fairly long time (in processor terms) and then go through a short transition period and move to a new area. This concept is fairly intuitive: Most programs, like most people, act on input relatively soon after they get it, mull it over for a time, and then move on.

Most 80386-based computers use statistical methods that count on the fact that most programs behave this way most of the time. They typically use 80-ns to 120-ns DRAM in conjunction with an architecture designed to capitalize on this type of program behavior.

When the program that is currently executing follows the predicted pattern, 80386s run with no wait states. When that program deviates from the pattern, there is often a penalty of one or two extra wait states beyond those required by the slower DRAM.

Each program's particular mix of instructions and data flow affects its performance. Minicomputers and mainframes have used various kinds of statistical approaches for years.

In addition to their gambling nature, most of these approaches share one other attribute: They concentrate far more on speeding memory reads than on helping memory writes. They do so because most programs read from memory far more frequently than they write to it. Some systems even let memory writes always run with wait states.

Interleaved Memory

Systems that use *interleaved*, or *bank-switched*, memory try to avoid paying the overhead of DRAM recharge time for most memory accesses. They rely on the fact that programs will tend to access memory locations consecutively.

To capitalize on this type of behavior, they divide memory into banks. The banks recharge at different times, so that only memory in the bank that the processor just accessed has to recharge. The other banks are available immediately.

The memory is split among the banks so that each bank contains every *n*th address, where *n* is the number of banks. In the simplest model, which most interleaved PC-based 80386s follow, there are two banks. One bank holds the memory locations with even addresses, and the other holds those with odd addresses. As long as a program accesses memory sequentially, it runs with no wait states. It hits first one bank, and then, while that bank is recharging, the other one.

This approach is great if a program is executing straight-line code (one statement after another with no jumps), because then the processor is fetching consecutive instructions from consecutive memory addresses. When a program starts working with memory locations that are not consecutive, as it might when it jumps or reads data, then it has a 50 percent chance of hitting the bank that is ready to go. If a program needs two memory locations from the same bank, then it is forced to pay the usual wait-state penalty.

The Chips & Technologies 386 support chip set (and, therefore, the machines that use it, such as the Tandy 4000) employs this architecture. That chip set's interleaving only works, however, when there is an even number of memory banks. If there is only one memory bank, it runs with wait states. This is why the Tandy 4000 runs faster with two 1-megabyte banks of memory than it does with one.

continued

Paged Memory

Another statistical option is *paged,* or *static-column,* DRAM. Don't be confused by the name: This approach does not use SRAM. It uses special DRAM chips that are more expensive and harder to find than normal DRAM chips, but they are still DRAM and far less expensive than SRAM.

This approach divides memory into fairly small (typically, 2K-byte) chunks, or *pages.* Consecutive accesses to memory locations in the same page can run without wait states. The word *static* refers to the portion of the address of each of those locations that identifies the page, because that portion does not change between the two memory accesses. When the program has to change that address portion (i.e., when it has to get memory outside the current page), it runs with the normal wait states.

Paged memory works best when programs tend to work repeatedly on the same page of memory. This situation occurs with page-size chunks of straight-line code, as well as with loops that fit within a page.

The first Compaq 80386-based system, the Compaq 386/16, used this approach with 2K-byte pages. Compaq claimed that it yielded an effective performance of about 0.8 wait states with 100-ns static-column DRAM.

Caching

While you can find 80386-based systems that use all these approaches, most of today's speedsters have settled on a compromise between SRAM and DRAM that involves a memory *cache.*

A cache is a small portion of very-high-speed memory. Most of today's fastest 80386 systems use a 32K-byte or 64K-byte cache of 25-ns to 35-ns SRAM. They use 80-ns to 120-ns DRAM for the bulk of their memory. The goal of the cache is to give as much of the performance benefit of SRAM as possible with a minimum amount of the expense.

The principle behind caching is easy to see: If the memory location the processor needs is in the cache (a cache "hit"), then it can get that memory without any wait states. With a 25-ns SRAM cache, a system can easily support even a 25-MHz 80386. If the memory the processor needs is not in the cache (a "miss"), then the processor has to pay in wait states while the memory comes from the slower DRAM (see the figure on page 102).

Any memory that the processor needs from DRAM goes into the cache, so if the processor needs it again later, it might be there. Of course, because the cache is small, it is usually full, so new entries have to displace old ones. When that happens, most caches use a technique known as LRU (least recently used) replacement to determine which entry to remove. This technique picks for removal the cache entry that the processor has least recently used.

Caching, like the other statistical approaches, counts on programs working with a relatively small number of memory locations for relatively long stretches of time.

You can state the effectiveness of a cache by its *hit rate,* which is the percentage of the time that the memory the processor needs is in the cache. One of the most common cache controllers, the single-chip Intel 82385, claims a hit rate of 95 percent with a 32K-byte cache. Many of today's fastest 80386-based com-

continued

puters, including the most recent machines from Compaq, ALR, and IBM, use the 82385.

Many cache controllers, however, do not handle memory writes as well as memory reads. Some caches send all memory writes to main memory, even if the desired memory location is in the cache. This technique is called *write-through*. It forces all main memory to pay the wait-state penalty of the slower system DRAM.

More sophisticated cache controllers, such as the 82385, use a *posted-write* approach to handle memory writes. If the memory location that is the object of the write is in the cache, the cache controller writes to the cache immediately, with no wait states. Then, while the processor is busy working on other things, the cache controller sends the memory write out to the main memory.

There are two potential problems with the posted-write technique. During the time after the cache controller writes to the cache and before it has finished writing to the slower DRAM, the values for the changed location are different in the cache and in the main DRAM. The DRAM location is out of date. If only the 80386 can read memory, that's no problem, because the 80386 can get the correct value from the cache. Most microcomputers, however, contain other direct-memory-access components, such as peripheral controllers. Those components can go to memory directly and could encounter out-of-date DRAM locations. The cache controller must make sure that any DMA reads get the correct value for each memory location.

Unfortunately, the problem can go the other way as well. A DMA component can write to a location in main memory that the cache controller is also keeping in the cache. The cache is then out of date, and if the processor reads that location from the cache, it will get an out-of-date value.

The 82385 solves this problem by a technique known as *bus snooping*, in which it monitors the system's bus constantly and watches for DMA writes. When a DMA device writes to memory, the 82385 checks the address of each target location to see if that location is in the cache. If it is, the 82385 marks the cache copy as invalid, so that the next time the processor tries to read that address, the cache controller will fetch the correct value from main memory.

The Winner?

Caching works most of the time for most applications; however, like the other statistical approaches, it offers no guarantees. The only architecture that can guarantee no-wait-state performance is pure SRAM, and most system manufacturers today consider it prohibitively expensive.

Because of the availability of relatively inexpensive, single-chip cache controllers like the Intel 82385, most of today's fastest 80386-based systems use caches. Some manufacturers, such as ALR with its FlexCache 25386, are also building their own cache managers.

In either case, caching seems to be the architecture of choice for the fastest 80386-based computers today, and it is most likely to remain so for some time to come. ■

Mark L. Van Name is a freelance writer and computer consultant. He can be reached on BIX c/o "editors."

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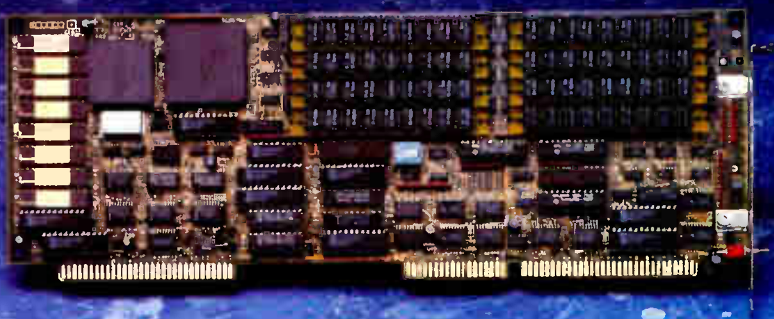

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WHITHER IBM AND UNIX?

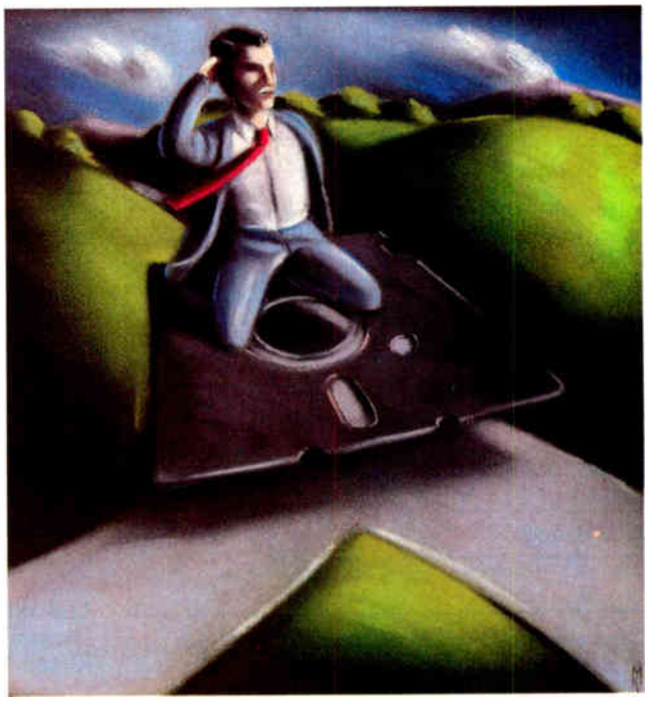
New entries in the operating system arena have heated up the battle for a powerful, standardized microcomputer version of Unix

Jason Levitt

Although Microsoft and IBM would have us believe that OS/2 is the operating system of the future, Unix has been gaining ground in the operating system marketplace. And while IBM has maintained a low profile in the Unix world, it is nevertheless a force to be reckoned with.

IBM has had Xenix and PC/IX running on the AT for some years now. Microsoft's Xenix, the most ubiquitous Unix in the industry, is well known. PC/IX, Interactive Systems Corp.'s (ISC) port of Unix System III to the XT and AT, is more obscure. PC/IX is an AT&T-licensed port of Unix that performs well on a PC XT and has proved itself in several documented projects, the most profound being Andrew Tannenbaum's Minix, a Unix version 7–compatible operating system developed under PC/IX. Unfortunately, PC/IX fell prey to anemic marketing and support due to its potential competition with IBM's proprietary products.

At the end of last year, Xenix became available for the IBM PS/2 in the form of SCO Xenix 386 from the Santa Cruz Operation (December 1987 BYTE). Now IBM is trying to center its entire Unix strategy for large and small systems around a version called AIX.



AIX: It's Never Too Late

Industry observers often chide IBM for getting on the Unix bandwagon late in the game. Although the C language was ported to the IBM/370 architecture in 1974, and a port of Unix running under the VM/370 operating system was in existence as early as 1976, these were not projects sponsored by IBM, but simply useful exercises demonstrating portability to an architecture radically different from DEC's PDP-11. IBM's current unified approach to Unix didn't take shape until the introduction of its RT workstation in 1985, nearly two years behind Unix workstation leaders Sun and Apollo.

AIX is ISC's port of Unix System V version 1.0 to the RT's RISC (reduced instruction set computer) processor. With the recent release of AIX for the PS/2 Model 80, AIX is now IBM's unified Unix approach for the future. Today, after several years of furious development within IBM, outside the auspices of ISC, AIX has matured considerably. The technical improvements of System V version 2.0, along with bits of version 3.0, and a host of Berkeley (BSD 4.2) Unix enhancements have been incorporated into AIX. AIX has its own distributed file system (see "The IBM RT Gets Connected," in the Fall 1987 *Inside the IBM PCs*).

One of the unique features of AIX is its use of the Virtual

continued

Resource Manager (VRM), an interface that hides the complexities of the hardware from the operating system software (see figure 1). In its original incarnation, the VRM could be viewed as a tiny version of VM/370, hosting different operating systems as specialized virtual machines. The AT coprocessor card, running DOS, is viewed by the VRM as a virtual machine. The VRM provides additional features not present in System V, such as virtual terminals (full-screen windows) and real-time capabilities.

An entity such as VRM, however, is not popular in the Unix world because of its proprietary hooks. Here is an interface written in IBM's own proprietary PL.8 systems language that hosts different operating systems and requires a VRM device driver for any corresponding specialized Unix device driver. Fortunately, the need for such a robust foreign interface within IBM's unified Unix strategy is waning. Andy Heller, IBM vice president and general manager of Advanced Engineering Systems, says, "We gave the VRM more autonomy than it really did need. Over the next year or two, the VRM as a stand-alone entity will probably disappear. But all of the interfaces that are part of the VRM, all of the Virtual Machine Interface structures will be there because those really are needed to use the system in a broad spectrum of applications."

Clearly, IBM sees OS/2 as being for end users and AIX for technical and research environments: "different operating systems coming from different heritages with different applications."

AIX and SAA: Big Pieces of the Puzzle

At a recent Uniforum conference, William Lowe, president of IBM's Entry Systems Division, said that AIX would eventually conform almost entirely to IBM's Systems Application Architecture, except for the user interface. The SAA specifies a set of interconnectability and software consistency across the broad range of IBM's hardware. Interestingly, the SAA's user interface is OS/2's Presentation Manager. So, although AIX for the PS/2 Models 70 and 80 is scheduled for release in the fourth quarter of this year, right alongside OS/2's Presentation Manager and beefed-up networking, it will still be essentially a line-oriented version of Unix (see the text box "OS/2 versus Unix" on page 112).

Although AIX includes MIT's windowing interface, X-Windows (but without applications written using the X libraries), it is only a little better than the full-screen windows available under AIX and Xenix, which allow the user to flip through virtual terminal sessions using a hot-key sequence. Clearly, IBM sees OS/2 as its solution for end users and AIX as the solution for the technical and research environments. Heller describes the IBM view as "different operating systems coming from different heritages with different applications."

So, although AT&T and Sun view Unix as the end-user solution, IBM plans to delegate only those tasks to Unix that it doesn't perceive to fall into the realm of OS/2 applications.

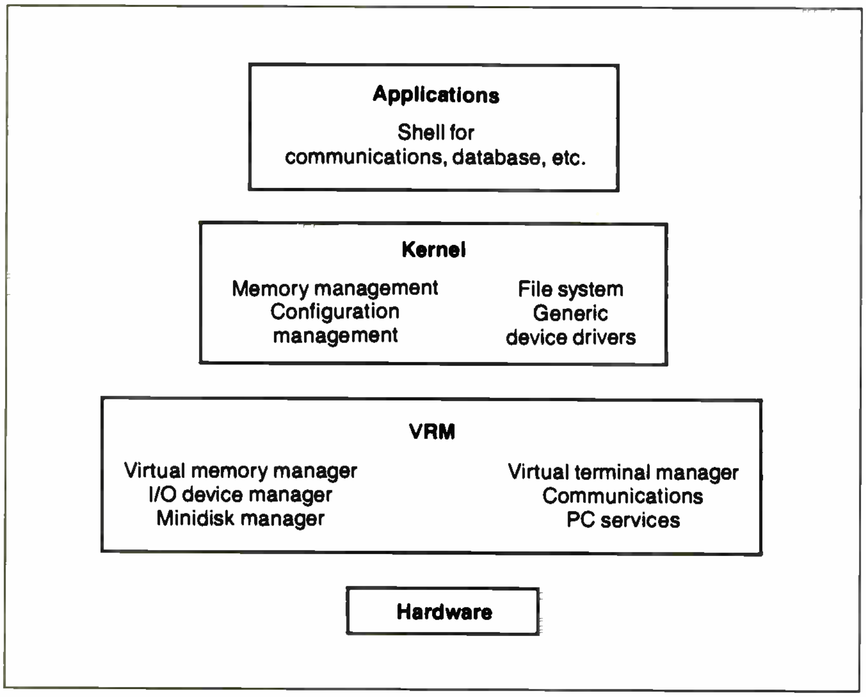


Figure 1: *AIX's Virtual Resource Manager (VRM) hides the complexities of the hardware from the operating system software.*

Unix and OS/2: Big Differences

If you're a Unix user, you need only pick up a copy of OS/2 Standard Edition 1.0 at your local computer store to see the disparity in these two operating systems. As packaged, OS/2 appears very much like MS-DOS. The same hierarchical file system persists, and, save for the addition of a handful of commands, the command-line prompt is the same barren landscape. A user-friendly shell called the Program Selector lets you jump among applications running in full-screen windows. OS/2 is multitasking, not multiuser, and it has a full complement of operating system facilities available to the systems programmer, including most of the interprocess communication facilities present in System V.

If you paid $3000 for the Microsoft OS/2 Software Developer's Kit, you can begin to hack out OS/2 programs using Microsoft C, CodeView, and a handful of utilities. To be fair, nobody really expects OS/2 to have the depth of software tools that is available under Unix. It's just a shame that so many common functions have to be programmed from scratch or purchased in order to create a useful software development environment. One major thing OS/2 and Unix do have in common is that they are both written largely in C.

And What About Xenix?

The availability of Xenix on PS/2 Models 70 and 80 is of little interest to IBM,

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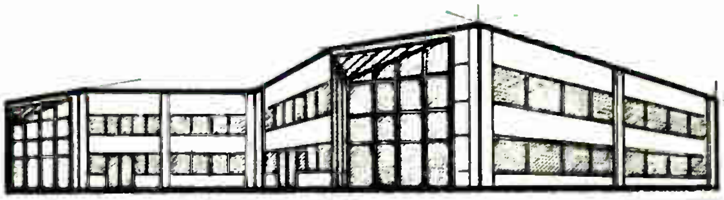

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OS/2 versus Unix: Is DOS Compatibility the Key?

The three main strengths of OS/2 are ease of use, DOS compatibility, and IBM connectivity. The architects of OS/2 make no secret of the fact that DOS compatibility took a huge amount of effort in the development of OS/2. Trying to develop a new operating system designed to overcome the limitations of DOS but at the same time maintain compatibility with it has clearly been one of the stumbling blocks for the developers. OS/2's IBM connectivity is strictly in the form of the LAN Manager and the Database Manager, both of which adhere closely to standards in the IBM mainframe environment, like the 3270 and DB2, but ignore standards of the DOS and workstation environment, like dBASE and Ethernet.

While OS/2 has other drawbacks, some of these may not be that important in the long run. OS/2 runs only on 80286- and 80386-based systems and adheres to the limitations of the 80286 chip (only 16 megabytes of addressable physical memory, for example). However, an 80386 version of OS/2 will supposedly be available late next year.

OS/2 is not a multiuser system, but advances in networking and distributed software will eventually make this a moot point. And although there are currently few applications available under OS/2, we can make the assumption that piles of software are being prepared to take advantage of OS/2's capabilities. OS/2 will probably overtake Unix in the breadth and variety of applications available.

While ease of use may be OS/2's most compelling advantage over Unix, the importance of DOS compatibility should not be underestimated. OS/2 offers DOS compatibility through the DOS Compatibility Box (DCB), which allows one DOS program to run at a time under OS/2.

When a DOS program is running under the DCB, it takes control of the screen and keyboard and is subject to all the constraints of MS-DOS: the 640K-byte memory limit, the 32-megabyte hard disk limit, and so on. A hot-key sequence lets you suspend execution of the DOS program and move into a protected-mode OS/2 environment.

Additionally, the DCB operates as one process under the OS/2's scheduler, so the program running in the DCB doesn't get 100 percent of the CPU as it would under DOS. The most extreme example is when you hit a hot-key sequence to temporarily get back to the OS/2 environment: The suspended DOS program gets no processor cycles, so real-time programs or timing-dependent programs will not operate properly. Basically, any DOS program that tries to poll or directly use any hardware without using the appropriate programming interface may fail. And since the offending program is running the 80286/80386's real or unprotected mode, it can bring OS/2 down with it.

In the Unix marketplace, several software packages have emerged in the form of Unix retrofits that allow Unix to execute in the full protected mode of the 80286/80386 while allowing multiple DOS tasks to execute in real mode. A typical system is Merge 286 by Locus Computing. Merge is a seamless union of DOS and Unix. DOS programs can run from either the DOS Environment (DE) provided by Merge or from the Unix shell. You can access both DOS and Unix partitions of the hard disk from either the Unix shell or the DE. Output from DOS commands can even be piped into the standard input of Unix commands.

On the 80286, Merge's limitations are identical to OS/2's: Only one DOS process can execute at a time, and if it decides to write zeros all over memory, it can. On the 80386, though, Merge uses the virtual 8086 mode, allowing multiple DOS programs to execute. (For more on this subject, see "DOS Meets Unix" by Dale Dougherty and Tim O'Reilly on page 117.)

The compatibility issues of DOS/Unix environments are similar to the ones mentioned for OS/2: hardware- or timing-dependent programs cannot run. However, errant DOS processes running under the virtual 8086 mode cannot escape the limitations of their address space and crash the host Unix system. There is no reason to assume, however, that OS/2 will not allow multiple DOS sessions when the 80386 version is released in late 1989.

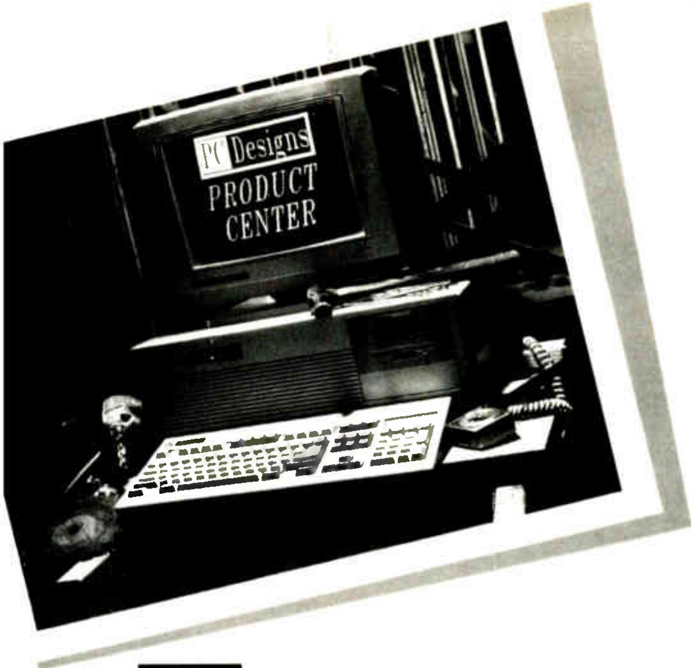
Ease of Use

OS/2 isn't going to win any converts strictly on the basis of DOS compatibility, but it might win some because it is easier to maintain and operate than Unix. This is the issue that springs up every time Unix is mentioned as an end-user system: Unix command syntax is too terse, Unix doesn't provide enough feedback, Unix isn't consistent.

True, Unix is available across a wide variety of architectures and exists in several different flavors. For example, system administration procedures vary significantly on a Sun-3, an IBM RT, and an IBM PS/2 Model 80 running Xenix. And only the Sun-3 has a well-developed windowing system with a lot of applications. OS/2 will have the Presentation Manager for its user interface, and that has the requisite Macintosh look and feel toward which the industry is leaning. Unix will have Open Look providing the same function. Both will be available in the fourth quarter of 1988: Presentation Manager from IBM on the PS/2 Model 80, and Open Look on the AT&T 6386 workstation.

Still, the large percentage of users who were attracted by the raw simplicity of DOS—those who want to run their applications and nothing else—will find, for now, that OS/2 maintains that basic simplicity. The installation and maintenance of OS/2 has been rendered elegantly simple due to the extensive help menus and auto-configuration. Because it's a single-user system, system administration is greatly simplified.

Unix has about a 10-year lead in technology and tools for multitasking, multisystem software development. But considering the massive capital mounting behind the DOS-to-OS/2 push, this might not be such an important point. Unix is still struggling to become a unified standard, and the prospect of waiting until the end of 1989 to see what happens between the AT&T/Sun team and the Open Software Foundation is not a pleasing forecast for Unix enthusiasts.



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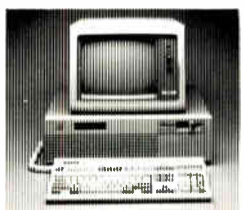

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Command-Line Unix, Windows, and Open Look

Historically, Unix has had a command-line interface. That is, the interface presented to the user is a simple prompt, like the one in MS-DOS. Unix researchers, though, have been particularly adept at enhancing this command-line interpreter, or "shell," as it's called in Unix parlance, to make it more robust. The result has been the creation of several enhanced shells that provide sophisticated command histories, the ability to retrieve previous typed commands, and a powerful interpreted programming language. The most notable in recent years, and certainly the most imitated, has been the Korn Shell written by David Korn, an AT&T Bell Labs researcher.

As Unix enters the commercial arena, the public has been clamoring for a user interface that is more suitable for end users. The result has been the creation of several windowing systems, but no clear, consistent standard has emerged against all others.

The most mature system is the BSD 4.2-based SunOS, which Sun has sold with its workstations since the mid-1980s. SunOS provides the familiar windows, icon graphics, and mouse that Macintosh users have become accustomed to, although applications running under SunOS don't always have the same look and feel that Mac applications have.

In fact, the Macintosh is the only system that provides a standard windowing look and feel across all its applications. AT&T and many others feel that the success of Unix as an end-user operating system will hinge on its ability to provide a similar look and feel among its applications. To this end, AT&T and Sun have announced their Open Look standard.

Open Look is not a windowing system in itself, but a set of guidelines that describe what the user interface should look and feel like to the end user. Thus, many existing windowing systems that provide facilities for windows, icons, and so on will be able to emulate Open Look. A toolkit written by manufacturers will use the libraries of the desired windowing system so that a programmer writing applications will use only features of the system that are present in the Open Look standard.

The first two windowing systems being adapted for Open Look are X-Windows and the PostScript-based NeWS. The Presentation Manager and Macintosh windows are logical future candidates. The Open Look is purported to be so similar to the Mac environment in its use of icons, scrollable windows, and pull-down/pop-up menus that Macintosh users should be able to adapt in just a few minutes. It is important to note that Apple won't be suing AT&T and Sun, though; Sun has licensed the graphical windowing technology directly from its originators, Xerox Palo Alto Research Center.

though AT&T has built Xenix binary compatibility into its recent version of System V. According to Heller, Xenix compatibility isn't really a major advantage at this point: "If it doesn't cost you much, it's worth doing simply because there are some people who want it, but I don't believe it's going to be a major issue in the future." Nevertheless, it is unlikely that Xenix will disappear as easily as PC/IX, given that it claims the largest installed base of Unix machines in the industry.

A Double Standard

IBM has recently joined the Open Software Foundation (OSF), a nonprofit corporation set up to develop an industry-standard computing environment based on Unix. Key players include Hewlett-Packard, Digital Equipment Corp., and Apollo, among others.

The creation of the OSF is in direct response to the AT&T and Sun agreement to provide the industry with a standard Unix platform that will meld Unix System V, Xenix, and SunOS into a unified operating system with Open Look as its interface. (See the text box "Command-Line Unix, Windows, and Open Look" above.)

As this issue goes to press, the OSF has officially stated that its proposed standard Unix will be based on technology contained in a future version of AIX. This probably means version 2.2. Though the OSF has not clearly detailed its plans, it is almost certain that its standard Unix will be System V version 2.0-compatible and will have a user interface based on X-Windows. The announcement is significant because AIX, which has lagged behind other Unix ports technologically, may now find itself in the forefront.

The prospect of having two Unix operating system standards instead of one means that other systems, such as OS/2, could gain an increased market share simply because of Unix factionalism.

However, developers on both sides of the Unix dispute have indicated a willingness to provide compatibility among their systems.

Running in Parallel

Research using the RT PC has pointed out another direction Unix standards might take. One such project uses eight RT RISC processors running in parallel. The so-called Advanced Computing Environment (ACE) supports parallel-processing research. It runs a new version of the Unix kernel developed at Carnegie-Mellon University, called MACH, that exhibits important advances in multiprocessing support.

IBM claims that its ACE-2 high-performance workstation currently under development has 200-million-instruction-per-second (MIPS) performance with the ability to handle interactive three-dimensional graphics on a 2K-byte by 2K-byte (2048 by 2048, or 4 million pixels) graphics display. Technology such as this might be IBM's response to the new breed of super workstations offered by companies such as Ardent and Silicon Graphics.

It's a Contender

In the long run, IBM views the AIX and the RT PC as its main contenders in the personal workstation marketplace. Heller claims, "We're spending at a rate equal to the rate we spend on PS/2, in terms of engineering, for follow-ons to the RT. But we've also extended our Unix capability through AIX down onto the 80386 PS/2 and up into 370, all the way through ESA [Enterprise Systems Architecture] machines."

With the support of the Open Software Foundation and Heller's contention that IBM is committed to "doubling the performance of the RT RISC-based processor pretty much every year," the RT PC and AIX could make significant gains in the industry. ■

Jason Levitt is a Unix consultant and freelance writer living in Austin, Texas. He can be reached on BIX c/o "editors."

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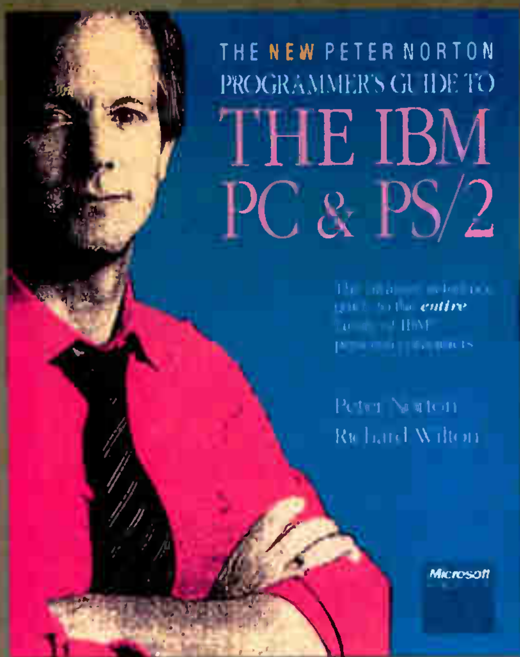

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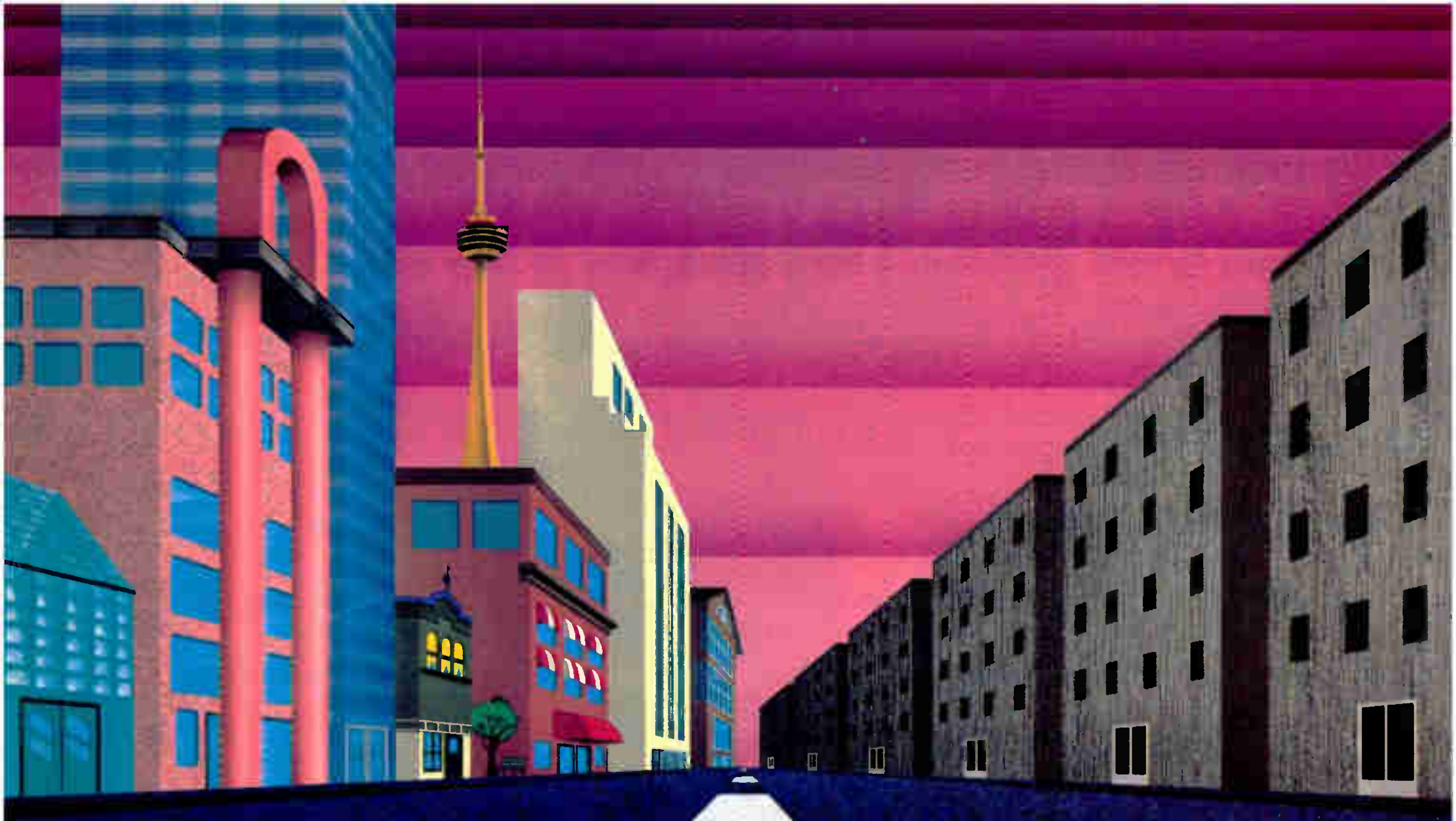

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DOS MEETS UNIX

Can awk and grep coexist with Lotus 1-2-3 and WordPerfect?

Dale Dougherty and Tim O'Reilly

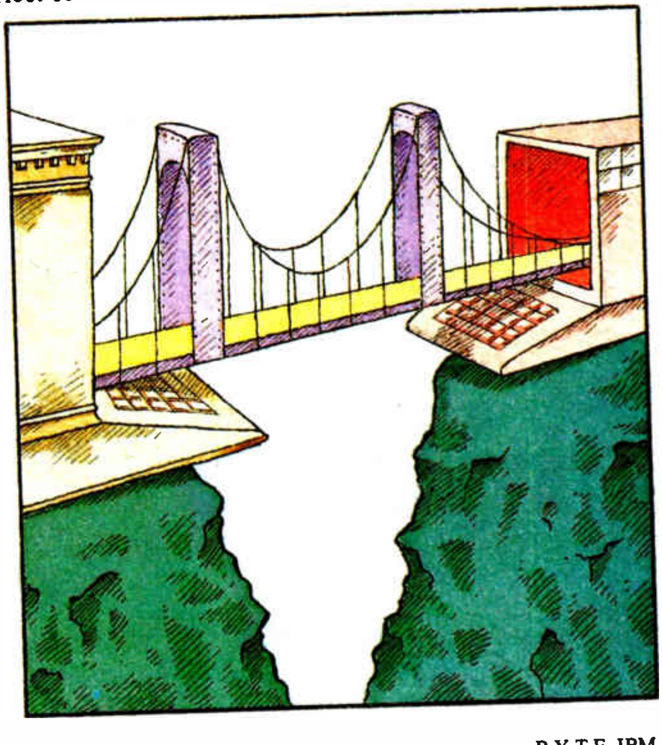
You might regard the news that 80386-based Unix systems can host DOS-based PC applications as a strange development. After all, it's rather like Chevrolet and Chrysler offering Japanese-made automobiles or the British building a bridge over the River Kwai. But can Lotus 1-2-3, dBASE III, and WordPerfect coexist in a multiuser, multitasking computing environment along with Unix utilities like awk, grep, make, and vi? Yes they can, but to understand how, you need to understand something about Unix.

Inscrutable Unix

Unix is the Zen Master of computing. It dispenses a philosophy of "small is beautiful" and teaches you to create your own tools from standard utilities. Much of what Unix does, however, is transparent.

Unix was developed in the early 1970s by researchers at AT&T's Bell Laboratories as a multiuser, multitasking operating system. Today there are two major versions of Unix, AT&T's System V and Berkeley Unix, or BSD 4.3 (Berkeley Standard Distribution).

As a multiuser environment, Unix lets several people work productively on the same machine, sharing disk, printer, and modem resources. As a multitasking operating system, Unix manages multiple tasks or processes by giving each task a slice of CPU time. When that time is up or the process itself determines that it must wait for another event, the task is suspended and another is started. Tasks don't run from start to finish before another is begun, but task processing is interleaved. Multitasking just makes it seem as though all processes run simultaneously.



Multitasking goes hand-in-hand with virtual memory. Rather than using physical addresses, programs operate in a relatively unlimited virtual memory space; thus, many more programs can operate "simultaneously." Unix works with special memory-mapping hardware to transfer small blocks of program data between disk and physical memory as the data is needed, using a "most-used" algorithm to keep disk access at a minimum. If virtual memory hardware is not available, Unix must swap entire processes out to disk when they are suspended—a much less efficient process.

What you see when you use Unix is its user environment. Several shells provide interfaces to Unix utilities and the underlying operating system. In addition, Unix has many general-purpose facilities for file management, print spooling, electronic mail, communications, batch and background job processing, and system administration. If you are experienced, these facilities form a powerful, cus-

continued

tomizable computing environment. In particular, Unix reflects its creators' interests and provides a model development environment for programmers. Because of this, Unix receives wide support from universities and government.

The operating system might have remained isolated in research environments if it weren't so portable. Because it's written mostly in C, Unix is easily ported to a wide range of computer architectures. Consequently, it has become a de facto standard operating system, practically eliminating the development of proprietary operating systems by workstation manufacturers. It is a stable applications platform that's not dependent on a specific hardware configuration.

The PC in Perspective

The enormous quantity of DOS-based microcomputer applications attracts a huge number of users, many of whom would not otherwise use a computer. These users have their own perspectives on computing, based on the applications they use. If Unix has its system gurus, DOS has its application artisans.

DOS application users tend to be practical, get-down-to-business types, who expect the computer to be easy to use and reliable—given a proven application and 12 function keys. Some even seldom use DOS, except to create and examine directories. Nonetheless, users know how to appraise applications and weigh competitive features.

Unfortunately, using DOS applications isn't as simple as it used to be. For example, if you bought a PC to run Lotus 1-2-3 spreadsheets, you probably bought new applications, added graphics boards and extra ports, and purchased tapes, printers, and modems. In addition, you most likely install the software, configure the devices, troubleshoot when things don't work properly, and perform regular backups to protect valuable files.

The time and effort you, and the people you work with, take to perform these duties adds up. Obviously, it's more expensive to maintain personal computer environments now, even though the hardware costs less.

Leading DOS Users to Unix

Manufacturers of Unix systems hope that personal computer users are outgrowing PCs and want to lead them into the multiuser Unix market. For example, a Unix computer provides the following:

- A platform for multiuser applications, such as database management, word processing, and communications.
- Centralized data storage and facilities for file security, file system backup, and distributed user access.
- A server that allows you to access multiple printers, modems, tape drives, and terminals.
- Centralized system administration services that perform regular maintenance tasks and monitor system activity.

These features might help persuade PC users that they need an operating system with Unix's features; the hard part is to convince them that they can work as productively in the Unix environment as they do in DOS. New users balk at investing time and energy in learning the Unix environment.

Unfortunately, many people equate the Unix user environment with the Unix operating system. Unix supports a vari-

continued

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SAMPLE OUTPUT

```
Regression Analysis
LONGLEY.MII: Longley test data from JASA vol.62, pp. 819-41.


Forwards Regression
Proportion:              0  Tolerance:           0  F enter:            0
  F remove:              0

Step:     6          Dependent Variable: Total        Degrees of Freedom:     9

Ind  Var   Coefficient    Std Error    Beta Coeff   F Statistic  Probability

    Index  15.06187227  84.91492577   .046282023       .03146    .863140833
      GNP  -.035819179   .033491008 -1.013746349      1.14387    .312681061
 Unemploy -2.020229804   .488399682  -.537542578     17.11003    .002535092
 Military -1.033226867   .214274163  -.204740692     23.25154    .000944367
  Popltion  -.051104106   .226073200  -.101221114       .05110    .826211796
     Year  1829.151465  455.4784991  2.479664383     16.12737    .003036803

                                                          r^2:   .995479005
        Intercept: -3482258.635                            r:   .997736942
      F-Statistic:  330.2853392                  r  (d.f.):   .996603485
   Standard Error:  304.8540736         Proportion Reduced:   .000015805
Std  Error  (d.f.):  373.3684631         Cumulative Reduced:   .995479005

---------------------------  Analysis of Variance  ---------------------------

              Sum of Squares     D.F.    Mean Squares      F Ratio      Probability
Regression      184172401.9        6     30695400.32    330.2853392     4.9840e-10
 Residual       836424.0555        9     92936.00617
  Total         185008826.0       15

------------------  Residuals   Durbin-Watson:   2.559487689  -----------------

 Case    Observed      Expected       Residual       -2s  -1s   0   +1s  +2s

   1     60323.00      60055.66         267.34       |    .    |    .*   |
   2     61122.00      61216.01         -94.01       |    .  * |    .    |
   3     60171.00      60124.71          46.29       |    .    |*   .    |
   4     61187.00      61597.11        -410.11       |*   .    |    .    |
   5     63221.00      62911.29         309.71       |    .    |    . *  |
   6     63639.00      63888.31        -249.31       |    *    |    .    |
   7     64989.00      65153.05        -164.05       |    . *  |    .    |
   8     63761.00      63774.18         -13.18       |    .    *    .    |
   9     66019.00      66004.70          14.30       |    .    *    .    |
  10     67857.00      67401.61         455.39       |    .    |    .    *
  11     68169.00      68186.27         -17.27       |    .    *    .    |
  12     66513.00      66552.06         -39.06       |    .   *|    .    |
  13     68655.00      68810.55        -155.55       |    . *  |    .    |
  14     69564.00      69649.67         -85.67       |    .  * |    .    |
  15     69331.00      68989.07         341.93       |    .    |    . *  |
  16     70551.00      70757.76        -206.76       |    .*   |    .    |
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ety of user interfaces, including a multiwindow environment. An application running in Unix can present a complete environment in which you never need to access Unix directly.

Moving DOS applications to a Unix system is one way to provide a familiar interface and new capabilities. Ideally, DOS developers will port their applications to Unix, but this is not always an easy task, because some applications were not designed to interface with an operating system on a high level. Until a significant number of these applications are available, however, the Intel 80386 processor offers an attractive opportunity to support off-the-shelf DOS applications on a Unix system.

Creating a Virtual PC

The Intel 80386 chip, when combined with specialized software, creates a virtual PC for running multiple DOS applications under the Unix operating system. To understand how this works, let's take a look at the architecture of the Intel 80386 microprocessor. The 80386 is designed to support four modes of operation and has the ability to switch between modes with very little overhead.

The default operating mode of the 80386 processor is a 16-bit real mode. It provides backward compatibility with the Intel 8086 and 8088, the chips originally used on the IBM PC. In real mode, the 80386 executes the instruction set of the 8086. Thus, the same copy of Lotus 1-2-3 bought for the original PC will run on a new Compaq 386. Unfortunately, real mode fails to take advantage of the more advanced processor. Using the 80386 to run in real mode is like buying a PostScript printer and setting it up to emulate an old dot-matrix printer.

The 80386 also has 16-bit and 32-bit protected modes. The 16-bit protected mode is designed for 80286 compatibility. (OS/2 is being designed to use this mode.) The 32-bit protected mode is the native mode, making the 80386 the most powerful Intel microprocessor. Native mode supports demand-paged virtual memory (a 4-gigabyte virtual address space) and provides privilege mechanisms that make true multitasking possible. Thus, the 80386 is well suited for running the Unix operating system.

In real mode, a DOS application runs in a single-tasking environment where it can do anything it wants, going directly to the hardware level if it desires, without worry that it has to compete with other applications. In protected mode, the processor uses privilege levels to determine which process to execute next. As in any situation where there is a limited resource and multiple opportunities to use it, there must be some priority established for allocating that resource.

The fourth mode of the 80386 is designed to run DOS programs in a multitasking environment. This special mode is called virtual-8086 mode, in contrast to real-8086 mode. In real mode, DOS applications use physical memory addresses, just as they do on the PC. In virtual mode, physical memory is mapped to a 1-megabyte virtual address space. The DOS program continues to think that it is working with actual addresses, but in fact these are being translated to virtual addresses.

Virtual mode also traps instructions that attempt to perform hardware-level operations, such as I/O. A DOS application is typically designed to act as though

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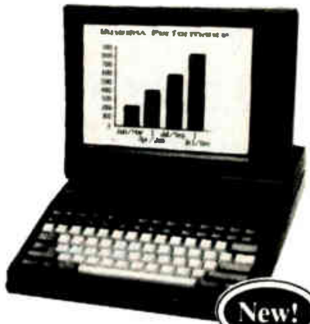

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Memory-mapped displays require transferring a larger amount of data than is possible with a serial link. (In its high-resolution monochrome mode, an IBM CGA has a resolution of 640 by 200, or a total of 128,000 pixels. At 9600 bits per second, it would take more than 13 seconds to paint the screen.)

To achieve high data transfer rates, you must connect the PC console directly to the processor and memory by a high-speed bus. Sun River's bit-mapped terminal was designed specifically for running DOS graphics applications on a multiuser machine. It is connected to the system with a high-speed fiber-optic link rather than an RS-232 cable.

One 80386-based system designed to support graphics applications is Sun Microsystem's Sun386i workstation. Running its own enhanced version of VP/ix, called DOS Windows, it supports monochrome and color graphics display adapters and monitors with resolutions of up to 1152 by 900 pixels. Software emulates monochrome, Hercules, and color graphics modes. Enhanced graphics display adapters are available for EGA and VGA graphics support. A DOS application runs on the Sun386i in its own fixed-size window, which is a portion of the full-size monitor (up to 19 inches diagonally). You can, for demonstration purposes anyway, have multiple windows running Flight Simulator or AutoCAD at the same time.

The Sun386i will also supply a driver for Microsoft Windows. Applications running under it can use the full screen size of a Sun386i monitor.

The Call of Unix

The DOS capabilities provided by the Intel 80386 chip and supported by Merge 386 and VP/ix are meant to entice DOS users and encourage them to migrate to Unix and settle in. But for this to work, DOS users must be convinced of Unix's value and its long-term usefulness.

What's really needed is a DOS-to-Unix bridge; running applications that are targeted for PCs on Unix systems isn't the ideal solution from a design perspective. However, if DOS developers see that users are willing to cross over, perhaps they'll be encouraged to develop DOS-compatible applications that are targeted for Unix. ■

Dale Dougherty is marketing manager and Tim O'Reilly is president of O'Reilly & Associates, Inc. in Newton, Massachusetts. They are coauthors of the Nutshell Handbook DOS Meets UNIX. *They can be reached on BIX c/o "editors."*

GRAPHICS: THE BIG PICTURE

IBM's open architecture has taken us from monochrome to stunning graphics displays—with a few stops in between

Bill Nicholls

Graphics displays are a hot issue these days. They're used heavily in business presentations, desktop publishing, scientific analysis, some word processors, and an operating system (OS/2), as well as in an operating environment (Windows). Graphics displays have two big advantages over character displays: They let you put more information on the display, and they let you draw arbitrary shapes, with blended colors (on a color monitor).

The question is, why aren't graphics displays universal? They would seem to be the logical display device for almost all uses. However, there are two obstacles to universal use of graphics displays. One is the cost of the controller and the display monitor; the other is the demands that a graphics display puts on the host processor.

These demands come from two requirements of graphics: The computer has to keep each pixel separately in memory, and it has to process and display each one. A character display requires only 1 byte (8 bits) per character, while in a graphics display, a character in the lowest resolution (a 5- by 7-pixel array) requires 35 bits of information. If each pixel can have 16 colors, this requires 4 bits per pixel, which results in 140 bits of information for one character. In this example, each graphics character requires 17.5 times the information that a character display would need.

If you have used graphics on your own system, you may have wondered why a graphics display is slower than a character display. A graphics display takes longer to display characters because each character represents multiple pixels, which are processed one at a time rather than as a character unit. Further delays occur as there are more CPU writes to the display memory, and the memory may be busy refreshing the display, adding wait states to the CPU write. Thus, the advantages of graphics to the user also place a burden on the system's performance.

Despite the extra computation involved, the benefits of graphics displays generally outweigh the costs. The initial solution to the speed problem used to be simple—get a faster processor. This worked for a while, until programs grew to need all the processor's time, and the display resolutions grew.

A Graphic History

The original IBM PC treated graphics as an afterthought. IBM recommended the Monochrome Display Adaptor (MDA), which had neither color or graphics. If you were in the (supposed) minority who wanted graphics, you could get the CGA, with 320 by 200 pixels in four colors,

continued

ILLUSTRATION: RANDALL ENOS © 1988

or 640 by 200 pixels in two colors. Text display was coarse but legible.

Hercules Computer Technology made its mark by quickly offering a text/graphics compromise of good text resolution and 720- by 348-pixel monochrome graphics. This became the default standard that the MDA should have been. Years later, IBM responded with EGA, then a big step forward with 640 by 350 pixels and 16 colors. But the EGA card was expensive. Sooner than expected, the clone makers copied the function of the EGA, extended its capabilities, and got the prices down to competitive levels. Now the EGA is considered a basic display standard. VGA followed later, correcting some EGA weaknesses and raising the resolution standard to 640 by 480 pixels with 16 colors. (Just to confuse the issue, there's also the PS/2's CGA-compatible MCGA—Multicolor Graphics Array—which has the VGA's 640 by 480 pixels but can display only two simultaneous colors at that resolution.) A standard VGA displays 2.4 times as many dots as the original CGA display and requires 9.6 times as much memory for internal storage. (See photo 1.)

While the above activity was happening in the IBM PC arena, other companies developed computers that had graphics as a basic element of the system. The Mac came out with a 512- by 342-pixel black-and-white display, with standard graphics routines in ROM. The Amiga 1000 started with 320 by 200 and 640 by 200 graphics, plus hardware support that improved graphics performance. The Atari ST machines also included graphics at the start, and Atari later added hardware support. It was clear from these events that the need for graphics extended beyond just IBM PC users.

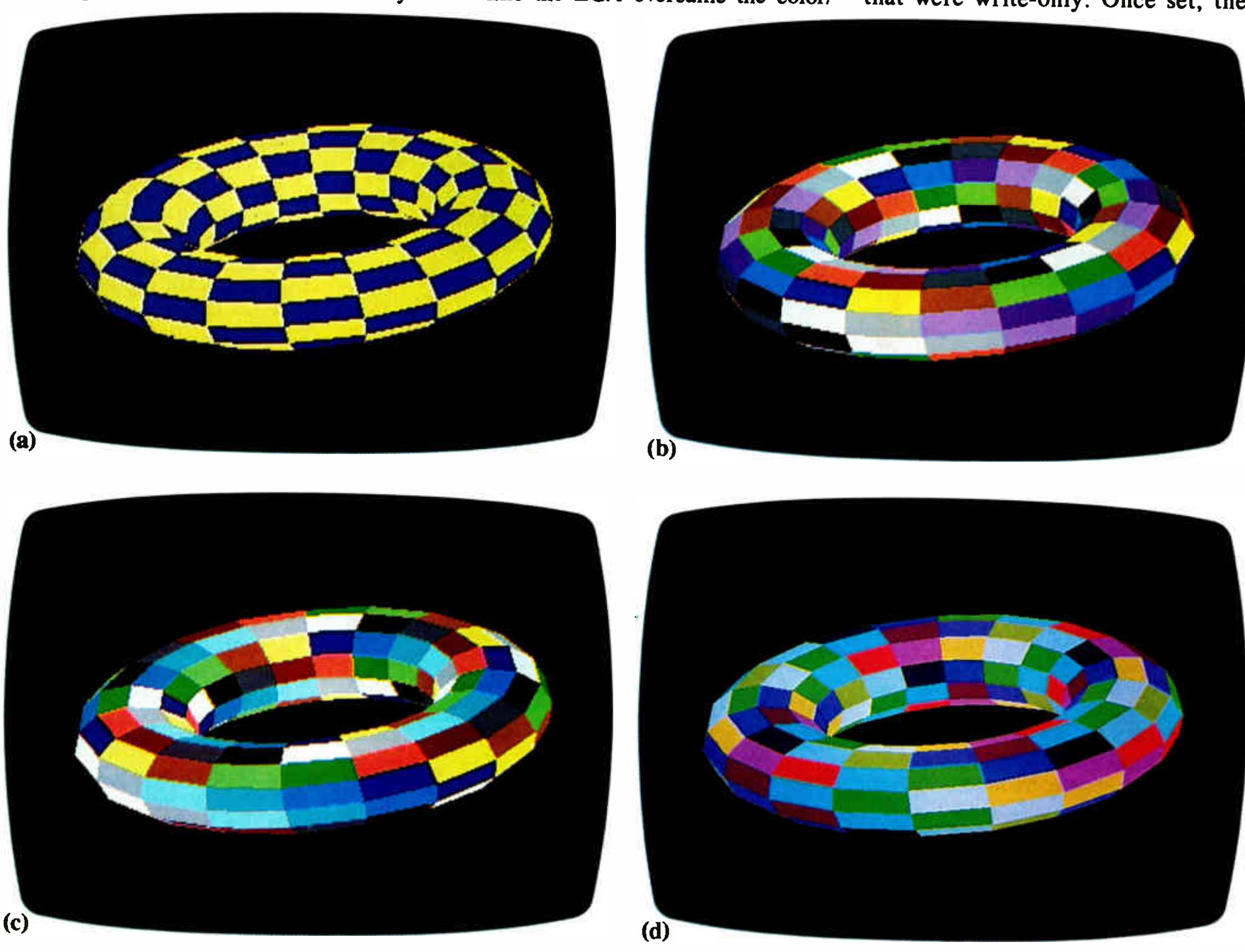
Although the first PC graphics were crude by today's standards, they opened a window into a new class of applications. However, shortly after the first graphics applications became available, problems popped up. Speed was less than impressive, especially on a 4.77-MHz PC. The limited number of colors and low resolution available on CGA seriously restricted detail that could be presented and provided limited eye appeal.

While the EGA overcame the color/resolution limitation, it worsened the speed problem. The CGA's 32K-byte video memory became a 112K-byte memory, and the EGA required five out of six memory cycles to be dedicated to display refreshing, which reduced the access speed to display memory. On top of that, EGA required that the CPU access the four memory planes of display memory one plane at a time. The complication required four accesses where one had done the job before.

Problems with Programming

In addition to speed problems, the EGA came with new programming requirements. Software vendors had to support the three major displays (CGA, Hercules, and EGA) to sell to the whole market, and all three required different techniques for best speed. Graphics speed is critically dependent on code quality, so all graphics support was done in assembly language, which increased programming difficulty still further.

Some new problems also had to be handled. The EGA had some registers that were write-only. Once set, they



(a) (b) (c) (d)

could not be read back later to see what the status was. This meant that programs had to keep (in low memory) information that specified what those registers contained. But not all software used or updated that information, thus creating incompatibilities, especially with terminate-and-stay-resident (TSR) programs. Another problem was the EGA's vertical retrace interrupt. Some programs used the vertical retrace interrupt to trigger actions, only to find out that not all EGA implementations handled it correctly, because of errors in IBM's published specifications.

While software vendors were tearing out their hair, users were demanding more speed and resolution. These made the display more attractive and useful but made the software vendors' job more difficult. Even with an 8-MHz AT, graphics displays were far from the instant update that a character display could deliver. Users wanted both—speed and graphics.

The Standards Dilemma

Along with all the other issues, various committees and manufacturers were developing standards for writing and displaying graphics and, later, standards for the interchange of graphics. Instead of one or two standards that could have advanced the industry, forces pulled in all directions:

- In order to have a standard, you need lots of products to sell the standard. In order to have products, you need a standard.
- To efficiently drive CGA, EGA, and Hercules, you need standards oriented to the hardware. To support programming efficiently, you need standards oriented to software.
- By promoting your own standard, you could gain a marketing edge, at the cost of compatibility and a proliferation of standards. If you wanted to support a standard, would you wind up supporting a competitor?

The result of these dilemmas was that literally dozens of graphics "standards" became available, ranging from single-product standards to the IEEE Computer Graphics Metafile (CGM). Only in 1988 have we seen the beginning of a resolution to the standards dilemma, which will likely take until 1990 to become pervasive. Even then, there will be more than one standard, but there should be few enough to be manageable.

Graphics Processors

As resolution and the number of colors increased and users demanded more speed, even the faster processor solution failed. It wasn't just speed that was the problem—good graphics requires a lot of programming as well as speed. Fortunately, by this time some of the basic graphics functions were well established, and these functions became the hardware nucleus of a new class of processors known as graphics processors.

GPs take the basic graphics operations and implement them in hardware, doing in one processor cycle what may have taken a software implementation several instructions and 20 or more cycles. GPs also add certain useful functions, particularly the bit-block transfer, known as BitBlt. This operation can take an arbi-

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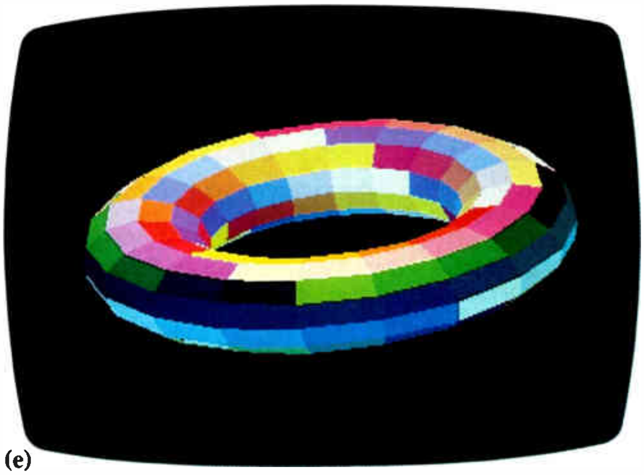

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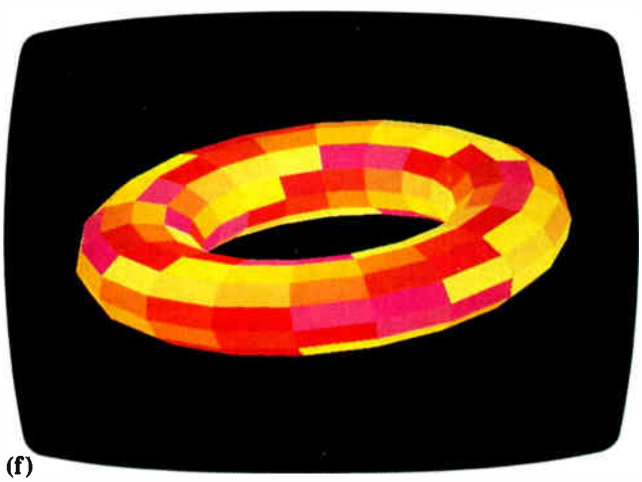

(f)

Photo 1: *This series of graphics, generated on an IBM PS/2 Model 80 with an 8514 color monitor, shows how far IBM graphics have come in a few short years.*

(a) *The CGA, capable of up to 4 colors in 320 by 200 resolution (here) or 2 colors in 640 by 200 resolution.*

(b) *The EGA, displaying 16 colors in 320 by 200 resolution.*

(c) *The EGA, displaying 16 colors in 640 by 200 resolution.*

(d) *The EGA, displaying 16 colors in 640 by 350 resolution (256K bytes of system RAM).*

(e) *The Multicolor Graphics Array, capable of 256 colors in 320 by 200 resolution (here) or 2 colors in 640 by 480 resolution.*

(f) *The Video Graphics Array, capable of up to 16 colors in 640 by 480 resolution.*

trary group of bits anywhere in memory and move them anywhere else, without being restricted by byte or word boundaries. Since graphics pixels are bit-oriented units, BitBlt enabled simple and rapid movement of graphics entities on the screen.

Two complementary factors helped reduce the cost barrier on graphics displays. On the technical side, mass production reduced the cost of chips and displays, and increasing semiconductor integration reduced the number of components while adding to their function and performance. On the human side, a number of management studies showed that graphics and fast response led to increased user productivity.

The combined cost push and management pull led to changing the evaluation of graphics displays. No longer an expensive toy, graphics displays became a key productivity tool. This helped fuel a rapid evolution in software and hardware that continues unabated today.

Evolution of the GP

One of the first GPs for PCs was IBM's PGA, which used an Intel 8080 processor and provided 640 by 480 resolution with 256 colors from a palette of 4096. Although the concept was correct, the price and performance were poor, and the PGA had only limited success. However, the ground was broken, and other controllers using a processor were introduced. Another early controller used the Hitachi 7220 chip, which was faster than the PGA but was limited in what it could do compared to a general-purpose processor.

Along with the extra processor capability came a new requirement. Each new GP had a different software interface with the host processor. In order for the GP to do more than just set single dots, applications need a software protocol between the HP and the GP that enables the HP to specify what the GP is to do. This means that for the GP to draw a line, the HP must pass the start, end, color, width, and form of the line in a manner that the GP can interpret. This forced each graphics application to write new code for each display controller that used a different interface.

As GP controllers arrived on the market, the combination of GPs and CGA, EGA, and Hercules caused the software problem to rapidly become too expensive for all but the largest software vendors. What followed was an explosion of incompatible products, incompatible software interfaces, multiple graphics software "standards," immense confusion for the general user, and duplication of effort almost everywhere graphics was developed or used.

Recently, however, the graphics environment has begun to stabilize. Microsoft Windows 2.0 and OS/2 Presentation Manager are establishing a set of conventions for applications to have a single interface to a virtual graphics device, with the operating system and environment dealing with the different interfaces to the display controllers, with or without a GP. Windows 1.0 was designed without taking the capabilities of GPs into account, and, as such, did not show significant performance increases when a GP was used (see "High-Performance Graphics Boards," January BYTE). Windows 2.0 was changed to make more effective use of GPs.

In addition to those environments, the third-party software market has begun to organize around a number of well-supported graphics drivers, such as MetaWindow, and the software tool makers have added graphics support to products like Turbo Pascal 4.0. Third-party software tool vendors like PMI are moving to support the Microsoft Windows and other window interfaces as an option with their products. The IEEE is nearing completion on a number of graphics standards, such as CGM, that have broad nonpartisan support.

All these products and standards recognize, to a greater or lesser degree, the need for an effective interface to graphics processors. This recognition has spread in 1988 so that future products will more likely support the GP interface effectively.

Performance

GPs mean higher performance for the user now, and even more in the future. In today's systems, a GP will show varying performance improvement. This will range from little or none while emulating current standards, to several times for graphics-intensive programs that match the GP's interface. CAD and desktop publishing have already benefited from early use of GPs.

Even if you're not a CAD or desktop publishing user, there are benefits for you. GPs can reduce the load on the host processor, making programs run faster and letting you increase the screen resolution without a corresponding slowdown of the host processor. Future displays with higher resolutions will let you display multiple windows simultaneously, making it more practical to watch and work with more than one program at a time. Higher resolutions and GPs also make it possible to use higher-quality text fonts. These fonts reduce eyestrain and improve the working environment, factors that are becoming increasingly important to everyone.

What's in It for You?

Most users today don't use GPs in their systems. The reasons for this range from cost and availability to need and software support. But things are changing rapidly, and most users should begin planning for the probable use of GPs.

What needs to be done? First, you should be aware of a few trends. The price of graphics technology continues to go in a downward direction, despite occasional glitches. The resolution and colors available continue in an upward direction. More and more software uses or supports a graphics interface. These trends are expected to continue, and all of them point to more graphics for the user.

If you accept that graphics is the coming display environment, what can you do to prepare? Start by reviewing what software you have and whether it operates in character mode, graphics mode, or both. Find out what resolutions and controllers it supports, and look particularly for support of graphics processors. Make up a list showing these facts and organize the list by the time it spends in each application.

Now consider your upgrade options. Are graphics versions of your software available, or have they been announced? Are there other products for this application that offer better options? Consider what other applications you might want to add in the future, and what graphics options are available for each of these. Make a list of the software and environment you would like to evolve to.

Turning to the hardware side, take a similar inventory. If you have an older machine, particularly an IBM PC, consider a system upgrade to at least a fast AT or 80386SX machine. Check your display controller and display. If you're running EGA or better, there may be no need for an immediate upgrade. If not, then budget and timing will determine the next step. If your budget can handle it, you can upgrade to a new GP controller now. If both the budget and time frame are short, avoid the EGA even if it looks inexpensive. VGA-compatible controllers are downward-compatible with EGA, without the EGA weaknesses. VGA is *not* a graphics processor, but it represents the current best value for non-GP graphics controllers.

continued

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Obvious candidates for GP-based controllers are CAD and desktop publishing. There are a number of less obvious candidates as well. Consider the high-end word processors. Most now support graphics preview of the finished page. Viewing the page on the screen is a lot faster than printing it and then trying to change the results. WYSIWYG depends in part on what you *can* see. Good graphics support can be a productivity aid for almost anything beyond the basic business letter.

Business graphics and analysis programs that use graphics as a primary output are other applications that can benefit from improved graphics capability. A column of numbers is harder to interpret than a graph and takes longer to read. While printing a graph is slow, a spreadsheet displayed as graphics output takes best advantage of the human ability to spot trends and exceptions. Again, user productivity is improved.

Finally, consider the programmer. His or her desk is usually covered with paper because he or she can't get enough on the screen at one time. With a high-resolution screen and a large display, you can open multiple windows at once, which facilitates quicker analysis, or multiple operations at once in a multitasking environment. Both mean greater productivity.

What Is a GP?

A GP is used to process data from internal form to pixels. It may be a standard CPU, a CPU with both standard and graphics instructions, or a custom device solely for the purpose of transforming data to pixels. Some of these might also produce a pixel output stream for direct transmission to a display unit.

GPs are oriented toward the pixel, not the data byte. Pixels are usually represented as 1 to 32 bits of information that might or might not begin on a byte boundary. A general-purpose processor must use extra instructions to manipulate non-byte-size pixels, and this takes extra code and time.

A window (a defined area on the display screen) is a logical element for a GP to handle, easing the load on the HP. Some GPs, like the Intel 82786, have hardware support for window operations, which speeds up the window displays and moves. Other GPs, like the Texas Instruments 34010, have no hardware support for windows but have special graphics instructions that speed up all graphics processing.

The earliest GPs were simply standard processors that were dedicated to doing graphics work. Even though this was a simple approach, it was effective because it brought more processing power to the system and allowed the HP to proceed while the GP drove the display. The GP removed the graphics calculations from the host and, in many cases, wrote directly to its own memory, avoiding other delays. The net effect was a real increase in capability.

Despite the early success in the use of a standard processor dedicated to graphics, second-generation designs rapidly ran into a bottleneck during graphics calculations. Even simple line drawing be-

continued

comes complex when the line style, angle, and antialiasing (smoothing the stair-step appearance of angled lines) has to be taken into account.

To effectively support these additional capabilities, system designers developed custom chips and standard processors with extended instructions for fast graphics processing. The best-known of these is the current TI 34010, a general-purpose processor with special hardware support for graphics operations. (See "The TMS34010 Graphics System Processor" by Carrell R. Killebrew Jr., December 1986 BYTE.)

A number of companies took the alternate approach of custom graphics processors. Intel and Hitachi made single chips, while AMD and National Semiconductor developed multiple chip sets.

The single-chip designs of Intel and Hitachi are far apart in terms of concept and architecture. Hitachi built a device (7220) that can be used alone or in pairs, but it still depends on the host for most of the graphics work internally, while serving as an interface to the display device.

Intel put three cooperating processors on one chip, with external interfaces to the host memory, display memory, and the display device, with processing and access shared on a priority basis. (See "Inside the 82786 Graphics Chip," August 1987 BYTE.) One processor does graphics functions on the display memory (based on commands from the host), a second handles memory refresh, and a third converts the internal representation to an external pixel stream, including multiple window support. A fourth component handles the priority conflicts between host, internal processors, and memory, for both system and display.

Multichip designs offer a more flexible organization and typically higher performance than single-chip designs, at the cost of a more complex design process and more board space. AMD's Am95C60 and National Semiconductor's DP8500 family are among the multichip graphics processors. Both these multichip versions preceded the Intel and TI single-chip processors.

While no single chip is representative of the whole set, the AMD Am95C, known as the Quad Pixel Dataflow Manager, is representative of this class of processors. As a minimum, the QPDM requires commands from the host via direct memory access, a video memory of four planes per QPDM chip, and a color palette. The QPDM processor does perform the basic graphics functions independently of the host and runs at a 20-MHz clock rate, providing fast graphics performance with up to a 2048 by 2048 display device.

The QPDM refreshes the graphics memory and the video display, updates the graphics memory based on commands from the host, and supports a single hardware window. Its basic commands include drawing lines, arcs, and circles, all including optional antialiasing, block move, filled rectangles, and string moves for fast character displays.

Today and Tomorrow

The current standard display controllers are "dumb"; that is, they depend on the host to calculate and write every pixel on the screen. Some current VGA controllers support 800 by 600 with 16 or 256 colors, and even fast systems will spend an excessive amount of time updating

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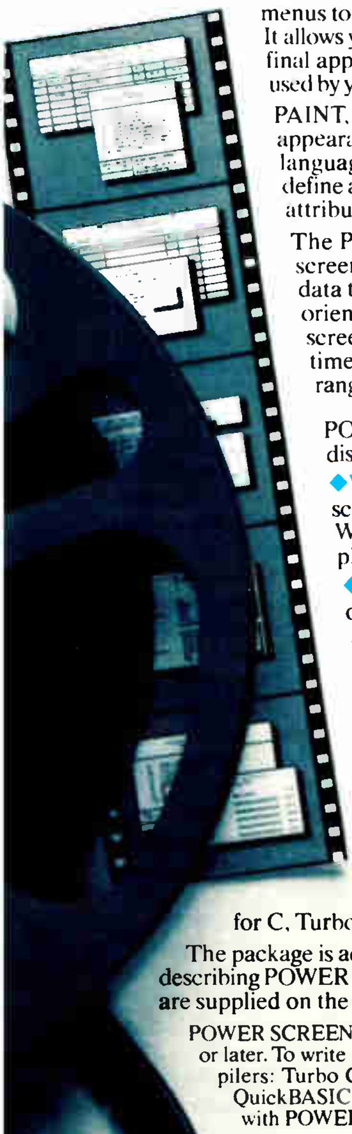

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that large a graphics display. Even with the performance of an 80386, we've just about reached the limit of this approach to support fast graphics. New applications will demand more of the host processor, leaving fewer cycles to drive the display without visible slowdown. All evidence points to the technology having reached a transition point.

What comes next should be obvious—display controllers driven by their own graphics processor. IBM has revealed in advance that its next display controller will have a graphics processor built in. The 8514/A controller for the PS/2s already has some processing built in, but its capability is limited. The interface is totally software defined, and hardware specifications are not even available. This prevents software vendors from bypassing the software interface in search of short-term gains at the expense of long-term compatibility.

As we enter the era of GP-driven controllers with megabytes of display memory, the old technique of driving the hardware directly is obsolete and counterproductive. New displays will require processing well beyond what current systems have available. By 1990, most, if not all, display controllers will have a graphics processor or two to provide capabilities we can only dream of today. We can expect these future controllers to have multiple windows, three-dimensional displays, rotating displays, hidden-line removal, and shading of objects.

In all this discussion about graphics processors, let's not forget about the final key in the display chain: the display monitor itself. While the pace of monitor improvement does not match that of the semiconductor industry, displays have come a long way. The $700 CGA display of 1984 has given way to the $600 EGA display of 1986, which has given way to the $500 VGA display of 1988. This trend should continue as GPs and new software provide the push for even higher-resolution displays, at mass market prices. Today's $2000 1280 by 1024 color display will be 1989's $1500 display and 1990's $1000 display, with even better displays entering at the $2000 level.

The acceptance of the graphics processor as a standard component of computer systems will change the way we view and use these systems in the years that lie ahead. ■

Bill Nicholls is an author and computer consultant with BGW Systems, Inc., in Puyallup, Washington. He can be reached as "billn" on BIX.

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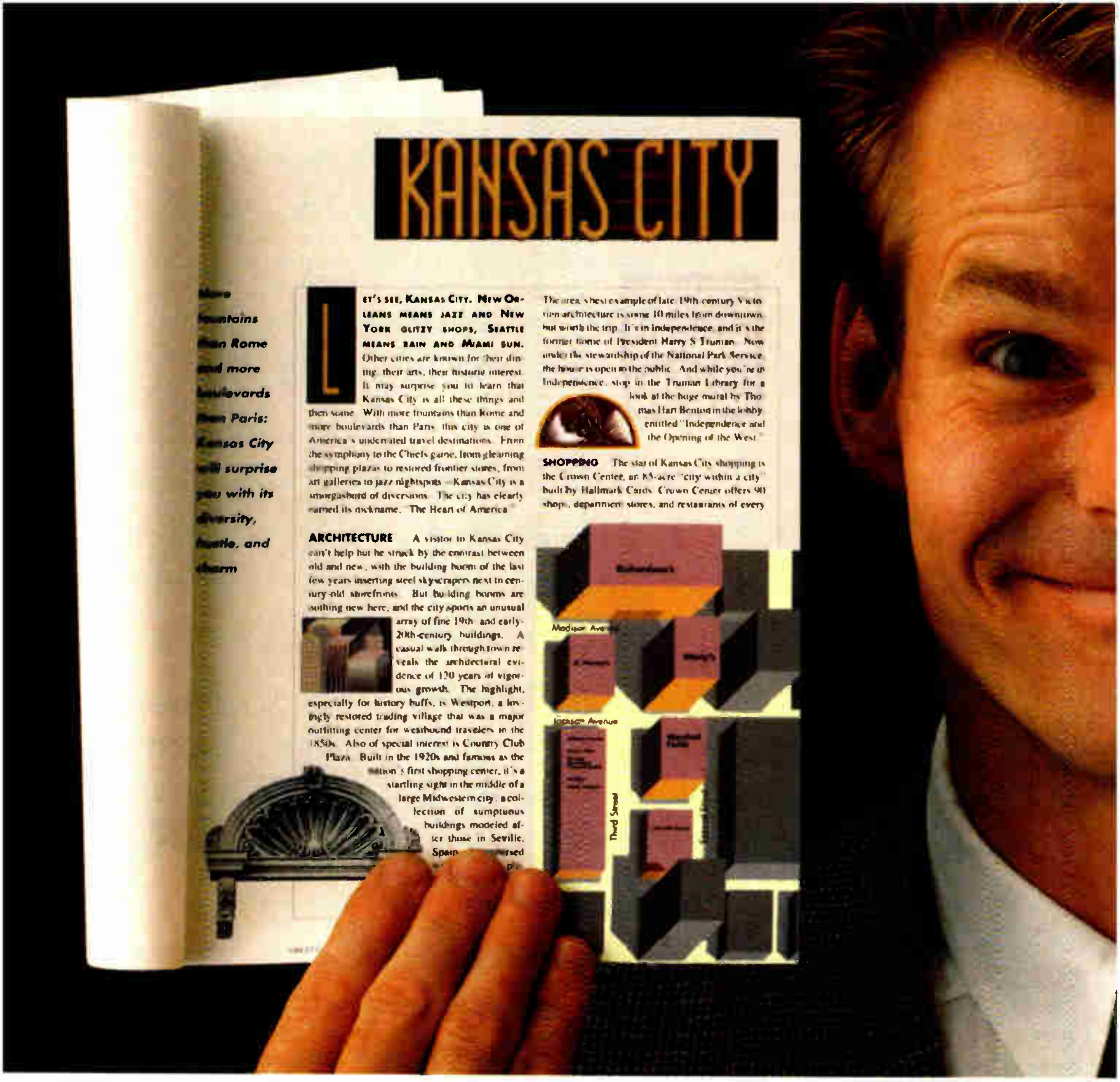

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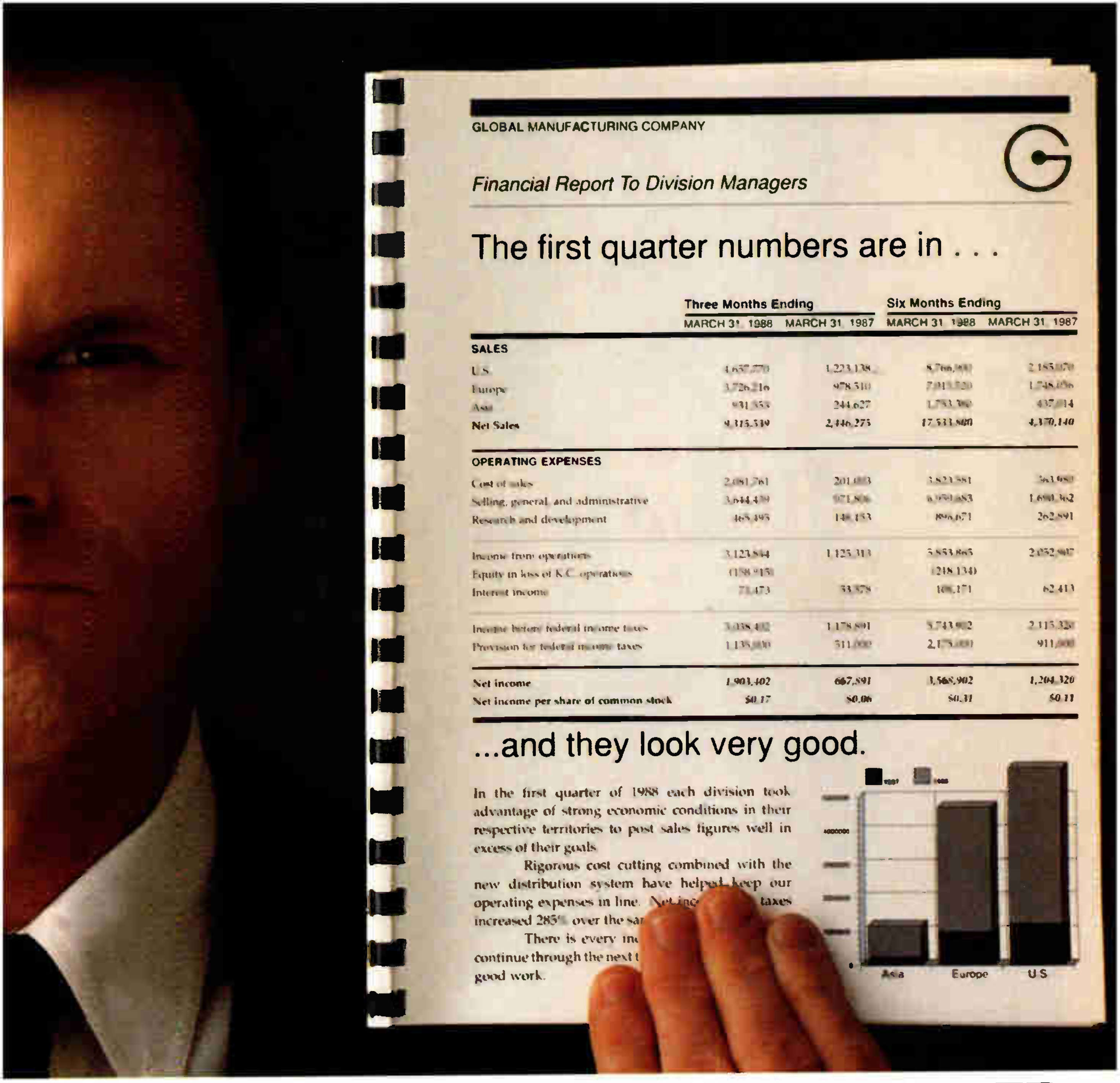

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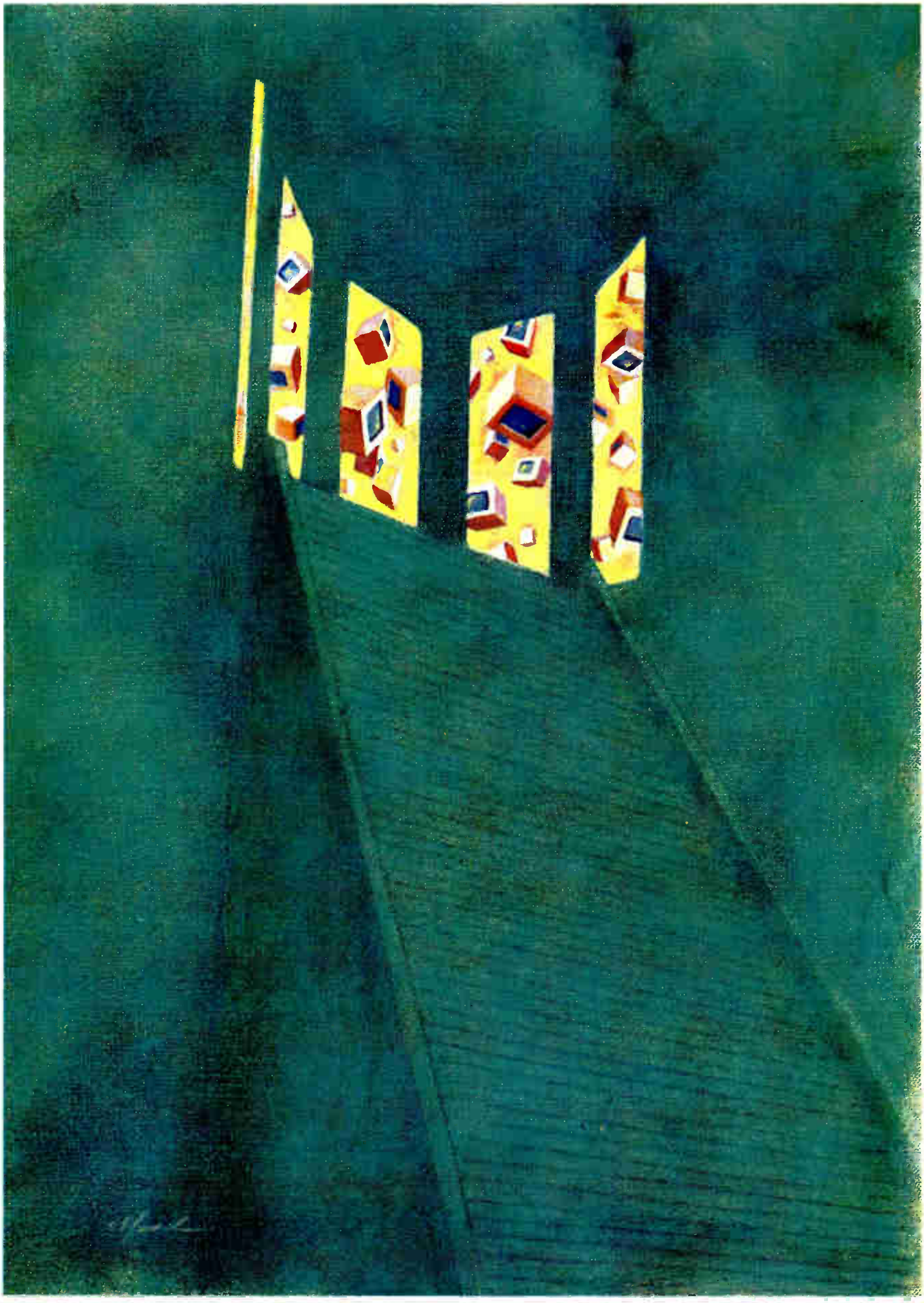

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LIFE AFTER DOS

Outgrown MS-DOS? Here are six programs that bring multitasking features to 80386 computers without resorting to OS/2

Namir Clement Shammas

In April 1987, IBM announced a new operating system, OS/2. Microsoft and IBM had collaborated in developing this new operating system, which caters to the 80286. The 80286 chip is found in the many IBM PC ATs and compatibles. OS/2 introduced new features, such as multitasking, task scheduling, and piping between different processes, just to name a few.

To the end user, OS/2 exhibits rather limited multitasking support for applications written for standard MS-DOS. This feature is attributable to the architecture of the 80286 chip. The limitations have been overcome by the more powerful 80386 and its virtual real mode, which is not available in the 80286. In real mode, one operating system and one program run at a time. Using the virtual real mode, the 80386 is able to execute multiple 8086 programs as though each were running on a separate machine.

In addition, the 80386 chip has virtual memory management and memory paging, and it handles memory segments that are larger than the 64K bytes of the 80286. These 80386 features let programmers create environments that support multitasking DOS applications, implement virtual 8086 machines, and break the 640K-byte memory barrier (by using extended memory to simulate expanded memory for memory paging). (Also see "High-Speed Memory Boards for ATs" by Barry Nance in the December 1987 BYTE and "It's a Natural" by Bud E. Smith in the July BYTE.)

The 80386-based concurrent-DOS environments bring multitasking and the use of all available memory into play. Now that these capabilities are actually at hand, programmers and end users must ask themselves how to put them to work. Two general ways to use such environments are as follows:

- Using the multitasking environment to quickly and frequently switch two or more applications. The emphasis is more on the ability to navigate among various applications or multiple instances of the same application. Performing background work is at a minimum or not used at all. If your interest is mainly in this type of application management, then 80386 environments are by no means the unique providers for such requirements.
- Using the multitasking environment to focus on one main application that requires rather extensive human interaction while running other programs in the background. Programs that function in the background must be able to run unattended for at least the duration of certain tasks. In this category, you have, for example, bulletin boards; print spoolers; archiving utilities; large spreadsheet recalculations; extensive and time-consuming number-crunching engineering, scientific, and statistical programs; and extensive database sorting or indexing.

Bulletin boards represent a special class of background tasks that suddenly need the attention of the CPU. Most 80386-based environments have catered to that need.

Personality Profiles

In this article, I will look at six 80386-based environments that support concurrent DOS. They include Windows/386 from Microsoft; VM/386 from IGC; DESQview 2.01 from Quarterdeck Office Systems; Omniview from Sunny Hill Software; Concurrent DOS 386 from Digital Research; and PC-MOS from The Software Link. Keep in mind that each package was designed to express a product personality reflecting the philosophy and intent of its developers.

Windows/386 is a graphics-based environment complete with pull-down menus, windows, and icons. Its interface is very similar to that of the OS/2 Presentation Manager, and it also provides file management facilities for single users.

VM/386 is a text-based environment for multiple virtual 8086-based PCs. The VM/386 emphasis is on defining virtual machines and spawning them as either background or foreground tasks. Any of the virtual machines can crash, and you can reboot them without affecting the others. VM/386 can run on IBM's Token Ring Network.

DESQview 2.01 has evolved from earlier versions that were designed to run

continued

with the 8086 and 80286 chips. Version 2.01, tailored toward the 80386, delivers a combination of text-based windows able to display different tasks, a family of well-designed pop-up menus, and multitasking capabilities. DESQview also runs on networks.

Omniview is an interesting product that really stands out for its flexible and modest hardware and software requirements, and it gives you the multitasking capability you seek. This program works with most networks.

Concurrent DOS 386 is an environment that attempts to bring an 80386 version of CP/M-86 to PC-DOS. Conceived by the company that developed the Z80-based CP/M, this product comes across like a cat with nine lives. From my comparison of this package with the other environments, I believe that Digital Research did not develop the package from the ground up. Instead, the company relied on upgrading previous versions. As a result, the product has design limitations inherited from previous (non-80386) versions. Concurrent DOS 386 does offer a superset of DOS commands, multitasking, and multiuser support with some practical limitations.

The PC-MOS environment is very different from the rest of the lot. It is an operating system that can be seen as a superset of PC-DOS implemented for the 80386 machines. It provides its own system file, its own command processor, internal and external MOS commands, a task manager, a text editor, a debugger, and multiuser support. PC-MOS employs many commands that are available in standard DOS and adds a few good new ones. Table 1 shows the system requirements of the six packages.

Table 1: *System requirements for the six packages. Note that DESQview and Omniview can operate with two 360K-byte floppy disk drives or one 360K-byte floppy disk drive and one hard disk drive.*

	Windows/386	VM/386	DESQview
Version run	2.1	1.1	2.01
DOS version	3.1, 3.2, or 3.3	3.0 or higher	2.0 to 3.3
Drives	1.2-megabyte floppy disk and a hard disk (2-megabyte space)	1.2-megabyte floppy disk and a hard disk (2-megabyte space)	Two 360K-byte floppy disks or one 360K-byte floppy disk and one hard disk
RAM (megabytes)			
Minimum	1	2	0.64
Recommend	2	2+	Not specified
Video	CGA, EGA, VGA	MDA, Hercules, CGA, EGA, VGA	(Optional) CGA, Hercules, EGA
Modem	Optional	No	(Optional) Hayes or compatible
Can run with			
80286	No	No	Yes
8086/88	No	No	Yes

Setting Up the Environments

How hard is it to install these multitasking DOS environments? And once you've got them installed, how hard is it to alternate between sessions that use the standard DOS and the concurrent environment?

To set up Windows/386, you use the SETUP.EXE program located on the distribution disks. The steps involve selecting the type of computer, display adapter, keyboard, and country. The setup process is very smooth. However, you may need to alter your CONFIG.SYS file so that it doesn't install RAM disks, and change the AUTOEXEC.BAT to avoid loading RAM-resident programs. You may elect to create a special boot disk with the customized versions of the AUTOEXEC.BAT and CONFIG.SYS files. With this process, you can run Windows/386 only when you need it; otherwise, you use standard DOS.

Installing the VM/386 environment is straightforward. First, you make copies of your current AUTOEXEC.BAT and CONFIG.SYS files because the system setup utility modifies them. Then you need to remove all RAM-resident utilities installed by the AUTOEXEC.BAT. The SETUP.EXE utility queries you about the compatibility level of your system. You may create a special boot disk to run VM/386 at your discretion and alternate with standard DOS.

The DESQview environment is very simple to install on a hard disk drive, a high-density floppy disk drive, or two 360K-byte floppy disk drives. While DESQview also runs under the 8088, 8086, and 80286, only the 80386 version offers concurrency utilizing a single CPU.

Installing DESQview for the 80386 involves two steps: You install DESQview itself, and then you install Quarterdecks's Expanded Memory Manager 386. The QEMM-386 is a driver that permits the use of extended memory in a manner similar to expanded memory (compatible with Expanded Memory Specifications [EMS] 3.2 and 4.0). Once installed, the QEMM-386 permits DESQview to swiftly swap concurrently running tasks between the extended memory and the first 640K bytes of RAM space. I was able to install DESQview on a high-density floppy disk drive after modifying my CONFIG.SYS and AUTOEXEC.BAT files.

When setting up Omniview, you will see that the program has incredibly modest requirements that don't compromise its very flexible nature. In other words, Omniview is a very resourceful package. The environment can be installed on either floppy or hard disks. It is worth pointing out that the CONFIG.SYS and AUTOEXEC.BAT need not be changed. In fact, I first installed Omniview on a 360K-byte floppy disk and was able to run it from the floppy disk. A better arrangement, though, was to copy the files of the installed disk to my RAM disk and run Omniview from there, after setting the swap DOS-environment variable to the RAM disk.

Omniview is able to take advantage of extended memory, expanded memory, enhanced expanded memory, RAM disk space, or hard disk space to overcome DOS's 640K-byte limitations. In order to use the extended memory, you must use separate drivers. Regarding expanded memory, Omniview supports the drivers for EMS 3.2 and 4.0.

You install Concurrent DOS 386 by booting from the first distribution disk. A setup program creates two new directories on the hard disk and modifies the AUTOEXEC.BAT. You will most likely

Omniview	Concurrent DOS 386	PC-MOS
4.0	2.0	2.1
2.0 to 3.4	3.0 to 3.3	Installs MOS over MS-/PC-DOS
Two 360K-byte floppy disks or one 360K-byte floppy disk and one hard disk	One floppy disk (for setup), plus one hard disk for operation	One floppy disk (for setup), plus one hard disk for operation
0.256 Expanded memory	0.512 Expanded memory	1 1+
MDA, CGA, EGA, VGA	CGA, EGA, VGA	MDA, CGA, EGA
No	No	No
No No	No No	No No

need to further modify your AUTOEXEC.BAT, copy your CONFIG.SYS file as CCONFIG.SYS, rename CONFIG.SYS, and edit the device drivers in CCONFIG.SYS. When you reboot, the AUTOEXEC.BAT prompts you to decide whether or not to run Concurrent DOS 386. This is a welcome choice not found in the other packages. While memory requirement is modest, Concurrent DOS 386 does not make any provisions to utilize extended memory—only expanded memory.

Setting up PC-MOS is slightly more elaborate than setting up the other environments because this program sets up its own operating system. As a result, the setup process involves new system files, a new CONFIG.SYS file, and a new AUTOEXEC.BAT file.

To avoid alienating the user, PC-MOS supports several of the declarations familiar to PC-DOS CONFIG.SYS files, such as `DEVICE`, `BUFFERS`, `COUNTRY`, and `SHELL`. Other declarations enable you to reassign the default time-slice period; declare the size of a PC-MOS's RAM disk, the amount of disk cache, and EMS memory size; and allocate the various types of memory parameters.

You should only install PC-MOS on your hard disk if you intend to become a dedicated PC-MOS user. Alternating between DOS and PC-MOS requires not only restoring your original AUTOEXEC.BAT and CONFIG.SYS files, but also removing the PC-MOS system files and making sure that your DOS system files are present. Handling system files, with hidden attributes, requires the use of special utilities.

User Interfaces

Windows/386 is a graphics-based interface that fosters the use of the mouse, although you can also use the keyboard. The MS-DOS Executive window appears when Windows/386 begins to run. An application can possess one of three display levels: entire screen, window, or icon. Windows/386 can display standard DOS applications in any of these three display levels.

The MS-DOS Executive window is the launching point for many applications. It displays the names of the files and subdirectories of the current directory. Subdirectory names are displayed first using bold characters, while the list of sorted filenames is shown using normal characters. The current file or subdirectory selection appears in reverse video.

Since you do not have access to a command-line processor, everything is performed using pull-down menus. The MS-DOS Executive window has three menu options: file, view, and special. With the file menu, you can perform many internal DOS commands, such as `rename`, `copy`, and `delete` files, as well as load and run programs. These options work only on the highlighted file.

You can use MS-DOS Executive to mark multiple files for collective copying or deletion. With the file option, you can run an application and its related data file by simply loading the data file. For example, if you load a data file created by a database written for Windows/386, you produce a special icon. Clicking on that icon invokes the database and loads the accompanying data file.

The View menu enables you to view files in either short format (i.e., only the filename), or long format (which includes file size and date/time stamps). You can also elect to display all or some of the files, or just programs. You can use MS-DOS Executive to display the filenames sorted by name, date, size, or time. The Special option offers more important commands that you don't use as often. With these options, you can create a directory, change the current directory, format a disk, create a system disk, and set the disk volume name.

When an application is in either full screen or windows, the upper screen line displays the control-menu box, a title bar, and the maximize/minimize boxes. Via the latter boxes, you can alternate between a full-screen, a window, and an icon display. Windows/386 applications utilize the second line to display their menu bars. You can access the boxes in the top line or the menu options in the second line by using either a mouse or key combinations.

You can use the control box of any application to manipulate the related window in the following ways: move, resize, manipulate the display status (i.e., maximize or minimize), close, or restore. At that point, you can tell which options aren't available to you, because they are displayed in blurred characters or faded colors. You can use the `close` command to end the window applications. With standard applications, you need to exit using their own particular commands first, and then close their windows.

VM/386 basically offers a transparent control center that manages multiple virtual 8086-based PCs. VM/386 employs menus enclosed in text-based windows. For the DOS-related management of programs and files with VM/386, you load a copy of DOS and perform the required chores. Once you have defined your virtual machines, the VM/386 user interface becomes more or less transparent.

Each application occupies the entire screen, and you can't split the screen between two tasks. Pressing the Alt-Sys-

continued

Req keys pops up VM/386's main menu, so you have the option of invoking the VM/386 Manager or selecting any other loaded task.

The DESQview user interface employs a series of text-based pop-up menus. You can select from the menu using the cursor-control keys, typing in the hot keys (which appear only when the option is available), or using a mouse (which enhances the speed of menu selection). DESQview's main menu is invoked by simply pressing the Alt key. The DESQview menus are characterized by being short; some option categories are broken into two menus to avoid long menus.

It is interesting to note that DESQview does not employ one-line pull-down menus like those found in Windows/386. The main DESQview menu offers options that fall into four categories: task management, window management, data transfer, and help/exit options.

With the task management options, you can open a new window to run a new task, switch between tasks, and close a window removing its inactive task. Via the task management submenu, you can run a copy of DOS, invoke the DOS services, or spawn a task from the task list. Other task management options enable you to add, change, and delete tasks from the task list.

Using the window management options, you can rearrange a window's size, position, color, and visibility, and zoom in on a task, making it occupy the entire screen. DESQview does not hide (or temporarily suppress) the screen output of a background task that runs as a full-screen application under standard DOS.

Omniview provides two types of user interfaces: pop-up menus and command-line oriented. You can invoke the pop-up menu by pressing the Shift-Ctrl-1 keys. The main menu options essentially focus on managing multitasking, and they permit you to run a task from the applications list, switch between tasks, and add, delete, and change an application's specification from the current applications list.

The applications list includes a small DOS (128K bytes), a big DOS (400K bytes to 600K bytes), Omniview's task status utility, and any other programs you may add. When you add the name of a program to the applications list, you specify a program title that begins with a two-letter hot key. For example, `WS - WordStar` is a title that also specifies the letters *WS* as the hot key. You can choose to run WordStar by simply typing *WS* when Omniview displays the applications list pop-up menu. Of course, you can also employ the cursor-control keys to select the applications you want to run.

The Omniview status option maps the presently loaded tasks and reports the memory size, base priority, current priority, and time slice for each task. Using a copy of DOS, I was able to locate the virtual files on my RAM disk where some of the applications are swapped. In addition, you can obtain a report from the system that shows you the amount of free memory, available virtual memory, and unused expanded memory.

Omniview's command-line version consists of five commands, one of which invokes the Omniview shell discussed above. With the other commands, you can start a task and run it in background mode; run a process with the option of switching it into the background; switch between processes; and display the status of the tasks and the amount of various types of free memory.

Concurrent DOS 386 supports up to four tasks. Each task starts with its own command-line prompt and occupies the entire screen. You can switch between tasks by pressing the Control and the 1, 2, 3, or 4 keys. Concurrent DOS 386 includes a file manager application that provides a DOS shell. The shell supports both DOS and CP/M-86 utilities. Concurrent DOS 386 adds new DOS commands related to file/directory deleting and copying. The file manager contains several windows of information: directory information, file information, a list of commands, and a map for the keyboard function keys.

When in the shell, you can use the file manager to navigate easily between drives and paths and perform various DOS functions, including running a program within that task. While Concurrent DOS 386 allows tasks to run concurrently, the screen output of background tasks overlays with the screen of the currently viewed task. This overlaid output severely limits the usefulness of Concurrent DOS 386 as a flexible multitasking environment to that of only a fast program switcher. To continue using the multitasking feature, you must program background tasks to beep and attract your attention.

Concurrent DOS 386 does not implement the various tasks as virtual protected machines. While I was running multiple applications, one of them crashed and caused my entire system to hang.

PC-MOS is a PC-DOS superset operating system that takes special advantage of the architecture of the 80386 chip. Thus, PC-MOS takes complete control and defines its rules from the ground up. For example, you start PC-MOS commands with a dot, although you can tell the system to absolve you from having to type the dot. When multitasking, you can use additional commands to launch,

continued

Items Discussed

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Inquiry 887.

DESQview 2.01 .... $129.95
Quarterdeck Office Systems
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Inquiry 885.

Omniview 4.0 .... $79.95
Sunny Hill Software
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Inquiry 886.

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for 5 users $595
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Inquiry 888.

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Santa Clara, CA 95054
(408) 986-8373
Inquiry 884.

Windows/386 2.1 .... $195
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Table 2: *Task specifications available in the 80386-based environments (●=yes; ○=no).*

	Windows/386	VM/386	DESQview	Omniview	Concurrent DOS	PC-MOS
User-defined title	●	●	●	●	○	○
EXE file	●	●	●	●	○	○
Subdirectory	●	●	●	●	○	○
Program parameters	●	●	●	●	○	○
Must invoke by a batch file only	○	○	○	○	○	●
Memory allocation						
Required	●	●	●	●	●	●
Desired	●	○	●	●	○	○
Expanded memory	○	●	●	●	●	○
Extended memory	○	●	○[1]	○	○	○[2]
Execution control						
Full screen	●	●	●	●	●	●
Background	●	●	●	●	●	●
Exclusive	●	●	●	●	●	●
Screen exchange						
Text	●	●	●	●	●	●
Graphics/text	●	●	●	●	●	●
Display options						
Window	●	○	●	○	○	○
Full screen	●	●	●	●	●	●
Task execution						
Suspend	●	●	●	○	●	●
Resume	●	●	●	○	●	●
Terminate	●	●	●	●	●	●
Reboot (single task)	○	●	○	○	○	○
Set priority	○	●	○	●	○	●
Set time slice	○	●	○	●	○	●

[1]Extended memory is handled as expanded memory by special drivers.
[2]Used by the MOS task manager itself.

remove, and manage a task. Every task launched has a task ID associated with it that acts as a handle. To switch between tasks, you hold down the Alt key while typing the digits of the task's ID. Each task occupies the entire screen. The main task has an ID of zero.

Table 2 compares the task-control features of the six packages. It reveals that most of these features are found in all these environments. Note that Windows/386, DESQview, and Concurrent DOS 386 do not let you assign priority levels and time-slice allocation to each task. VM/386 offers the most sophisticated task-control features; they go beyond simply assigning values for the time slice and task priority.

Windows/386 employs a special algorithm regarding the allocation of time slices to multiple tasks: Initially, the main task slows down when secondary tasks are launched. When the total number of tasks reaches a critical limit, more time is assigned to the main task, while the secondary ones slow down. From the DOS level of Concurrent DOS 386, you can simply flag whether a task can run in the background or not. Each running task is given a time slice in sixtieths of a second. You are not able to alter the time-slice value or assign task priorities.

Perks Included

Microsoft has included a number of applications with Windows/386 (the same ones included with the other Windows versions) to promote the environment use. Two major applications bundled with Windows/386 are Write—a scaled-down version of Word—and Paint, a mini-version that is similar to MacPaint. The Windows manual dedicates an adequate number of pages to illustrating how these applications are used. Other applications included are a notepad, a cardfile, a calendar, a calculator, a clock, a terminal emulator, and the Reversi game. These applications were developed to take advantage of Windows/386's style of user interface.

The VM/386 package does not include any special utilities, but this is not a detriment since the design philosophy of the product seems to let users keep employing their own utilities in the various virtual machines.

DESQview comes with an auto-dialer for Hayes-compatible modems and a keyboard macro utility. Both are accessed through the hierarchy of menus. Using the auto-dialer, you can make local phone calls or long-distance calls via AT&T, MCI, and Sprint. You can select the phone number either manually or from a list of numbers.

The Omniview package includes Super Macs, a keyboard macro utility program written in Turbo Pascal 4.0.

Concurrent DOS 386 includes the file-manager DOS shell, a cardfile application, and the EDIX text editor. The file manager is similar to XTree, a very nice DOS-shell product, and it employs a good user interface. The cardfile application is characterized by a visibly poor interface but good functionality.

The designers of PC-MOS have sought to make it an independent 80386-based operating system. Consequently, it supports batch-file programming and offers its own text editor and debugger (with commands similar to those of DEBUG).

continued

Table 3: *The 80386-based environments at a glance (● = yes; ○ = no).*

	Windows/386	VM/386	DESQview	Omniview	Concurrent DOS	PC-MOS
Graphics-based	●	○	○	○	○	○
Uses mouse	●	○	●	○	○	○
Uses extended memory	●	●	●	●	○	●
Pop-up control center	○	●	●	●	○	○
Offers file/direct management	●	○	●	○	●	●
Provides significant						
extension to DOS	●	○	○	○	○	○
replacement to DOS	○	○	○	○	●	●
Easily alternates between environment and standard DOS	●	●	●	●	○	○
Views concurrent tasks in multiple windows	●	○	●	○	○	○
Supports multiple users	○	○*	○*	●	●	●
API available	●	○	●	Some	○	○

* Planned for future releases.

Running Multiple Applications

The ability to run multiple applications is dependent on memory availability (basic, extended, and expanded), the environment's ability to manage the tasks' time slice and priority, and video output management. Regarding the availability of memory, I highly recommend that you install 1 to 2 megabytes of RAM (the more the better, but of course you have to consider the cost). Adequate available memory is half the solution.

The other half of the solution is dealing with the limitations you encounter when using memory-hungry applications. Two specific examples are language development environments such as Turbo Pascal and Turbo C. If you assign insufficient memory to these tasks, you may be able to load the environment and a program file, but you may not be able to compile. On the other hand, if you allocate a generous amount of memory to these language environments, you may limit the memory that permits you to run other applications, such as word processors.

If you plan to harness the power of multitasking to the fullest, then the task management capabilities of the environments become vital. With environments that offer little or no control for, at least, the time-slice and task-priority parameters, you have little control over task management. VM/386 and PC-MOS are in the forefront of the packages that deliver extensive task-control features. You can assign distinct values for the various concurrency-control parameters. The values of the task-control parameters depend on the number of concurrent tasks, their functional nature, and your need (or lack thereof) for certain tasks to quickly achieve their goals.

There is another aspect of running concurrent tasks that may seem trivial: video output control. Neither DESQview nor Concurrent DOS 386 stops full-screen applications running in the background from also sending screen output. You may find this situation a source of annoyance for many applications.

In these two programs, there are a few cases where a full-screen application—for instance, one that you might write or have a programmer customize—can run in the background. For example, the application may beep to signal the termination of a number-crunching phase. Another solution is to have the application display a status in a specific location of the screen. Alternatively, you may have the background applications send their status information to the printer or a text file—each message is accompanied by a task ID.

David versus Goliath

History seems to repeat itself. Consider the battle between the young, slim David and the huge Goliath, and the outcome that upset the odds: the Goliath of OS/2 against the David (or Davids) of the 80386-environments. Like the David of old, these new Davids have the 80386 chip to sling at the face of the modern Goliath. The various 80386-based environments (see table 3) should appeal to different groups of DOS users.

When it comes to setup requirements, the most flexible environments are Omniview and DESQview. Windows/386, VM/386, and PC-MOS require slightly more hardware. While Concurrent DOS 386 is able to run with 512K bytes, its inability to use extended memory (only expanded memory is employed) imposes very severe functional restrictions in the area of supporting concurrent tasks.

If you are looking for a graphics-based environment, then Windows/386 could meet your needs. Its resemblance to the OS/2 Presentation Manager may be regarded as an additional bonus if you also plan to use machines that run OS/2. VM/386, DESQview, and Omniview are environments that support virtual PCs. VM/386 provides you with sophisticated task control—a valuable feature if you plan to run concurrent tasks frequently and would like to fine-tune their execution speed. [Editor's note: *At press time, IGC had announced version 1.2 of VM/386, with support for DOS 4.0, additional networks, and printer sharing.*]

PC-MOS offers an alternative to the new OS/2 and to staying with standard DOS. As such, PC-MOS will most likely appeal to those who have highly specialized applications installed on corporate micros. If you have used earlier versions of Concurrent DOS and would like to continue with the 80386 version, then Concurrent DOS 386 meets your needs. The power of such environments succeeds in extending the longevity of standard DOS. ■

Namir Clement Shammas is a columnist for several computer magazines and a freelance writer living in Glen Allen, Virginia. He can be reached on BIX as "nshammas."

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OS/2 COMMUNICATIONS

OS2COMM, a simple OS/2 communications program, proves that going on-line with OS/2 isn't necessarily that hard

Jim Gilliland

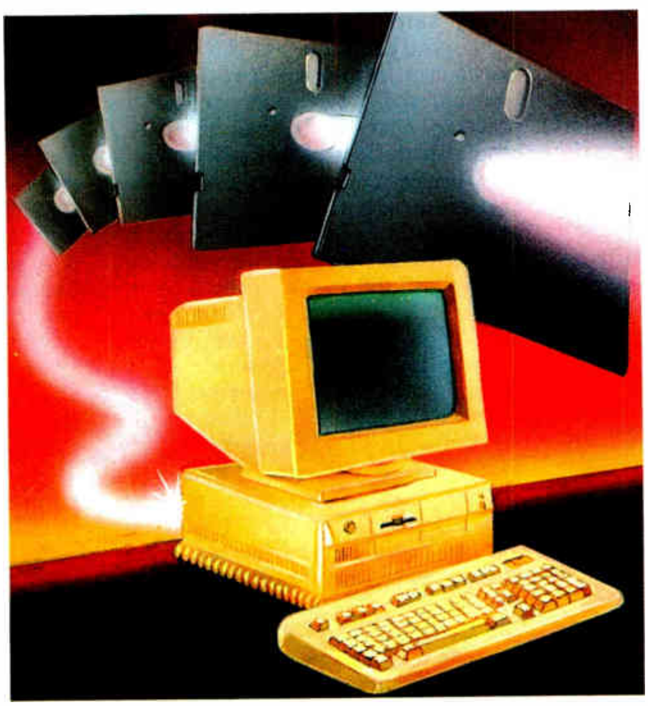
If you listen to people talk about the advantages of a multitasking environment like OS/2, you will invariably hear them give the example of downloading a file from a remote source while using a word processor, spreadsheet, or database. Of course, in order to do that, you need a communications program that runs under OS/2. If you can't find one, then you have to write your own.

Now, writing software that takes advantage of OS/2's advanced features is not a trivial task (see "Making the Move to OS/2," August BYTE). The sheer mass of the documentation for OS/2 is overwhelming; the OS/2 *Technical Reference* itself comprises some 1500 pages of text. For obvious reasons, many have concluded that programming under OS/2 will be a complex task.

Writing communications software under OS/2, then, would seem to be a doubly difficult assignment. Even with MS-DOS, developing communications software is tricky. The programmer must have intricate knowledge of the communications hardware and write code that not only interfaces to the communications port, but also works with the interrupt mechanisms of the CPU and its support circuits. If writing MS-DOS communications software is that hard, is it any wonder that many programmers expect writing communications software for OS/2 to be an enormously difficult job?

Yet nothing could be further from the truth. Writing asynchronous communications software under OS/2 is actually much easier than it was under MS-DOS. There are two reasons for this. First, the OS/2 COM device driver provides much better support for communications than was available under DOS. Second, the asynchronous communications process fits OS/2's multithread model very well.

Before I talk about communications with OS/2, let's take a look at how such things are done under MS-DOS.



DOS Talk: Interrupt-Driven

MS-DOS and BIOS offer some support for serial communications, but neither is very useful. Both are based on a simple polling mechanism that is completely unsuitable for high-speed communications. The DOS functions support only sending and receiving characters to and from the serial port. The BIOS adds functions for parameter setting and error checking. These routines can support communications at up to around 1200 bits per second, and no faster. If you need higher data transfer rates, you must use interrupt-driven communications, and that means you must write

continued

code that talks directly to the hardware.

The first step in writing an interrupt-driven routine is to initialize the transfer rate and other parameters within the universal asynchronous receiver/transmitter, the chip that directly supports the COM port. The UART used in the IBM family of microcomputers is the Intel 8250 and its successors, the 8250A, 16450, and 16550. There is a BIOS routine that you can use to initialize the UART, but on some machines it is bug-ridden, so most designers write directly to the relevant I/O ports instead.

After initializing the UART, you must put in an interrupt-service routine (ISR). This requires manipulating several bits in several control registers in both the UART and the 8259 Interrupt Controller chip. You must be careful setting these registers, as other processes can be affected if you change the wrong bits. The 8259 is especially vulnerable in this regard, because it handles every interrupt in the system.

To support high transfer rates, you must keep the ISR short. The incoming data should be placed in a circular buffer for later use by the main processing logic of the program, and the ISR should perform little additional work. Both the ISR and the main program must contain logic to deal with the data buffer.

As you can see, communications programming under DOS is a complex process. I haven't even mentioned the difficulties of the transmit logic, or XON/XOFF processing, or the various other issues just waiting to complicate an MS-DOS communications program.

The Privileges of OS/2

Under OS/2, the picture changes radically. It is just as necessary to use interrupt-driven code to provide high transfer rates under OS/2 as it is under DOS. But under OS/2, application code cannot service interrupts.

The OS/2 system uses several different levels of privilege for the code that runs under it. These different levels are referred to as "rings," with ring 3 having the lowest privilege and ring 0 having the highest. Ring 3, where almost all user code is executed, has no direct I/O access. Ring 2, which can be made available to user code under special conditions, can execute In and Out instructions but cannot service interrupts. And ring 1 is not used at all under OS/2.

This leaves ring 0 as the only privilege level capable of servicing interrupts. Only OS/2's kernel and the device drivers run at ring 0. But the design philosophy of OS/2 requires that the kernel contain no device-specific code, thereby keeping it consistent in all the various OS/2 implementations. Thus, the device driver is the only valid place for an interrupt handler.

OS/2 needs device drivers for all the hardware devices with which it is expected to work. OS/2 provides device drivers that support all the basic components of most desktop computer systems: keyboard, screen, clock, printer, disk drives, serial ports, and mouse. New drivers will be produced as needed for new peripherals, by either the system vendor or the peripheral vendor.

For communications, OS/2 comes with two COM drivers. One of them, COM01.SYS, supports COM1 and COM2 on the AT and the XT/286. The other, COM02.SYS, supports COM1, COM2, and COM3 on PS/2 systems. If you intend to run communications software under OS/2, you must specify the appropriate driver in your CONFIG.SYS file. From the point of view of the application, though, the two drivers are identical, so I won't differentiate between them from here on.

The OS/2 COM device driver is a well-designed and complete interface to the COM ports under OS/2. It is far more powerful than the corresponding COM support under MS-DOS. The Application Program Interface (API) to the driver uses the same set of system calls that would be used to read and write a file, plus one more that is used to set up communications parameters.

The device driver provides for all necessary hardware, including both the COM port hardware and the interrupt mechanism. It also services the device interrupt and provides support for the necessary character buffers. The driver handles both sides of the buffering process, leaving the application completely unaware of the buffering. The driver also supports XON/XOFF processing and offers a number of different ways to control and react to the various modem control signals. The driver provides full status reporting of both hardware and software.

Using the OS/2 COM driver eliminates almost all the complexity of dealing with the serial I/O hardware, since the device driver supplies all the hardware interface requirements that, under MS-DOS, have to be coded into the application. Thanks to the COM driver, you can develop a simple communications program using very little code.

Using the COM Driver

Using the COM device driver in an application program is remarkably easy. All you need are five OS/2 function calls, which are used as follows:

1. Use `DosOpen` to open the COM port.
2. Use `DosDevIOCtl` to set the relevant communications parameters.
3. Use `DosRead` to receive characters from the COM port.
4. Use `DosWrite` to transmit characters via the COM port.
5. Use `DosClose` to close the COM port when finished.

Let's look at each of these functions in a little more detail.

`DosOpen` opens the COM port. The actual name of the port (COM1, for example) is passed as the filename; other parameters should specify a normal, existing, read/write file being opened for exclusive access. The Open call will return a file "handle," which is then used to identify this device to the I/O Control, Read, Write, and Close calls. (In Gordon Letwin's book *Inside OS/2*, he calls this handle a "magic cookie," which means that it is a value that you simply accept from the system and give back when requested. You never need to care what the actual value is.)

`DosDevIOCtl` allows an application to send control information to a device driver. The Standard Edition 1.0 of OS/2 defines 11 categories of I/O Control (`IOCtl`) calls, including floppy disk control, serial I/O control, printer control, and so on. Each of these categories is associated with a particular OS/2 device driver, and each has a set of functions and codes defined for that driver.

The functions for the COM driver fall under I/O Control category 1. These functions control communications parameters such as transfer rate and data bits, as well as various time-out parameters, whether XON/XOFF should be used, and how the RS-232C hardware signals should be used.

After all the necessary settings have been made via `DosDevIOCtl`, the COM port can be processed just like a file. `DosRead` retrieves data from the port, either a character at a time or a bufferfull at a time. You can use `DosWrite` in the same fashion—processing as many characters at a time as necessary. The `DosClose` function is the simplest of them all, requiring only the COM handle as a parameter.

For more information on the `DosDevIOCtl` functions and their parameters, you should consult the IBM *Technical Reference* for OS/2. While there are other books available that cover the tech-

continued

Listing 1: *OS2COMM.C version 1.2 is a simple communications program that runs under OS/2.*

```
#define    LINT_ARGS
#define    INCL_BASE
#define    INCL_DOSDEVICES
#include   <os2.h>
#include   <stdio.h>
#include   <conio.h>
#include   <process.h>
#include   <malloc.h>
#define    STK_SIZE    1024

void main(int, char**, char**);
int       initcomm(int, char, int, int);
void far keytocom(void);
void far comtodsp(void);
int       parsarg(char*, char*, int*,
                  char*, int*, int*);
unsigned short   com, cfile;
unsigned int     cflag, ktcid, ctdid;
unsigned long far main_sem, far ctd_sem;

char *usage ="\nOS2Comm - usage is:\r\n"
"\n\tOS2COMM COMx:baudrate,parity,"
                "databits,stopbits"
"\n\twhere:"
"\n\t\t COMx      = COM1, COM2, or COM3"
"\n\t\t baudrate = 300,1200,2400,"
                  "4800,9600, or 19200"
"\n\t\t parity   = N,O,E,M, or S"
"\n\t\t databits = 5,6,7, or 8"
"\n\t\t stopbits = 1 or 2\r\n";

void main(argc, argv, envp)
int argc;
char **argv, **envp;
{
 char far *ctdstack, far *ktcstack;
 RESULTCODES retcodes;
 unsigned int act, baud, dbits, sbits;
 char parity, comport[8];

 puts("OS2Comm.c version 1.2");
 puts("Copyright 1988 by Jim Gilliland");

 if (argc < 2 || argc > 3)
    {  puts(usage);
       exit(1);     }

 if (parsarg(argv[1], comport, &baud,
             &parity, &dbits, &sbits))
    {  puts(usage);
       exit(1);    }

 /* Open com device driver: */
 if (DosOpen(comport, &com, &act,
             0L, 0, 0x01, 0x0012, 0L))
  {  fprintf(stderr,"\nError opening port");
     exit(1);  }

 /* Initialize com device driver: */
 if (initcomm(baud, parity, dbits, sbits))
  { fprintf(stderr,"\nPort setup error");
    exit(1);   }

 /* Open capture file, if specified: */
 if (argc > 2)
   if (DosOpen(argv[2], &cfile, &act,
               0L, 0, 0x12, 0x0022, 0L))
     { fprintf(stderr,"\nErr: %s\n",argv[2]);
       exit(1);    }
   else cflag = 1;
 else cflag = 0;

/* allocate stack for threads: */
 ctdstack = malloc(STK_SIZE);
 ktcstack = malloc(STK_SIZE);

 if (ctdstack == NULL || ktcstack == NULL)
    {  puts ("Unable to allocate stacks");
       exit(2);    }

 /* Create receive and display thread: */
 if (DosCreateThread(comtodsp, &ctdid,
                     ctdstack+STK_SIZE))
   { puts("Can't create COM receive thread");
     exit(1);    }

 /* Set semaphore to block main thread: */
 DosSemSet(&main_sem);

 /* Create transmit thread: */
 if (DosCreateThread(keytocom, &ktcid,
                     ktcstack+STK_SIZE))
   { puts("Can't create COM transmit thread");
     exit(1);    }

 puts("Alt-X will end this program");

 /* Set high priority for COM threads */
 DosSetPrty(2,3,0,ktcid); /* time-critical */
 DosSetPrty(2,3,1,ctdid); /* time-crit +1  */

/* Wait for clear semaphore (see keytocom) */
 DosSemWait(&main_sem, -1L);

/* Suspend the other threads before ending */
 DosSuspendThread(ktcid);
 DosSuspendThread(ctdid);

 /* Close com driver and capture file: */
 DosClose(com);
 if (cflag==1) DosClose(cfile);

 DosExit(1,0); /* Exit: end all threads */
}
/**********************************************/

void far comtodsp()
/* This routine is run as a separate thread */
{
 char comchar[512];
 unsigned int bytes, readerr, cnt;

 while (-1)    /* Do forever: */
 {
    /* read character(s) from COMport: */
    readerr = DosRead(com,comchar,512,&bytes);
    if (readerr)      continue;
    if (bytes == 0)   continue;

    /* Write character(s) to screen: */
    VioWrtTTy(comchar,bytes,0);

    /* write character(s) to capture file: */
    if (cflag == 1)
       DosWrite(cfile,comchar,bytes,&cnt);
 }
}
/*********************************************/

void far keytocom()
/* This routine is run as a separate thread */
{
 KBDKEYINFO keyinfo;
 int written;
 char charcode, scancode;
```

continued

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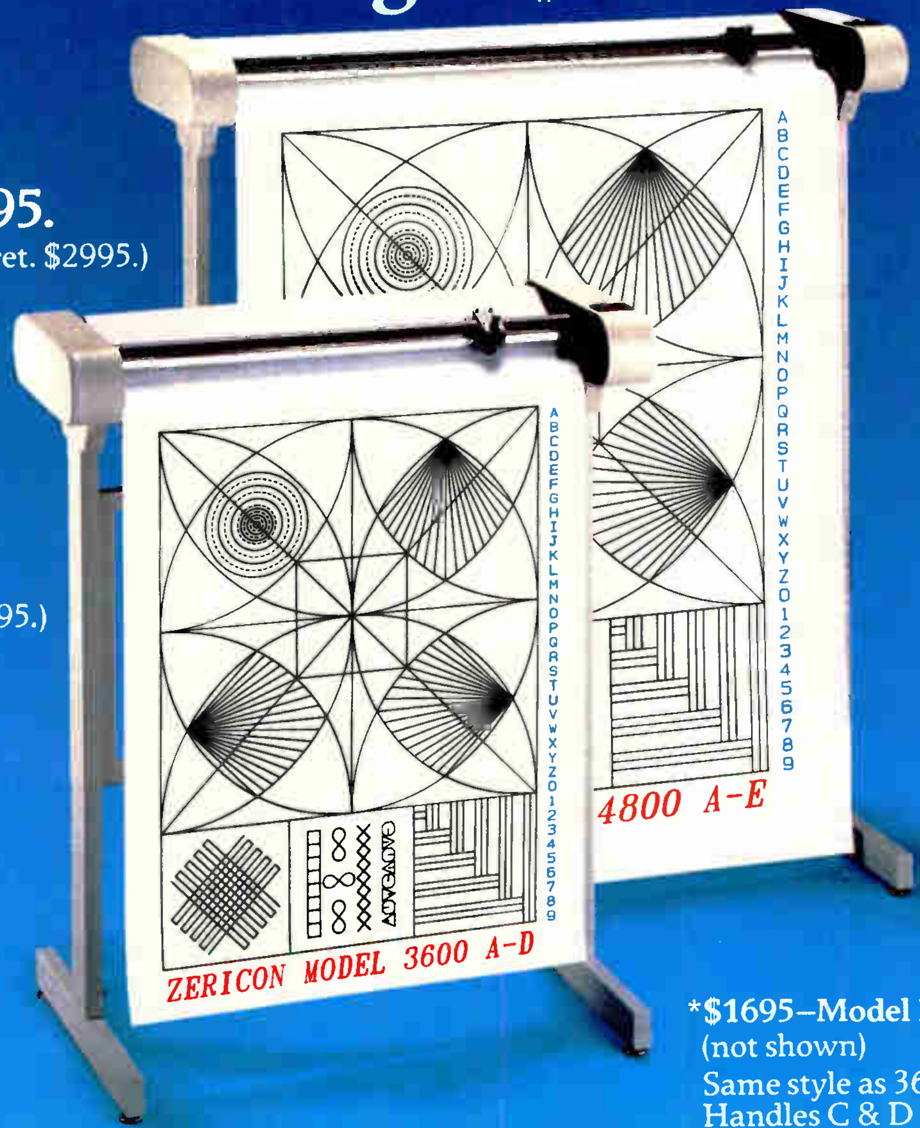

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```
 while (-1)   /* Do forever: */
 {
   KbdCharIn (&keyinfo, 0, 0);
   charcode = keyinfo.chChar;
   scancode = keyinfo.chScan;

   /* Alt-X indicates End-Of-Processing: */
   if (charcode == 0x00 && scancode == 0x2D)
      {
      /* Clear Main semaphore:  */
      DosSemClear(&main_sem);
      continue;
      }

   /* skip Alt-keys & F-Keys: */
   if (charcode == 0x00) continue;

   /* Write character(s) to com port: */
   DosWrite(com, &charcode, 1, &written);
 }
}
/*********************************************/

int initcomm(baud,parity,dbits,sbits)
char parity;
int baud, dbits, sbits;
   /* this routine used by main thread */
{
struct {
  unsigned char databits, parity, stopbits;
  } linechar;

struct {
  unsigned char onmask, offmask;
  } modemctrl;

struct {
  unsigned int wtime, rtime;
  unsigned char flags1, flags2, flags3;
  unsigned char errchar, brkchar;
  unsigned char xonchar, xoffchar;
  } dcb;

int comerr, act;

 /* Set bitrate: */
 if (DosDevIOCtl( NULL, (char *)&baud,
                       0x41, 01, com))
   { fprintf(stderr,"\nBitrate error");
     return(1);      }

 /* Set databits, stopbits, parity: */
 if (parity == 'N') linechar.parity = 0;
 if (parity == 'O') linechar.parity = 1;
 if (parity == 'E') linechar.parity = 2;
 if (parity == 'M') linechar.parity = 3;
 if (parity == 'S') linechar.parity = 4;
 if (sbits == 2) linechar.stopbits = 2;
 if (sbits == 1) linechar.stopbits = 0;
 linechar.databits = dbits;
 if (DosDevIOCtl( NULL, (char *)&linechar,
                       0x42, 01, com))
    { puts("Line characteristics error");
      return(1);      }

 /* Set modem control signals: */
 modemctrl.onmask  = 0x03; /* DTR & RTS on */
 modemctrl.offmask = 0xff; /* nothing off */
 if (DosDevIOCtl( (char *)&comerr,
       (char *)&modemctrl, 0x46, 01, com))
     { puts("Modem control error");
       return(1);      }

 /* Set com device processing parameters:  */
 dcb.wtime = 100; /* 1sec transmit timeout */
 dcb.rtime = 100; /* 1sec receive  timeout */
 dcb.flags1 = 0x01;  /* enable DTR,        */
 dcb.flags2 = 0x43;  /*    RTS, XON/XOFF   */
 dcb.flags3 = 0x04;  /* recv timeout mode  */
 dcb.errchar = 0x00; /* no error translate */
 dcb.brkchar = 0x00; /* no break translate */
 dcb.xonchar = 0x11;  /* standard XON  */
 dcb.xoffchar = 0x13; /* standard XOFF */
 if (DosDevIOCtl( NULL, (char *)&dcb,
                       0x53, 01, com))
     { puts("Device control block error");
       return(1);     }

 return(0);
}

int parsarg(arg,port,baud,parity,dbits,sbits)
char *arg, *port;
char *parity;
int *baud, *dbits, *sbits;
    /* this routine used by main thread */
{
  int strptr;
  char strhold[8];
  strupr(arg);   /* cvt to uppercase */

  /* Parse cmdline for COM port: */
  if ((strptr = strcspn(arg,":")) == 0)
                                  return(1);
  if (strptr > 8) return(1);
  strncpy(port, arg, strptr);
  *(port+strptr) = '\0';
  arg = arg+strptr+1;

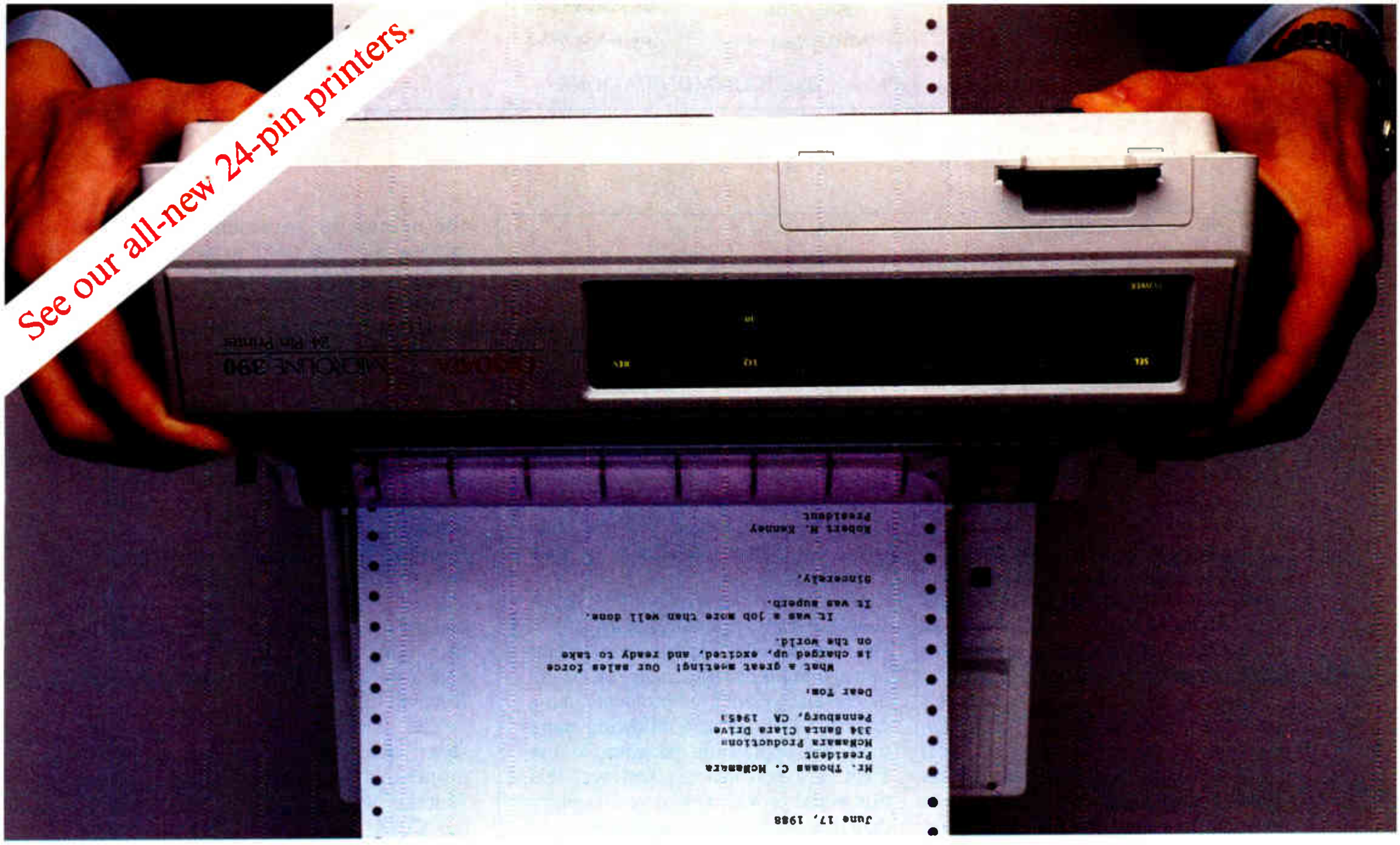
  /* Parse for cmdline baudrate: */
  if ((strptr = strcspn(arg,",")) == 0)
                                  return(2);
  strncpy(strhold, arg, strptr);
  *(strhold+strptr) = '\0';
  *baud = atoi(strhold);
  if (*baud != 300 &&  *baud != 1200 &&
      *baud != 2400 && *baud != 4800 &&
      *baud != 9600 && *baud != 19200)
                                  return(2);
  arg = arg+strptr+1;

  /* Parse cmdline for parity: */
  if ((strptr = strcspn(arg,",")) == 0)
                                  return(3);
  *parity = *(arg+strptr-1);
  if (*parity != 'N' && *parity != 'O' &&
      *parity != 'E' && *parity != 'M' &&
      *parity != 'S')             return(3);
  arg = arg+strptr+1;

  /* Parse cmdline for databits: */
  if ((strptr = strcspn(arg,",")) == 0)
                                  return(4);
  *dbits = *(arg+strptr-1) - '0';
  if (*dbits != 5 &&   *dbits != 6 &&
      *dbits != 7 &&   *dbits != 8)
      return(4);
  arg = arg+strptr+1;

  /* Parse for stopbit value: */
  if ((strptr = strcspn(arg,",")) == 0)
                                  return(5);
  *sbits = *(arg+strptr-1) - '0';
  if (*sbits != 1 && *sbits != 2) return(5);

  return(0);
}
```



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File Transfer with OS2COMM

At present, OS2COMM merely allows you to establish a link between an OS/2 system and another computer. In order to make the program most useful, a file-transfer enhancement would be desirable. One way to add this feature is to build the transfer protocol into a separate program.

Here's how the technique works. The parent process uses the `DosDupHandle` function to associate the COM port with both `STDIN` (file handle 0) and `STDOUT` (file handle 1). It then uses `DosExecPgm` to initiate the transfer program as a child process.

Since a child inherits its parent's open files, the `STDIN` and `STDOUT` handles will be pointing to the COM port when the child protocol program receives control. The child process needs to open only the file to be sent or received (the name can be passed as a command-line parameter), and to process the transfer via the `STDIN` and `STDOUT` handles.

The beauty of this technique is that you can build the child process as a simple program that opens just one file and uses the standard I/O handles for the actual transfer of data and the related ACK/NACK blocks. It doesn't even have to realize that it's reading from and writing to a COM port.

For further discussion of this technique, see chapter 4 of Gordon Letwin's *Inside OS/2*.

Of course, other possibilities exist. It should be fairly straightforward (if less flexible) to build the transfer protocols into the main program. Also, it would be feasible to build the protocols into a dynamic-link library, allowing more than one application program to use them. It's not obvious, however, that this would provide any more flexibility than the `DosDupHandle` approach.

Since I have not (yet) tried any of these techniques, I will not presume to know which one of them is best in a given situation.

nical details of OS/2, I have not seen any that discuss this particular topic in adequate depth.

Triple-Thread Communications

The OS/2 multitasking model offers several methods for concurrent processing of multiple tasks. The simplest multitasking method uses OS/2 *threads*, units of work that together make up the OS/2 process. Using threads is the most appropriate method for implementing multitasking in serial communications. This is because the basic communications process is made up of two inherently asynchronous processes: getting keystrokes from the keyboard and sending them to the COM port, and getting characters from the COM port and sending them to the display. Since the program has no way to tell when the user might press a key, nor when the COM port may receive a character, a simple design approach is to set up a separate thread for each process and let the OS/2 dispatcher control which thread runs at any given time.

I've written a simple telecommunications program, OS2COMM.C, which works in exactly this manner (see listing 1). The program doesn't have any fancy features like automatic dialing, file transfer, and so on, but it does let you emulate a simple terminal and establish a link with another computer.

OS2COMM.C version 1.2 is written in C and uses both C library functions and OS/2 function calls. You can compile it using either the IBM C/2 compiler or the Microsoft C 5.1 compiler. It uses OS/2 multitasking features, so it will not run under MS-DOS or OS/2's DOS mode. After you've compiled OS-2COMM, you invoke it as follows:

```
OS2COMM COMx:baudrate,parity,
  databits,stopbits capture-
    filename
```

The `capture-filename` is optional, but the other arguments are required and shouldn't have any blanks between them.

How OS2COMM Works

I designed OS2COMM for simplicity, to demonstrate how easy it is to use OS/2's COM driver. The program uses three threads (see figure 1). The first thread, `main`, does all the housekeeping and then creates the two threads that perform the actual communications processing.

One of these threads, `comtodsp`, simply reads the COM device for characters received and then displays them on the screen. The other thread, `keytocom`, reads the keyboard and sends the characters to the COM port.

Each of these threads has some noteworthy features. The main thread parses the command arguments (using the `parsarg()` function) to determine the communications parameters. The main thread then `DosOpen`s the COM port and uses the `initcomm()` function to perform the `DosDevIOCtl` function calls described earlier.

The `main` thread then opens the "capture" file, allocates stack memory for the other threads, and creates them (using `DosCreateThread`). Then it places the other threads into the time-critical priority class. Next, it sets a semaphore and blocks on it, waiting for the `keytocom` thread to clear it. It will wait in this state until you are ready to end the program. After being released by `keytocom`, the main thread will close the COM port, close the capture file, and force all threads to exit (using `DosExit`).

The `comtodsp` thread, though quite short, also contains some items worth discussing. First, note that the `DosRead` function will never block completely on the COM port. After some amount of time (the time-out value set in `initcomm`) with no character received, it will return with a count of 0 bytes read. The program must test for this possibility and react accordingly. Also, note that this routine contains code to write the received characters to the disk-capture file.

The only special feature of the `keytocom` thread is that it clears the main semaphore when the user types Alt-X (scancode 2Dh). This semaphore blocks the main thread, and clearing it here allows the main thread to resume execution. The main thread then terminates, taking the other two with it, and the program ends.

OS2COMM uses "Wait for something" read-time-out processing. This allows it to use a relatively large (1-second) read time-out, and still echo keystrokes quickly. Keystrokes are echoed to the screen only after they have been received by the device at the other end of the communications line and have been echoed back as incoming data. OS2-COMM does not have a "local echo" capability (though it would be easy to add one).

Bells and Whistles

OS2COMM is about as simple as it could possibly be while still performing a useful communications function. The program contains none of the amenities you would usually expect in a PC communications program. I designed it to provide a clear view of the process necessary to make communications work. Within its limited function, the program works re-

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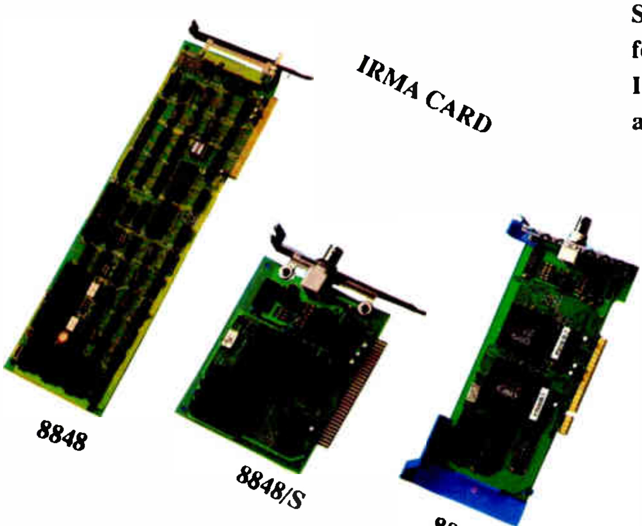

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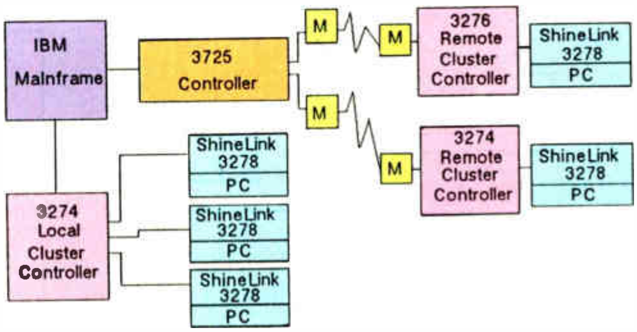

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liably. Clearly, though, there is much room for enhancement.

Arguably the most important enhancement, though perhaps not the most obvious, is error detection. OS2COMM contains almost no error checking. Almost all the OS/2 API calls can return an error code, and these are largely ignored within this program. If you were to use OS2COMM (or a program like it) in a commercial product, then you would need to include code to test for return codes on all the OS/2 calls used. You can also use `DosDevIOCtl` to check for specific communications errors.

Features like parameter-setting dialogues, dialing directories, and script languages would also be useful additions to OS2COMM. Certain other features (such as editors, file browsers, and the ability to exit to the operating system) don't make sense in the OS/2 environment; since OS/2 lets you perform these functions with a separate application while the communications program continues in the background, there is really no point in building them into your program.

File-transfer protocols would be an-

continued

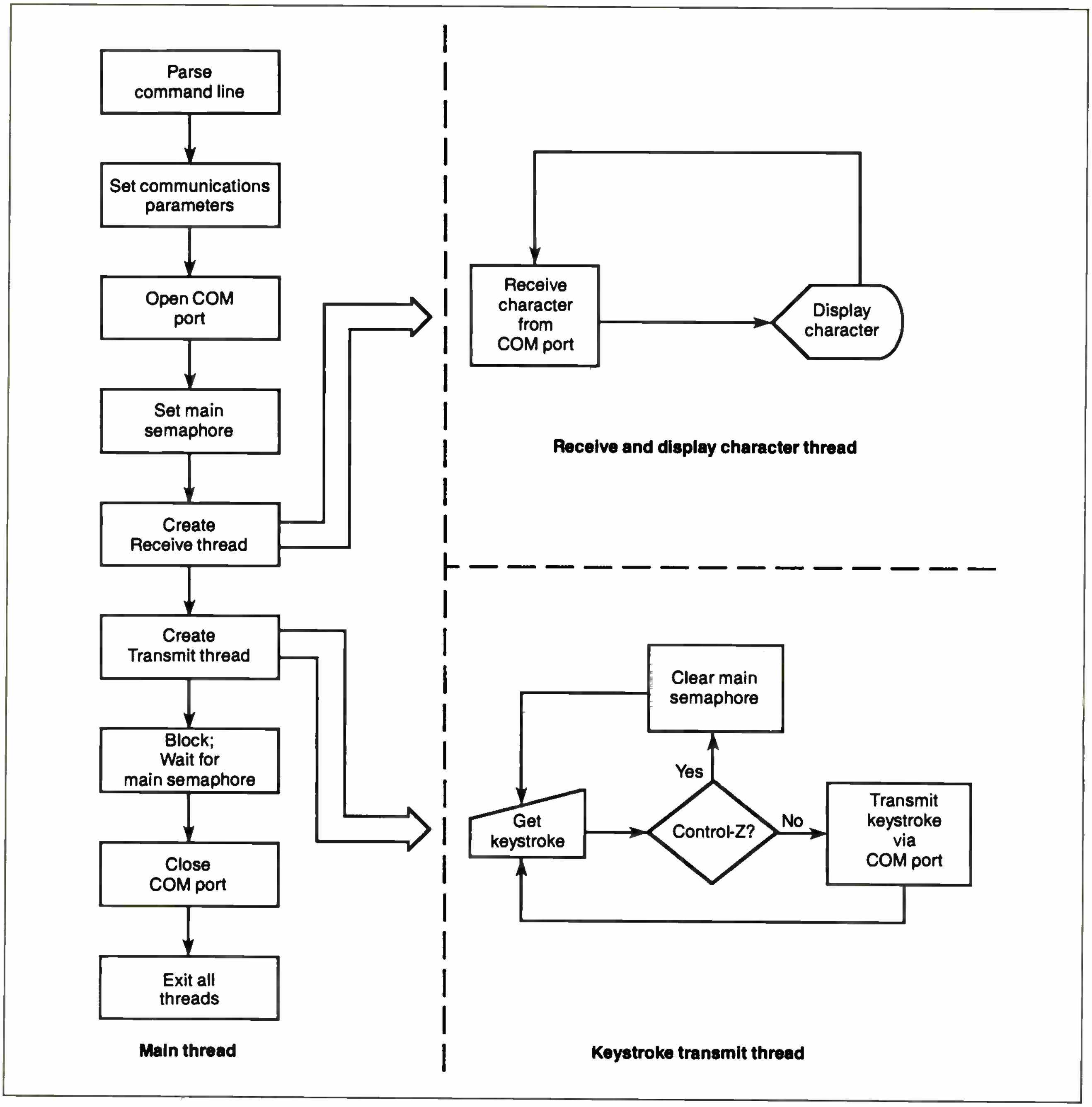
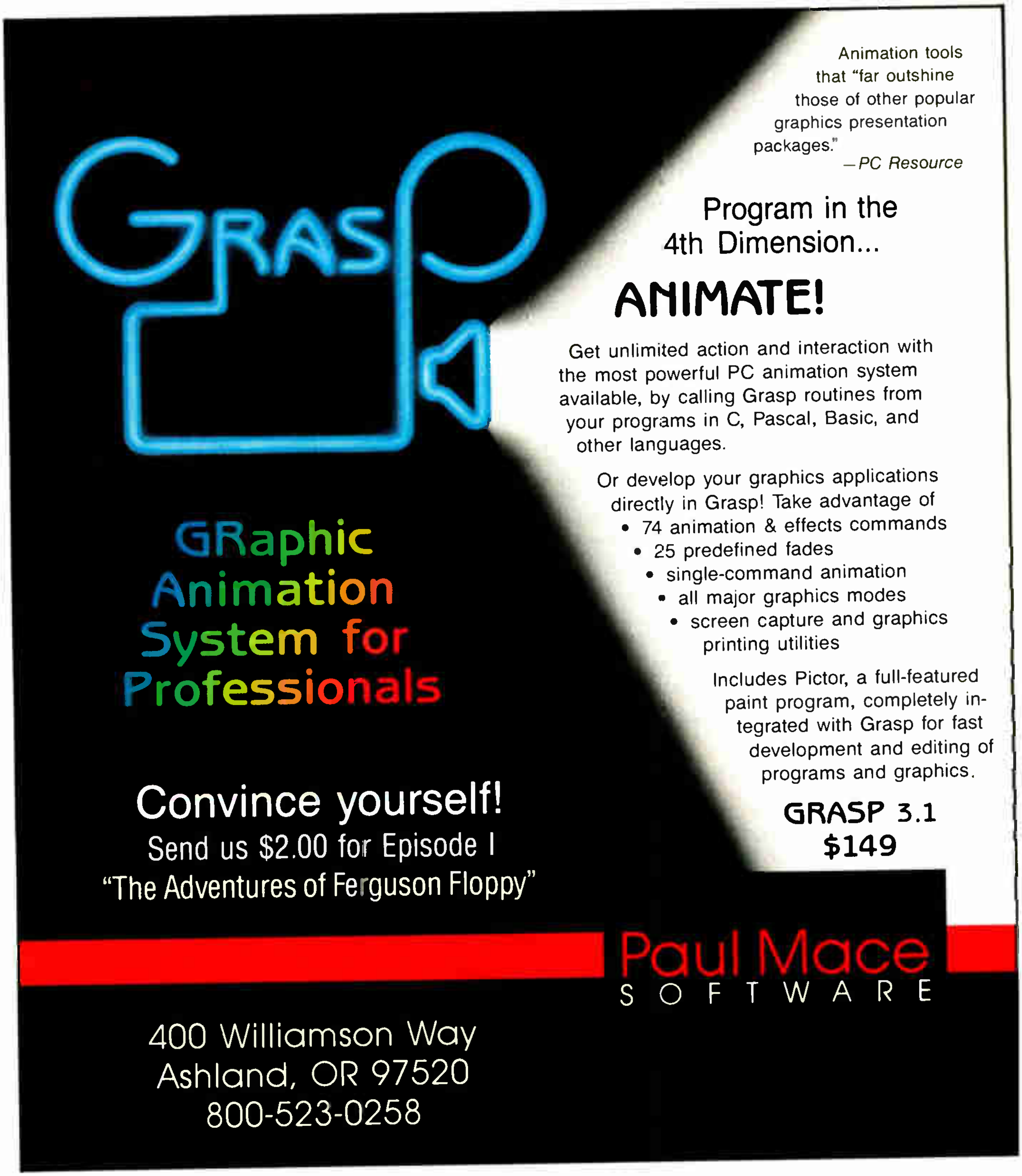


Figure 1: *The main thread of OS2COMM creates two additional threads that do the actual communications processing:* `comtodsp` *receives characters from the COM port and displays them on the screen, and* `keytocom` *reads keystrokes from the keyboard and sends them to the COM port.*



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other very useful enhancement. They could be implemented in several different ways. One approach is to build the transfer protocols into a set of separate programs. (See the text box "File Transfer with OS2COMM" on page 160.)

There is one other point you should consider before attempting to add any new features, though. The design I've presented here uses three threads—one is for general housekeeping; the other two have very specific purposes. You must consider the program design carefully before adding new features. Take, for example, script processing. A script language requires access to both the transmit and receive data streams. Since these are processed in different threads, implementing script processing is awkward. Several solutions to this dilemma are possible, but the point you should not miss is that a multitasking design introduces a whole new way of looking at program-design issues.

Another multitasking concern is brought up by the current generation of language tools. The C compilers for OS/2 from Microsoft and IBM are excellent products, but the library functions supplied with them are not fully reentrant, which means that only one thread can use a given function at a time. A multithread program design requires careful attention to the possibility of one thread entering a library function while that function is in use by another thread. Version 5.1 of the Microsoft compiler provides an awkward method for dealing with the reentrancy problems, but I hope the next version of the compiler will provide libraries that are fully reentrant.

What Price Performance?

The topic of OS/2 performance has been widely discussed in the computer press, though much of the discussion has been based on speculation. Performance is an important issue with any computer system, and it has significant effects on communications processing.

One problem unique to the 80286 processor makes communications performance an even more important issue under OS/2. OS/2 uses the 80286 in protected mode, but it must shift back to real mode when processing DOS-mode applications. Unfortunately, the 80286 does not provide any easy mechanism for this shift, so you must reset the CPU to get back to real mode. This mechanism has been described as "turning off the engine to change gears," and it is a remarkably clever solution to this particular 80286 shortcoming. Nevertheless, it poses a problem for communications software.

The problem is that this shift takes a relatively long time—up to a millisecond, according to Gordon Letwin—during which time interrupts are disabled. The COM port hardware can retain one character that it receives during this period, as long as a second character does not arrive before interrupts are serviced again. Thus, one character arriving during the transition causes no problems, but the second one has a chance of getting lost.

I've taken a good look at the transfer rates you can use in an OS/2 multitasking environment. I ran a series of tests between an IBM PS/2 Model 80 (16-MHz 80386) and an IBM PC AT Model 339 (8-MHz 80286), both running OS2COMM at transfer rates of 2400, 4800, 9600, and 19,200 bps. (I used a Rolm CBX, with no modems, to connect the systems. Both machines were running under OS/2 version 1.0, with `maxwait` set to its default of 3 in the CONFIG.SYS file.)

The tests involved sending a 20K-byte file between the two systems. I ran each test in both directions, from the PS/2 to the AT and vice versa, so I could see the differences between 80286 and 80386 performance. In each test, the transmitting computer ran only OS2COMM. During some tests, I had the receiving system run a compile-and-link task concurrently with the communications task. This created a realistic multitasking situation, since a compiler alternates between being CPU-bound and I/O-bound and uses both I/O and CPU resources heavily.

Even before examining the test results, we can estimate what results we should expect by looking at the actual times necessary to transmit a character at either 9600 or 19,200 bps. Let's assume an 8-bit character with no parity, one start bit, and one stop bit, for a total of 10 bits transmitted per character. (10 bits per character also applies to 7-bit data with parity.) So at 9600 bps, you can transmit a maximum of 960 characters per second. Taking the reciprocal, single characters should arrive no more frequently than one every 1.04 ms.

Similar arithmetic for 19,200 bps suggests that characters will arrive at a maximum frequency of one every 0.52 ms. Assuming that the mode-switch time of 1

continued

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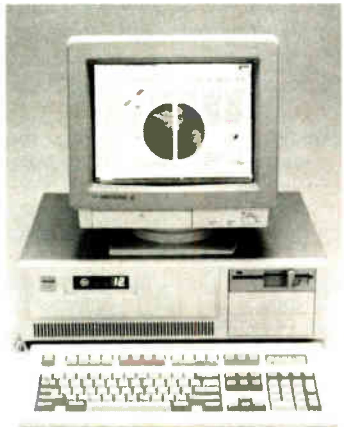

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Table 1: *The results of tests run on an IBM PS/2 Model 80 (16-MHz) and an IBM PC AT Model 339 (8-MHz), transmitting a 20K-byte file using OS2COMM. The transmitting PC had no additional tasks running. Multitasking was performed only on the receiving PC. Note that the communications task actually ran faster in the background (compare tests 6 and 7), since it did not have to place characters on the screen as it was receiving them.*

Test	Transfer rate	Receiving PC	Background tasks	Foreground tasks	Characters dropped	Transmit time (min:sec)
1a	2400	AT	None	Communications	None	1:24
1b	2400	PS/2 80	None	Communications	None	1:24
2a	4800	AT	None	Communications	None	0:42
2b	4800	PS/2 80	None	Communications	None	0:42
3a	9600	AT	None	Communications	None	0:21
3b	9600	PS/2 80	None	Communications	None	0:21
4a	9600	AT	Communications	Compile	None	0;21
4b	9600	PS/2 80	Communications	Compile	None	0:21
5a	9600	AT	Comm. & compile	DOS "TREE"	None	0:21
5b	9600	PS/2 80	Comm. & compile	DOS "TREE"	None	0:21
6a	19200	AT	None	Communications	None	0:17
6b	19200	PS/2 80	None	Communications	None	0:12
7a	19200	AT	Communications	None	None	0:11
7b	19200	PS/2 80	Communications	None	None	0:11
8a	19200	AT	Communications	Compile	None	0:11
8b	19200	PS/2 80	Communications	Compile	None	0:11
9a	19200	AT	Comm. & compile	DOS "TREE"	6	0:11
9b	19200	PS/2 80	Comm. & compile	DOS "TREE"	None	0:11

ms is accurate, then we would expect that 9600 bps would be achievable on an 80286, but that 19,200 would not.

That is exactly what the actual testing showed (see table 1). Overall, I found a number of interesting results.

The tests showed that the PC AT was capable of communicating at up to 9600 bps without losing any data, even with several additional tasks running. Tests at 19,200 bps were successful only when there was no DOS-mode activity on the AT.

This result would indicate that on an 8-MHz 80286, mode switching will cause communications failures at 19,200 bps, but not at 9600 bps and below, which confirms our estimated calculations.

The PS/2 Model 80 handled transfer rates of up to 19,200 without difficulty.

The results of tests 6 and 7 were interesting. In both tests, OS2COMM was the only task running. In test 6, when I ran OS2COMM in the foreground, the receiving system (even on the PS/2) had to use XOFFs to keep the incoming data from overflowing its buffer. In test 7, I ran OS2COMM in the background (with the OS/2 Program Selector displayed on the screen), and data was transferred at the full 19,200-bps bandwidth. The only difference between these tests is that OS/2 had less work to do when OS-2COMM was in the background. Since the program did not have to actually display the characters it received, it was able to support the higher transfer rate.

In this regard, it's also interesting to compare tests 6 and 8. In test 6, both receiving systems had to use XON/XOFF processing to avoid losing data. In test 8, however, neither system had to use XON/XOFF, even though there was another major task executing. The difference is that in test 6, the OS2COMM's display and communications threads were both running at high priority and were conflicting with each other. In test 8, the conflicting task was running at a standard priority, and only OS2-COMM's communications thread ran at a time-critical priority (the display thread was not needed). As you can see, a communications program must make judicious use of the time-critical threads so that it does not compete with itself for CPU resources.

Note that using transfer rates of 9600 bps and higher on either machine caused the other tasks to come almost to a complete halt. This is the result of running OS2COMM at a time-critical priority.

Sophisticated Software, Design Dilemmas

OS/2 provides all the mechanisms necessary to write excellent serial communications software without requiring that programmers deal directly with the communications hardware. However, along with this sophistication come new design issues, which we have not had to deal with before. Fortunately, OS/2 offers many different techniques to resolve these issues, and the resulting flexibility will allow for the creation of full-featured communications software that no longer has to sneak behind the operating system to get its job done. ■

Editor's note: *The C source code for versions 1.2 and 1.3 of OS2COMM (1.3 provides a plain-ASCII file-transfer capability) is available in a variety of formats. See page 3 for further details.*

Jim Gilliland is manager of systems for the corporate tax department of BP America in Cleveland, Ohio. He can be reached on BIX as "jgilliland."

Circle 102 on Reader Service Card (DEALERS: 103)

KEEP YOUR PC HEALTHY

A few simple tricks, practiced regularly, can add to your computer's life span

Gene B. Williams

All things age, including your computer system. The older the system, the more likely it is that something is going to go wrong with it. You can't stop the ravages of time, but you can slow them down while also reducing or preventing common problems.

The most common problems, especially with older computers like the IBM PC and XT, are mechanical in nature. A disk drive door might break off; the keys might "clog" or even break; the power switch might wear out; a cable or other wire might break; a contact or even the read/write heads of the floppy disk drive might corrode or become coated with a contaminant.

There is little involved in proper maintenance. Most of it is simple common sense and cleanliness. (For further information, see my book *How to Repair and Maintain Your IBM PC.*)

Preventive Maintenance

Preventing a problem is better than having to fix it after it has happened. This is where cleanliness and proper operating procedures come into play.

All computer systems have three primary enemies: dust and other contaminants; excessive heat and cold; and static electricity, power-line surges, and spikes. These enemies become even more significant as your computer ages.

The key to preventing malfunctions is to eliminate or at least reduce those factors. For example, keep your work area clean. Vacuum or use a slightly damp cloth to remove dust, so it gets picked up and not just moved around. A dry cloth tends to kick the dust into the air, which actually increases the amount of dust that will find its way inside the computer.

Other contaminants should be kept away from the work area. If you smoke, either give it up or take breaks well away from the computer. The tars and smoke particles are virtually guaranteed to eventually gum up everything they shouldn't.

Airflow is critical for proper operation. All the electronic and electrical components in your computer produce heat when in operation. This is particularly true for older PCs that have been packed with expansion boards. These boards require cool air to prevent a deadly heat build-up. Be sure that all cooling vents in the front or sides of the computer are open and that air circulation is good. Check the clearance at the back of the computer; make sure the fan is not blocked by cables or papers. Don't push your computer flush against the wall; leave it some breathing space. Heat can destroy computer chips.

Conversely, cold temperatures can also affect a com-

continued

puter. Cold can slow down disk drive motors and change the critical positioning of the read/write heads. This can make your computer impossible to boot.

Because all PCs are air-cooled, dust can enter your system through the ventilation slots. At least once a year, take the cover off your computer and vacuum the interior to remove accumulated dust. Use a brush attachment on the vacuum and carefully go over all exposed parts. If you are feeling energetic and have experience with add-in boards, remove all the expansion boards so you have access to the motherboard. You can use a can of compressed air (available at photographic supply stores) to blow out the dust in areas that the vacuum can't reach. Clean or replace all clogged filters.

Power surges, spikes, and static electricity are great "killers" of computers. A standard computer power supply is designed to work reliably with 110 volts of 60 Hz AC. Spikes, sometimes caused by lightning strikes on power lines, or power surges caused by heavy-duty electrical equipment can terminally increase the voltage to your computer and literally fry a power supply or other circuits in the computer. Static electricity, generated by simply walking across a carpeted floor on a dry day, can range up to several thousand volts.

The first line of defense is a commonly available surge suppressor/spike filter. This inexpensive option is available in forms ranging from a simple one-switch power strip to fancy desktop power-control centers.

If you use telecommunications services like BIX, don't ignore your phone lines as a potential source of trouble. Phone-line surge suppressors are available that will prevent your modem from "taking a hit" due to surges on the phone lines. Another solution is to invest in an uninterruptible power supply. The UPS will isolate your computer from most of the trouble on the power lines and, in case of a power failure, give you time to shut down your computer without losing data. However, even a surge suppressor or a UPS can have its problems. (See Mark Waller's two-part series on PC power in the October and November issues of BYTE.)

Static electricity problems can be eliminated by using antistatic sprays on carpeting, by placing antistatic mats underneath your chair, or with a desktop antistatic mat beneath your keyboard.

Disk Drives

Because floppy disk drives are largely mechanical devices, they are prone to a variety of malfunctions. They are also critical in the overall function of a computer system—especially if your system doesn't have a hard disk drive.

On many older, full-height floppy disk drives, the drive door and hinge assembly are made of plastic. This assembly is held in place by two screws, which do a fine job of holding it in place but create another weak spot.

To prevent breaking the door or hinge, use your thumb and finger. The idea is to get the thumb pushing inward to prevent the door from snapping open. The too-common practice of flipping the door from the bottom is a sure way to break the door.

A sneakier situation is when one side of the hinge is cracked. The door will seem to operate, but the spindle inside the drive won't be able to clamp properly. You'll get nothing but read/write errors. Replace the door assembly.

Fortunately, replacing the drive door assembly on full-height drives is easy (once you locate a new door assembly). Remove the computer case, and you'll have easy access to the two screws that hold the door in place. To realign the new door (or to realign one that has slipped), simply make sure that the front of the door, when closed, is flush with the front of the drive.

Cleaning the drive heads is still a matter of controversy. Some people say they should be cleaned on a regular basis, while others swear that it's not only unnecessary but damaging. However, if the choice is between cleaning the heads or having to replace the drive, you have nothing to lose.

Hard disk drives require little maintenance because they are sealed units. The best procedure is to back up your files onto floppy disks at regular intervals.

In everyday operation, DOS stores files in any available sector on the hard disk. Eventually, all your files are fragmented into sectors all over your hard disk. DOS has to search all over the hard disk, switching from track to track and sector to sector, in order to access a large file or program.

To renew hard disk performance, you can use a defragger program, like the Disk Optimizer from Solution Systems or the Speed Disk program that is part of

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Table 1: *Common IBM POST audible error codes and screen codes for the IBM PC.*

POST error responses

Indication	Problem
Nothing happens	Power
Continuous beep	Power
Repeating short beeps	Power
1 long, 1 short	System board
1 long, 2 short	Monitor
1 short, no display	Monitor
1 short, BASIC on-screen	Disk drive

Common code errors

Code	Problem
101, 131	System board
201, xxxx201	Memory
Parity Check x	Power
301, xx301	Keyboard
601	Floppy disk drive
1701	Hard disk drive

Table 2: *The POST diagnostics error code will identify which RAM chip has failed. The error code will be xxxx201, with the first two x's indicating the bank and the second two x's indicating the bit chip. For example, a RAM error code of 0C40 would mean that the bit 6 chip on bank 3 has failed. A code of 0220 would mean that the bit 5 chip on bank 2 needs to be replaced.*

IBM system board RAM error codes

The first two digits indicate the bank.

	Older: 16K to 64K	Newer: 64K to 256K
Bank 0	00	00
Bank 1	01	04
Bank 2	02	08
Bank 3	03	0C

The last two digits indicate the bit chip.

Parity bit	00	Bit 4	10
Bit 0	01	Bit 5	20
Bit 1	02	Bit 6	40
Bit 2	04	Bit 7	80
Bit 3	08		

The Norton Utilities Advanced Edition. A defragger speeds up disk operation by rearranging files into contiguous sectors. This reduces the time DOS requires to access your files and can reduce wear and tear on the drive.

Because hard disks are critically important in most computer systems, you may want to invest in the SpinRite package from Gibson Research. SpinRite performs an analysis on a hard disk and can do a low-level, nondestructive reformat of the disk if it detects any problems. It is useful in correcting hard disk problems before they become serious.

Basic Troubleshooting

You don't need a degree in engineering to diagnose and repair the most common malfunctions. Troubleshooting is nothing more than a process of elimination. The problem can be in just so many places. Find out where it's not, and you'll know where it is. Always begin with the simplest and most obvious source of the problem. For example, if your computer is completely dead, start with the AC power outlet. If you're getting read/write errors from the disk drive, begin by examining the drive door. Don't forget the disk.

Symptoms the computer exhibits will help you in the elimination process. For example, if the computer seems to be functioning but the monitor is dead, there's no need to test the disk drives. You should first check the power light on the monitor to see that it's getting power. If the monitor is powered up, the problem is isolated to one of three places: the monitor circuitry, the video cable, or the video board in the computer. You can test the cable with an ohmmeter to see if any wires are broken or short-circuited. You can test the monitor and video board by substituting another component that you know is good. If the problem goes away after the substitution, you've isolated the defective component.

You already have a tool that will help you diagnose your computer: the built-in power-on self-test your computer performs every time you turn it on. This POST puts the computer through a quick "once-over." The test covers the system board, RAM, video board, keyboard, and floppy disk and hard disk drives. If an error occurs, the computer should respond with audible signals and error codes on the screen. Error codes vary on different computers. Common codes for the IBM PC are shown in table 1.

The POST diagnostics will tell you, for example, which RAM chip has failed (see table 2). The error code will be xxxx201, with the x's being digits. The first two indicate the bank; the second two indicate the bit chip. (The 201 is the code for RAM problems.) The RAM chips are highly sensitive to static electricity and transient voltages, and they can become more sensitive with age (especially if the computer has overheated).

You can do a more thorough check by using the diagnostics program or disk sold with most computers. This performs a more thorough test of every system, including a read/write test of the floppy disk and hard disk drives (see table 3). An even more exhaustive set of tests is available in the IBM Advanced Diagnostics disk or the Disk Technician package from Prime Solutions. These programs will generate detailed reports to indicate the source of the trouble.

The fastest way of checking suspected circuit boards and components is by substitution with a good one. If the substituted part works in your computer system, you have isolated the bad part. You

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Table 3: *This is a list of IBM diagnostics disk error codes. If the last two digits are 0, the system is operating correctly.*

IBM diagnostics disk error codes

Code	Problem
02x	Power
1xx	System board
20x, xxxx, xx20x	Memory
30x, xx30x	Keyboard
4xx	Monochrome monitor
5xx	Color monitor
6xx	Floppy disk drive
7xx	8087 coprocessor
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can also test the suspected bad part in another system to verify that it is defective.

If It's Dead

It's relatively rare for a computer to fail completely. If this does happen, the problem is almost certain to be in one of two places. Either the wall outlet is dead, or the power supply has failed. As always, begin with the easiest. Check the outlet to be sure it's supplying power. (You can eliminate the outlet immediately if the cooling fan is operating.)

Then, you can use a volt ohmmeter to perform a number of simple tests. A cable can be eliminated as the possible cause of trouble by using the VOM to check for continuity. You can also use it to probe for the presence of voltage. A suspected power supply can be checked easily for DC voltage output in the 5-V and 12-V ranges at the four pins bringing power to the floppy disk drives. The location of the pins can vary depending on the type of drive you have. On older PCs, these are located at the left rear of the drive, with the pin closest to the edge being pin 1. The two pins in the center are ground. If you find 11.5 to 12.6 V DC between pins 1 and 3, and 4.8 to 5.2 V DC between pins 2 and 4, the power supply is probably doing its job, and something else is wrong.

Other Troubleshooting

Even while sitting in their slots and sockets, the components in your computer are subject to the ubiquitous effects of corrosion and oxidation. Even gold-plated contacts are no guarantee against oxidation. The chips themselves have a tendency to creep out of their sockets due to thermal expansion and contraction.

A simple troubleshooting method is what I call the "laying on of hands" technique. This involves simply opening up your computer, pressing down on every socketed chip, and gently pulling apart and reseating every cable connection. This will displace any oxidized metal and reestablish a good electrical connection. Removing and reseating expansion boards is also wise. A surprising number of sick or dead computers spring back to health after this treatment.

For persistent or recurring oxidation problems, you can use Cramolin R2 spray. This is an antioxidizing lubricant that cleans metal surfaces and forms a protective layer to maintain electrical conductivity. It is useful for parallel, serial, and expansion board connections. (Cramolin R2 is available from Craig Laboratories, Inc., 1175-O Industrial Ave., P.O. Box J, Escondido, CA 92025, (619) 743-7143.)

If Pain Persists

Sometimes, despite every diagnostic technique, the cause of a problem may still elude you. That's the time to call in the professional computer repair technician. After going through all the maintenance tests and procedures, you'll be able to tell the technician where the problem is not located.

But if you follow these simple maintenance procedures, your PC can live a long and productive life rather than die an early death due to neglect. ■

Gene B. Williams is an Arizona-based author. He can be reached on BIX c/o "editors."

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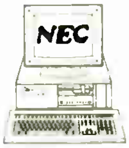

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WRITING OS/2 GRAPHICS PROGRAMS

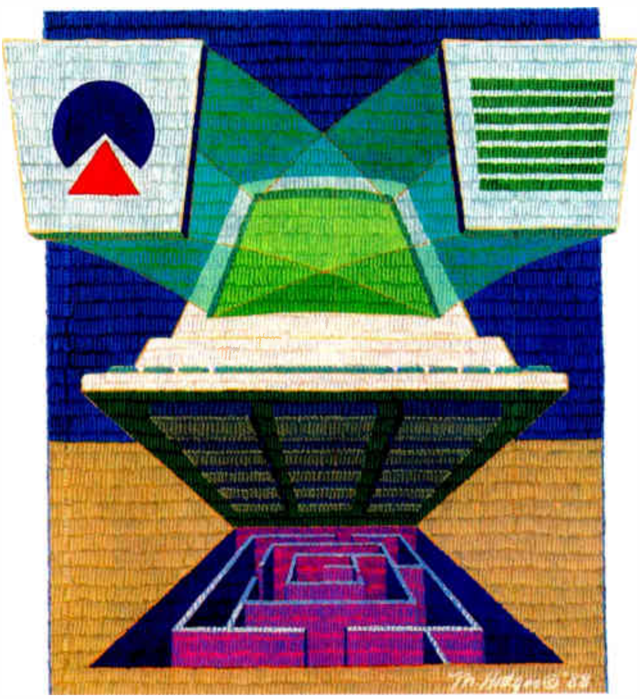
The attractions and perils of the hardware labyrinth

Mitchell M. McLain and Timothy E. Stevenson

Most programmers understand the necessity for high-quality graphics in their applications, and the advanced features of OS/2 make the need for clear, precise graphics displays even greater. When writing graphics applications to run under OS/2, you can take a number of approaches, from writing directly to the hardware, to using a standard windowing environment, to using device-independent graphics drivers.

Writing OS/2 graphics applications directly to the display hardware involves a number of challenges, and it requires that you understand some OS/2-specific programming issues, such as 80286 protected-mode programming rules; OS/2 privilege levels; OS/2 multitasking features; specific implications of multitasking for graphics programming; supporting mouse devices; and National Language Support.

It is important to realize that OS/2 *does* allow graphics programmers to address display hardware directly. Just as in DOS, you can obtain a pointer to the display buffer and program the adapter's registers. Although the DOS INT 21h (hexadecimal) function interface and the DOS INT 10h video interface have been replaced by a much richer set of function calls, the overall approach behind direct-to-hardware graphics programming in OS/2 is much the same as in DOS. The main difference is the set of considerations that the protected-mode multitasking nature of the environment introduces.



80286 Protected-Mode Programming Rules

Every protected-mode program in OS/2 must adhere to 80286 protected-mode programming rules. The first rule is that segment registers (ES, DS, and SS) can be used only for valid selectors (which are analogous to segment base addresses in real-mode DOS programming). Loading any one of these registers with something that is not a valid selector initiates a General Protection Fault (GPF), and your program will be aborted. The practical result of this rule is that segment registers cannot be used as scratch pads, as they can in DOS.

The second protected-mode programming rule is that your program cannot access memory that it doesn't own (as DOS programs can) unless the owner gives permission. In addition, memory segments have defined upper and lower bounds. Thus, it can no longer be assumed that every segment will be 64K bytes in size. Each segment's upper limit is defined when it is created (the lower limit being 0). Addressing beyond either of these limits will cause your program to abort with a GPF. This feature

continued

might seem like a limitation at first, but you will begin to appreciate it when you discover how well it enables you to find errant pointer bugs.

OS/2 Privilege Levels

In addition to 80286 hardware considerations, direct-to-hardware graphics programmers must be aware of some rules that OS/2 itself imposes. These rules stem from the fact that the 80286 protected-mode architecture lets OS/2 partition its running environment into four rings of privilege levels (see figure 1).

The operating system employs privilege levels 3, 2, and 0 (0 being the highest level). Most of the code you write will run at privilege level 3 (PL3). This level provides access to all system services, such as memory management, file I/O, keyboard and mouse input, and text-mode video I/O. You can read from and write to the display buffer at PL3, but the code that programs the video hardware registers must run at PL2.

The 80286 hardware lets the operating system specify the privilege level at which access to hardware registers will be permitted. OS/2 restricts this access to PL2, although very early prerelease versions of the operating system allowed register access at PL3. DOS system services, however, cannot be called from PL2 (although it would be technically feasible to relax this restriction in future versions of the operating system).

These restrictions mean that your direct-to-hardware graphics programs will need to move between PL3 and PL2. To move to PL2, your program has to pass through a call gate. Call gates provide the mechanism that permits your program to move from a lower privilege level to a higher one.

During a privilege-level transition, various access rights are checked to make sure that you are allowed into PL2, and you are given a different stack on which to run. If you passed any parameters to your code at PL2, they are copied to your new stack as part of the call-gate transition.

A lot more goes on during a call to a higher privilege level than you may be used to seeing during an intersegment (far) call. (By the way, call gates look like far calls when you disassemble them.) Call-gate transitions are at least four times slower, depending on the number of parameters passed, than intersegment calls at the same privilege level. Thus, you want to minimize the number of call-gate transitions that your application makes.

Although the INT 10h DOS video interface has been replaced by a rich set of video function calls in OS/2, those function calls apply only to text-mode functions and some limited support for CGA graphics modes. The only graphically oriented system service that OS/2 provides is the ability to change the display mode. All other aspects touching the graphics display must be done either by the application itself or by using external graphics routines. The one system service that OS/2 provides is useful because changing the display to a graphics mode involves more than programming the display-adapter registers; it also involves coordinating with the mouse driver and the operating system.

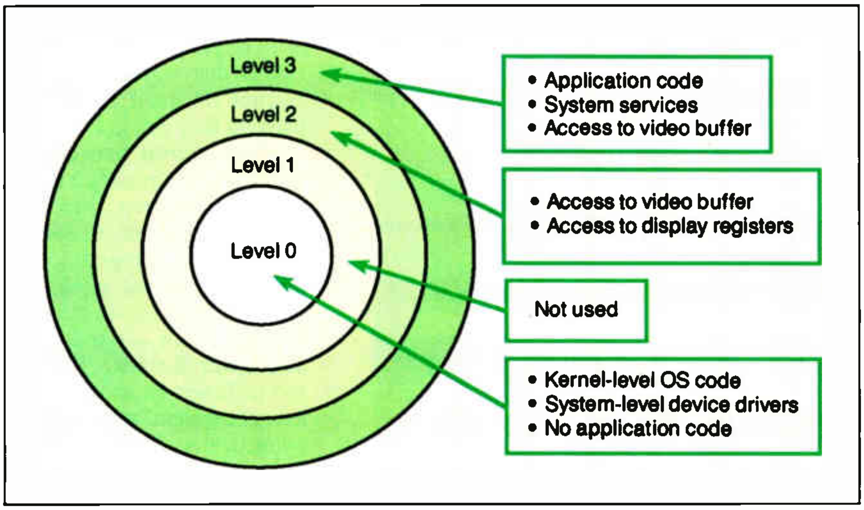


Figure 1: *The 80286 protected-mode architecture allows OS/2 to partition its running environment into privilege levels, which specify the access to system services and hardware registers. A similar drawing of real-mode DOS programming would show only one circle.*

OS/2 Multitasking Features

So far, we have concentrated on the issues you would face in a single-tasking protected-mode environment. However, OS/2's multitasking features lead to a series of considerations based on how your program will cooperate with the system in sharing "serially reusable resources" (e.g., the keyboard, the mouse, and the display screen).

Several applications may want to use these resources at unpredictable intervals, yet only one application can use them at a time. In addition, OS/2 occasionally needs to take ownership of the screen to display pop-up windows to notify the user of error conditions. OS/2 provides a series of interrelated mechanisms to resolve these potential resource conflicts.

Two key concepts on which OS/2 is based are *processes* and *threads*. Processes are units of ownership; for example, a process owns its own file handles and its own portions of memory. Threads, on the other hand, are units of execution. Every process owns at least one thread, and all threads owned by a process have equal access to everything else the process owns. When a process's last thread terminates, the process terminates with it.

Figure 2a shows a simple nongraphics (alphanumeric) application with three threads, each accessing input and display devices through system services. Figure 2b shows a graphics application with three required threads (explained below) that use system services to access the keyboard and mouse but that must use external graphics routines to access a (non-CGA) graphics display.

A thread can request permission to write to the screen, and prevent other threads from writing to the screen until it is done, through *screen locking*. Screen locking is necessary if your application has several threads, because any number of them might want to write to the screen at the same time. When one thread is done writing, it unlocks the screen so another thread can write to the screen. Although a thread can attempt to write to the screen without requesting permission (via screen locking), the result will be a screen full of "garbage."

Another important reason for a thread to lock the screen before writing to it is to coordinate *screen swapping*. Screen swapping operates on *screen groups*, which are simply entities that can own the screen, keyboard, and mouse. Each screen group can consist of multiple applications (e.g., under control of a window manager) or a single application. Screen swapping switches the foreground screen group (i.e., the application that owns the screen, keyboard, and mouse) into the background and simultaneously switches a background screen group into the foreground (see figure 3). Screen swapping can happen at any time when the screen is not locked; thus, coordination via screen locking is important.

You can also use screen locking to coordinate your application with unpredictable pop-up window displays. OS/2 uses pop-up windows to communicate errors to the user without destroying the contents of the user's display screen; background screen groups also use them to communicate messages to the user. Pop-up windows can be displayed at any time, with one exception: They will never be displayed when the screen is locked.

Pop-up windows are displayed in text mode, and they take up the entire screen. When a pop-up is taken down, OS/2 replaces the bits in the video buffer that were overwritten by the pop-up. This happens even if the display was in graphics mode before the pop-up was displayed. Incidentally, this is another reason to use OS/2's mode-setting service (so the operating system can properly save and restore the screen bits before and after a pop-up window is displayed).

Although screen locking prevents screen swapping and pop-up window displays, there is a limit to its power: If a screen swap or pop-up window display is pending, a thread has 30 seconds to unlock the screen from the time it was locked. After 30 seconds, the process that owns the thread holding the screen lock is suspended and swapped to the background.

Implications of Multitasking

Soon after your application is loaded and the main thread begins to execute, your application will need to create two additional threads. The first is called the *save/redraw wait* thread, and the second is called the *mode-restore* thread. The save/redraw wait thread handles screen swapping, and the mode-restore thread handles display-mode restoration after pop-up windows are taken down (see figure 4). Each screen group can have only one save/redraw wait thread and one mode-restore thread.

These threads are required in graphics applications because your application knows best what format to use for an off-screen bit map, where the screen bits are stored when the application is swapped to the background. Furthermore, at any given time, your application knows what state the hardware should be in after a pop-up window is taken down.

Some of your application's end users may be using IBM PC AT–compatible machines with EGA boards. Remember that EGA registers cannot be read; they are write-only. Although OS/2 can restore most of the EGA registers when it returns the display to graphics mode after taking down the pop-up window, it cannot restore them all. The mode-restore thread must restore the remaining registers.

The save/redraw wait thread interacts with OS/2 via the function called `VioSavRedrawWait`. Whenever this function is called, the calling thread is suspended until a screen swap is initiated on the thread's screen group. A screen swap

continued

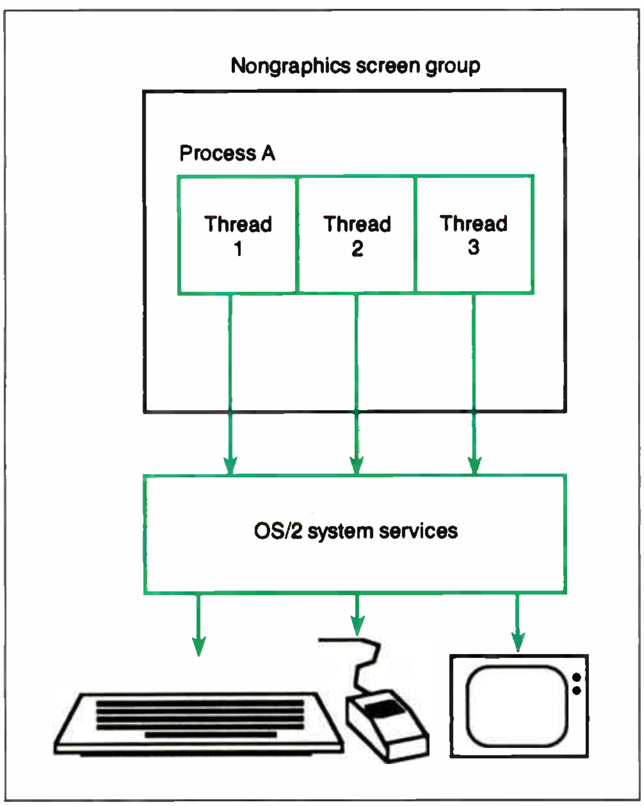


Figure 2a: *In a nongraphics (alphanumeric) OS/2 application, a process's threads access input and display devices through system services.*

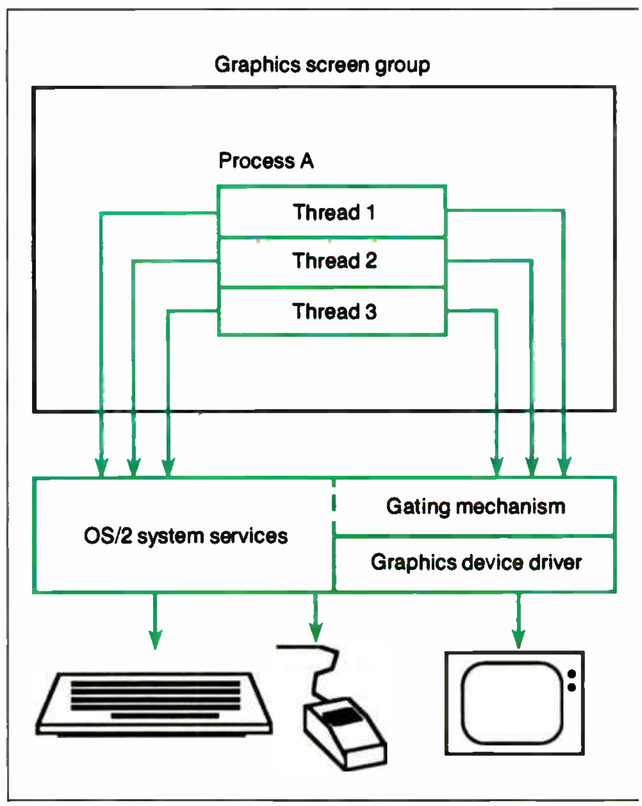


Figure 2b: *An OS/2 graphics application needs three required threads, which use system services to access the keyboard and mouse but must use external graphics routines to access the graphics display.*

in progress is signaled by the return from VioSavRedrawWait. A flag indicates if your screen group is being swapped to the background or to the foreground.

When it's being swapped to the background, the save/redraw wait thread must save the current screen image by whatever means are appropriate. If the screen group consists of a single graphics application, then your save/redraw wait thread should probably create an off-screen bit map large enough to hold the entire contents of the display buffer. This off-screen bit map can be created in a format that lets the application continue executing while it is in the background. Nothing in OS/2 precludes a graphics application from running in the background. However, given the complexities of redirecting output to the background video buffer, some programmers may decide to suspend the application when it is in the background.

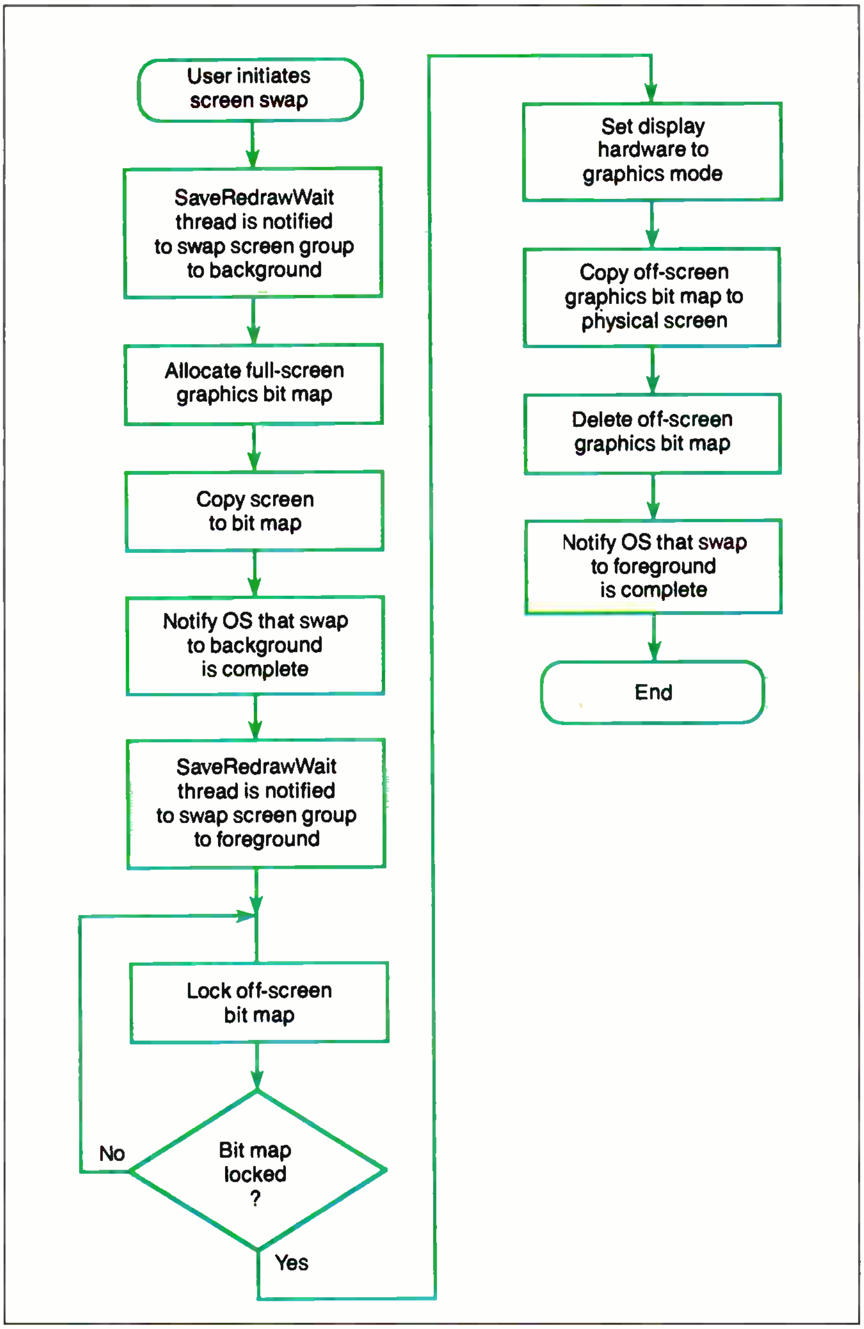


Figure 3: *The left-hand portion of the flowchart illustrates the first part of a screen swap, where the foreground screen group is put into the background. The right-hand portion shows the second part of a screen swap, where the background screen group is put into the foreground.*

Once the screen image is safely tucked away into an off-screen bit map (also known as a Logical Video Buffer, or an LVB, in graphics mode), the save/redraw wait thread notifies OS/2 that its job is complete. This is done by again calling VioSavRedrawWait. Now the screen group is truly in the background (either still running or suspended while waiting to be swapped to the foreground).

The save/redraw wait thread is also responsible for handling the screen swap to the foreground. This operation is almost a mirror image of what took place during the swap to the background. The bits in the off-screen bit map (LVB) are copied into the display buffer. However, before that can happen, the display adapter must be set to the appropriate graphics mode.

While swapping your application to the foreground, your save/redraw wait thread must make no assumptions about the state of the display hardware. It cannot assume that the previous screen group left the display adapter in a predetermined mode after it was swapped to the background. Your save/redraw wait thread should first set the display hardware and then copy the saved off-screen image into the display buffer.

Another subtle complexity of screen swapping involves the interaction of the save/redraw wait thread with other application threads that write to the display buffer. When a screen group is running in the foreground, screen locking is used to gate access to the display buffer. The screen lock will be unavailable whenever another thread has it—for example, during a screen swap or during the display of a pop-up window.

When a thread requests the screen lock (by calling VioScrLock), the thread has two options: 1) It can request to be blocked until the lock is available (if the lock is already available, the thread won't be blocked at all); or 2) it can request an immediate return without blocking, even if the screen lock is unavailable. In the latter case, VioScrLock will return a flag indicating whether the lock was obtained or not, and the requesting thread can then determine the proper course of action.

When your screen group is running in the foreground, you will probably want VioScrLock to gate access to the display buffer. However, when your screen group is running in the background, you must use the second VioScrLock option.

If you do not, OS/2 will suspend the calling thread because the screen lock is unavailable to background screen groups.

If you use the second ("no lock") `VioScrLock` option to enable your application to run in the background, you must make sure that you do not leave your off-screen bit map (now acting as the display buffer) open to being written into by multiple threads simultaneously—this would raise havoc with the bits. You also need to make sure that, during a swap to the foreground, you do not allow threads to write into your off-screen bit map while it is being copied into the physical display buffer.

To prevent those problems, you need to create your own gating mechanism for use while running in the background and during screen swaps. OS/2 provides several methods for interthread and interprocess communication. An in-depth discussion of these is beyond the scope of this article, but the basic concept is to allow only one thread at a time to have

continued

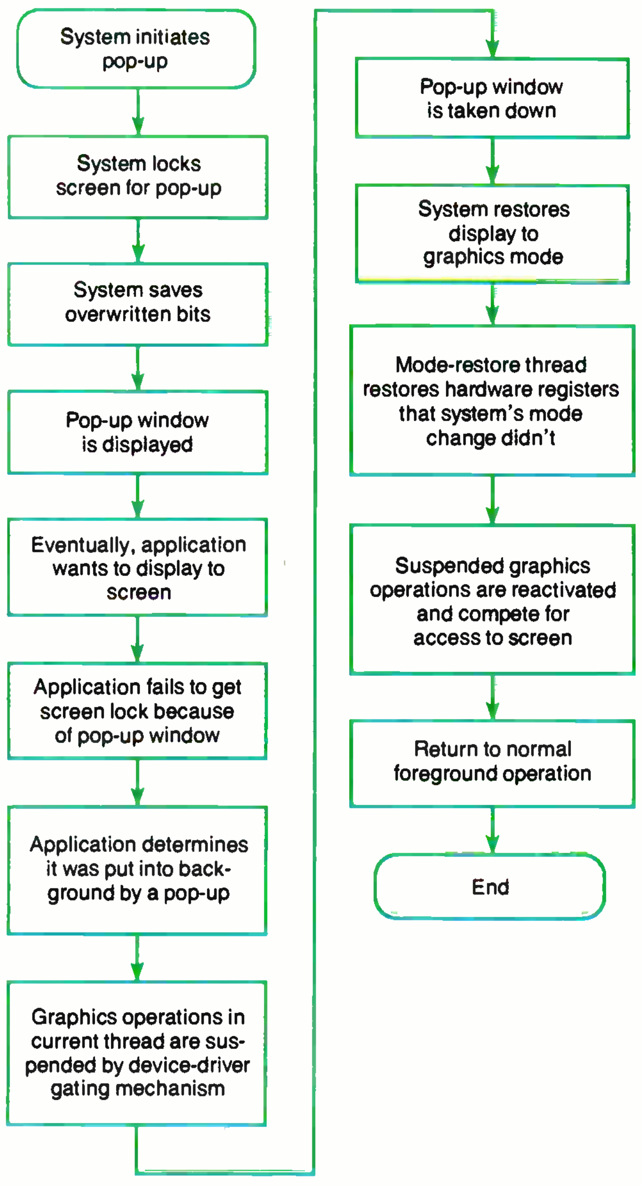


Figure 4: *The left-hand portion of the flowchart illustrates the display of a pop-up window and what the foreground application does in response to the event. The right-hand portion shows what happens when the pop-up is taken down.*

access to the video buffer (whether it is the physical display buffer or the off-screen display buffer). We suggest that you look first at semaphores (RAM semaphores or semaphores of your own creation) as indicators of whether the video buffer is available or not.

The other thread required of graphics applications is the mode-restore thread. This thread is responsible for restoring the mode of the display adapter after a pop-up window is taken down. It must know what mode the application thought it was in before the pop-up window was displayed, but it does not have to know much else. OS/2 restores the bits in the display buffer that it overwrote with the pop-up window, so your thread does not have to deal with that.

Soon after the mode-restore thread is created, it must call an OS/2 system function called `VioModeWait`. As with the call to `VioSavRedrawWait` in the save/redraw wait thread, the thread calling `VioModeWait` is blocked until the occurrence of an event—in this case, the removal of a pop-up window from the screen. Notification is given by the return from the function. After the return, the thread restores the mode of the display adapter and then calls `VioModeWait` again, being blocked until the next time a pop-up window is taken down.

Like screen swapping, mode restoration has its subtle complexities. The mode-restore thread must cooperate with all the other threads of the screen group that want to write to the display buffer from time to time. Your screen group is never swapped to the background without the save/redraw wait thread being notified, except when a pop-up window is displayed. This doesn't present a problem if you are using `VioScrLock` to gate access to the physical display buffer. But doing that means your application will be blocked and, thus, unable to run in the background.

Alternatively, your application can run in the background if you use your own gating mechanism (you can do so in the foreground as well as in the background). You must still call `VioScrLock` to coordinate with the screen swapping and the pop-up window mechanisms (these events won't occur when the screen is locked)—but you might be calling `VioScrLock` with the "don't block if you can't lock" option. In this case, you won't get the lock because there's a pop-up window on the screen.

Your application must be very careful in interpreting why it didn't get the screen lock. It would be only partly correct if it assumed it didn't get the lock because it was swapped to the background. It *was* swapped to the background, but not in the normal way: The save/redraw wait thread was never started, and an off-screen bit map was not set up to save the screen. Thus, your application could end up in a state of limbo. To avoid this undesirable situation, when a pop-up swaps your application to the background, the application should go into a loop that calls `VioScrLock` until it gets the lock. Although your application's background execution would halt when a pop-up window is displayed, your application could still run in the background at other times, such as when the user swaps it out of the foreground.

Supporting Mouse Devices

Another issue to consider when writing direct-to-hardware OS/2 graphics applications is the mouse. OS/2's designers integrated the mouse into the system so

continued

that programmers would not have to write mouse drivers. But there is a problem when the display is in graphics mode.

The mouse driver knows the resolution of the screen at all times because OS/2 coordinates its mode-setting actions with the mouse driver, but it cannot display its pointer in graphics modes. It is up to your application to display the pointer at the appropriate position on the screen. For your application to control when and how the pointer is drawn, you should disable the mouse driver from doing anything other than return position reports.

National Language Support

One final consideration is working with IBM's National Language Support standard. NLS is IBM's method of using the correct character sets for various languages throughout the world. Germans, for example, have different key caps on their keyboards than do the French, and each would expect your application to display the appropriate character set for their keyboards.

OS/2 provides the means to support NLS through code pages (IBM's terminology for different character sets), but your graphics application must handle them correctly. It has to note the current code page and behave appropriately. For example, if you intend to support printers with your application, you must create images for every character in each of the five supported code pages. That sounds worse than it really is—most of the characters are duplicated in each code page—but you should be aware of this requirement.

A Variety of Approaches

We've attempted to provide some insight into the issues and challenges associated with writing direct-to-hardware graphics programs for OS/2. Clearly, it can be done—and sometimes must be done.

When you don't want to write directly to the hardware, you can use the graphics support found in high-level languages. At present, however, the high-level languages running under OS/2 generally offer limited graphics support, perhaps as a result of the rush to release OS/2 versions. This will undoubtedly change in the months to come.

There are also two device-independent approaches to OS/2 graphics application development. The first approach is programming with a software tool (such as the GSS Graphics Development Toolkit) that provides a library of device-independent graphics functions that work through prewritten device drivers. The second is programming to a window manager (such as the Presentation Manager) that includes prewritten drivers, graphics functions, and higher-level window/icon functions that allow your application to conform to a standard "look and feel."

Each method of writing graphics under OS/2 has its advantages and disadvantages. There are times when you will want to go directly to the hardware, times when you want to support a standard window-manager environment, and times when you want to make use of a device-independent graphics toolkit. ■

Mitchell M. McLain is a senior graphics software engineer responsible for managing OS/2-based software development at Graphic Software Systems, Inc. (GSS). Timothy E. Stevenson, director of Entry Systems Engineering, is a cofounder of GSS. They can be contacted on BIX c/o "editors."

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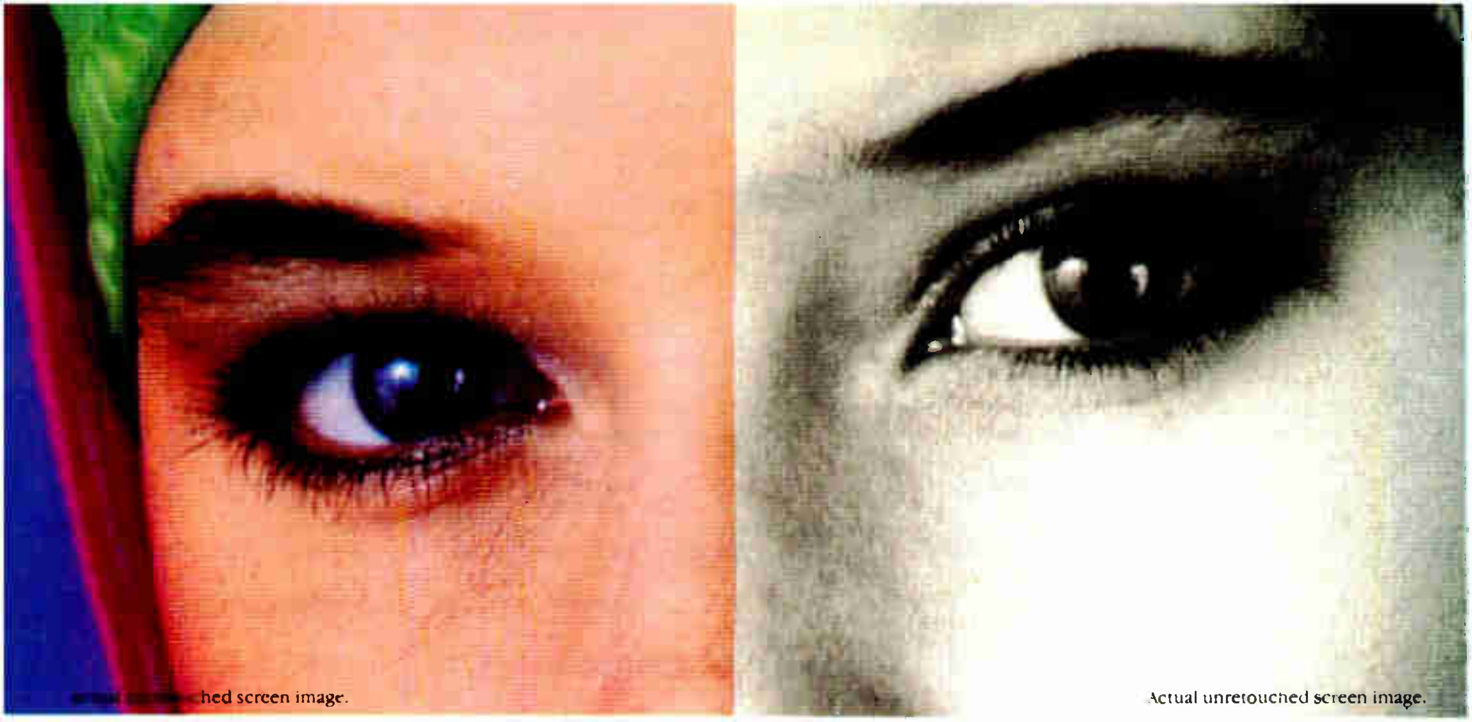

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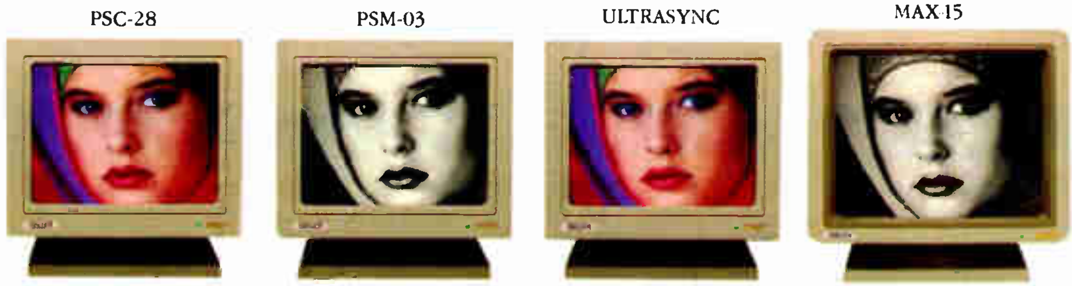

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VGA VIDEO MODES

Complete control of IBM's VGA system

Richard Wilton

The VGA is the video subsystem built into IBM's PS/2 Models 50, 60, and 80. It is also widely available as an adapter for the IBM PC XT and AT. In terms of capability and performance, the VGA is essentially a mildly improved version of the EGA. Surprisingly, however, the VGA is much more flexible than the EGA in terms of the resolution of the video modes that it can display, particularly when you use it with a variable-frequency video monitor.

Like the EGA, the VGA has several programmable control components, including a CRT controller (CRTC), a sequencer, an attribute controller, and a graphics controller. You can program each to modify essential timing signals and addressing modes within the video subsystem. The VGA's ROM BIOS contains a set of routines, invoked through interrupt 10 hexadecimal function 0, that program the VGA controllers into any of 24 different configurations (video modes).

Each of the VGA's controllers has a number of registers whose contents control their function. The VGA ROM BIOS contains tables of appropriate register values for each supported video mode, so most programmers call the ROM BIOS to select video modes instead of updating the registers directly. If, however, you want to create video modes unsupported by the video BIOS, you need to know what values to store in these registers to obtain the video configuration you want.

Why take the trouble to create your own video modes? The usual reason is to obtain higher-resolution graphics or more displayed text than the usual ROM BIOS video modes can provide. Some widely used commercial applications, including Microsoft Word and Lotus 1-2-3, can do this for you. If you want higher resolution in your own applications, however, you need to do some extra programming yourself.

Video Mode Control

You can differentiate video modes from each other in several ways:

- Vertical resolution: number of rows of pixels (scan lines) displayed on the screen.
- Horizontal resolution: number of characters or pixels per row.
- Data representation in the video buffer.
- Attribute decoding: colors, blinking, and so on.

When you program the VGA, you have a great deal of control over vertical and horizontal resolution. You have much less flexibility in regard to data representation and attribute decoding because of the VGA's hardware design. For this reason, the easiest

continued

way to set up alternative VGA video modes is to use the ROM BIOS mode-set routines to establish a baseline video mode, and then modify the horizontal and vertical resolution to produce a new video mode.

Video Display Timing

Controlling the resolution of the displayed image is—like many other activities in life—a matter of timing. Both horizontal and vertical resolution are related to the timing of the VGA's output signals that control the electron beam in the video monitor. The image on the video screen is not static, of course. It is produced by the cyclic sweep of the monitor's electron beam across and down the screen (see figure 1). The screen image is completely refreshed between 50 and 70 times per second, depending on the video mode.

As each scan line of pixels is displayed, the electron beam's intensity is modulated by signals generated by the VGA. (In a color monitor, there are three adjacent electron beams, one for each primary color, but for the purposes of video display timing, they can be regarded as a single beam.) The monitor moves the beam from left to right at a constant rate across each scan line and downward from scan line to scan line. The VGA generates a horizontal sync signal that controls when the monitor deflects the beam from the rightmost end of one scan line to the start of the next scan line (horizontal retrace). There is also a vertical sync signal that controls the deflection of the beam from the bottom of the screen back to the upper left corner (vertical retrace).

The VGA is always programmed so that the amount of time required to display data from the video buffer is less than the total amount of time it takes to sweep the electron beam horizontally and vertically. The extra time is spent in horizontal and vertical overscan. You can assign a color to the overscan area (also known as the border area) of the screen to provide a visual frame for the displayed video data, but that area's basic purpose is to center the displayed image on the screen.

You can control the horizontal timing signals generated by the VGA's CRT controller by updating the appropriate CRTC registers. The timing values that you store in these registers are measured in "character clocks." A character clock corresponds to 8 pixels in VGA graphics modes and either 8 or 9 pixels in alphanumeric modes. You might want to think of a character clock as a unit of time (i.e., the time required to display one character's worth of data on the screen).

The key parameters that control horizontal timing are as follows:

- *Horizontal total.* The total amount of time spent in displaying each scan line, including the time required for horizontal retrace.
- *Horizontal displayed.* The number of character clocks of data displayed from the video buffer in each scan line. The difference between the horizontal total and the horizontal displayed parameters describes the amount of horizontal overscan.
- *Horizontal sync.* The character clock at which the horizontal sync pulse begins.

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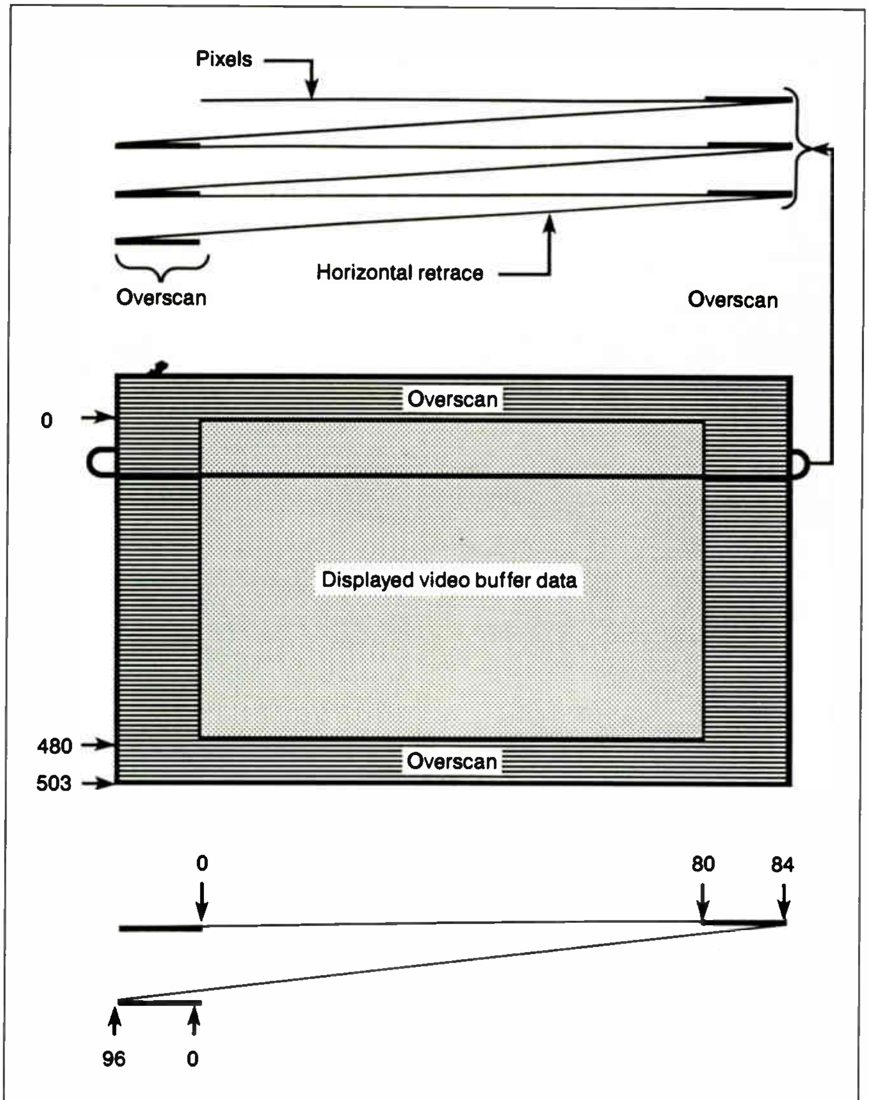

Figure 1: *On a video screen, the electron beam's scan cycle starts with the first pixel of the displayed video buffer data near the upper left corner of the screen. Scan lines are traced horizontally, left to right, then retraced down and across, right to left. In one scan line of a 640- by 480-pixel 16-color graphics mode, the horizontal total (100) specifies the duration of one complete horizontal scan cycle. Horizontal displayed (80) specifies the amount of displayed data. Horizontal sync starts at character clock 84 and lasts for 12 character clocks, so there are 4 characters of overscan at each end of the scan line. The vertical displayed (480) specifies the number of scan lines of displayed data. Vertical sync starts at scan line 503 and lasts for 2 scan lines, so there is a total of 42 scan lines of vertical overscan above and below the screen image.*

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Table 1: *Tolerances of a few VGA-compatible monitors.*

Monitor	Dot rate (MHz)	Maximum vertical scan rate (kHz)	Horizontal scan rate (Hz)
IBM 8503 (monochrome)	28	31.5	50-70
IBM 8513 (color)	28	31.5	50-70
NEC MultiSync	30	35	56-65
NEC MultiSync Plus	30	45	56-80
Electrohome ECM 1310	30	34	47-85
Sony Multiscan CPD 1302	25	34	50-100
Princeton Ultrasync	30	35	45-120

Table 2: *I/O ports used for VGA control.*

Port	Function	Access
3C0	Attribute controller	Read/write
3C2	Miscellaneous output	Write only
3C4/3C5	Sequencer	Read/write
3CC	Miscellaneous output	Read only
3CE/3CF	Graphics controller	Read/write
3D4/3D5*	CRT controller	Read/write

* 3B4/3B5 in modes 7 and 0Fh.

The timing parameters that control the vertical size and on-screen location of the displayed image are analogous to those that control horizontal timing. Vertical timing parameters are usually specified in terms of number of scan lines. As with character clocks, you might want to consider a scan line to be a unit of time (i.e., the amount of time it takes to draw one scan line on the screen and return the electron beam to the beginning of the next scan line).

Here are the vertical timing parameters you need to consider when you establish a VGA video mode:

- *Vertical total.* The total number of scan lines in one complete refresh cycle.
- *Vertical displayed.* The number of scan lines of data displayed on the screen. The difference between the vertical total and the vertical displayed parameters determines the amount of vertical overscan.
- *Vertical sync.* The scan line in which the vertical sync pulse begins.

VGA Timing Constraints

In order to use these general timing parameters to program the VGA, you need to know the basic timing frequencies used by the VGA and by your video monitor. There are three different control-signal frequencies or rates to consider: The rate at which pixels are displayed, the rate at which the electron beam sweeps across the scan lines, and the rate at which the entire screen image is refreshed. These three rates are commonly called the dot rate, the horizontal scan rate, and the vertical scan rate.

- *Dot rate.* The rate at which the video subsystem displays pixels is called its dot rate; this frequency is also known as the pixel rate or the video bandwidth. This rate is established by a high-frequency crystal oscillator called the dot clock. You can program the VGA to use one of several dot clocks with different frequencies. Two different crystal oscillators are built into the VGA with frequencies of 25.175 MHz and 28.322 MHz; you can select a third oscillator from the auxiliary video connector on the system board of a PS/2 Model 50, 60, or 80.
- *Horizontal scan rate.* The horizontal scan rate is the number of scan lines displayed per second. When you program the VGA, you indirectly specify a horizontal scan rate by specifying the total number of pixels contained in each scan line. If you divide the dot-clock frequency by the total number of pixels per scan line, you get the horizontal scan rate.
- *Vertical scan rate.* The vertical scan rate (also called the refresh rate or frame rate) is the number of times per second that the screen is refreshed. You determine the vertical scan rate by programming the VGA to display a specified number of scan lines during each refresh cycle. You can calculate the vertical scan rate by dividing the horizontal scan rate by the number of scan lines per frame.

The key to establishing alternative VGA video modes lies in programming the VGA to produce timing signals that fall within the limitations of your monitor. When you set up a video mode by programming the VGA, you must select a dot rate, horizontal scan rate, and vertical scan rate that lie within the tolerances of the monitor you're using. I've listed the tolerances of a few VGA-compatible monitors in table 1.

For example, consider the default ROM BIOS video mode 12h—that is, 640- by 480-pixel 16-color graphics mode. This mode is designed to work with IBM's PS/2-compatible monitors, which expect a horizontal scan rate of 31.5 KHz. The BIOS uses the VGA's 25.175-MHz dot clock in this video mode, so you can easily determine the relevant timing constraints.

To compute the horizontal total, you divide the dot rate by the horizontal scan rate to obtain the number of pixels per scan line. Then you divide this value by 8 (the number of pixels per character clock) to determine the number of character clocks per scan line:

$$\text{Horizontal total} = (25175000/31500)/8 = 100 \text{ character clocks}$$

Since each scan line contains 640 pixels of data, the horizontal displayed parameter is 640 divided by 8, or 80. The extra 20 character clocks represent the time spent in horizontal overscan and in horizontal retrace. To center the displayed pixel data, the horizontal sync signal starts at the eighty-fourth character clock, and the horizontal sync pulse lasts for 12 character clocks. The result is a scan line with 4 character clocks of overscan at each end.

The ROM BIOS relies on similar calculations to determine the vertical timing parameters. The BIOS sets up this video mode so that 60 frames are displayed per second. This vertical scan rate lies in the middle of the tolerance range of IBM's PS/2 video monitors. The vertical total, measured in scan lines, is the quotient of the actual horizontal scan rate (scan lines per second) and the desired vertical scan rate of 60 frames per second:

$$\text{Vertical total} = (25175000/(100\times 8))\ /\ 60 = 524 \text{ scan lines}$$

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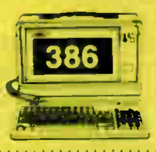

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Table 3: *VGA CRT controller registers used for video-mode programming.*

Register number	Name	Contents
0	Horizontal total	[Horizontal total] – 5
1	Horizontal display enable end	[Number of character clocks of displayed data] – 1
2	Start horizontal blank	Character clock at which horizontal blanking begins
3	End horizontal blank	End of horizontal blanking pulse (bits 4-0 only)
4	Start horizontal retrace	Character clock at which horizontal sync begins
5	End horizontal retrace	End of horizontal sync pulse (bits 4-0 only)
6	Vertical total	Vertical total (bits 7-0 of a 10-bit value)
7	Overflow	Bit 0: vertical total bit 8 Bit 1: vertical display enable end bit 8 Bit 2: start vertical retrace bit 8 Bit 3: start vertical blank bit 8 Bit 5: vertical total bit 9 Bit 6: vertical display enable end bit 9 Bit 7: vertical retrace start bit 9
9	Maximum scan line	Bits 4-0: [scan lines per character] – 1 Bit 5: start vertical blank bit 9
10h	Start vertical retrace	Scan line at which vertical sync pulse starts (bits 7-0 of a 10-bit value)
11h	End vertical retrace	Bit 7: write-protect CRTC registers 0-7 Bits 3-0: scan line at which vertical sync ends
12h	Vertical display enable end	Number of scan lines of displayed video data (bits 7-0 of a 10-bit value)
13h	Offset	Logical line width of video buffer data in words
15h	Start vertical blank	[Scan line at which vertical blanking begins] – 1 (bits 7-0 of a 10-bit value)
16h	End vertical blank	Scan line at which vertical blanking ends (bits 7-0)

Listing 1: *Updating a CRTC register.*

```
cli              ; disable interrupts
mov al,RegNumber  ; AL = register number
mov dx,3D4h
out dx,al     ; write to port 3D4H
mov al,RegValue     ; AL = new register value
inc dx
out dx,al     ; write to port 3D5H
sti              ; enable interrupts
```

Listing 2: *Unlike previous graphics adapters, the VGA's control registers can be read as well as written.*

```
cli             ; disable interrupts
mov al,RegNumber ; AL = register number
mov dx,3D4h
out dx,al          ; write to port 3D4H
inc dx
in  al,dx    ; AL = register value
sti             ; enable interrupts
```

The vertical displayed parameter is 480, the number of rows of pixel data that are displayed in this video mode. The remaining 44 scan lines represent vertical overscan plus the time required for vertical retrace. The BIOS starts vertical retrace after 503 scan lines and specifies the duration of the vertical sync pulse to be 2 scan lines. Thus, the 480 scan lines of video data are displayed with a total of 42 (524−480−2) scan lines of vertical overscan above and below.

Video-Mode Programming

Once you decide what the horizontal and vertical timing parameters will be for a video mode, you can program the VGA to display it. There are five tasks you must perform to coordinate the different components of the VGA subsystem:

- Program the CRTC.
- Program the sequencer.
- Select a dot-clock frequency.
- Specify the displayed character height.
- Update relevant ROM BIOS variables.

You program the VGA's controllers through a set of I/O ports (see table 2). You must access these ports with either assembly language `IN` and `OUT` instructions or their high-level-language equivalents. To access the ROM BIOS, you need to execute interrupt 10h, either directly in assembly language or through a high-level-language construct such as the `int86( )` function in Microsoft C.

Most of the VGA's control over the horizontal and vertical timing parameters is obtained through the CRTC. The CRTC controls the duration of the horizontal and vertical timing signals sent to the monitor. It also synchronizes the timing signals with the rate that data is extracted from the video buffer and processed by the display circuitry. You control these functions by updating the appropriate CRTC registers (see table 3).

To update a CRTC register, you must write a register number to I/O port 3D4h and then write the register's new value to port 3D5h (see listing 1).

There are a couple of tricks to CRTC programming on the VGA. First, you can use a single 16-bit port write to obtain the same results:

```
;AL = register number
 mov al,RegNumber
;AH = new register value
 mov ah,RegValue
 mov dx,3D4h
;Write to port 3D4h/3D5h
 out dx,ax
```

continued

If you don't use 8-bit port accesses, be sure to clear the interrupts. Otherwise, a hardware interrupt may occur between the port writes and disrupt your program by transferring control to a service routine that does its own CRTC programming.

Also, if you're programming in ROM BIOS modes 7 or 0Fh, use ports 3B4h and 3B5h instead of 3D4h and 3D5h. These port addresses mimic those that are used in the Monochrome Display Adapter; they let you operate both a VGA and another color video subsystem in the same computer.

Unlike the control registers in previous IBM video subsystems, you can perform both reads and writes to the VGA's control registers (see listing 2). This is particularly convenient because it lets you save the current state of the CRTC registers before you modify them.

The VGA sequencer has several interrelated functions, including synchronization of the video subsystem's character clock with the dot clock. The character clock determines the rate at which bytes of data from the video buffer are displayed. You can set the character clock so that one character is displayed every 8 or 9 ticks of the dot clock. In other words, each byte of data in the video buffer may be displayed as either 8 or 9 horizontal pixels, depending on how you program the sequencer.

In default VGA alphanumeric modes, the VGA displays 9 pixels for each character on the screen. In EGA-compatible 350-line alphanumeric modes and in graphics modes, the system programs the sequencer to display 8 pixels per character. The extra (ninth) pixel increases the sharpness of displayed text, but omitting the extra pixel allows you to display more characters across the screen.

You would access sequencer registers through I/O ports 3C4h and 3C5h (see table 4). The same programming techniques I've shown to access the CRTC will work for accessing the sequencer registers, but there is a catch: When you select a new dot clock or change the number of pixels per character, you must temporarily reset the sequencer by toggling bit 1 of its reset register. An example of this is in listing 3, which programs the sequencer to generate 8 pixels per character.

Bits 2 and 3 of the VGA's miscellaneous output register specify which dot clock frequency to use (see table 5). You can update this register by reading I/O port 3CCh to obtain its current value, masking bits 2 and 3, and then writing port 3C2h. When you do this, however, you should temporarily reset the sequencer, as in the previous program example.

In default alphanumeric modes, the video BIOS configures the VGA to display 25 rows of characters. For example, in 400-line alphanumeric modes (the power-on default), each character is 16 scan lines high. You can modify any alphanumeric mode to display more than 25 rows of characters simply by using shorter characters that are displayed in fewer scan lines.

Bits 0 through 4 of CRTC register 09h, the maximum scan-line register, control the displayed height of alphanumeric characters. The value in this bit field is one less than the character height in scan lines. Thus, in default alphanumeric modes, the value in bits 0 through 4 is 01111 binary (0Fh). If, for example, you change this value to 00111 binary (07h), the CRTC would display only 8 scan lines per character, so you would have a video mode that consisted of 50 character rows instead of 25.

Although you can update the maximum scan-line register directly, it is usually better to use the ROM BIOS to do the work for you. The ROM BIOS provides considerable flexibility in setting the displayed height of alphanumeric-mode characters because it lets you select an appropriate character set at the same time. For example,

```
;AH = 11h (ROM BIOS function
 number)
;AL = 12h (subfunction number)
 mov ax,1112h
```

continued

Table 4: *VGA sequencer registers used for video-mode programming.*

Register number	Name	Contents
0	Reset	Bit 1: synchronous reset
1	Clocking mode	Bit 0: 1=8 pixels per character 0=9 pixels per character

Table 5: *VGA dot-clock selection through the miscellaneous output register (I/O port 3C2h).*

Bit 3	Bit 2	Dot-clock frequency
0	0	25.175 MHz
0	1	28.322 MHz

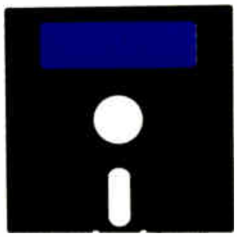
Listing 3: *Programming the VGA's sequencer to produce 8 pixels per character.*

```
cli ; disable interrupts
mov dx,3C4h
mov ax,0100h   ; AH = value for Reset register:
             ; bit 1 = 0; bit 0 = 1
out dx,ax   ; Sequencer synchronous reset

mov al,1    ; AL = Clocking Mode reg number
out dx,al
inc dx
in  al,dx   ; AL = Clocking Mode reg value
dec dx

or  al,1    ; set bit 1
mov ah,al   ; AH = new Clocking Mode reg value
mov al,1
out dx,ax   ; update Clocking Mode register

mov ax,0300h   ; AH = value for Reset register:
     ;  bit 1 = 1; bit 0 = 1
out dx,ax
sti
```



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```
mov bl,0
;Call the video BIOS
int 10h
```

This sequence calls the video BIOS to display a character set in which each character is only eight scan lines high. The BIOS loads the character set into the hardware character generator, programs the CRTC appropriately, and updates its global data area with the new number of character rows displayed.

Two Examples

I've created two programs that automate the process of calculating the CRTC register values for different video modes. (I used Microsoft C 5.0 to compile these programs. If you use another vendor's C compiler, you may need to rewrite the references to the `int86()` library call that invokes interrupt 10h.) The alphanumeric-mode program, AVMODE, lets you specify the number of displayed character columns, the size of the displayed character matrix, and an optional horizontal adjustment factor that helps to center the screen image. For example, you can create a 90-column mode that uses 8 by 8 characters by running the program with this command:

```
AVMODE 90 8 8
```

If the resulting image is not centered horizontally, you can also specify an adjustment to the horizontal sync position. For instance, you could shift the image one character position rightward by executing the program with the following:

```
AVMODE 90 8 8 -1
```

The program uses the video BIOS character-generator interface to give the CRTC the specified height of the character matrix. It then programs the sequencer to display characters that are either 8 or 9 pixels wide. The rest of the program sets up the CRTC with horizontal timing parameters appropriate for the number of characters to be displayed.

For simplicity, AVMODE.C performs all its sequencer and CRTC programming in high-level subroutines. In practice, however, you should probably use assembly language to do this. The reason is that the C functions `inp()` and `outp()` compile as subroutine calls instead of in-line `IN` and `OUT` instructions. This means that subroutines that call `inp()` and `outp()` (e.g., `SetSeqReg()` and `SetCRTCReg()`) are somewhat lengthy and too susceptible to interference from hardware interrupts to be thoroughly reliable.

You will find that an IBM VGA (in a PS/2 Model 50, 60, or 80) or IBM VGA adapter can produce an alphanumeric mode with about 96 8-pixel characters per row using an IBM PS/2 monitor. Higher resolutions exceed the tolerances of IBM's monitors.

If you use a variable-frequency monitor, you can push the VGA up to 132 characters per row. (Of course, the characters are pretty tiny when you squeeze 132 in a row.) You will probably have to adjust the vertical hold control on your monitor, because the vertical scan rate with a 132-character alphanumeric mode is only 51.5 Hz. Also, you may notice that the screen image flickers when you display a large, bright field of color; this, too, is a consequence of the low vertical scan rate.

Use the PC-DOS `CLS` command with caution if you use AVMODE to change the number of displayed character rows. The video BIOS keeps track of the number of character rows in a byte in its global data area at address 0040:0084h, but PC-DOS ignores this value and assumes that there are always 25 rows of data to clear. If you program the CRTC to display 50 lines of data, `CLS` clears only the top half of the screen. To avoid this problem, you could write your own screen-clear command (see listing 4), using interrupt 10h function 6.

GVMODE, the graphics-mode example, requires you to specify the number of pixels to be displayed horizontally and vertically. For example, to set up a 720- by 480-pixel 16-color graphics mode, you execute GVMODE as follows:

```
GVMODE 720 480
```

The program uses the desired resolution to select which of the VGA's dot clocks to activate. This lets GVMODE produce a wider range of video modes than it could if it relied on just one dot-clock frequency. Apart from these small differences, however, GVMODE's operation is similar to that of AVMODE.

With an off-the-shelf IBM VGA and PS/2-compatible monitor, you can use GVMODE to produce a graphics mode with about 720- by 512-pixel resolution, although displaying this many pixels pushes IBM's analog monitors to their limits. However, 800- by 600-pixel resolution is well within the tolerances of a non-IBM variable-frequency monitor.

Again, higher resolutions imply lower vertical scan rates. You may find that the resolution you want to use in your programs is limited by the amount of per-

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Listing 4: *A custom screen-clear program.*

```
;
; Name: vgacls.asm
; Function: Clearscreen routine for
; alternative VGA video modes
; Notes: Build executable file by
;  assembling and linking, e.g.
;       MASM VGACLS;
;       LINK VGACLS;
;
CodeSeg SEGMENT byte
        ASSUME  cs:CodeSeg,ss:StackSeg
VGAcls  PROC    far
        mov  ah,0Fh      ; AH = INT 10H function number
        int  10h         ; Get video status:
; AH now = displayed char. columns
; AL now = video mode
; BH now = current video page
        push bx          ; save BX and AX on stack
        push ax
        mov  ax,1130h    ; AH = 11H (INT 10H function number)
                         ; AL = 30H (subfunction number)
        int  10h         ; Get character generator info:
                         ;  DL = [displayed character rows]-1
        pop  ax          ; restore AX
        mov  dh,dl       ; DH = last row on screen
        mov  dl,ah
        dec  dl          ; DL = last column on screen
        sub  cx,cx       ; CH = 0 (first row on screen)
                         ; CL = 0 (first column on screen)
        mov  bh,7        ; BH = default alphanumeric attribute
        cmp  al,7
        jle  L01         ; jump if alphanumeric mode
        xor  bh,bh       ; BH = default graphics attribute
L01:    mov  ax,0600h    ; AH = 6 (INT 10H function number)
                         ; AL = 0 (number of lines to scroll)
        int  10h         ; Scroll up (clear screen)
        pop  bx          ; BH = current video page
        xor  dx,dx       ; DH,DL = 0 (new cursor location)
        mov  ah,2
        int  10h         ; Set cursor location to upper left
        mov  ax,4C00h
        int  21h         ; call DOS to terminate program
VGAcls  ENDP
CodeSeg ENDS

StackSeg SEGMENT stack
         DB      800h dup(?)
StackSeg ENDS
         END     VGAcls
```

ceptible flicker on the screen at lower vertical scan rates. [Editor's note: *The source code for AVMODE.C and GVMODE.C is available in a variety of formats. See page 3 for details.*]

VGA Clones

The ICs that IBM used in the VGA subsystem are proprietary. IBM's competitors have been forced to reverse-engineer the VGA hardware to produce the same capabilities in their own products. This means that a VGA clone may not necessarily be hardware-compatible with an IBM VGA. Two ways the clones may differ are in the values stored in the control registers and in the dot-clock frequencies you can use.

The register-programming techniques I've described are not applicable to all VGA subsystems because not all VGA clone makers have designed their CRT controllers to use the same register values as IBM's. For example, when you try to program the CRTC on Video Seven's VEGA VGA, you'll discover that many of the CRTC registers require different values than they do with a true-blue IBM VGA. Other adapters, including the Paradise VGA Plus, expect the same register values as an IBM VGA, so programming these clones is much easier.

Manufacturers of VGA clones generally implement higher-resolution, non-IBM video modes using a higher-frequency dot clock. For example, the Paradise VGA Plus uses a 36.000-MHz dot clock in 132-column alphanumeric modes and in 800- by 600-pixel graphics modes. With the higher dot-clock rate, the resulting horizontal and vertical scan rates in these modes are higher than they are when you use a true-blue VGA's 28.322-MHz dot clock. The scan rates are much closer to the middle of the tolerance range of most monitors, and the increased vertical scan rate results in less flicker.

Alternative Video Modes

Clearly, these alternative VGA video modes are not for everybody. Using them requires some understanding of how the video subsystem works. However, if you're writing a program that does full-screen text or graphics output, you should be able to incorporate support for alternative video modes without too much anguish.

On the other hand, alternative video modes are rarely supported by off-the-shelf software. Making your favorite spreadsheet or word processor run in an alternative video mode might require you to customize the program's installation process. If you use a VGA clone with a BIOS that supports non-IBM video modes, you might be able to include special drivers provided by the clone's manufacturer when you install your software. Otherwise, you may need to patch an existing driver or write your own driver in order to exploit an alternative video mode.

Nevertheless, there is a reasonable amount of support in the VGA hardware and video BIOS for alternative video modes. If you program the hardware carefully and exploit the services offered in the ROM BIOS, you can run applications with higher resolution or more characters than the usual ROM BIOS video modes provide. ■

Richard Wilton is the author of Programmer's Guide to PC and PS/2 Video Systems *and coauthor of* The New Peter Norton Programmer's Guide to the PC and PS/2, *both published by Microsoft Press. He lives in Los Angeles, California, and he can be reached on BIX c/o "editors."*

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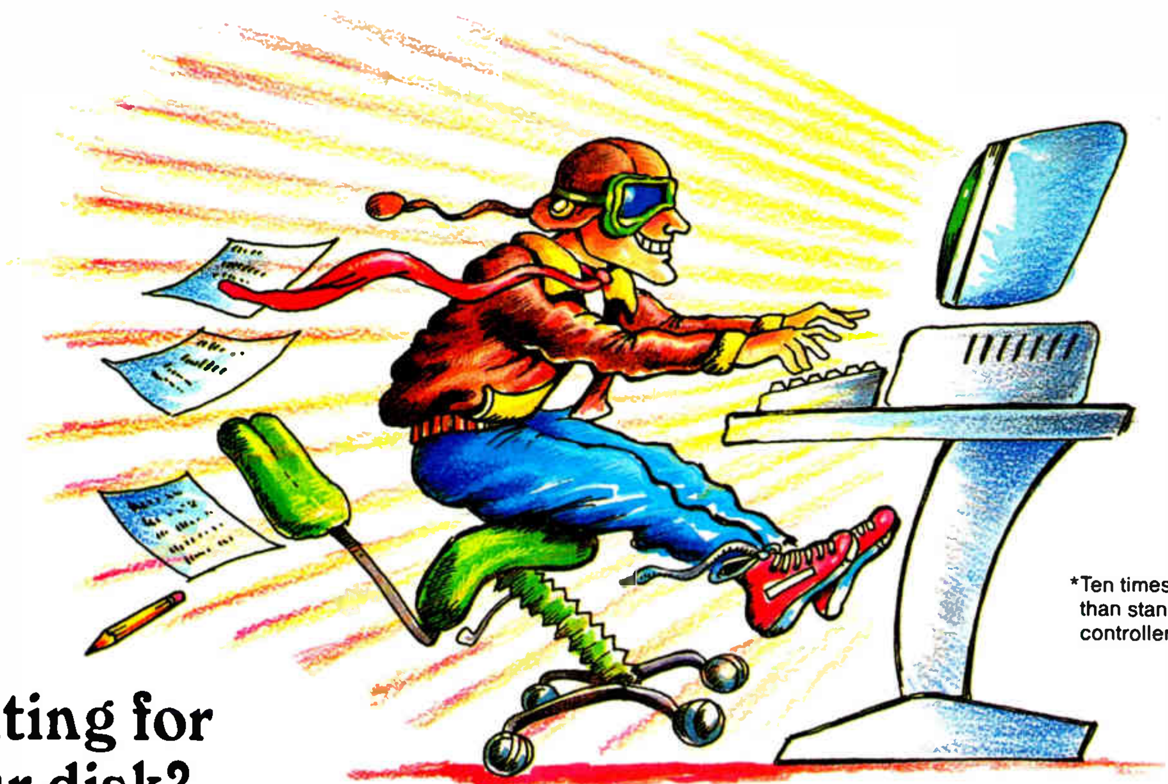

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EXPLORING OS/2 WITH A LISP INTERPRETER

Extensions to XLisp provide a convenient way to experiment with OS/2

Andrew Schulman

Programmers who want to master OS/2's many functions have to write programs that exercise those functions. These folks may find, as I did, that the C compiler and the linker packaged with the OS/2 Software Development Kit (SDK) don't support the kind of interaction with OS/2 that helps novices ascend the long learning curve. Ideally, you want something like a pocket calculator with keys labeled `DOSSLEEP`, `VIOPOPUP`, `KBDSTRINGIN`, and so on; then you could compose expressions using these keys and instantly see the results.

A Lisp interpreter works like that, so I've extended XLisp (David Betz's implementation of Lisp; see "An XLisp Tutorial" in the March 1985 BYTE) to create OS2XLisp, a version of XLisp that runs under OS/2. OS2XLisp is an educational tool that you can use to try out individual OS/2 functions and interactively develop small OS/2 programs.

As its name implies, OS2XLisp requires an OS/2-capable machine and OS/2. Since OS2XLisp is not a bound executable (an .EXE, created by the `BIND` utility, that can run in both protected and real modes), it won't run in the DOS compatibility box.

Hello OS/2 World

At the core of all Lisps, you'll find a read-evaluate-print loop. The interpreter reads each expression that you type, evaluates it, and prints the value of the expression. Since the first program that you write in any language is the one that prints the phrase "Hello world," let's do that program in OS2XLisp. (Note that I'll give the expressions that you type in, followed by OS2XLisp's responses.)

The first version is trivially easy:

```
>"Hello world"
"Hello world"
```

The expression "Hello world" is a string. The OS2XLisp evaluator applies the rule that strings (like characters and numbers) evaluate to themselves and simply returns the string.

Now let's use OS2XLisp with an OS/2 function to print the string "Hello world." You start with `loadmodule`, an OS2XLisp function that returns a handle for a named *dynlink* (dynamic-link) library.

```
>(define viocalls (loadmodule
  "viocalls"))
1360
```

When you type parenthetical expressions like this one, Lisp treats the first object after each left parenthesis as a function call and the rest of the objects as arguments to the function. Every expression returns a value that an enclosing expression can use; Lisp evaluates complex expressions from the inside out. Here, `loadmodule` returns the library handle 1360 to the enclosing `define` expression. The `define` expression creates the variable `viocalls`, assigns the handle to it, and returns the handle as the value of the whole expression. OS2XLisp then prints the value.

Using the handle, you can retrieve the address of an OS/2 function.

```
>(define vio-wrt-tty
  (getprocaddr viocalls
    "VIOWRTTTY"))
15142831
```

The OS2XLisp function `getprocaddr` takes a dynlink handle and the name of a function and then returns the function's address. Now you can use `call`, OS2XLisp's gateway to OS/2, to invoke the function. According to the OS/2 *Programmer's Reference*, the function requires a string, a word specifying the length of the string, and a video handle (a word that is, for now, reserved as zero).

```
>(define hello "Hello world\r\n")
"Hello world\r\n"
```

```
>(call vio-wrt-tty hello
  (word (length hello)) (word 0))
Hello world
0
```

When given a string argument, `length` returns the number of characters in the string. OS2XLisp prefers 4-byte longs,

continued

but `vio-wrt-tty` requires 2-byte words, so you use the OS2XLisp function `word` to cast the arguments to the appropriate size.

The outputs shown come from two different sources. The text comes from OS/2; from Lisp's perspective, it's merely a side effect of the evaluation of the expression. Lisp itself printed the 0, which is OS/2's return code indicating success.

Now you can refine this example by hiding the details inside a Lisp function. Let's define a function `print-str` that prints any string that is supplied as its argument:

```
>(define (print-str str)
  (call vio-wrt-tty str
    (word (length str))
    (word 0)))
PRINT-STR

>(print-str "Hello world\r\n")
Hello world
0
```

continued

Listing 1: *The OS2XLisp* `dir` *function.*

```
; (dir) An OS2XLISP file-listing function.

; usage: (dir [match-str|ext-sym] [print-flag])
; defaults: match-str is "*.*", print-flag is t
; examples:
;     os2xlisp                os/2 equivalent
;  -----------------        -------------------
;  (dir)                    c:>dir *.*
;  (dir "*.lsp")            c:>dir *.lsp
;  (dir 'lsp)               c:>dir *.lsp
;  (dir "*.lsp" nil)        none (returns list)

; get handles for OS/2 system calls

(define doscalls (loadmodule "DOSCALLS"))
(define DOSFINDFIRST
  (getprocaddr doscalls "DOSFINDFIRST"))
(define DOSFINDNEXT
  (getprocaddr doscalls "DOSFINDNEXT"))
(define DOSFINDCLOSE
  (getprocaddr doscalls "DOSFINDCLOSE"))

; get handle for C run-time library call

(define crtlib (loadmodule "CRTLIB"))
(define printf (getprocaddr crtlib "_printf"))

; package printf for convenient use

(defmacro printf (mask &rest args)
    `(c-call printf ,mask ,@args))

; OS/2 file-search structure

;struct FileFindBuf {
; unsigned create_date;
; unsigned create_time;
; unsigned access_date;
; unsigned access_time;
; unsigned write_date;
; unsigned write_time;
; unsigned long file_size;
; unsigned long falloc_size;
; unsigned attributes;
; unsigned char string_len;
; char file_name[13];
; };

; equivalent OS2XLISP structure

(define FileFindBuf
  '((word create_date)
    (word create_time)
    (word access_date)
    (word access_time)
    (word write_date)
    (word write_time)
    (long file_size)
    (long falloc_size)
    (word attributes)
    (byte string_len)
    ((char 13) file_name)))

; print selected elements

(define (print-dir filelist)
  (dotimes (i (length filelist))
    (printf "%-20s %8lu\n"
      (cadr
        (assoc 'file_name (nth i filelist)))
      (cadr
        (assoc 'file_size (nth i filelist))))))

; directory routine

(define (dir &optional filespec (print-flag t))

  (if (null filespec)
    (setf filespec "*.*"))
  (if (not (equal 'STRING (type-of filespec)))
    (setf filespec
      (format nil "*.~A" (symbol-name filespec))))

  (let*
    ((filelist nil)
     (hdir (word -1))
     (attr (word 6))
     (buf (make-struct FileFindBuf))
     (buflen (word (length buf)))
     (find-count (word 1)))

  (if (zerop (call DOSFINDFIRST
     ^filespec
     ^hdir
     attr
     ^buf
     buflen
     ^find-count
     D))

   (progn
     (setf filelist
       (list (unpack-struct FileFindBuf ^buf)))
     (while (zerop (call DOSFINDNEXT
            hdir ^buf buflen ^find-count))
       (nconc filelist
         (list
        (unpack-struct FileFindBuf ^buf))))))

  (call DOSFINDCLOSE hdir)

  (if print-flag (print-dir filelist) filelist)))
```

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Of course, you've gone to a lot of trouble to echo a string—something OS2XLisp does quite simply—but it illustrates the method that you use to call any OS/2 function.

A Directory Program

In addition to the command-line-oriented interactions we've seen so far, OS2-XLisp supports a file-oriented mode. You can use a text editor to create a file containing definitions of variables and functions. When you start OS2XLisp from the operating system's command line, you can supply the name of such a file; OS2XLisp reads and evaluates the definitions. Or you can load definitions from within the interpreter by using the `load` function.

When you want to explore OS/2 functions that require complicated lists of arguments and to combine those functions algorithmically, you'll prefer text files to typing in definitions at the OS2XLisp prompt. Listing 1 presents one such file, DIR.LSP, which defines the file-listing function `dir`.

The `define` expressions create dynlink handles and, using those handles, addresses for the functions that `dir` will need. The functions come from two different dynlink libraries: OS/2's own DOSCALLS.DLL, and the C run-time library provided with Microsoft C 5.1 (CRTLIB.DLL). Although I've been emphasizing that OS2XLisp can call OS/2 functions, you can use it to call any function exported by a (commercial or homegrown) dynlink library. There's a nice synergy here between Lisp's ability to load functions at run time and OS/2's dynamic linking facility.

The `defmacro` expression encapsulates the function `printf`, exported from the C run-time library, as an OS2XLisp function. From the Lisp perspective, to the symbol `printf`'s function slot (as distinct from its value slot, which retains the address of `_printf` in CRTLIB.DLL) you're binding a function that takes one required argument (the mask, or format string) and a list of subsequent arguments. The body of the function uses the OS2XLisp primitive `c-call` to invoke the compiled function, passing the mask and argument list. (The `,@` directive splices together the mask and arguments to create a single list.) From the OS/2 perspective, note that you're using `c-call` rather than `call`. That's necessary to distinguish between the C calling convention used by the C run-time library and the Pascal calling convention that OS/2 uses.

The `struct FileFindBuf` expression shown in comments (Lisp comments begin with a semicolon) illustrates the C definition of the structure used by the functions `DOSFINDFIRST` and `DOSFINDNEXT`. The next `define` expression creates a similar definition in OS2XLisp. In a C program, you'd declare an instance of the structure like this:

```
struct FileFindBuf dirEntry;
```

After a call to `DOSFINDFIRST` or `DOSFINDNEXT`, you'd retrieve values with expressions like `dirEntry.file_name`.

> **O**S2XLisp
> *can call any function exported by a dynlink library.*

In the OS2XLisp `dir` function, you use `make-struct`, a function that analyzes the definition of a structure and creates an object of the appropriate size. On the output end, you use `unpack-struct` to convert the structure into a Lisp association list (a collection of name-value pairs) and `assoc` to convert names to corresponding values. The file STRUCT.LSP, distributed with OS2XLisp, defines the functions `make-struct` and `unpack-struct`.

The calls to `DOSFINDFIRST` and `DOSFINDNEXT` use the `^` macro to take the address of objects, in those cases where OS/2 requires an address. In the case of the strings `filespec` and `buf` (`make-struct` stores the structure that it creates in a string), the address macro is not strictly necessary, since `call` converts strings to their addresses, but it helps to document the kind of arguments that OS/2 expects.

The Lisp function progn groups expressions for serial evaluation. The list `filelist`, set to the value returned by `DOSFINDFIRST` (unpacked by `unpack-struct`), grows by destructive concatenation as nconc appends to it the results of each call to `DOSFINDNEXT`. When zerop ("is-it-zero?") returns false, `DOSFINDNEXT` has failed; `DOSFINDCLOSE` closes the search handle. If `print-flag` is true (as it is by default), `print-dir` uses `dotimes` to iterate over the list, assoc to retrieve values from sublists, and `printf` to display them. Voilà! OS2-XLisp prints a list of files in the current directory.

Allocating Huge Memory

One of OS/2's more intriguing functions is `DOSALLOCHUGE`, which allocates a sequence of 64K-byte segments and returns a pointer to the first segment's selector. Let's allocate a megabyte of memory.

```
>(define first 0)
0

>(call
   (getprocaddr doscalls
     "DOSALLOCHUGE")
   (word 16) (word 0) ^first
   (word0) (word 0))
; the disk light flashes now
0

>first
863
```

Ignoring the other parameters to `DOSALLOCHUGE`, you asked OS/2 to allocate 16 64K-byte segments and place the number of the first segment in the variable `first`. The 0 returned indicates that `DOSALLOCHUGE` succeeded, the disk activity indicates that OS/2 did some swapping to satisfy your request, and `first` now has the value 863.

You can use OS2XLisp's `lsl` function to verify that `first` refers to a 64K-byte segment. This function corresponds to the 80286 protected-mode instruction LSL; it returns the last legal offset within a memory segment:

```
>(lsl first)
65535
```

So, `first` contains a selector for a 64K-byte segment. What about the other 15 segments that make up your 1-megabyte huge object? The difference between one segment selector and the next is 1, shifted left by the value that `DOSGETHUGESHIFT` returns.

```
>(define shift 0)
0

>(call (getprocaddr doscalls
   "DOSGETHUGESHIFT") ^shift)
0

>shift
4

>(shl 1 shift)
16
```

continued

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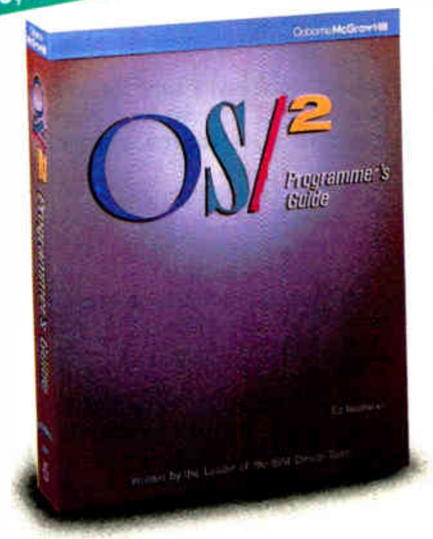

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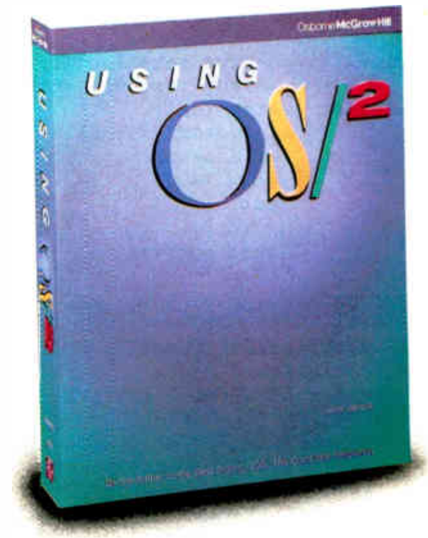

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Listing 2: *Using OS2XLisp to allocate huge memory.*

```
(define (alloc-huge segs &optional (rem 0) (opt 0)
               &aux (seg 0) (shift 0) (lst nil))
  (if (not (zerop (call
           (getprocaddr doscalls "DOSALLOCHUGE")
             (word segs)
             (word rem)
             ^seg
             (word 0)
             (word opt))))
   nil
   (progn
    (call
      (getprocaddr doscalls "DOSGETHUGESHIFT")
        ^shift)
    (setf shift (shl 1 shift))
    (setf lst (list seg))
    (dotimes
      (i (if (zerop rem) (1- segs) segs))
      (nconc lst
        (list (+ seg (* (1+ i) shift)))))
    lst)))
```

Thus, the next segment in the huge object is:

```
>(+ first 16)
879

>(lsl 879)
65535
```

and so on, for all the segments that make up the huge object.

All this can be packaged into a function that allocates a huge object and returns a list of its segment selectors (see listing 2). The first (and only required) argument to `alloc-huge` is the number of segments to allocate. You can easily allocate 512K bytes.

```
>(define big (alloc-huge 8))
(863 879 895 911 927 943 959 975)
```

OS2XLisp returns a list of eight segment selectors. However, 64000K bytes is too much to ask for:

```
>(define impossible
  (alloc-huge 1000))
NIL
```

The `NIL` return signals OS/2's failure to satisfy the request.

One of the optional arguments permits you to allocate a huge object whose final segment isn't a full 64K bytes. For example, you can allocate a huge object made up of four 64K-byte segments and a fifth 1K-byte segment.

```
>(define 1k-bigger
  (alloc-huge 4 1024))
(1927 1943 1959 1975 1991)

>(lsl 1991)
1023
```

The last segment, as `lsl` shows, is indeed a 1K-byte segment.

It's easy to traverse the entire huge object in one operation. In the directory example, you used `dotimes` and `nth` to iterate over a list. Here you'll use `lambda` to create a temporary function that pokes a string into a segment, and you'll use `mapcar` to apply that function to each element of the list `1k-bigger`.

```
>(mapcar
  (lambda (seg)
    (poke
      (mk-fp seg 0)
      (format nil "~A" seg)
      'str))
  1k-bigger)
```

The `mk-fp` function manufactures a far pointer from a segment and an offset; `format` (a Lisp `printf` analog) builds a string containing the segment selector; `'str` specifies that the object being poked is a string; `poke` puts the string into the segment.

The following verifies that you have really poked data into the object:

```
>(mapcar
  (lambda (seg)
    (peek
      (mk-fp seg 0)
      'str))
  1k-bigger)
("1927" "1943" "1959" "1975"
 "1991")
```

Last, you need a function to release a huge object. You can let it work on the entire list or just the first segment.

```
>(define (free-huge seg)
  (zerop (call
    (getprocaddr doscalls
     "DOSFREESEG")
      (word (if (listp seg)
        (car seg) seg)))))
FREE-HUGE
```

After you free a segment, its size becomes zero. If you then try to read or write into the segment, you'll see what's meant by "protected mode":

```
>big
(863 879 895 911 927 943 959 975)

>(lsl 863)
65535

>(free-huge big)
T

>(lsl 863)
0

>(poke (mk-fp 863 0) "Hello, big?")
break: Segmentation Violation
```

The segmentation violation doesn't trigger a return to OS/2, by the way, as it would in most OS/2 applications. OS2XLisp keeps control, and you can proceed.

An OS/2 Laboratory

If you're running OS/2 but don't have Microsoft's SDK, OS2XLisp can give you a preview of what it's like to program under OS/2. If you already own the SDK, OS2XLisp can still be an alternative to compiling and linking C programs.

Lisp's interactive style makes it easy to try out OS/2 functions singly or in combination. The OS/2 dynlink facility merges nicely with Lisp; you can write Lisp functions that make calls to OS/2 functions, to functions in the C run-time library, or to functions in any .DLL file that you create under OS/2. ■

Editor's note: *Source code and documentation for OS2XLisp are available in a variety of formats.* *See page 3 for details.*

Andrew Schulman is a software engineer at Meta Software in Cambridge, Massachusetts. He can be reached on BIX c/o "editors."

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Several of the hundreds of conferences on BIX (the BYTE Information Exchange) deal with IBM computers and the software that runs on them. We've culled the following messages from recent discussions in the IBM PC AT, MS-DOS, PS/2, and OS/2 conferences of BIX. The topics range from installing hardware and using application programs to in-depth discussions of technical tricks and traps.

IBM PC AT

INTERNAL/EXTERNAL MODEMS

ibm.at/hardware #3032, from jfrickson (John Frickson).

I have two questions I hope some of you BIXen can answer for me.

1. I recently inherited a Hayes internal 1200-bps modem. The catch is, I have no manual. So, could someone explain the settings? There is a switch block with three switches, a three-position jumper, and a two-position jumper. What do they all do?
2. I also have a multifunction card that came with my computer (a Quantus AT clone). The documentation for this card that was sent with the computer is the wrong documentation. When I recently tried to contact the manufacturer, I was told they were out of business (so much for my 3-year warranty!). Anyway, the card appears to be a DTK 286 Courier I/O II card with two serial ports and a game port.

I have been using COM1, which is a DB-9 connector, for some time now, but I have been unable to get COM2 to work. There are half a dozen jumpers on the card, but no configuration I try gets COM2 to work. Does anyone know anything about this card?

ibm.at/hardware #3038, from jfleming (Jon Fleming). A comment to message 3032.

Did you ever have COM2 working on this card? Most cards that include provisions for two serial ports come with an empty DIP socket into which you must plug an 8250 UART to get COM2 to do its thing-although for an AT you might want a 16450 or 16550A. Perhaps some more hardware-oriented type can come up with more suggestions.

ibm.at/hardware #3040, from jfrickson. A comment to message 3038.

The card has an 8250 plugged into a socket (it was ordered with two COM ports). But when I connect my modem up to the COM2 port, the lights look funny. I don't remember offhand, but I think carrier detect and another light were on. Whichever they were, it didn't look normal and the modem wouldn't respond. The lights on the modem changed when I tried different jumper configurations, but I could never get the thing to work right.

ibm.at/hardware #3042, from bredd (Brandt Redd). A comment to message 3040.

What does the socket for the second port look like? Often on cards like that, the bracket contains a male DB-9 connecter, which is COM1, and a female DB-25 connecter, which is a parallel printer port. The second serial cable is usually obtained on a male DB-25 connecter, which has a short ribbon cable connecting to pins on the card. If this is really a parallel port, it would explain the funny light pattern on the modem.

ibm.at/hardware #3050, from jfrickson. A comment to message 3042.

The bracket for this card has a male DB-9 connector and a female DB-25 connector. There is also a second bracket with a female DB-15 connected to a pin connector on the card (I think this is a

continued

game port). Also on the card is a 10-pin connecter, but I received nothing to attach to this. Could this be the connector for COM2?

As I believe I mentioned earlier, the board seems to have all the parts necessary for two COM ports. It has an 8250 in a socket. Also in sockets are two chips labeled:

NC1488N VE321
+18317 DS1489N NC1489P

So, am I right in assuming that the card has everything necessary for two serial ports, but that I need a 10-pin-to-DB-25 ribbon cable? If so, where can I get such a cable?

ibm.at/hardware #3052, from irae (Ira Emus). A comment to message 3050.

The DB-9 is probably COM1. The DB-25 is a printer port, and the DB-15 is almost certainly a game port, which leaves that 10-pin connector as COM2: You will need a header to DB-9, although in mine, I use a DB-15 and just ignore the extra six pins. Ugly, but it works.

ibm.at/hardware #3058, from bredd. A comment to message 3052.

That sounds right. I assume that there is another 8250 that is soldered in. In any case, if there are two serial ports, there will be two 8250s. I would guess that you'll need to contact your distributor about the 10-pin-to-DB-25 (or DB-9) connector or find someone to build it for you. (pause) I just took a look at ours, and the cable swaps pins as follows:

10-pin	DB-25
1	8
2	3
3	2
4	20
5	7
6	6
7	4
8	5
9	21

This is on a machine from PC's Limited. Your pin-out may vary. Incidentally, the pin numbers on the 10-pin end correspond exactly with the pin numbers on a DB-9, which would imply that you could connect a DB-9 to one end of a ribbon cable and the 10-pin connector to the other. There is only one problem with this-the pins are numbered differently:

DB-9	10-pin
1 2 3 4 5	1 3 5 7 9
6 7 8 9	2 4 6 8 10

ibm.at/hardware #3061, from jfrickson. A comment to message 3052.

I hooked up my printer to the DB-25, and guess what? It's LPT2! So it looks like I got a second parallel port I didn't ask for (though I won't complain about it :->) and a second serial port if I can figure out how to connect it up.

ibm.at/hardware #3062, from jfrickson. A comment to message 3058.

I don't recall seeing another 8250. jfleming mentioned earlier (msg. 3038) 16450 or 16550A chips. The 8250 is socketed, so I assume it's for COM2. There are several chips soldered in, one of which could be either an 8250 or a 16x50. I'll check it out for sure when I get a chance. But it appears that I have two serial ports (one connector there, and one I have to wire up) and a parallel port.

USING EXTRA MEMORY

ibm.at/hardware #3063, from dhudes (Dana Hudes).

We got some ATs in at work. They are connected via ARCnet and Novell SFT 2.1 to an 80386 server. The ATs have 1 megabyte of physical RAM. With DOS 3.3 and Novell, we end up with about 460K bytes of RAM left. Is there a way to make any use of the memory we have above 640K bytes? A RAM disk isn't terribly useful since these machines have 40-megabyte hard disk drives and the server has 140 megabytes. I doubt it would be a large-enough RAM disk for the temporary files from a C compile (we have Microsoft C 5.1 and Archimedes C-8051).

How can we get back or otherwise increase the free RAM while maintaining our network connection (I can get just under 100K bytes back by removing the TSRs that handle the network)?

It is my understanding that EMS memory can only be used by software written to take advantage of it. Is this correct? Also, I thought someone had a board that expanded your memory to 720K bytes or something like that. These ATs have only Hercules (clone) cards for display adapters. That frees up the rest of the memory reserved for display adapters.

I realize that various portions of the region from 640K bytes to 1 megabyte are reserved for various things, most of which I suspect we don't have.

ibm.at/hardware #3064, from rbrukardt (Randall Brukardt). A comment to message 3063.

It is possible to get boards that allow the use of 704K bytes in DOS. These boards map memory into the unused (if you are using MDA, Hercules, or CGA) A000 bank of memory. There is a public domain program called 704K that allows that 64K bytes to be added to DOS. Several very old memory boards have that capability, and that is what I've been using on our machines (mainly our old Seattle Computer PC memory boards). The only new board I've been able to dig up that does that is the JRAM-3 board. But there must be others. (We don't like our JRAM-3 much.)

ibm.at/hardware #3065, from feenberg (Daniel Feenberg). A comment to message 3064.

MAXIT and HiCard are two memory cards that allow 704K bytes of DOS-usable memory in an XT or AT with a Hercules or monochrome card. You get 736K bytes with a CGA and no extra with an EGA. Even with an EGA, they do allow TSRs to run *above* the display adapter, which can be nice. There is a thread in this conference (beginning with msg. 827) that discusses these cards.

ibm.at/hardware #3066, from dnanian (David Nanian). A comment to message 3065.

You can do it with a RAMpage board, too. You just map the memory there and write a small interrupt handler that removes those page-frame areas from the mapping table.

80287 COPROCESSORS

ibm.at/hardware #3070, from rgrenader (Robert Grenader).

I'm confused. I've got an AT clone that runs at 12.5 MHz. Which 80287 is required? The 10-MHz, or 8, or what?

continued

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ibm.at/hardware #3071, from blaszczak (Michael Blaszczak). A comment to message 3070.

When you drop any 80x87 chip into your system, that math processor must only be rated at *two-thirds* the speed of the CPU.

Since I have an 8-MHz PC's Limited, I need a 6-MHz 80287.

Since you have a 12.5-MHz CPU, you'd need an 8.33-MHz 80287. I would bet that you could get by with an 8-MHz part.

Be wary of dealers who tell you otherwise!

MS-DOS

DOS 4.0

ms.dos/other #1309, from sfulk (Steven Fulk).

Today, IBM very quietly introduced DOS 4.0 and OS/2 Extended Edition 1.0. The highlights, according to the literature, are as follows:

DOS 4.0 supports all members of the IBM PS/2 and PC families (except PCjr, XT/370, and AT/370) and is upward-compatible with DOS 3.30.

DOS 4.0 provides a new program warranty with defect service for 1 year.

DOS 4.0 supports large hard disk files greater than 32 megabytes in a nonpartitioned manner. The new addressing format of 32-bit versus 16-bit removes the limitation of 32-megabyte DASD partitions. However, it can install on and utilize currently formatted hard drives.

The DOS 4.0 shell provides program, file, and directory services as user-friendly alternatives to the command line. This shell is similar in appearance to the OS/2 Presentation Manager. Apparently, any user actions are accomplished from selection from a menu with mouse or keyboard. The installation of this shell is optional.

DOS 4.0 provides support for LIM/EMS 4.0. Expanded memory is addressed through a combination of an EMS device driver and an IBM adapter capable of expanded memory.

A full-screen installation utility, called SELECT, is provided to simplify the installation of DOS 4.0. AUTOEXEC and CONFIG.SYS files are automatically generated.

DOS 4.0 provides support for a text-mode (versus graphics) command-line display interface when not using the shell. DOS 4.0 supports greater than 25 lines of text on those EGA and VGA displays with that capability. The GRAPHICS and GRAFTABL commands have been enhanced.

Many of the other DOS commands, such as ANSI.SYS, APPEND, BACKUP, BUFFERS, CHKDSK, COUNTRY, DEBUG, DISPLAY.SYS, ERASE, FASTOPEN, FDISK, FORMAT, KEYB, MEM, MODE, PRINTER.SYS, REM, REPLACE, SYS, TREE, and VDISK, have been enhanced. DOS 4.0 will list for $150.

ms.dos/other #1311, from jfachini (John Fachini). A comment to message 1309.

Oh yea. Any chance (even small?) of upgrades? Upgrades-we don't give no stinkin' upgrades!

ms.dos/other #1312, from cosby (Steve Cosby). A comment to message 1309.

So, is it worth buying to run on a non-IBM clone? Or has IBM installed enough IBM specifics to thwart that?

ms.dos/other #1313, from jbc.tangram (James Casler). A comment to message 1311.

>Upgrades

You can get an upgrade to IBM PC-DOS (not MS-DOS) through one of two means. If you bought it at a computer store, ask your dealer for the upgrade form. You have to mail it to IBM in Connecticut. Or, if you got it through an IBM branch, you can send the form to them. Upgrades for DOS 4.0 will be $90 (I think). Lots of other IBM PC-DOS programs have been upgradable this way, but I don't think dealers explain this. We get our info from IBM electronically via our branch, and the announcements always have upgrade info in them.

ms.dos/other #1314, from rduncan (Ray Duncan). A comment to message 1309.

>in a nonpartitioned manner

Well, not exactly. MS-DOS 4.0 defines a new type of partition. A driver that knows how to read/write that partition uses 32-bit sector numbers in the request headers from the kernel for read and write operations. Also, the BPB (BIOS Parameter Block) for such partitions is extended, and Int 25h and 26h operations directed to the logical units represented by the new partition type use a different parameter-passing scheme.

In other words, you can SYS MS-DOS 4.0 onto an existing hard disk, and nothing special will happen. To take advantage of the new partition type, you'd have to back up your hard disk, delete the old partitions, declare a new "huge" partition, then restore the files into the new partition. Or you could leave your existing primary partition alone, delete the DOS 3.3-style "extended partition" containing multiple logical drives, and replace the extended partition with a new huge partition.

MS-DOS 4.0 uses EMS for the disk cache (BUFFERS=) and for the FASTOPEN name/extent cache. It does this via the Int 67h interface of the EMS memory manager. There is no change in the definition of the EMS interface to application software, and MS-DOS 4.0 doesn't add anything in the way of new EMS capabilities.

ms.dos/other #1315, from jfachini. A comment to message 1313.

This thing's gonna run on my ALR 386, right?

ms.dos/other #1316, from jbc.tangram. A comment to message 1315.

It certainly might. With PC-DOS it mostly matters how compatible to "blue" your BIOS is. I could believe that the IBM EMS may not, but the new large disk partitions and the character shell should work.

continued

NATURAL LANGUAGE INTERFACE

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ms.dos/other #1317, from jfleming (Jon Fleming). A comment to message 1314.

```
>use a different parameter-passing scheme

Will this "break" existing programs that use Int 25h or 26h?
```

ms.dos/other #1318, from rduncan. A comment to message 1317.

```
No, because Int 25h and Int 26h work the "old" ways on the "old"
types of partitions. However, a lot of Norton Utilities-type
things won't work on the new huge partitions.
```

ms.dos/other #1319, from ronlepine (Ronald Lepine). A comment to message 1318.

```
>However, a lot of Norton Utilities-type things won't work
>on the new huge partitions.

We had that problem with large partitions in PC-MOS/386. I know
I also tried smaller partitions, but I'm not sure that completely
solved all problems. I know it solved some because I decided to
leave it that way. Isn't it nice-some multiuser, multitasking
DOS workalikes may be more compatible and have more features
than PC-DOS 4.0.

Here's some real questions, though.

1. Will it work with older 8088 machines as well as the 80286
PS/2 series?
2. If it does work, will there be some restricted calls?
3. Will enough people upgrade to it (there are a lot of PCs out
there) to make support for it required? Or will only people with
huge databases switch? Will only those with database-type
products support it?
4. Wouldn't those with large databases already have moved to
faster processors/other operating systems, and wouldn't those
trying to move down to PCs decide on OS/2 or another
alternative?
5. With multitasking/multiuser alternatives that can run DOS
programs and have more features, should you really consider
going to another single-user/single-task operating system? If
you have need for the large disks, I'd think it's likely you need
more processor than an older PC has.
```

ms.dos/other #1320, from rduncan. A comment to message 1319.

```
From my understanding, it will run on any IBM PC, and there are
no restricted calls.
```

ms.dos/other #1321, from billbourn (Bill Bourn). A comment to message 1309.

```
The IBM announcement letter is now in the listings area as file
dos40.ark. Note that PKXARC is required to unsquash it. I call
the files that require the PK-series ".ark" to avoid grief
later. Let me know if you have trouble with the format.
```

TSR HANDLE PROBLEM

ms.dos/secrets.2 #15, from dmick (Dan Mick).

```
Apparently, if you redirect stdout for a TSR program, you
permanently lose one handle from your FILES= number. This
happens with DOS 3.3 and 3.2, at least. Try running a little
program that opens as many files as it can simultaneously and see
how many you get. Then do some MARK>NULs and see the number go
down. Weird, eh?
```

ms.dos/secrets.2 #16, from billbourn. A comment to message 15.

Just as speculation, if you redirect a TSR's stdout, does a handle have to be used to do that? And since the TSR hasn't ended, the handle isn't released yet, so the available number is decreased until the TSR ends. This has implications for those neatniks who redirect their batch AUTOEXECs. The unavailable handles might stay that way for the whole IPL?

ms.dos/secrets.2 #17, from twagner (Thomas Wagner). A comment to message 15.

Not so weird. If you redirect stdout and the program that "owns" this file terminates and stays resident, the file must remain open for the TSR to use it. Only if the TSR explicitly closes the file does the handle become available again. It's different with the normal standard handles, because they are all mapped to one internal handle. NUL, apparently, is not such a special handle.

ms.dos/secrets.2 #18, from rkrten (Robert Krten). A comment to message 16.

I usually redirect messy programs, like "print /d:prn >nul," but surely you cannot redirect the whole AUTOEXEC.BAT? (Actually, if you *can*, I could really get right into that.)

This raises the question: Does my redirecting the output of PRINT.COM to NUL chew up a file handle? Or does only part of the PRINT.COM program fork off and become resident?

ms.dos/secrets.2 #19, from dmick. A comment to message 18.

If you have C, try this program to find out. Do it before the "print>nul" and after:

```
/* eathand.c */
#include <stdio.h>

main()

{
  FILE *fd[30];
  char fn[10];
  int i;
  int c;

  for (i=0; i<30; i++) {
    strcpy(fn,"FILE");
    c = i + 'A';
    strcat(fn,(char *)&c);
    fd[i] = fopen(fn,"w");
    if (fd[i] == (FILE *)NULL) break;
    printf("%s: %d\n",fn,fileno(fd[i]));
  }
}
```

ms.dos/secrets.2 #20, from dmick. A comment to message 17.

Ah, I think I see what you mean. The "normal handles" are mapped to internal handles 0 to 2, actually, but for in/out/err it's all 0, and those never get closed at all. However, yes, NUL must be created as another entry (just thought of a way I can find out, actually) and then not closed because TSR is different from TERMINATE. Hmm. Anyway, it certainly has dire consequences for redirecting output from a TSR; you'll have fewer handles than you expect (and may not notice for a while). News, if not odd.

continued

IBM PS/2

MODEL 80 MEMORY EXPANSION

ibm.ps/model.80 #846, from rfm (Richard MacAllister).

I have a Model 80-041 with only 1 megabyte (minimal configuration). Now that memory-expansion boards seem to finally be available, does anyone know if I can put in extra memory on the MCA bus without putting in the other 1-megabyte "system board" (actually a little daughtercard) memory from IBM? Are there any gray marketers selling the IBM memory expansions at a discount?

ibm.ps/model.80 #849, from jgotwals (John Gotwals). A comment to message 846.

Since the memory "daughtercard" that plugs into the system board is faster than memory added via the MCA, why would you want to add MCA memory before adding the second memory card?

ibm.ps/model.80 #860, from rfm. A comment to message 849.

Because memory not by IBM is likely to be Much Cheaper, at least when the current RAM crunch goes away.

WHEN IS 4 MEGABYTES NOT 4 MEGABYTES?

ibm.ps/model.80 #851, from ereno (Edward Reno).

I finally got my 80-111, and I had it delivered with supposedly 4 megabytes installed. When I boot up, however, it clicks off to only 3986 (or something close to that–I don't have the machine here right now). I immediately called my supplier, and he gave me a story that sounded, well, unbelievable.

He says that IBM's been having trouble fabricating true 1-megabit chips and that this is reflected in their 2-megabyte expansion card, which doesn't quite make it to 4 megabytes (i.e., original 2 Mb + expansion-card 2 Mb). I have the authentic IBM expansion card.

Is he right, or am I being sold a bill of goods?

Also, I want to go to 8 megabytes. He's suggesting an Everex card that he *thinks* will work. Wants to send it to me with 1 megabyte on it to try it out. If it works, he'll send me the other 3 megabytes. Should I? Also, should I be specific as to the nanosecond rating of the chips on the Everex board? The IBM chips are supposedly 80 ns.

The point of all this memory is that I want to use 386MAX to turn it all into expanded memory so I can build gigunda spreadsheets in 1-2-3. I assume that 386MAX will let me do this?

ibm.ps/model.80 #852, from billbourn (Bill Bourn). A comment to message 851.

You might try your Everex question on the folks in the ecsd (Everex) conference.

ibm.ps/model.80 #853, from mpeppler (Michael Peppler). A comment to message 851.

I believe that the ROMs are copied to RAM at boot time, and that it is reflected in the RAM byte count. On our Model 80-111s with 2 megabytes, we get 1920K bytes instead of 2048. The difference (128K bytes) is equal to the ROM size.

In any case, checking the system with the installation disk shows that we have 2 megabytes physically installed but only 1.9 usable (and there is no way to change it).

ibm.ps/model.80 #854, from matt.trask (Matt Trask). A comment to message 853.

Some MCA adapters (I believe that the ESDI controller is one of the guilty) will grab memory off the top of 640K bytes at boot time, but I guess that doesn't explain where 128K bytes from the top of memory goes.

ibm.ps/model.80 #858, from suer (Sue Rosenberg). A comment to message 851.

Two points. About the memory: You should get all the advertised memory. Take the card back. But you still might not be able to access all 4 megabytes with your 1-2-3 spreadsheets. Version 2.01 stores pointers to that 4 megabytes of memory in the (in)famous 640K-byte region. If your spreadsheets have lots of equations, you'll have too many pointers to fit within the 640K barrier, so you'll end up with a couple of unused megabytes of memory up there and an incomplete spreadsheet.

ibm.ps/model.80 #859, from cpapoudaris (Christos Papoudaris). A comment to message 851.

80-111 Shadow BIOS: The highest 128K bytes of memory are used as Shadow BIOS (BIOS copied to RAM) for faster access.

AT KEYBOARDS FOR PS/2s

ibm.ps/model.80 #855, from rbrukardt (Randall Brukardt).

Is there any place that we can get real AT-style keyboards for our PS/2s? Our programmers hate the so-called "Enhanced" keyboards to the point where no one will use the PS/2 Model 80 for anything but testing. I suspect that this is partially because of the editor we're using (which will delete lines when you try to change windows if you reach a bit far and hit the function keys instead of the number keys), but in any case, I'd like to make the machine usable.

ibm.ps/model.80 #856, from jfachini (John Fachini). A comment to message 855.

Sounds like time to get a better editor, not keyboard.

ibm.ps/model.80 #861, from rbrukardt. A comment to message 856.

Better programmers, too!? I'm not thrilled at having two different keyboard layouts around here again. (I just got rid of all the oddball non-AT layouts). Different layouts make it very hard to move from machine to machine. We're trying a Northgate keyboard to see if that will do the trick.

2-MEGABYTE MEMORY LIMIT?

ibm.ps/the.bus #126, from awright (Alexander Wright).

A recent article in PC Week said that the Micro Channel spec was somehow flawed (or incomplete) so that designers couldn't figure out how to make a memory card larger than 2 megabytes. I can't see anything in the spec that would restrict a card to 2 megabytes. Anyone else out there see something I don't?

continued

ibm.ps/the.bus #128, from curtf (Curt Franklin). A comment to message 126.

I've heard rumors about this, too, but I've got an 8-megabyte board sitting in a Model 50 here, and it works fine. For those who are interested in more info on Micro Channel memory boards, a review of seven boards will be posted on BIX (probably in the ibm.ps conference) sometime in the next couple of weeks.

OTHER MCA MACHINES?

ibm.ps/the.bus #130, from awright.

I was looking through the Model 80 Technical Reference today and noticed an interesting comment. On the page following the default cycle timing, it shows a small diagram of the RTN signals. Note 2 about CHRDYRTN says something like, "this signal is a positive AND of all the CD CHRDY signals. Note that this is a change from other machines using the Micro Channel architecture."

Checked the Model 50/60 Technical Reference. Same diagram, but the note is different. However, the written description of CHRDYRTN says (in both manuals) that it is a positive AND, etc. Now what other machines used the Micro Channel architecture? Hmmm...

ibm.ps/the.bus #132, from rfm. A comment to message 130.

IBM execs are on record stating that there will be Micro Channel RTs. However, I wouldn't read too much into this. They very well might have designed the 50/60 bus, documented it, done the 80 bus, discovered that this is what the line ought to do, changed the 80 bus and put the note in since they didn't think they'd have time to change the 50/60 bus, found that they *did* have time to change the 50/60 bus, changed the 50/60 bus, but ran out of time and didn't get the note taken out of the Model 80 documentation. All this is pure speculation on my part, but it does sound like The Way Things Work, doesn't it?

ibm.ps/the.bus #133, from awright. A comment to message 132.

Yes, it does. Discovered the same note in the seminar proceedings. Could be the original (or different) Micro Channel used a "wire-ored" Ready line, like most buses do.

HELP WITH UNDOCUMENTED SYSTEM ERRORS

ibm.ps/the.bus #134, from jursery (Jesse Ursery).

Help! I am trying to figure out what is going wrong with an interface card that we designed to work on the Micro Channel. The card seems to behave properly on our Model 50 when the automatic configuration program is run. But when the system is rebooted, we get a long beep followed by two short beeps, then either system error 101 or system error 108. These are system board or power supply errors, in general, but we need to know specifically what the errors indicate because we are virtually certain that the problem is associated with our interface card. Can anyone tell me what these errors mean?

For reference, the card is a clone of one of our PC-bus cards, which looks like 64K bytes of memory and a single 8-bit I/O port (no DMA and no interrupts). The card is actually a shared-memory interface to a microprocessor-based instrument. We have analyzed the card's bus interface logic, and it appears to work just like the Technical Reference describes. We can enable the card with Debug, and the card functions correctly with our software, but we can't get past the power-on self test with our card in place.

ibm.ps/the.bus #135, from mslater (Michael Slater). A comment to message 134.

Does your card stay off the bus until CDEN is set (POS[1] bit 0, I think)?

ibm.ps/the.bus #136, from jursery. A comment to message 135.

Yes. From CHRESET until CDEN, we are completely isolated from the bus. Any other ideas?

ibm.ps/the.bus #137, from chips (Mark Garetz). A comment to message 134.

You *do* have an Adapter Description File for it, don't you? If not, can you tell if the system aborts before or after your card is initialized?

ibm.ps/the.bus #141, from jursery. A comment to message 137.

Yes, we have an ADF, and the system seems to initialize the card correctly. The problem is that when we reboot after configuring the card, we get nothing but the undocumented system errors. Any other ideas?

MCA ENHANCEMENTS?

ibm.ps/the.bus #138, from mramsden (Mike Ramsden).

A buddy of mine (unenlightened re: BIX) is bugging me to find out if there is any info floating around on BIX about possible extensions or enhancements to the Micro Channel (32-bit version). The president of one of the local hardware shops here in Toronto tells him that there are rumors floating around to the effect that the MCA will have new features added this year. I'm wondering if these are simply extensions for the RT PS/2 machine; my buddy is concerned about buying a Model 80 because he thinks it might be made obsolete quickly if there is indeed a "fixed" 32-bit MCA bus. Anyone hear any interesting rumors?

ibm.ps/the.bus #139, from chips. A comment to message 138.

IBM has essentially implied that it will increase the transfer rate to 20 megabytes per second as the first enhancement. Reading through the lines, this means 32-bit DMA. Note that the architectural spec for the Micro Channel doesn't preclude this now, just the system implementation. IBM also doesn't say when. It *will* mean a new machine and new controllers to take advantage of it. My guess is not soon—maybe a year.

Also note this interesting tidbit gleaned from IBM just yesterday: The matched memory cycle (IBM's way of "violating" its own spec) is intended to be defined from a timing standpoint on a machine-by-machine basis. Those who have assumed that the 187.5-ns timing in the Technical Reference is the upper limit for a matched memory cycle are wrong.

Another note: IBM says it is working on a solution to the 2-megabyte memory problem (other than requiring a ROM on each memory card) and will announce it within a month or so. It is currently evaluating several options and hasn't decided which one to go with yet. As I see it, the options are:

1. Replace everybody's BIOS ROMs.
2. Patch OS/2.

3. Do both (well, start shipping machines with fixed BIOSes and patch OS/2 to take care of machines already shipped).

ibm.ps/the.bus #140, from jrichter (Jake Richter). A comment to message 139.

From the PC Week article about the MCA evolving over the next few years, it seemed that an updated bus design might be in the works. This seems kind of tied in with the previous message. My concern is that yet another generation of hardware boards will have to be designed for the new bus–i.e., rendering the up-and-coming PS/2 MCA boards useless for the enhanced design. Any comments?

ibm.ps/the.bus #142, from mslater. A comment to message 140.

I'd be surprised if IBM enhanced the bus in such a way that old cards wouldn't work on the new bus. It's more likely that they'll add features and high-speed matched-memory cycles that will be transparent to older cards. Existing memory cards may well not work at full speed in new machines.

ibm.ps/the.bus #143, from cjackson (Craig Jackson). A comment to message 142.

IBM is unlikely to enhance its own cards into incompatibility. However, the cards were most likely designed to a slightly different spec than the spec publicly distributed. One that has more information about future directions.

OS/2

I/O

os.2/kernel #887, from abrunner (Andy Brunner).

I wrote an FAPI application that drives the IRMA 327x board directly through In/Out instructions in C. In PC-DOS and the DOS mode of OS/2, everything works fine. I now tried to set up IOPL for the C segment, which does nothing else than inp(xx) and outp(xx). Before calling this IOPL C segment, I also did the necessary DosPortAccess. But I get a TRAP 0D exception at entry to my IOPL segment. I am passing a parameter to the IOPL segment (the value to be sent to the I/O port).

1. Is it possible to use a C function as an IOPL segment?
2. If the answer to (1) is yes, is it possible to pass a parameter to it?
3. If (1) and (2) are yes, what did I do wrong?

os.2/kernel #888, from barryn (Barry Nance). A comment to message 887.

This is a dumb question, but I have to ask it: Do you have IOPL=Yes in your Config.Sys file?

os.2/kernel #889, from abrunner. A comment to message 888.

There is no dumb question...But yes, IOPL is enabled. Strangely enough, when I remove the parameter passing to the IOPL segment and add a dynamic link library call (such as DOS...API call), I receive an error message, telling me that dynalink calls are not allowed from ring 2. This is true–therefore I *am* at IOPL level 2. So I suspect that the problem is with the parameter passing on the stack, which might be on a wrong ring authorization level.

continued

os.2/kernel #890, from rduncan (Ray Duncan). A comment to message 889.

I don't know anything about writing IOPL routines in C yet, but the symptom you are having sounds like the problem I had when I failed to clear the parameters from the stack properly with a "RET n" to exit from the routine in the IOPL segment. Maybe you need to declare the IOPL routine as FAR PASCAL or something?

os.2/kernel #895, from cyco.netherlan (Cyco Automatisering). A comment to message 890.

On IOPL segments:

You can have IOPL segments, but there are some strange things about them. First, the DosPortAccess makes no sense (and you can indeed forget about calling this function) because when you have IOPL=Yes, an IOPL segment can access any port, anyhow, and if you don't, a program with an IOPL segment won't even start. The special problem is to pass parameters to a function. The IOPL function will have its own stack. So, forget about DS==SS as normal in C programs.

If you pass parameters via the stack, you should copy the part of the stack you want from the old stack to the new one. (Note that DS is your old SS. I can't remember how to get the old SP, but I'm pretty sure that it can be found.)

Most strange, I think, is that you can tell the processor (through some info in your descriptor) that it should automatically copy an area from the old stack onto the new one. But I can't find any reference in the manual on how to put this in the .DEF file (where I think this belongs). I did look in the link.exe file to see if some text could be found that reminded me of copy or stack copy or so, but no luck. So I think it really isn't there. Further, remember that you can *never* call a non-IOPL function from an IOPL function. This should automatically be clear to you if you understand what privileges are all about.

os.2/kernel #897, from rduncan. A comment to message 895.

True, DosPortAccess doesn't "do" anything in the current version, but you should follow the rules and make the appropriate calls to it in your program anyway. In the 80386 version, the kernel will be able to control port access on a per-process basis, and DosPortAccess will be necessary. Presumably, "old" 16-bit protected-mode applications that are running under the 32-bit version of the operating system and don't call DosPortAccess will fault and terminate.

The parameters are copied from the ring 3 stack to the ring 2 (IOPL) segment stack automatically. Each IOPL routine must be specified with an EXPORT segment in your .DEF file, and the argument for the EXPORT segment is the number of stack cells to be copied. The EXPORT statement puts something into the file header that causes a call gate to be built for the routine at run time.

In OS/2 1.1, they have changed things a little bit. Many of the DOSxxx routines are now "conforming," which means they can be called from the IOPL segment. There is also a new API called DosCallBack, which lets a ring 2 routine call any ring 3 routine in the same process.

FOREGROUND AND BACKGROUND

os.2/kernel #883, from ddoman (Daniel Doman).

It turns out that Microsoft has some funny ideas about "foreground" and "background." My application needed to know if it was running in the foreground or the background. The LocalSeg structure ForeGround flag is only set *after* keyboard I/O. Once you have read from the keyboard, you can reliably call DosGetInfoSeg and test the foreground flag in the LocalSeg structure. If you DosExec, however, the keyboard focus is lost, and the flag cannot be used *until* you read from the keyboard again.

I submitted a TAR to Microsoft, and they said, "Yeah, so?" So I think it's a bug.

os.2/kernel #893, from greenber (Ross Greenberg). A comment to message 883.

Take a look at the hack in my DLL article in MSJ.

Basically, if gdt->ground_process==ldt->parent_pid, then you're in OK shape.

os.2/kernel #900, from ddoman. A comment to message 893.

I did try comparing gdt->foreground_process to ldt->parent_pid and did not find the results consistent. According to Microsoft, the foreground process is the last process to have had the keyboard focus. That's not my understanding of the word ForeGround. I'm a mere mortal, but I have always thought of the foreground process as the guy in the foreground *now*.

os.2/kernel #901, from rduncan. A comment to message 900.

The foreground process is the last process to call KbdGetFocus or KbdCharIn.

os.2/kernel #902, from greenber. A comment to message 901.

Interesting. I found the results to be consistent across 1.0. I'll have to play some more with 1.1.

Hmmmm.

OS/2 ON TANDY 3000

os.2/kernel #894, from rkrten (Robert Krten).

Does OS/2 run on the Tandy 3000 series of computers? I would like to know for all the various HD, HL, etc., configurations.

os.2/kernel #903, from mnice (Mike Nice). A comment to message 894.

Beware of trying to run the Microsoft SDK version of OS/2 on the Tandy 3000HL. After trying a ROM upgrade, it still didn't even begin to boot-some sort of incompatibility in the bootstrap code. I finally ended up trading with someone else for an IBM PC AT. I heard that the 3000HD can run Microsoft's OS/2 with the proper ROM. In any case, both should be able to run Tandy's version of OS/2, possibly with ROM upgrades.

DISK GEOMETRY

os.2/kernel #896, from bkliewer (Bradley Kliewer).

I realize OS/2 doesn't use the BIOS for disk support, but what about the drive geometry? I have a Seagate ST4096, which has nine heads and 1023(?) cylinders. I'm considering getting a PROM that extends the drive table. My question is, will OS/2 read the PROM, or does it have its own internal table (and if so, could I modify one of the unused entries)?

A second (unrelated) question: OS/2 always hangs when I boot (IBM PC AT, but with an Inboard 386/AT). I suspect the Inboard is causing problems, but I should note that I didn't fill back the 640K bytes (I only have 512K for DOS). Does OS/2 need a full 640K bytes in the first megabyte of address space?

os.2/kernel #898, from glass (Brett Glass). A comment to message 896.

I recommend patching your ROMs or getting an extension PROM.

The problem with the Inboard, as best I can tell, is not related to memory size. Intel supposedly has a fix for it; call PCEO in Oregon.

os.2/kernel #899, from bkliewer. A comment to message 898.

This is a new (OS/2-compatible) Inboard. Intel says it should work. I was just wondering whether anyone else has had problems with it.

PHYSICAL MEMORY MANAGEMENT

os.2/kernel #904, from intel (Cliff Purkiser).

Is there a mechanism to free an area of physical memory away from use by OS/2? The purpose would be to use a specific area of physical memory for a device driver. When the device driver is not in use, it would be advantageous to let the OS/2 kernel use it.

Example:

An add-in card for a special graphics printer has 4 megabytes of memory on it. The memory is dual-ported, such that it can be accessible from the AT's CPU or from the printer's dedicated CPU. When the printer is not in use, the memory is used as any other normal extended memory.

When the printer is used, the printer's device driver signals the OS/2 kernel to free that 4 megabytes of memory. The kernel frees that area of memory and continues, ignoring the existence of that area of memory. Later, when the printer is finished, it can signal the OS/2 kernel that the 4 megabytes of memory is again usable.

Any ideas of what OS/2 calls would allow such operations?

os.2/kernel #905, from glass. A comment to message 904.

Yes, there is one, but it's a DevHlp, not an API call, which means it can only be called by a device driver. It's called AllocPhys.

os.2/kernel #906, from rduncan. A comment to message 905.

Not really. AllocPhys doesn't let you choose the address of the memory that the driver will use. It just allocates some "fixed" (nonswappable, nonmovable) memory and returns the linear address of that memory.

os.2/kernel #909, from rnelson (Ross Nelson). A comment to message 906.

Yeah, I haven't looked at the code recently, but what we do is request actual GDT slots and modify them ourselves to get the exact descriptor that we want. Protected mode? What protected mode?

continued

READING CONTROL-C

os.2/kernel #907, from leifur (Leifur Hekanarson).

In msg. 499, someone asked for info on reading Ctrl-C. He was referred to the SDK. Well, I have the Programmer's Development Toolkit, which does *not* document how to do this. Could someone explain how (perhaps by means of a program fragment)?

It seems to me that by marketing *two* development environments, Microsoft has caused no end of confusion, what with different spelling of library calls, etc.

os.2/kernel #908, from rduncan. A comment to message 907.

If you put the keyboard into binary mode with KbdSetStatus, you can read Ctrl-C and the other funny keys (like Ctrl-S) with the usual KbdCharIn and KbdStringIn.

If you do not really want to read Ctrl-C and Ctrl-Break, but instead want to prevent your program from being terminated by these keys, you need to register a signal handler for them with DosSetSigHandler.

WHAT SCREENS FOR OS/2 PM?

os.2/windows #149, from cyco.netherlan.

Does anyone know what kind of screens might be supported for the Presentation Manager? Will there be non-memory-mapped screens, and if there are, how should their states be saved? We think these screens are extremely important and *must* be supported in some way. BTW, for those of you who have the PM already, what's it like? We're burning to know, but Microsoft is very slow shipping its products to Europe (even slower than the PM release in the States).

os.2/windows #150, from gshapiro (Geoffrey Shapiro). A comment to message 149.

I am a bit confused by what you mean by "what kind of screens will be supported by the Presentation Manager." PM supports its particular brand of API (à la Windows and IBM's GDDM/SAA) to bit-mapped displays, printers, etc. In addition, PM supports a large subset of the OS/2 VIO API for character-oriented output.

Is either of the above two what you had in mind? If not, please clarify your original queries.

os.2/windows #151, from mlavelle (Mark Lavelle). A comment to message 150.

And in the question related to video modes, don't expect to see support for anything other than IBM MDA, CGA, EGA, and VGA for quite a while.

os.2/windows #152, from cyco.netherlan. A comment to message 151.

>what kind of screens

You (Geoff) selected a special kind of screen yourself: bit-mapped displays. There are, however, screens that are not memory-mapped. Is it possible (and if it is, will it be done) to use these screens as well with the PM? The problems I expect are with the saving/restoring with session switches. Microsoft keeps saying that the PM is just one session under the session manager. I can't believe it, but they say so and they should know. How (if there is no memory map of the screen) could the screen be saved/restored without a memory map of its contents?

Think of this: You are using AutoCAD with a very special screen (hardware zoom and pan, 200-inch screen with a 10000000 × 1000000 resolution). Can you expect to see a PM version of AutoCAD someday where this big-bucks screen is used, or is this impossible? If you can't, then what is the value of the PM? Does anyone have any idea how difficult it will be for a screen manufacturer to produce the drivers needed for his or her screen to be used on every OS/2 version?

os.2/windows #153, from cjackson (Craig Jackson). A comment to message 152.

I suppose that the manufacturer of such a screen would need to provide at least a replacement for the VIO subsystem. You'd have to be an OS/2 OEM to do that, I suspect.

os.2/windows #154, from rduncan. A comment to message 152.

The PM is certainly just one session under the session manager. You can have other sessions going, too, that contain "old-style" character-based APPS, or APPS that contain their own graphics drivers.

From what I can see about the way the video subsystem is organized, it should be a fairly straightforward job for the manufacturer of a display adapter to supply a new kernel driver (.SYS) and subsystem driver (.DLL?) to use with that adapter—particularly if the system will also contain one of the "standard" adapters. Then the new subsystem can just register itself with VIOCALLS.DLL (the video router) on a per-screen-group basis, and the screen groups it doesn't register for will still be directed to the standard adapter.

I don't see any reason why such a custom video subsystem would need to be maintained in any more than one version. The different OEM versions mainly involve hardware customizations of the base set of device drivers, different available code page sets, and possibly mods of the mode-switching logic to take advantage of any special hardware support. The interface between the kernel and the video subsystem and driver should not be affected by these things.

os.2/windows #156, from glass. A comment to message 154.

The question in my mind is: Why can't *any* developer write a screen driver with ordinary tools and have the user install it when the special adapter is installed? Why require it to be built into the kernel?

os.2/windows #157, from rduncan. A comment to message 156.

Nothing in the video driver or subsystem is built into the kernel, and it is all (theoretically) perfectly replaceable in the field. The problem is that the video subsystem really has three elements: SCREEN.SYS or the equivalent; BVSCALLS.DLL or the equivalent, which contains an IOPL segment to twiddle the hardware; and VIOCALLS, which routes VIOxxx API calls to BVSCALLS or another subsystem on a per-screen-group basis.

There is also another dynlink library, ANSICALL.DLL, which is called by BVSCALLS to interpret escape sequences embedded in VIOWRTTTY strings: It calls back to BVSCALLS via VIOCALLS using things like VIOSETCURPOS. All these elements work together in weird and mysterious ways, and the person who wants to completely replace the video subsystem has to duplicate all entry points and calling conventions (mostly undocumented, or vaguely alluded to, in the regular Programmer's Reference) in each of the modules. ■

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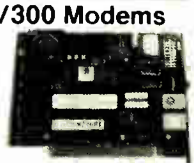

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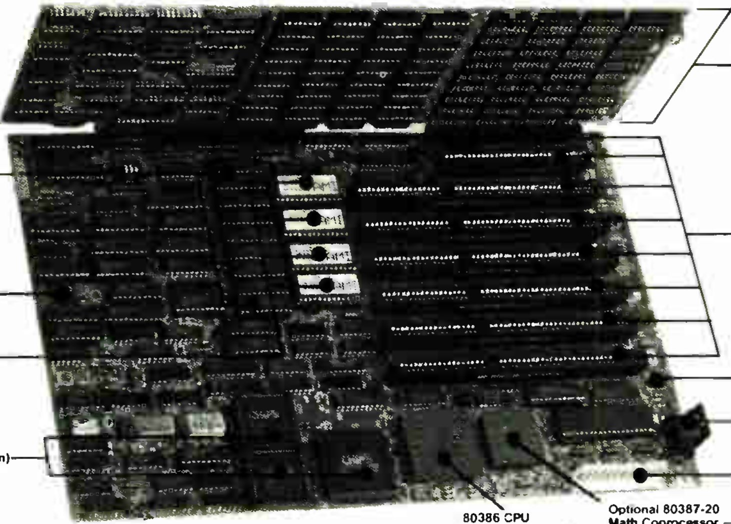

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JE3025 Pictured

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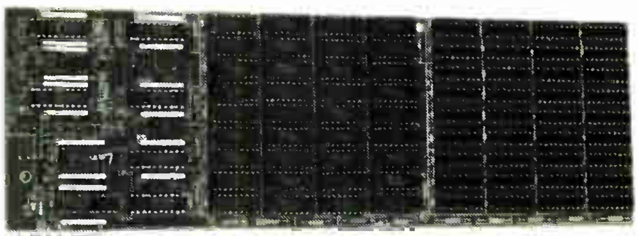

JE3030 – 8 Megabyte Daughterboard Option (Zero-K RAM)

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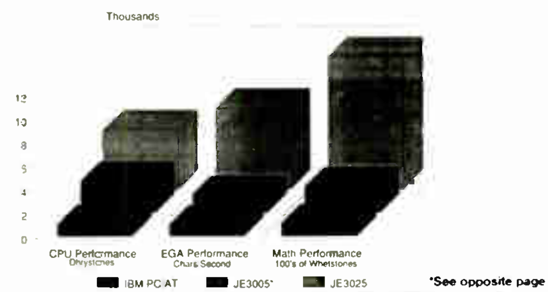

*See opposite page

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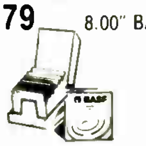

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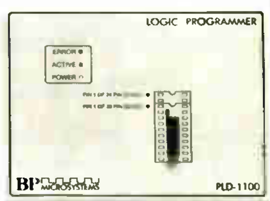

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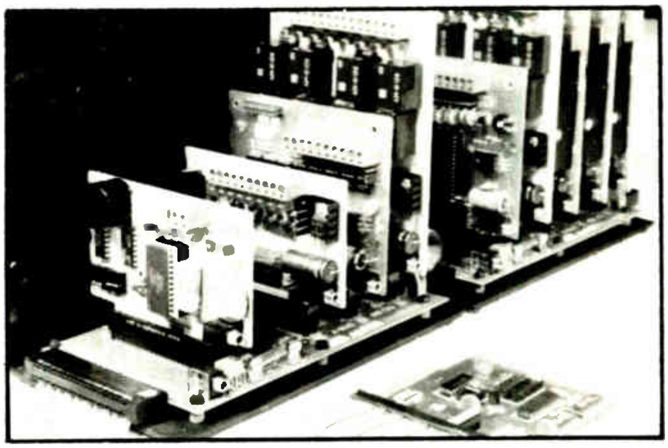

An A-BUS system with two Motherboards
A-BUS adapter (IBM) in foreground

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A-BUS control can be entirely done in simple BASIC or Pascal, and no knowledge of electronics is required!

An A-BUS system consists of the A-BUS adapter plugged into your computer and a cable to connect the Adapter to 1 or 2 A-BUS cards. The same cable will also fit an A-BUS Motherboard for expansion up to 25 cards in any combination.

The A-BUS is backed by Alpha's continuing support (our 11th year, 50000 customers in over 60 countries).

The complete set of A-BUS User's Manuals is available for $10.

About the A-BUS:

- All the A-BUS cards are very easy to use with any language that can read or write to a Port or Memory. In BASIC, use INP and OUT (or PEEK and POKE with Apples and Tandy Color Computers)
- They are all compatible with each other. You can mix and match up to 25 cards to fit your application. Card addresses are easily set with jumpers.
- A-BUS cards are shipped with power supplies (except PD-123) and detailed manuals (including schematics and programming examples).

Relay Card RE-140: $129
Includes eight industrial relays. (3 amp contacts, SPST) individually controlled and latched. 8 LED's show status. Easy to use (OUT or POKE in BASIC). Card address is jumper selectable.

Reed Relay Card RE-156: $99
Same features as above, but uses 8 Reed Relays to switch low level signals (20mA max). Use as a channel selector, solid state relay driver, etc.

Analog Input Card AD-142: $129
Eight analog inputs. 0 to +5V range can be expanded to 100V by adding a resistor. 8 bit resolution (20mV). Conversion time 120us. Perfect to measure voltage, temperature, light levels pressure, etc. Very easy to use.

12 Bit A/D Converter AN-146: $139
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Digital Input Card IN-141: $59
The eight inputs are optically isolated, so it's safe and easy to connect any "on/off" devices, such as switches, thermostats, alarm loops, etc. to your computer. To read the eight inputs, simply use BASIC INP (or PEEK).

24 Line TTL I/O DG-148: $65
Connect 24 input or output signals (switches or any TTL device) to your computer. The card can be set for: input, latched output, strobed output, strobed input, and/or bidirectional strobed I/O. Uses the 8255A chip.

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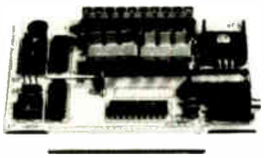
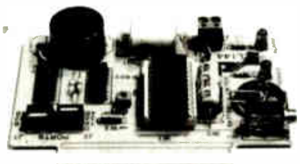
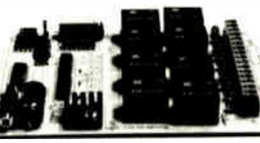


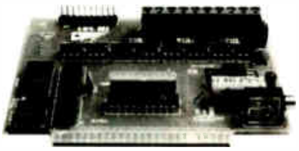
ST-143



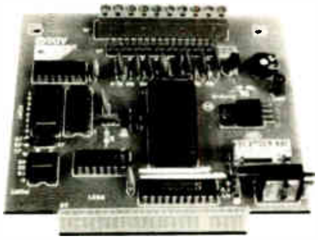
CL-144



RE-140



IN-141



AD-142

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Remote Control Keypad Option RC-121: $49
To control the 4 motors directly, and "teach" sequences of motions.

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Special Package: 2 motors (MO-103) + ST-143 **PA-181: $99**

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Connects the A-BUS adapter to one A-BUS card or to first Motherboard.
Special cable for two A-BUS cards: CA-162: $34

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CC16-P

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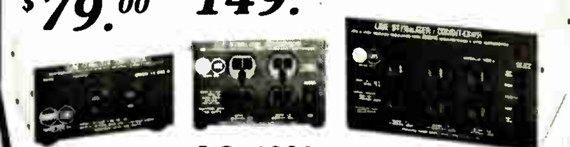

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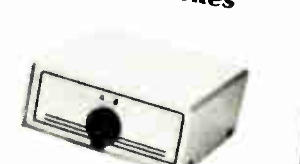

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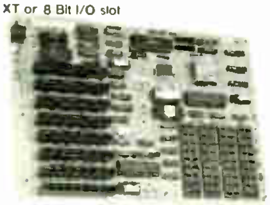

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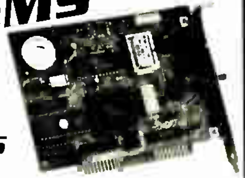

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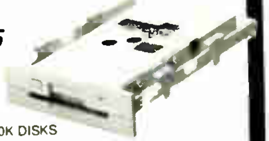

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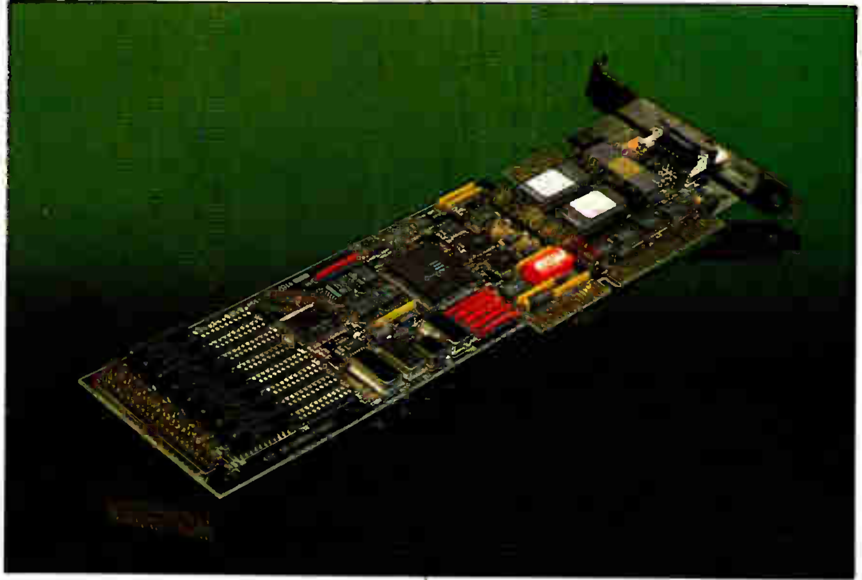

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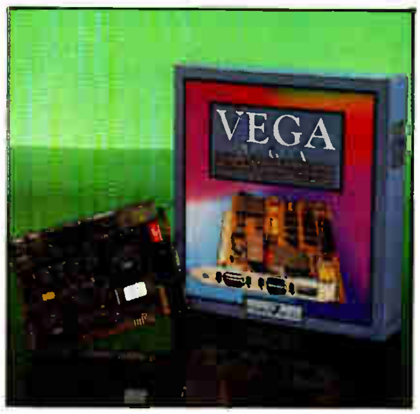

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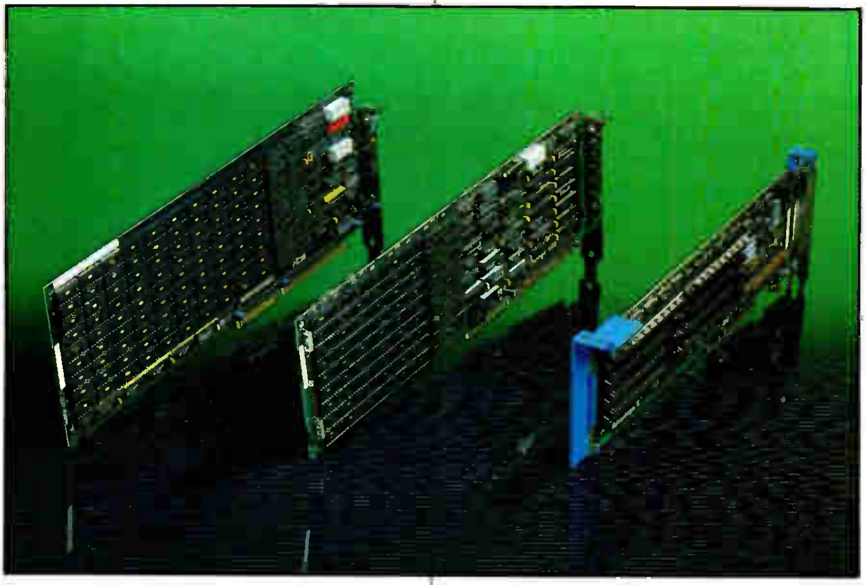

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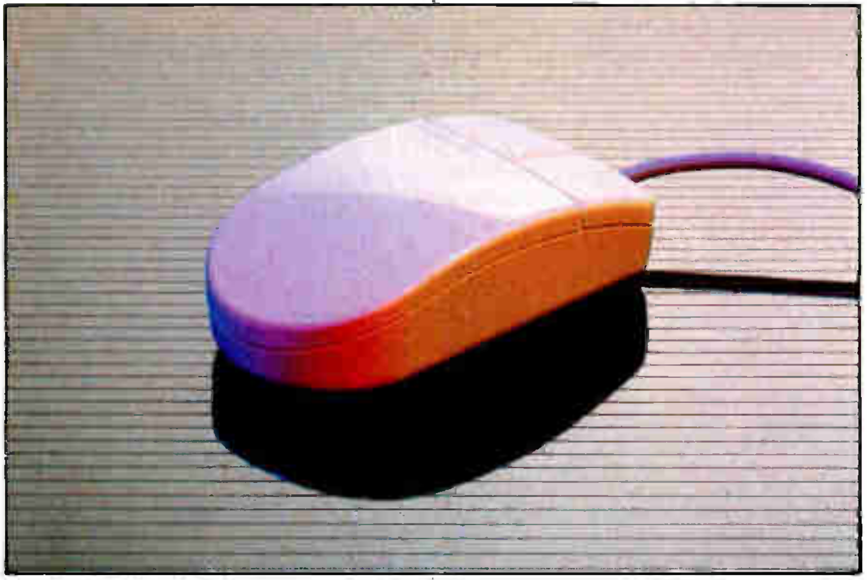

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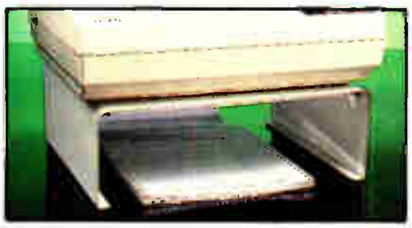

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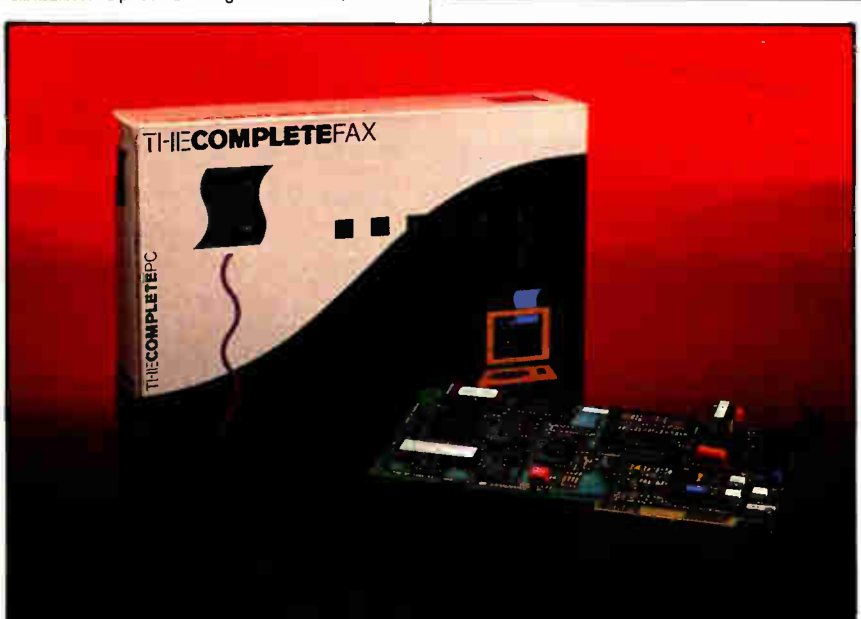

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Epson

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80 Column / 132 Column

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MATE/12

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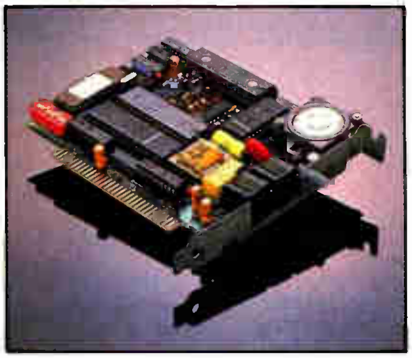

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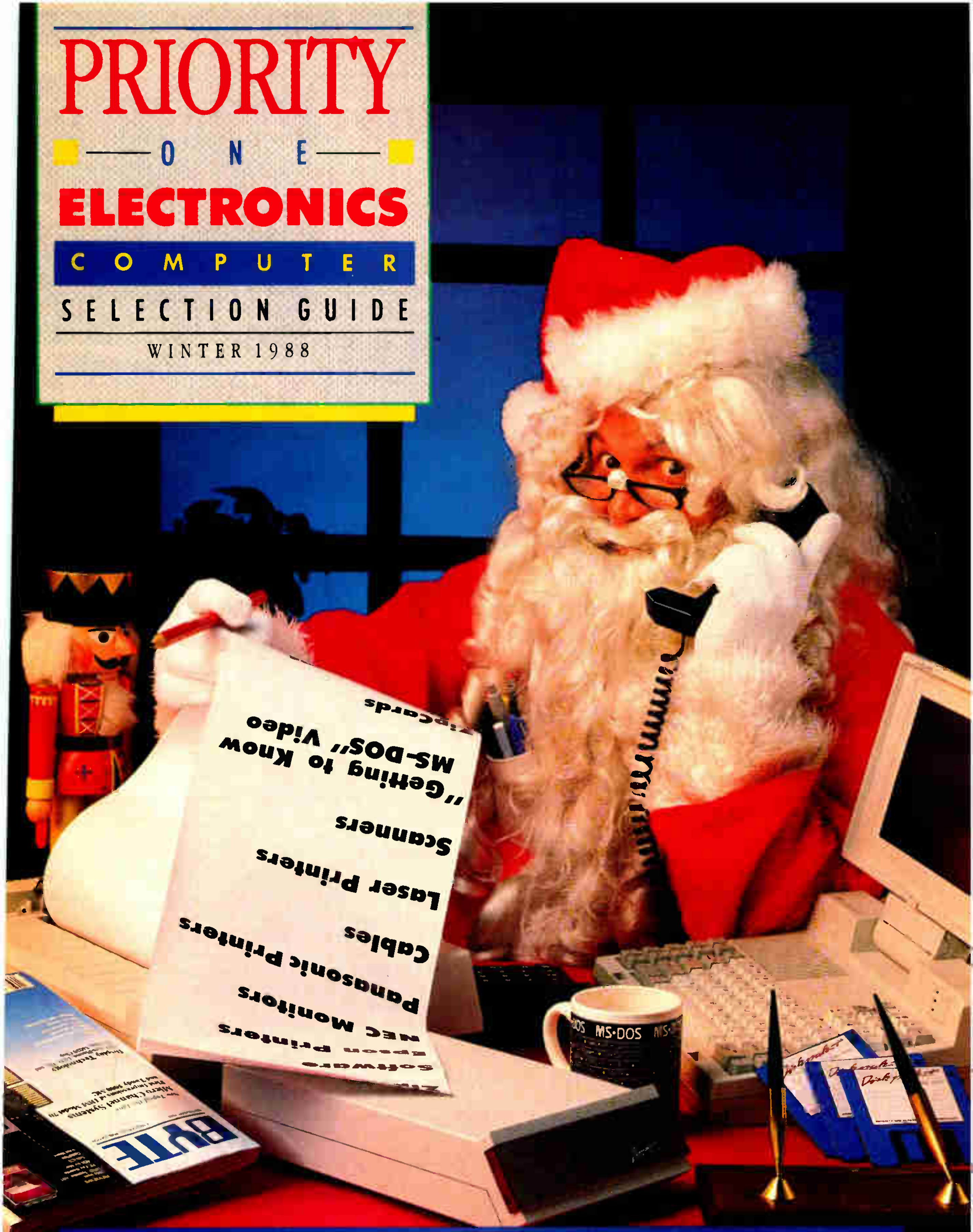

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