THE INDEPENDENT GUIDE TO IBM-STANDARD PERSONAL COMPUTING

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STARTING THIS ISSUE:
PC AFTER HOURS, THE LEISURE SIDE OF PERSONAL COMPUTING

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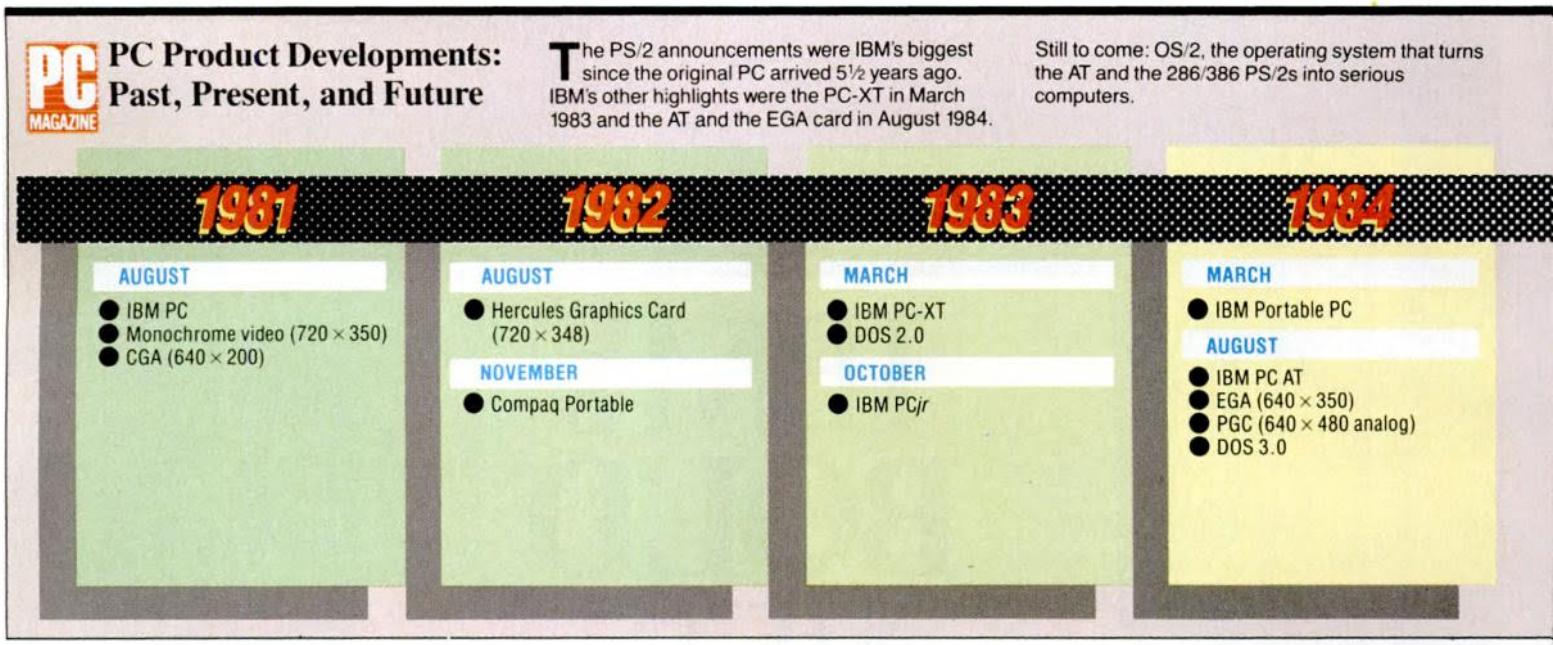
IBM's BOLD NEW MOVE

Burned by too many quarters of losing market share, losing revenues, losing its leadership and generally losing face, The Empire Finally Struck Back: IBM has introduced its new line of personal computers.

Though the Personal System/2 machines have both a good deal of sizzle and the smell of success about them, IBM's prices remain high—especially for machines whose

IBM's Personal System/2 line has the smell of success, but is it too late for the company to regain control of the market? Big Blue is betting many will follow its giant step.

Photograph: Roberto Brosan



most important new features are as yet largely inaccessible, and ignored by present software. If the new Models 30 and 50 are seen as replacements for existing PC-XTs and PC ATs, IBM's PS/2 price tags look a little better. But only a little. And only if you exclude the rest of the PC-compatible universe.

In an era of $1,000 10-MHz AT clones, it's hard to get too excited about a $3,295 AT-successor from IBM. Until, of course, that new Micro Channel bus comes into its own—and until we get the new Operating System/2 and companion applications programs that should unlock, finally, the protected-mode mysteries of the 80286 chip.

Then, some say, there's going to be blood in the streets. Maybe. To be sure, the importance of the new Micro Channel bus would be hard to overstate. After almost 6 years of wrestling with the limited bus of the original PC, the concurrency available on the new bus—especially in concert with the interprocess communications promised when IBM's more-or-less proprietary extensions to OS/2 become available sometime next year—should delight PC hardware and software designers.

Because the new bus can handle several jobs at once, rather than the one-at-a-time approach of the old PC bus, effective computing-speed improvements well beyond those presently visible in the new machines should be possible. IBM has historically referred to the intermachine communications subsystems of its larger computers as "channels," and it seems clear that the new Micro Channel bus in the PS/2 PCs, which allows much more sophisticated data-handling within the computer, will be exploited by IBM in succeeding product announcements dealing with improved "connectivity" between its PCs and larger mini and mainframe computers.

So, nice going, R&D.

What else is promising, or least interesting? Squeezing the Models 30 and 50 into civilized, small-footprint boxes is important, especially the really small Model 50, which looks *right*, somehow, for a desktop computer.

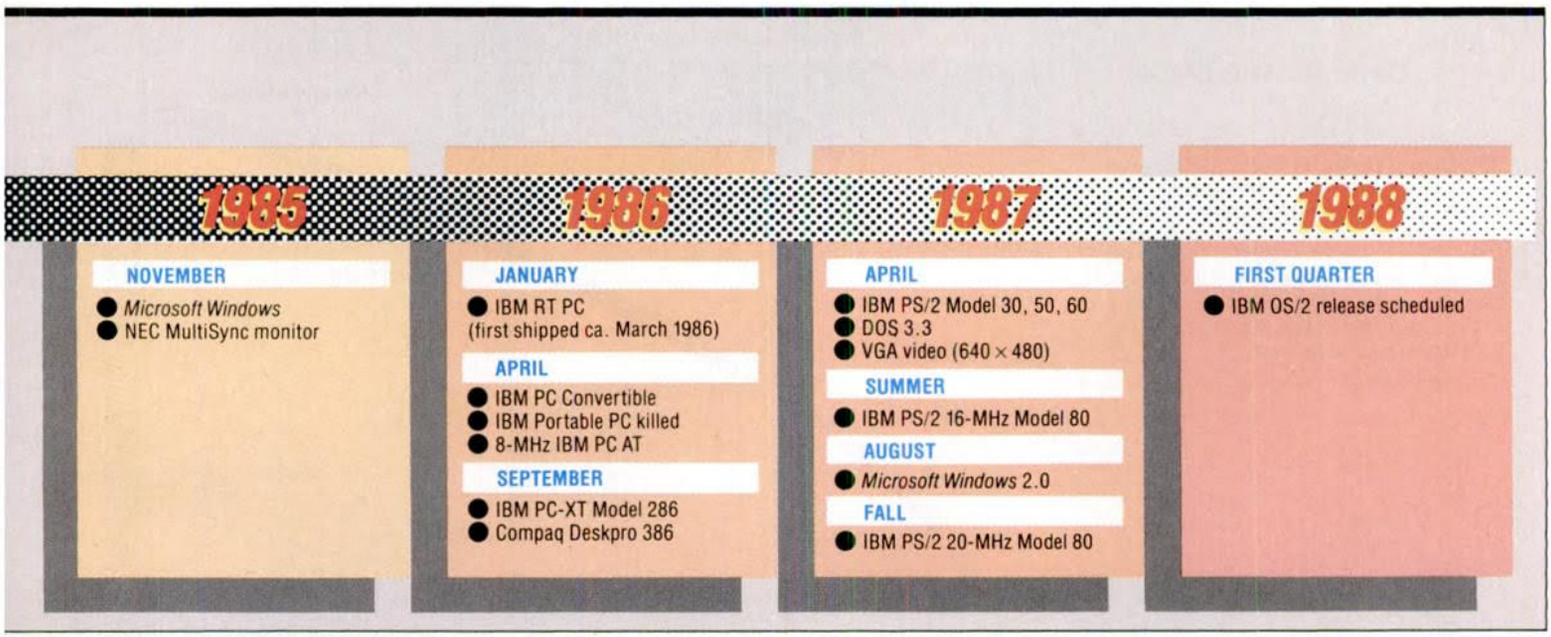
One of the minor mysteries of the new line is the Model 30, which, although allowed to carry the escutcheon of the new line, is really a high-style bridge product from old to new, yesterday to tomorrow—or maybe, 'til midafternoon today. Although it has the look and size of the new PS/2s, there's no Micro Channel bus—only the old-style PC bus.

Actually, the $1,695 two-floppy Model 30-002 makes a nice little *de facto* dedicated word processor. And IBM uses the hard-disk-equipped Model 30-021 with the new 8503 long-gray-scale black-and-white monitor as the platform for an $8,500 desktop publishing system built around Aldus's *PageMaker* and including IBM's tiny new laser printer, which is at least a nice positioning exercise up against Apple's Mac-based $10,000 desktop publishing systems.

TO HAVE—OR HAVE LESS? *PC Magazine* editor Bill Machrone has for some time been saying that, with 80286 PCs and the (perpetually) pending release of a version of an operating system that can address lots of memory in protected mode, IBM and Microsoft are creating a world of Haves, with '286/'386 PCs; and Have Lesses, stuck with 8088/8086 machines. Introducing a nice but limited machine such as the Model 30 may add a new category: the Been Hads.

Buyers eyeing that 8-MHz 8086 chip in the Model 30 should beware of the machine's sludgy hard disk, for which IBM claims an only 80-millisecond access time. IBM has learned its lesson about selling no-drive and one-floppy machines for buyers to fill up with better or lower-priced aftermarket drives: the only way you can buy a Model 30 is with two 3½-inch floppy disks or with one floppy and that retrograde hard disk.

Actually, moving data between the 3½-inch floppies of the new-generation IBMs and the 5¼-inch drives of rest of the IBM-compatible world won't be nearly as difficult as some naysayers predict. Traveling Software's *Lap-Link* package, *The Brooklyn Bridge*, and other low-cost serial-port transfer programs are easy to use for occasional data exchange; if you're



changing formats with any regularity, you'll want an external 5¼-inch drive for the PS/2 machines. And IBM introduced with the PS/2 series an odd but interesting program, *Data Interchange Facility*, which moves data between two PCs using different-size disks via their parallel ports, using a standard parallel printer cable. In any case, floppy disk sizes aren't such a big deal anymore. In an era of hard-disk PCs, we've reduced floppies to software distribution and backup roles.

The technological changes in the PS/2s make sense, though the Rod Canion camp will continue to defend the 5¼-inch floppy—until about 1 minute before they introduce 3½-inch-equipped machines, which won't be long.

SEND IN THE CLONES But what happened to the "clone killer" side of the new IBM line? Sure, it'll take a while for the Phoenix Technologies of the new bus to emerge, but someone's going to bust the bus: it's only a matter of time 'til we see PS/2 clones.

It was the pricing on the new IBM line that was supposed to make the clone shops wither and blow away. Some withering. Some blowing away. Compaq and Tandy have been by far the biggest thorns in IBM's side. Others may be cheaper, others may be more technologically advanced—but Compaq and Tandy have distribution, they have volume, and they have big gross margins. As IBM's newfound attention to its distribution problems shows, IBM understands just how big a role effective distribution plays in building volume. And what nice things volume combined with decent margins does to your balance sheet. Or in this case, to the *other* guys' balance sheets.

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But it's hard to see how IBM's new prices—scaling all the way up to $10,995 (sans display) for a 20 MHz 80386 Model 80-111—will put a dent in Compaq or Tandy's sales. Compaq's Deskpro 386 pricing is already competitive with IBM's low-end Model 80s, which in any case won't be available until July. That means IBM has given Compaq almost a year's head start in the 386 PC business—since the introduction of the Deskpro 386 early last September. In this business, that's a *lot* to give away.

And Tandy looks comfortable with its big-volume Model 1000 EXs and 1000 SXs—both priced way below IBM's base Model 30—as well as with its sub-$2,000 Tandy 3000 HL (which IBM cloned with the XT-286) and its Tandy 3000 HD, a full-scale AT clone that can surely come down a long way from its current $4,299 (recently selling at a typical Tandy promotional discount price of $3,595).

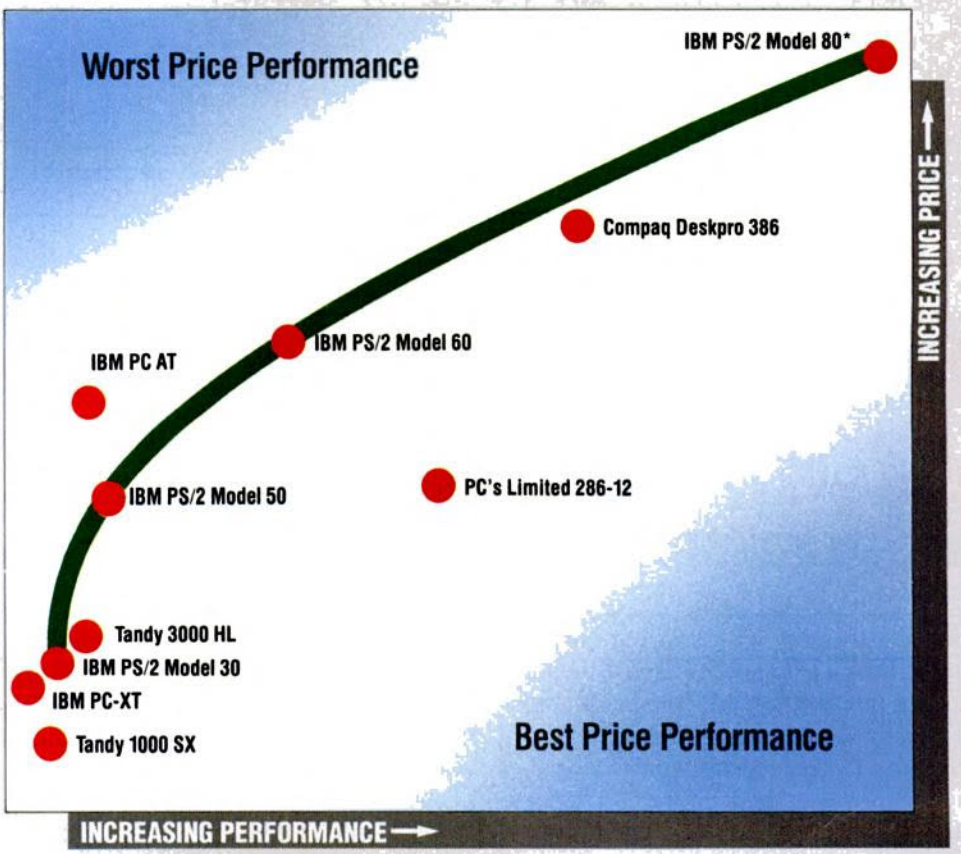
The mail-order clone shops are already below even those prices, of course. PC's Limited, for example, sells its 8-MHz AT clone for $1,495, and a 12-MHz AT clone roughly equivalent in real-world throughput to the new IBM PS/2 Model 50 for an IBM-like $3,495—but including an EGA card and monitor. You can bet *those* prices are highly adjustable, too.

IBM seems to have erected a price umbrella over its most dangerous competition, giving them time to milk the cash flow from their current lines and prices a little longer, while they funnel that cash into R&D on how to match or best IBM's new technical wonders.

THE WINNERS' CIRCLE Texans may not smile much under those big hats, but there were a lot of big grins and toasts to

Bang for the Buck

To compare the value of the PS/2 line with other high-performance computers, factors such as CPU speed, memory size, memory speed, disk capacity, and disk access time were weighted and combined; the machines were then ranked in ascending price order. The index shows positioning of the PS/2 line and indicates where opportunities for IBM's competitors may occur.



*Not yet available

continued prosperity in Fort Worth (Tandy), Houston (Compaq) and Austin (PC's Limited) on the day IBM announced the PS/2 machines.

Microsoft, of course, was one of the biggest winners in the PS/2 announcements. The advent of OS/2 (nee "286 DOS" and "DOS 5.0") is important enough. But IBM's acknowledgement that OS/2 would be backward-compatible on PC ATs and XT/286s, combined with Microsoft's assurances that OS/2 would also be available to all their other licensees, means Gates & Friends will get richer still.

Even better for the Puget Sound economy—and for users tired of DOS's crankiness—the Presentation Manager facility within OS/2 is the affirmation of *Windows* as the dominant graphical interface in the PC business. (An IBM spokesman did, however, say at the PS/2 introduction that present *Windows* applications may not run under OS/2's Presentation Manager without "a little migration." Read: You're gonna have to buy new versions of your *Windows*-compatible programs.)

None of this should be read as criticism of IBM. If anything, leaving so much money on the table for the rest of the PC industry, while creating so many rich and promising opportunities for customers through potential technological extension of the "PC standard," was a good and generous step by IBM.

The technical advances in the new IBM models represent genuinely superior engineering. And while to its great credit IBM didn't resort to such clone-countering ploys as embedding fingerprints in the new machines' ROM code to foil competitors, IBM Entry Systems Division president William Lowe promised that the company will "vigorously protect its sizable R&D investment in these new computers" in the courts.

Fair enough, IBM: that's playing it straight down the middle. Good luck finding judges who understand microcode and bus timing.

The Personal System/2 series is surely IBM's boldest move yet in small computer systems—a larger step forward than even the introduction of the first IBM PC in August, 1981, and the trend-setting PC AT in August, 1984.

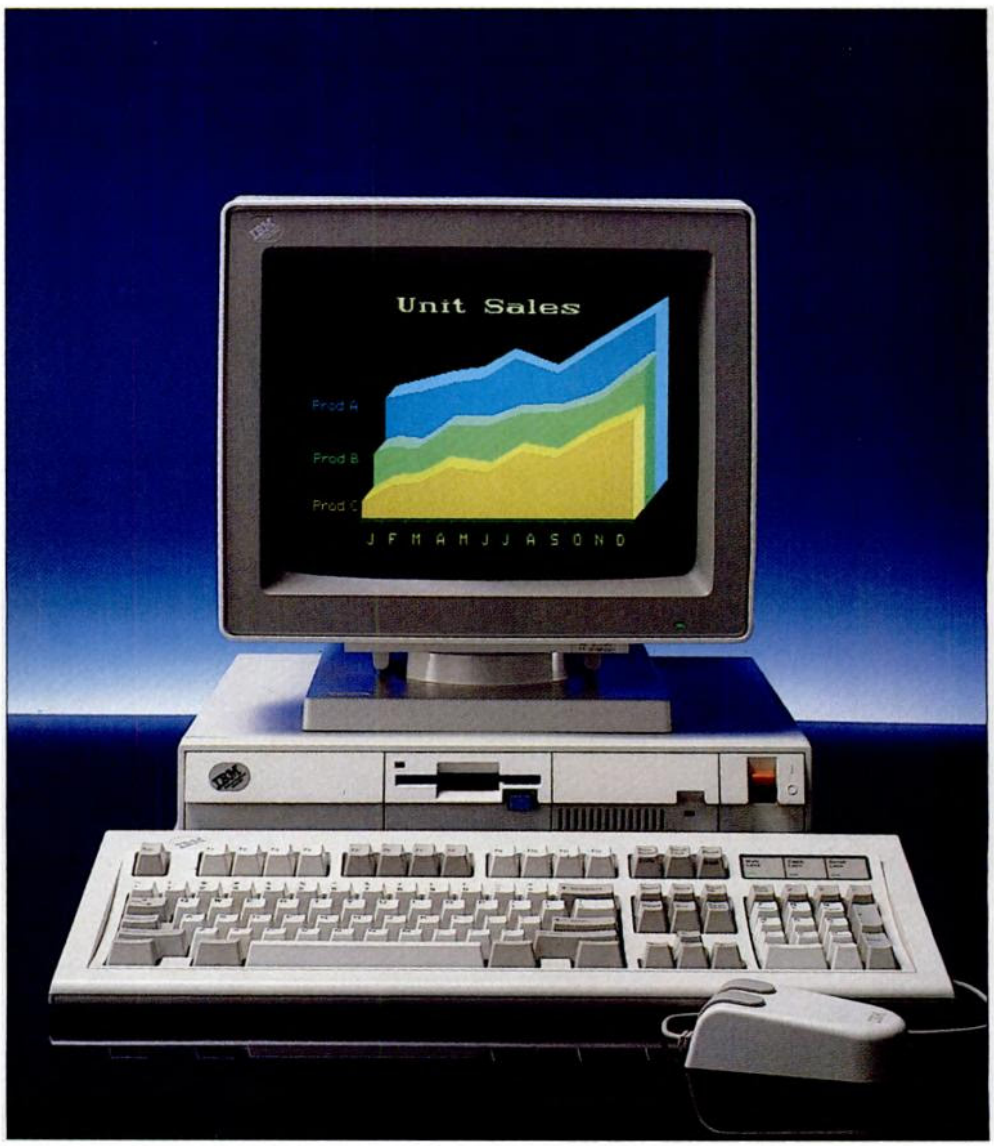
And the PS/2 pricing, if not low enough to wound very many competitors, is at least within the context of IBM's traditional pricing strategies fairly aggressive, and indicative of a corporate determination to do whatever is necessary to regain leadership in the PC market.

The question that has not yet been answered is whether the dynamics of the PC market have moved beyond even IBM's ability to reassert control, and whether in an acutely price-sensitive marketplace, advanced but as yet largely unexploited technological features combined with moderate prices can edge out very good performance within a much broader technical standard at substantially lower prices. We'll soon find out.

Stay tuned, friends: We are in for a *wonderful* couple of years.

Jim Seymour is a contributing editor of PC Magazine.

IBM PERSONAL SYSTEM/2 MODEL 30



The IBM PS/2 Model 30 is based on an 8086 processor that performs just about as fast as the 80286 processor found in an AT. Disk access, however, is sluggish. The Model 30-021, pictured here, comes with one 3½-inch floppy disk drive, a 20-megabyte hard disk, 640K RAM, a graphics controller, and a full-AT-style keyboard. The price is $2,295, not including a VGA-compatible monitor. The dual-floppy-disk model lists for $1,695.

Photograph: Roberto Brosan

The PS/2 Model 30 has something old and something new. Consider it IBM's bridge to the future of personal computing.

The lasting impression you get from the Model 30 is, What took them so long?

IBM says it took hundreds of people working for the past few years to develop the Personal System/2 line. The Model 30 maintains the "16-bit processor on an 8-bit bus" design used in the original PC, XT, and AT. But the blueprints for this machine take advantage of surface-mount and VLSI technologies widely exploited by expansion board manufacturers for 2 years now.

With 640K bytes of RAM, a graphics controller, parallel and serial ports, and both floppy and hard disk controllers on the motherboard, this slim 8-MHz PC has an efficiency of design that makes most of its competitors look as antiquated as a transistor radio in a world of solid-state digital stereo Walkmans.

So why didn't IBM produce this machine a year ago, when it really would have killed a few clones? Answer that question, and you'll solve a puzzle many have asked ever since the PS/2 line was announced in April: What is the purpose of this machine?

The Model 30 is IBM's link to its new world. It's the computer that can help wean the wary away from PC compatibles and get them thinking about the extra power and better graphics available when they're ready for the real next-generation personal computers IBM has announced: the Models 50, 60, and 80.

IBM asks that you forsake 5¼-inch floppies and embrace the 3½-inch 720K-byte disk when you move up to this new line. It also wants you to mothball your digital monitors—MDA, CGA, or EGA—and install one of IBM's new analog displays.

Only then will you be ready for the next generation in personal computing. And if you're not prepared for the major-league investment needed for a Model 60 or 80, you can get the base Model 30, with monitor and at list price, for under $2,000.

You won't be able to run OS/2 when it becomes available next year (the new operating system will only run on 80286-based computers), so you'll always have to live with DOS's 640K-byte limit, but you'll be another step closer to state-of-the-art computing.

THE HEARTBEAT MCGA graphics are at the heart of that strategy. Although the newly introduced display adapter in the Model 30 is based on low-resolution CGA standards, MCGA actually produces a text display that is marginally better than EGA. For everyday chores, it even beats the current crop of so-called better-than-EGA cards now being touted by NEC, Paradise, and Tseng Labs; they can display *Microsoft Windows* and a handful of other programs at 640- by 480-pixel resolution. The Model 30's MCGA text mode brings up ordinary text screens in 640 by 400 resolution, using a character box of 8 by 16 pixels, better than the EGA's 8 by 14, and arguably a toss-up against MDA's 9 by 14. (See Charles Petzold's article, "Triple Standard: Three New Video Modes from IBM.")

Unfortunately, IBM's PS/2 color displays cannot do justice to this enhanced standard. The Model 30's text display is fuzzy at close range. To me, the image is noticeably better than an EGA only at distances of more than 3 feet, where the extra dots in each character improve legibility. At closer distances, however, the characters lack clear definition; they're cloudy.

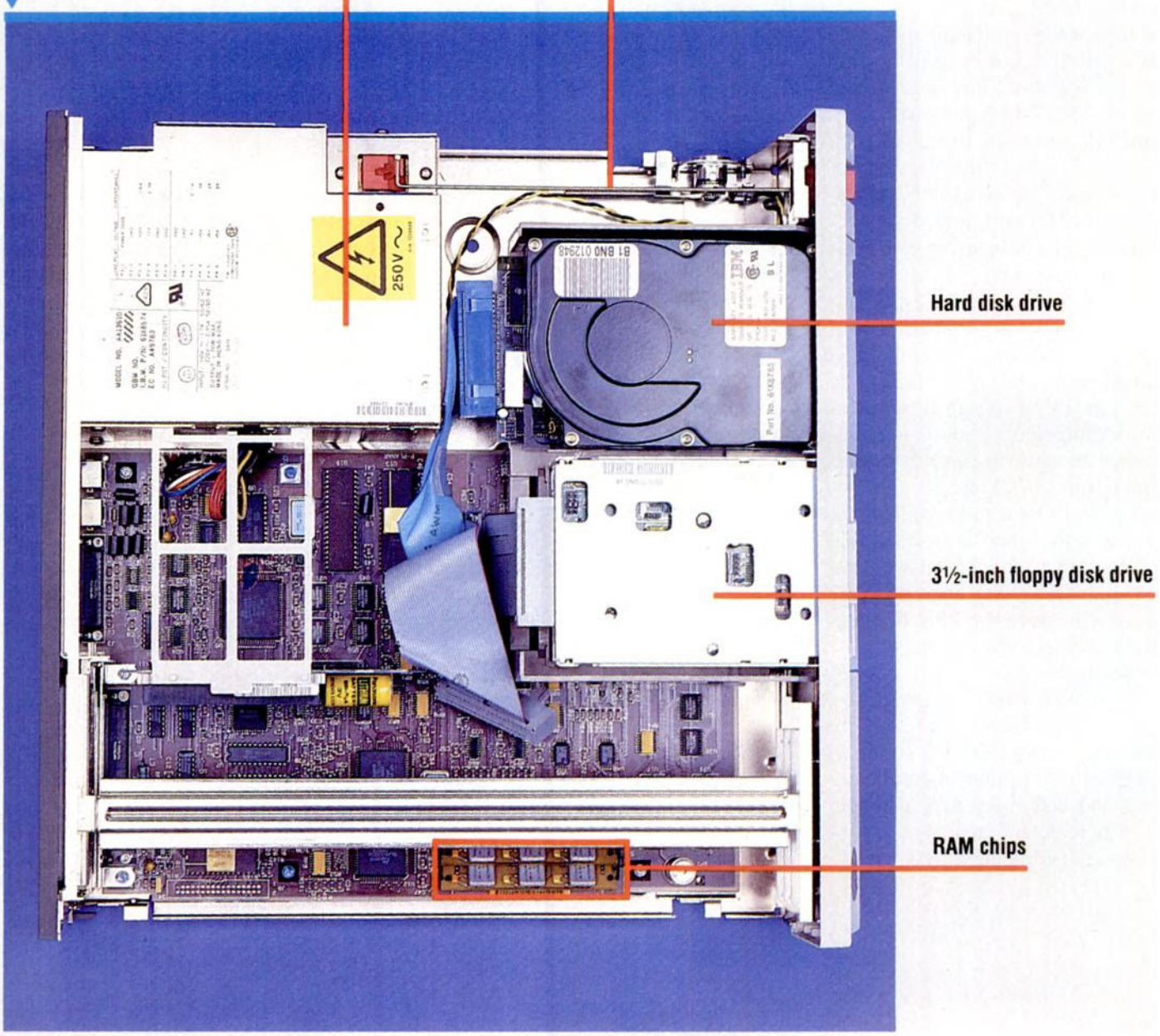
MCGA also provides the most colorful of the new modes in VGA graphics: 256 colors out of a palette of 262,144 at a resolution of 320 by 200 pixels. Right now, most graphics software manufacturers are working overtime to develop programs that realize the potential of this new burst of color.

Everything else about the machine echoes what's gone before and, in most cases, shows a better way of doing it.

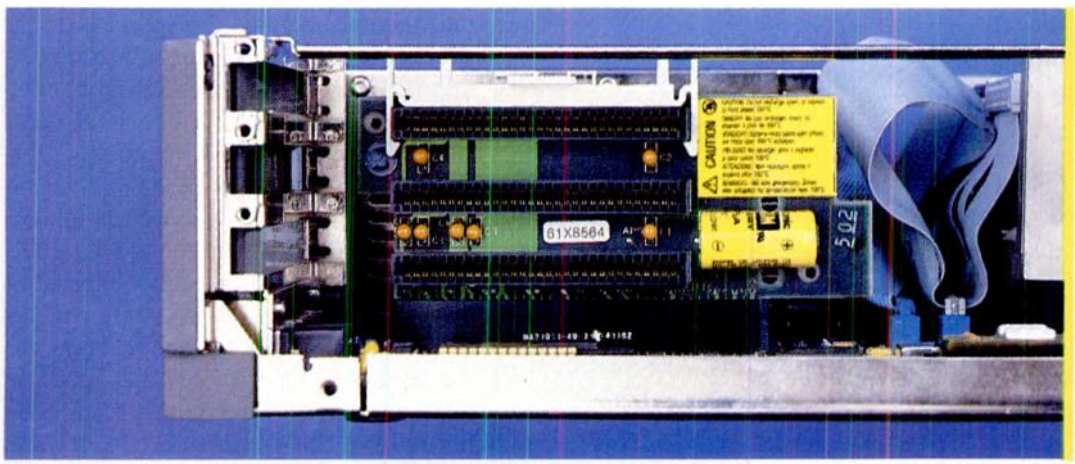
Until OS/2 emerges, the Model 30 can deliver enough computing power to run apace with an 8-MHz AT on most chores except disk access. The Model 30's 8086 processor does not have the full range of

PS/2 Model 30

The Model 30 uses an 8086-2 microprocessor that yields AT-class performance. Optimum configuration, shown here, includes one floppy disk, one (slow—80-millisecond access time) hard disk, and 640K RAM (only 512K are visible in this photo). Heavy use of VLSI technology puts ports and controllers on the system board.



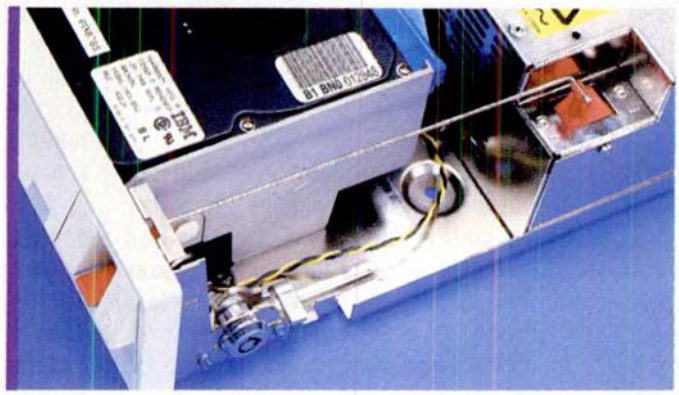
Photographs: Thom O'Connor



The Model 30's expansion slots are placed horizontally, parallel to the system board. This saves space and contributes to the machine's 16- by 15.6- by 4-inch footprint.

Expansion slots

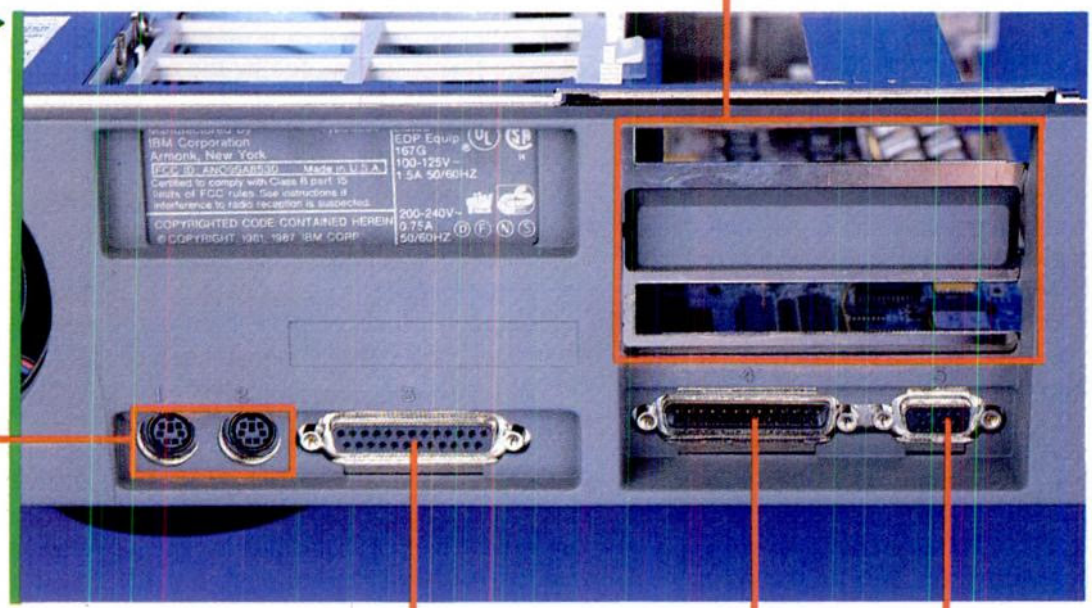
IBM calls this the Generally Operational Linear Digit-Controlled Biphase Electrical Retardance Gate (GOLDBERG—as in Rube), but you can call it the power rod. It connects the big red switch with the power supply.



Power rod

Horizontal expansion slots

The compact back panel of the Model 30 includes interchangeable keyboard and mouse connectors, parallel, serial, and video interfaces, and three horizontal expansion slots.



Interchangeable keyboard/ mouse connectors

Parallel port

Serial port

Video connector

instruction sets supported by an AT's 80286, but it will run most current PC software faster than an 8088-based machine, and roughly as fast as an 8-MHz 80286. The Model 30 lagged behind an AT on pure number-crunching performance tests, but equaled it on string manipulation.

The Model 30 comes in two configurations, a two-disk version (both are 3½-inch, 720K-byte drives) and a hard disk system with a 20-Mbyte drive and one floppy disk drive. None of those disk drives are high achievers. At 80 milliseconds, the 3½-inch hard disk in the Model 30 is only slightly better than the disks IBM installs in XTs, and far behind a stock AT's 40-millisecond hard disk.

The floppy disk drives test at about 300-millisecond access, noticeably slower than the 230-millisecond floppy drives in an XT.

There's little else to criticize about the Model 30. IBM is giving customers almost everything they've been screaming for since the PC was introduced.

The keyboard and monitor cables are a free-wheeling 6 feet long. The on button is right up front, conservatively shielded from accidental brushes by a sloping front canopy. The cover is detached with but four screws that can be easily reached on the machine's sides, so you don't have to disconnect tightly stretched cables and swing the machine around to install a board.

The most merciful of all ergonomic considerations is the complete banishment of jumper switches. All options are software configurable and stored in ROM. There's a battery-powered clock as well.

For the security-conscious, several holes have been drilled into the system unit to readily accommodate bolts. A lock and key is standard on hard disk–equipped machines. Several inches have been shaved on all sides: the Model 30 is 1.5 inches shorter than an AT, 3.6 inches narrower, and 0.5 shallower.

BY THE BOOK Even documentation has been generously improved. A slim handbook replaces the cloth-covered 3-ring binders that did more to obfuscate than elucidate. Purists may object to the condensed instructions; some valuable information is being held back, they may fear. Indeed, whereas IBM once devoted a full page—with a series of illustrations and exploded diagrams—to fully explain the principles involved in keyboard tilt adjustment, nary a sentence appears on the topic in the new manual.

You may have to grapple with such grave issues on your own this time, but I felt more than compensated by the new handbook's concise, clear style. It's a welcome change.

Most people will find installation is easier than on any other computer, although labeling the identical keyboard and mouse ports on the rear panel would save us all from confusing the two.

The new IBM mouse plugs right into the system, rather than through a serial port, but serial and bus mice will still work.

FILLING THE SLOTS Up to three 8-bit XT-compatible expansion boards can plug into the unit's expansion bus, which connects to the system through a card that has three sockets and attaches to the motherboard at a 90-degree angle. It's held in this upright position by a flimsy plastic bracket that extends several inches from the top of the power supply, behind it.

Expansion boards slide into the expansion bus connector card. They are supported on the left by openings in the machine's rear panel that you create by prying off a strip of plastic with a screwdriver. They are supported on the right (if it's a full-length board) by molded slots. It's a shaky system that requires you to mangle the plastic slots IBM has attached to the expansion board's opening on the rear panel. In addition, you are forced to hold the expansion card firmly in place as you slide the board into its connector—a moderately painful experience, thanks to the dozens of sharp wires that protrude from the rear of the expansion bus connector.

While most expansion boards will present no problems, there may be difficulty with some of the more bulky hard disk cards: the expansion bus connector also houses the system's battery and takes up some of the space required by a few hard cards.

With a power supply of 70 watts, the Model 30 uses slightly less than half the power that an XT does (130 watts) and allots 20 watts to power the three slots. That's enough to run most hard cards (which can require up to 13 watts) but it won't leave much for other options you may want to include.

Although there's no current option to do so, RAM expansion may be possible, since 512K bytes of system RAM is removable. Although 128K bytes are soldered to the system board, two 256K-byte banks of IBM's new SIP (Single Inline Package) memory can slide out.

Model 30 owners who envy only the graphics capabilities of the other PS/2 machines have IBM's commitment that a $585 VGA graphics board will soon be available.

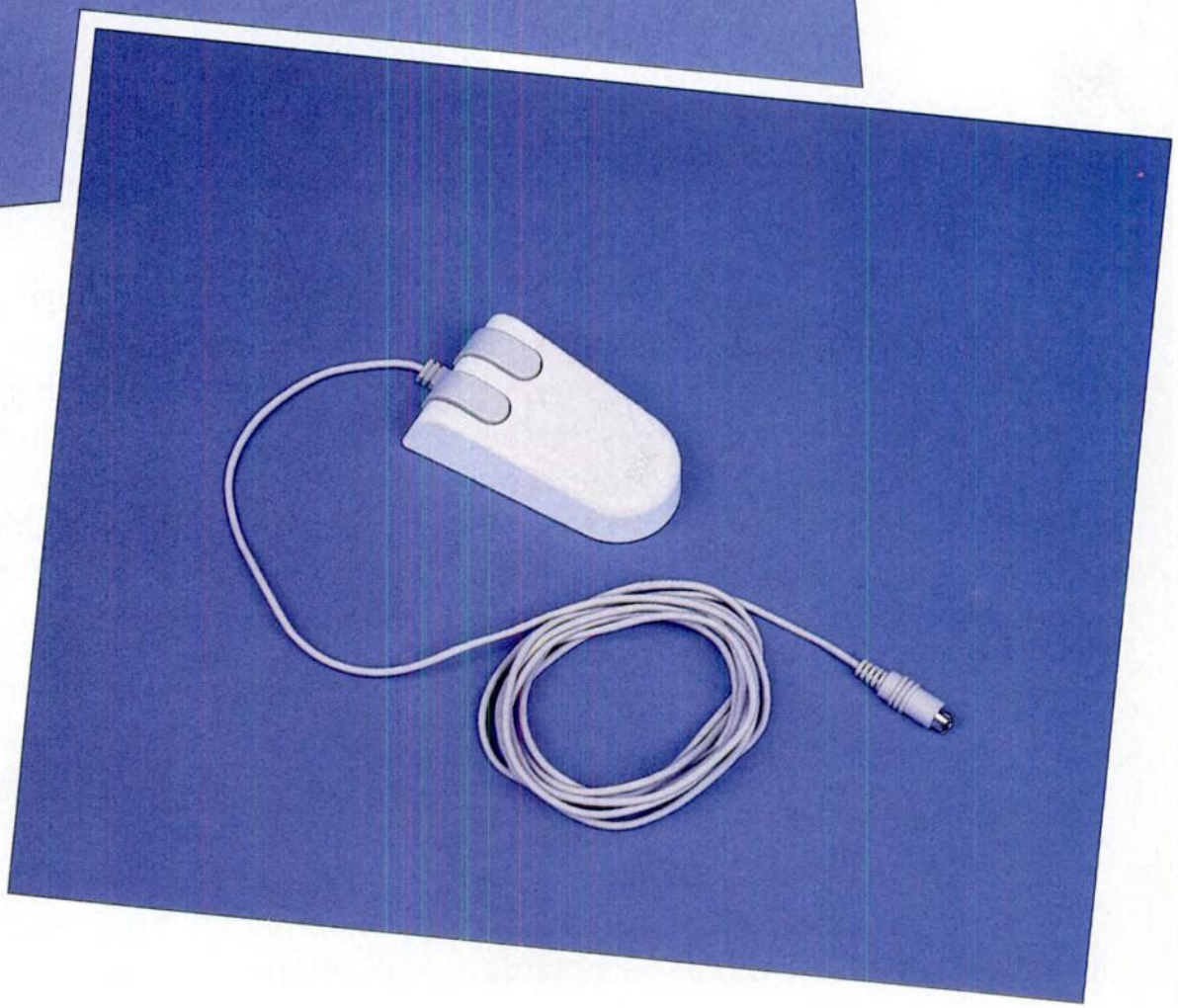
IBM's marketing force didn't exactly roll up their sleeves and clench their fists when they priced the Model 30. Clearly, you can find a comparable system at a lower price elsewhere, without switching to 3½-inch disks. But this time, other than passing up the IBM reputation, you'll also be missing your chance to get in on the ground floor of the new system.

Gus Venditto is senior editor at PC Magazine.

PC MAGAZINE FACT FILE

IBM Personal System/2 Model 30
IBM Corp.
Consult your local authorized IBM dealer:
(800) 447-4700
List Price: Model 30-002, $1,695, includes two 3½-inch, 720K-byte disk drives; Model 30-021, $2,295, includes one 3½-inch, 720K-byte disk drive and a 20-Mbyte hard disk.
Requires: DOS 3.0 or later, VGA-compatible monitor.
In Short: Smart engineering and VLSI technology put most everything you need on the Model 30's system board: graphics, 640K RAM, and disk controllers. You can add three XT-compatible expansion boards, but the shaky design of the expansion bus connector won't instill confidence.

CIRCLE 657 ON READER SERVICE CARD



The Model 30's 101-key keyboard has a luxuriously long 6-foot cable. The design, featuring 12 function keys and LED displays, is identical to that of the enhanced AT keyboard. The two-button mouse (a $95 option) plugs directly into the system rather than into a port and comes with a device driver.

Photographs: Thom O'Connor

IBM PERSONAL SYSTEM/2 MODEL 50

The PS/2 Model 50 is tiny in comparison with the AT it supersedes, yet it is more powerful and priced in the same range. Standard equipment includes a 3½-inch microfloppy disk drive and an agonizingly slow (80-millisecond access time) 20-megabyte hard disk that cries out to be replaced by a larger, faster unit. The VGA monitor is optional, and four models ($250–$1,550) are available.

Photograph: Roberto Brosan

With its small footprint, Micro Channel bus, and 10-MHz speed, the Model 50 could set the standard for the next generation of desktop workstations.

At first thought, the prognosis for the Personal System/2 Model 50 is grim: a new, smaller PC incompatible with the old hardware and made mostly from plastic. For a clone the future would seem bleak. Even IBM should have learned a lesson from such previous designs.

Lo! The Personal System/2 Model 50 proves itself a worthy successor to the PC line. Although its advantages might not be obvious today, eventually the Personal System/2 Model 50 will be the machine to own.

At 10 MHz, generally operating with one wait state, the Personal System/2 Model 50 uses the fastest 80286 technology that IBM offers, matching what undoubtedly is the new standard of the PC industry. It incorporates a novel design that makes adding or modifying the system hardware configuration a matter even the most ham-handed klutz can handle. It's small enough to fit into a desk drawer (if you have a large, empty desk drawer). At $3,595, it's amazingly affordable (in the IBM scheme of things). And it offers innovations that truly make the Personal System/2 Model 50 the next generation of personal computer.

The breaks with the past should be expected: the PC standard is more than 5 years old, edging past the lifetime predicted for its design when the machine was first introduced in 1981 (the standard IBM product cycle was then pegged at 5 years). Without giving up software compatibility—and access to the largest base of business computer software in the world, programs written to the MS-DOS standard—the Personal System/2 Model 50 pushes the personal computer into new levels of technology needed for miniaturization and multitasking. It also adds more built-in security and a design that's optimized for automatic assembly, helping IBM build a made-in-America product that's cost-competitive with low-cost Pacific Basin labor.

ENGINEERING INNOVATIONS

More compact than any previous IBM-brand 286-based computer (5½ by 14 by 18½ inches, HWD) the Personal System/2 Model 50 earns its small size by shrinking just about everything from disk drives to integrated circuit chips. Along with that size reduction comes a rethinking and reengineering of the PC expansion bus into IBM's new Micro Channel Architecture—resulting in such a complete restructuring that ordinary AT and PC expansion boards won't work in the Personal System/2 Model 50.

Part of the explanation is readily visible: the Personal System/2 Model 50 uses smaller expansion connectors, ostensibly so that their more closely spaced pins (on .05-inch centers) better match the spacing of the leads of the surface-mount components that are rife throughout the Personal System/2 Model 50.

The slots themselves are smaller, too. The new limit on expansion board size is 11½ by 3 inches, with spacing of about ¾ inch between the slots.

The Personal System/2 Model 50 provides four slots, all with the new 16-bit Micro Channel bus, but one is used by the standard equipment hard disk controller. Two of the others (and the hard disk slot) use dual 58-pin connectors that look like miniaturized versions of the old AT bus. The fourth adds an extra section for exchanging video signals with the new graphics system that's built into the system board.

Expansion cards are secured at the bottom rather than the top by knurled captive screws. Unless Rambo starts installing blank retaining brackets on the IBM production line, you should be able to loosen the screw and swap cards using no tools, just your fingers.

THE NEW BUS More important than the physical innovations, however, are alterations IBM has made to the electrical structure of the expansion bus. Many of the characteristics of the Personal System/2 Model 50 Micro Channel expansion bus are familiar: 24 address lines capable of handling 16 megabytes, 16 data lines, and the ability to detect when 8- or 16-bit bus expansion cards are used. Beyond

that, IBM has incorporated additional measures of control, including a special bus arbitration manager.

The new bus arbitration hardware allows the Personal System/2 Model 50 to shift more efficiently between different tasks. In addition, the Personal System/2 Model 50 features eight Direct Memory Access (DMA) channels, all of which may be operated simultaneously to shift bytes between memory, disks, video, and I/O ports. Thus the very heart of Personal System/2 Model 50 proves that it was designed from the beginning to be a multitasking computer.

Other bus modifications, such as the use of level-sensitive instead of edge-sensitive interrupts, will be of concern only to hardware developers. However, IBM has also made life easier for end users to install system options by incorporating a new Programmable Option Select (POS) system into the Personal System/2 Model 50. The POS system detects the expansion options installed in the Personal System/2 Model 50 and automatically sets the machine up accordingly. No more DIP switches or jumpers to worry about.

The new Micro Channel bus continues the IBM personal computer tradition of open architecture. IBM technical reference materials furnish all the support necessary for hardware developers to create their own internal peripherals.

PHYSICAL CONSTRUCTION The physical construction of the Personal System/2 Model 50 shows that IBM can learn from its mistakes, and learn a lot. The construction of the Personal System/2 Model 50 continues the tradition started with the PC*jr* and carried on by the Proprinter: an easy-to-manufacture plastic case filled with snap-together subassemblies. The result in the Personal System/2 Model 50 is that the whole system can be field stripped into its major subassemblies in a minute or two, even if you've never taken a glance at a service and repair manual.

The case, although different in design and execution, is conceptually the same as that of the PC*jr*—high-impact plastic liberally painted with conductive silver paint for the radio frequency shielding required to make the Personal System/2 Model 50 meet FCC Class B emissions specifications. One large plastic casting serves as the foundation and back panel for the chassis. A second provides an inner drive shelf, and a third becomes the front panel itself.

PC MAGAZINE FACT FILE

IBM Personal System/2 Model 50
IBM Corp.
Consult your local authorized IBM dealer:
(800) 447-4700.
List Price: $3,595
Requires: DOS 3.63, VGA-compatible monitor.
In Short: The Model 50 is the foundation of IBM's Personal System/2 line: a cost-effective, multitasking single-user workstation. With three available 16-bit Micro Channel expansion slots, built-in communications ports, 1 Mbyte of RAM, and VGA graphics, it's affordably priced.

CIRCLE **656** ON READER SERVICE CARD

Only the top and sides are genuine metal, a single-piece stamping with rolled bottom and rear edges, plus spot-welded brackets for the attachment of the front panel. Metal braid in lips around the edges of this cover ensures that no stray electrical emissions leak out.

The exterior of the front panel is divided into four functional areas. On the right, the red paddle of the on/off switch pokes through. Two small rectangular cutouts allow LEDs to gleam through to indicate power on (green) and hard disk activity (yellow).

Next on the right are two cover panels for the floppy disk drives. Unlike those on previous PCs, these covers are part of the chassis front panel—not the disk drive. They are individually removable for upgrading the system drive endowment.

The final section on the far left merely covers the speaker and provides a convenient resting place for the IBM logo. The bottom third of the front panel is slotted for system ventilation.

The rear panel looks Spartan compared with previous IBM designs. On the left are three shiny metal retaining brackets hiding internal expansion slots. At the right rear is a single power connector but no provision for juicing up a display. Along the bottom run the connectors for the built-in ports: serial, parallel, display output, and two input ports. At top left is a key lock that prevents people from poking inside the chassis when you're not around. Two knurled, finger-tight captive screws at the top of the rear panel hold the lid on the system.

INSIDE THE PS/2 The inside of the Personal System/2 Model 50 holds its real wonders. There's not a loose wire to be found. The whole computer consists of naught but plug-together subassemblies. Even the lowly screw has been nearly banished. Most of the machine merely snaps or slides together.

Dominating the right side of the system unit is the long, narrow chrome box of the switching power supply. As with that of the XT Model 286, this unit automatically figures out what kind of electricity you've plugged it into and adjusts itself accordingly, between 90 and 260 volts (in two discrete ranges, 90 to 137 and 180 to 265 VAC) at any frequency between 50 and 60 Hz.

The real efficiency of the Personal System/2 Model 50 design is best illustrated by the Personal System/2 Model 50 disk drives. The system has the capacity for three 3½-inch form-factor units: in the IBM scheme, two floppies and one hard disk. All of these drives mount on a molded plastic shelf which, again, is coated with conductive paint that shields the drives from the system electronics.

The two floppies (one is standard equipment) install side by side directly behind the front panel. The drives are secured in place by special plastic rails on the bottom. They slide backward into a card edge connector that's mounted on either branch of a T-shaped printed circuit board that plugs into the system board below the mounting shelf. A small tab under the front edge of each drive latches it in place. To slide a drive out, you must gently lift this tab. During installation, it snaps securely down on its own. The drives themselves are made by Alps Electronics.

The hard disk drive installs inside the chassis, behind the floppies. It is held in

place by a pair of rails, but it is also locked in place by a pair of plastic tabs, one at either side of the front of the drive. The hard disk plugs directly into its controller, which in turn plugs into one of the expansion connectors on the system board.

The standard Personal System/2 Model 50 hard disk itself is one of the system's major disappointments. A major step backward, the capacity of the IBM-made drive is a paltry 20 megabytes. Worse yet, with an average access time of 80 milliseconds, it performs like an XT drive. Only IBM would have the gall to put a slower drive in a faster computer. The Personal System/2 Model 50 really cries out for a better-performing, higher-capacity hard disk.

Higher-capacity drives (70 megabyte and beyond), which are available from IBM for step-up models of the new Personal Systems, use the enhanced small device interface (ESDI) interconnecting scheme and a 10-MHz data transfer rate. However, the 20-megabyte units of the Personal System/2 Model 50 are strictly standard ST-506, with a 5-MHz transfer rate. Presumably, the flexibility gained by putting the hard disk controller on an expansion card rather than on the system board promises that a higher-performance product may become available for the Personal System/2 Model 50.

The entire drive shelf is secured by eight snap-lock connectors that can be popped loose either with a finger grip or by using a special tool (actually a small piece of molded plastic) that is included inside the Personal System/2 Model 50. The whole shelf can be removed, with or without the drives remaining in place (if you don't mind sliding out the controllers and T-board adapter at the same time).

At the rear of the shelf, to the right of the center of the system unit, is a large diameter fan in a slide-in plastic mounting that's also secured by a snap-lock connector. Because of this fan and its placement, system airflow and cooling is superior to previous PC designs. Fresh air is sucked through the ventilation slots in front of the machine, over the electronics and disk drives, and exhausted directly out the rear of the machine. The hottest element of the system—the hard disk drive—is located nearest to the fan.

Quieter than the power supply fans of previous IBM desktop machines, the new fan—rated at 40 dB with system noise increasing to 46 dB when the disk drives are running—the fan noise should be objectionable only in quieter offices. (It still bothers me.)

The loudspeaker and battery pack comprise a third removable assembly, normally located in the left front corner of the chassis. The battery is separately removable from this chassis and is, thankfully, a relatively common Panasonic 6-volt unit.

A more formidable obstacle to the clone makers is surface-mount technology used for the system board and the hard disk controller of the PS/2 Model 50.

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THE SYSTEM BOARD Underlying all is a near-masterpiece of a system board. Besides the nominal circuitry of previous AT system boards, it contains the serial and parallel ports, clock, and full megabyte of memory that AT-compatible makers have been installing on their motherboards for years. To this basic endowment, IBM adds a floppy disk controller and an entirely new video system.

Prominent on the board are three square aluminum cans and a similar black epoxy chip, each about 2 inches on a side. These components are very large scale integration (VLSI) circuits custom-made by IBM. Some reporters believe that these proprietary chips are IBM's attempt to prevent (or make more difficult) the cloning of the Personal System/2 Model 50. But, noting the rapid appearance of Chips and Technologies' EGA and AT VLSI chip sets, undoubtedly the Personal System/2 Model 50 chips are under the electron microscope right now, and engineers are heading full speed in reverse.

A more formidable obstacle to the clone makers is the surface-mount technology used for the system board and the hard disk controller of the Personal System/2 Model 50.

Ordinarily, discrete parts are installed on conventional printed circuit boards by sliding component leads through holes in the circuit board, then soldering the components into place. Although large board makers automate their production lines, this assembly technique is just as available to garage and basement manufacturers. Anyone with a soldering iron can build this sort of circuit board.

Surface-mount technology changes all that. Surface mount puts chips and other circuit components into packages a fraction the size of those with ordinary leads. That makes circuit boards more compact and helps shrink the size of the Personal System/2 Model 50 motherboard.

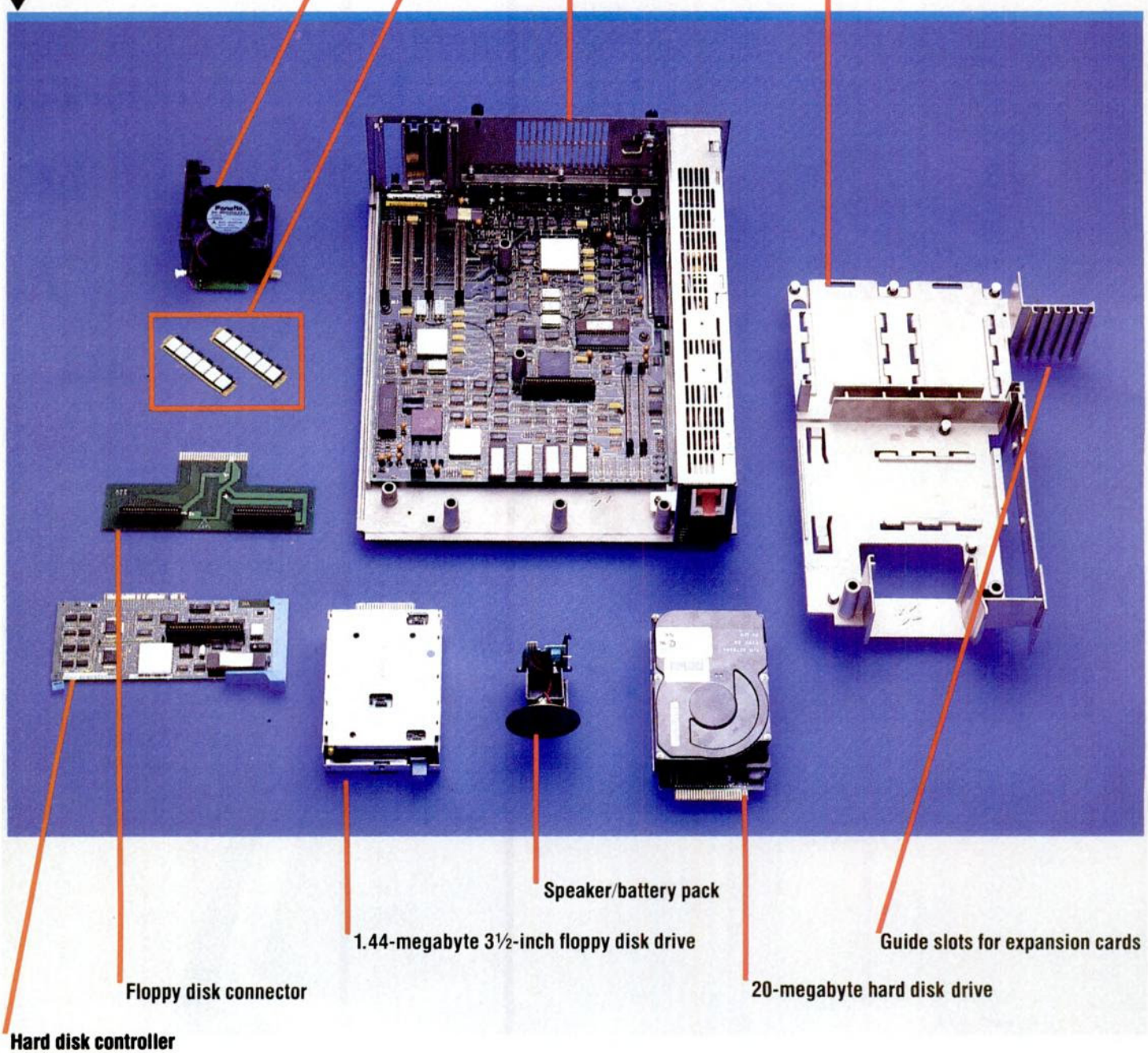
However, as the name implies, surface-mount technology breaks with past tradition. Component leads solder to the surface of the circuit board rather than sliding through holes in it. Because of the small chip size and the unconventional installation technique, making surface-mount circuit boards requires specialized and expensive machinery, currently out of reach for the garage shop. Smaller and low-volume manufacturers will have a difficult time breaking into the Personal System/2 Model 50 market.

SYSTEM AND VIDEO MEMORY Despite the VLSI chips, the Personal System/2 Model 50 motherboard still uses a large amount of discrete logic. Eventually these chips may be squeezed into the VLSI arrays, too, condensing the system board (or that of a clone) even further.

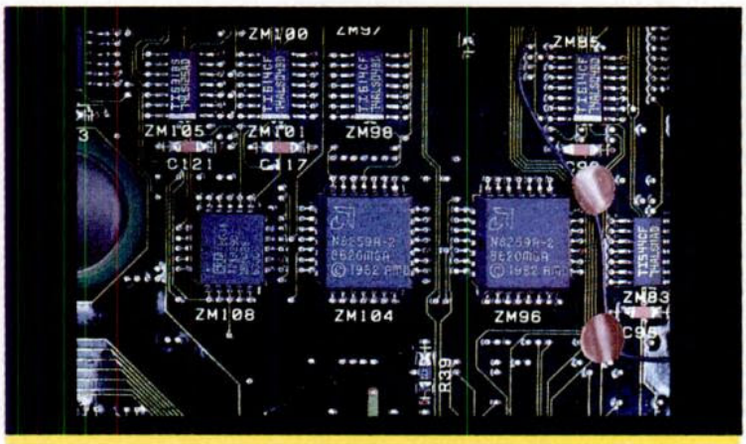
On the right side of the system board are two separate memory banks for system RAM and the video display. Base configuration of the Personal System/2 Model 50 includes a full megabyte of dynamic RAM, implemented in two memory boards, each of which contains six IBM proprietary RAM modules near the

PS/2 Model 50

A marvel of modular design, the Model 50 should make for easier PC maintenance and repair. All of the main elements can be easily removed from the CPU chassis.



Photograph: Thom O'Connor



By using Single Inline Memory Modules (SIMMs) and Surface Mount Devices (SMDs), IBM engineers packed an 80286 microprocessor, an 80287 math coprocessor, a megabyte of RAM, and three expansion slots onto a compact motherboard that helps make the Model 50 the slimmest IBM desktop computer yet. Only 14 inches wide, it's 6 inches narrower than a PC or XT and 9 inches narrower than an AT.

front of the system board. The IBM memory map divides this endowment into 640K-byte base memory for DOS and 384K-byte extended. (Expansion board options can increase the official IBM RAM endowment to 7 megabytes, although the microprocessor can handle up to 16.)

Behind the system memory are eight 4-bit by 64K-bit chips used for video memory—a total of 256K bytes—soldered to the motherboard. Across the front edge of the system board runs a series of four socketed 32K-byte ROM chips, giving a total of 128K bytes of firmware (including, of course, BASIC). Another 64K bytes of battery-backed-up CMOS RAM, used for system setup information, is contained in the time-of-day clock chip, which is also located on the system board.

At the left front of the system board is the microprocessor, an Intel-made 80286-10, and nearly adjacent to it is a socket for an 80287-10 coprocessor. Both the main processor and coprocessor operate at 10 MHz, derived from a 40-MHz crystal soldered to the board. Because the microprocessor only devotes about 7 percent of its time to system overhead such as refreshing memory, it's actually a trifle faster than the 10-MHz speed in other one-wait-state machines.

The essentials of the system board floppy disk control system represent a continuation of past practices, based on a NEC 765 controller chip. However, system firmware has changed allegiances to support only 3½-inch floppy disk media at the old 700K bytes per disk, as well as the new 1.44 megabytes per disk formatted data densities. New, improved PC DOS 3.3 is also required to make use of the miniature high-density diskettes.

Although the parallel port built into the system board brings no new surprises, the serial port advances on its predecessors by supporting a speed one notch higher—19,200 bits per second—through use of a 16550 UART chip (a newer version of the 16450 used by the AT). Unlike the AT, however, the Personal System/2 Model 50 serial port uses a full-size male DB-25 connector. The parallel port uses the standard female DB-25.

The new Video Graphics Array (VGA) system is disappointing in that it incorporates no video coprocessor, such as Intel's 82786 or Texas Instruments TMS34010. Instead it is built around a proprietary gate array that offers improved resolution without the ten-to-hundredfold speed increase possible with a coprocessor. (A new, proprietary coprocessor board is available from IBM as an option.)

The highest color resolution supported by the system is 640 by 480 with 16 on-screen colors.

RESOLUTION The highest color resolution supported by the system is 640 by 480 with 16 on-screen colors (selectable from a palette of 256). A degraded, two-color (monochrome) mode is also available at the same resolution. That resolution capability is very desirable because it results in easy-to-calculate and -manipulate square pixels on normal 4:3 aspect ratio monitors. A new 320 by 200 graphics mode that allows 256 simultaneous on-screen colors is also available.

Text resolution is even sharper: 720 by 400 pixels in either 16 colors or shades of gray in monochrome. Characters in this mode are more detailed than ever before, with each constructed from a 9 by 16 matrix of on-screen dots. These same characters are also available in a new 360 by 400 16-color text mode for 40-column displays.

As with previous new IBM video standards, taking full advantage of VGA requires an entirely new kind of monitor that uses an analog interface (rather than the digital displays used with all previous PC displays except the PGC).

Most of the new video modes require a horizontal frequency of 31.5 KHz with a refresh rate of 70 Hz to reduce flicker. Also available are two 60-Hz graphics modes that trade off a slower refresh rate for a greater number of text lines in graphics mode: 30 lines per screen, instead of 25 lines.

IBM offers four new displays to match the new VGA standard: three color (12, 14 and 16 inches, measured diagonally) and one paper-white monochrome. Color or monochrome displays can be plugged in interchangeably and still operate properly. The monochrome monitor displays up to 64 shades of gray, mapped from color by using only the green signal from the RGB triad.

The new display standard also incorporates a new connector with 15 pins instead of the previous 9, so you have no worries about accidentally plugging in the wrong display and turning it into charcoal.

For full software compatibility, the new VGA system also supports past IBM video modes down to 40-column text and graphics. In the old-fashioned 200-line video modes (320 by 200 and 640 by 200 graphics), the displays are double-scanned at a 400-line rate, making on-screen characters look sharper but just as chunky as on a 200-line display.

KEYBOARD AND MOUSE Although the keyboard used by the Personal System/2 Model 50 is the same as that of the latest AT models with the 101-key Advanced Keyboard layout, IBM has been at work updating the input provisions of the computer, too. The system unit now features built-in support for a pointing device (read: mouse).

The two input jacks on the rear panel of the Personal System/2 Model 50, which both use 6-pin DIN connectors, are supposedly identical so that the keyboard and pointing device can be plugged in interchangeably. However, the evaluation system wasn't as forgiving as IBM promised and gave an error message when the keyboard was connected to what it thought was the wrong socket.

Password protection is now built right into the keyboard system. The keyboard itself can be locked out so that unauthorized people cannot tamper with the system. The password is set with the new Personal Option Select setup utility.

IBM now supplies its own two-button mouse, rather elongated (though usable) in shape, that plugs into the Personal System/2 Model 50 with a single cable and requires no separate power supply. The IBM mouse is built around a free-spinning rubber trackball, much like the Microsoft product.

Even the setup and diagnostic software supplied with the Personal System/2 Model 50 has stepped a generation forward. Instead of the stark white text of previous products, the new system uses colorful menus that give a stacked windows-like effect as you dive through their depth. Option selection is now automatic, facilitated by the POS system.

THE DOWNSIDE Buying the Personal System/2 Model 50 today has its downside: 3½-inch disks only, and no internal expansion options except for those supplied by IBM. Only when IBM's multitasking Operating System/2 finally becomes available (promised early next year) and software makers release new products for it will the Personal System/2 Model 50 really prove its worth. If you need hefty PC power now and price is important, a cheap AT clone is still a good bet.

As time goes by, however, the current shortcomings of the Personal System/2 Model 50 will disappear (though the machine will still be burdened by a slow hard disk). Its upside is its future. The Micro Channel bus and downsized everything hold the potential for being the standard for the next generation of desktop workstations. Buying a clone today may load down your desk with obsolete hardware the day you decide you need a multitasking system.

Compared with the brand name 10-MHz AT compatibles that are currently available, the added expense in acquiring the $3,595 Personal System/2 Model 50 is trifling once you figure in all the built-in features (like VGA) and its future promise. It's an attractive machine at an attractive price that promises to become increasingly valuable to you, notwithstanding physical depreciation, as progress is made in software.

Winn L. Rosch is a contributing editor of PC Magazine.

Triple Standard

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THREE NEW VIDEO MODES from IBM

IBM's new Personal System/2 line of products includes three new video standards and four new monitors. All of the PS/2 models have a video adapter built into the system board. All you need to get running is one of the new monitors.

The three new video standards are the Multicolor Graphics Array (MCGA), which is built into the Model 30 system board; the Video Graphics Array (VGA), which is built into the Models 50, 60, and 80 system board (the VGA is also available as an add-on board for the Model 30 or existing PCs, XTs, and ATs); and the 8514/A, a high-resolution add-on board for the Models 50, 60, and 80.

All of the new video adapters include 640 (horizontal) by 480 (vertical) graphics resolution, which ia a step up from the 640 by 200 graphics of the IBM Color/Graphics Adapter (CGA) and the 640 by 350 graphics of the Enhanced Graphics Adapter (EGA).

IBM has also gone analog—all of the new video adapters are capable of displaying 256 simultaneous colors out of a palette of 262,144 total colors. There's a catch, however. Although IBM was able to dazzle spectators with some stunning 256-color displays during its PS/2 announcements, the morning-after analysis revealed a disappointment: with the exception of the expensive 8514/A, the 256 simultaneous colors can only be displayed in 320 by 200 graphics resolution.

The new video adapters have compatibility modes that emulate the CGA and EGA, so most existing software should

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With three new standards and four new monitors, IBM hopes to change your definition of high-quality video output.

run with only the usual number of problems inherent in video emulation. Expect software support for the new video modes real fast: IBM has wised up and now recognizes the importance of communicating with software vendors.

THE 640 BY 480 ADVANTAGE The 640 by 480 resolution is not new, even to IBM. IBM's $2,995 Professional Graphics Controller used 640 by 480. But this is the first time IBM is giving this resolution to the masses. In doing so, they're a little behind other manufacturers. Many of the "super EGA" boards—such as those from Paradise, STB, Tseng Labs, and Video-7—have already been offering 640 by 480 for owners of the NEC MultiSync and other variable-sync monitors.

What's so magic about 640 by 480? The viewing area of most video displays has an aspect ratio of 4:3, which means that the display is one-third wider than it is high. With a resolution of 640 by 480, the number of pixels per inch is the same both horizontally and vertically.

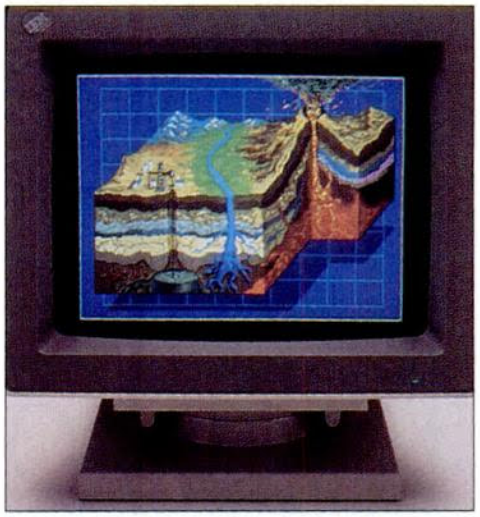
While this little dividend is nice for programmers, it also benefits users. In some cases, it means faster graphics with less distortion. A graphics program can use the same digitized fonts for both horizontally and vertically aligned text, reducing storage necessary for the fonts.

IBM has also made the switch from digital to analog. This allows a greatly increased array of colors.

In a digital video system, each color signal that the adapter sends to the monitor can be either on or off. The CGA had four color signals and can display 16 different colors. The EGA has six color signals and can display 64 different colors.

An analog system requires only three color signals: red, green, and blue. However, each of these signals can be varied over a continuous range. All the new IBM video adapters can generate 64 different levels for each of the three color signals. The total number of red-green-blue combinations is 64 times 64 times 64, or 262,144. This is called the "palette."

In most analog video systems, the number of colors that can be *simultaneously* displayed is much lower. This is a restriction based on the amount of video memory and its organization within the adapter hardware. At best, the new IBM video adapters can display only 256 of these colors at once.



Photograph: Courtesy of IBM

The effective resolution of the VGA adapter's 80-column text mode is 720 by 400.

The Multicolor Graphics Array (MCGA) is the low-end member of IBM's new line of video adapters. It is found only on the PS/2 Model 30. The MCGA has 64K bytes of video memory and offers emulation of the IBM CGA (320 by 200 graphics mode with four colors, 640 by 200 graphics mode with two colors), a new 320 by 200 graphics mode with 256 colors, a new 640 by 480 graphics mode with two colors, and use of an 8 by 16 character box in text modes.

In 80-column text mode, the effective resolution is 640 by 400, but this resolution is not available in graphics. In all video modes, the colors can be chosen from the palette of 262,144 colors. (As you might expect from past experience, IBM does not give you a utility to do this.)

The PS/2 Models 50, 60, and 80 have an on-board video adapter called the Video Graphics Array (VGA). This adapter has 256K bytes of memory (the same amount as a fully loaded EGA) and offers emulation of the IBM EGA (including CGA emulation), 320 by 200 graphics mode with 4 or 16 colors, 640 by 200 graphics mode with 2 or 16 colors, 640 by 350 graphics mode with 16 colors, a new 320 by 200 graphics mode with 256 colors, a new 640 by 480 graphics mode with 2 colors, a new 640 by 480 graphics mode with 16 colors, and use of a 9 by 16 character box in text modes.

The effective resolution of the 80-column text mode is 720 by 400, but this is not duplicated in the graphics modes. As in the MCGA, the colors can be chosen from the 262,144-color palette.

SORTING OUT THE MODES The new (and old) video modes seem to encompass a lot of different dimensions, but they separate into a few groups.

All of the graphics modes have a horizontal resolution of either 640 or 320. The VGA text mode is an oddity at 720. All the modes use one of three possible vertical resolutions: 350, 400, or 480. What happened to the vertical resolution of 200? For these modes, the adapter simply displays each scan line twice for 400 scan lines. The 400 scan lines are also used in the text modes: each character is 16 pixels high, and 25 lines of text are displayed.

The VGA gets by with only two crystals: a 25.175-MHz for the 640 and 320 horizontal resolutions and a 28.322-MHz for the 720 pixels used for text. All video modes have a horizontal sync rate of 31.5 KHz. The 350- and 400-scan-line modes have a vertical sync rate of 70 Hz; the 480-scan-line modes run at 60 Hz.

The VGA BIOS contains three fonts that can be loaded into the adapter or used to display text in graphics modes. An 8 by 8 font is used with the 200-scan-line graphics modes when writing text, an 8 by 14 is used for the 350-scan-line graphics modes, and an 8 by 16 font is used in the text modes and the 480-scan-line graphics modes.

On the EGA it is possible to use the 8 by 8 font in text mode to get 43 lines on the display instead of 25. With the VGA you can also use the 8 by 8 font in text mode, but then you will get 50 lines per screen.

An owner of a Model 30 (or an existing PC, PC-XT, or PC AT) can add VGA by the purchase of the PS/2 Display Adapter

for $595. (We have not seen this board yet; IBM expects to release it this month.) Since VGA is also EGA compatible, this is a very nice price and comparable with existing "super EGA" boards.

With both the MCGA and VGA, the only way you can get 256 simultaneous colors is with the 320 by 200 graphics mode. It sure looks pretty, but if you want to display text along with the graphics, you're limited to 25 lines of 40 characters. This is not adequate for many applications.

What makes this problem all the more frustrating is that the 256K bytes of video memory in the VGA is sufficient for a graphics video mode of 640 by 400 with 256 colors. Whether such a mode is possible with custom programming of the VGA registers is not clear yet, but it's definitely not supported by the BIOS.

With the arrival of OS/2, most graphics applications will probably be programmed for the OS/2 Windows Presentation Manager. *Windows* requires an 80-character-wide display, which means that *Windows* will need to use the 640 by 480 mode with 16 colors.

The only way you can get more than 16 colors in a 640 by 480 mode is to make the step up to the 8514/A adapter (described here later).

PROGRAMMER'S PERSPECTIVE From the programmer's perspective, the VGA is very similar to the EGA: it uses the same registers, similar color plane mappings for the 640 by 480 modes, and has an enhanced BIOS interface that builds upon the EGA BIOS.

IBM has fixed some of the hardware and BIOS bugs in the EGA and made most registers read/write. This means that it's possible to retrieve and later restore the entire video state. This is very useful for a multitasking environment when dealing with programs that directly access the video hardware.

The video adapter hardware and register documentation is included in IBM's *Technical Reference* manuals for the PS/2 models. IBM also has a new "BIOS Interface Technical Reference" that documents the BIOS for all PC and PS/2 machines. This manual includes lots of programming hints: for instance, how to deal with the ever-more-perplexing problem of determining what type of adapter is attached to the machine.

However, the "BIOS Interface" manual does not include actual BIOS listings. Programmers will have a rougher time determing what's really going on inside the BIOS in order to resolve questions about BIOS quirks and BIOS bugs and to learn about techniques for using the PC and PS/2 hardware directly. The manual also does not include other vital information, such as the video parameter tables.

All the new video adapters have a new 15-pin connector for the monitor cable. The boards cannot be used with previous IBM monitors and most compatible monitors. IBM has four new analog monitors (see table) for the PS/2 machines. You can connect any of these four monitors to either the MCGA or VGA adapters.

The low-cost 8503 is not a high-persistence green-screen monochrome display of the type we're accustomed to, but a true black-and-white monitor capable of displaying 64 gray shades.

Even with four monitors, this selection isn't satisfactory. The 8512 uses black-stripe technology, and it's a bit too fuzzy; the 8513 is too small compared with previous IBM monitors; the 8503 is priced right, but it's also small and doesn't display color; the 8514 is just about right—except that it's too expensive.

Can NEC deliver a conversion cable to connect a MultiSync to the new adapters? The unofficial word is yes, but we haven't seen one yet. If NEC comes through with one, *PC Magazine* readers will be among the first to know about it.

THE 8514/A ALTERNATIVE The 8514/A Display Adapter board is IBM's high-end add-on for the PS/2 series. Neither the 8514/A nor technical documentation is available yet; at the time of this writing, IBM anticipated a June 1987 release.

The 8514/A uses the new bus connector, so it can be installed only in the PS/2 Models 50, 60, and 80. The board occupies a special slot in these machines that allows integration with the on-board VGA. The 8514/A board costs $1,290 and has a 1,024 by 768 16-color graphics mode in addition to the VGA modes. The resolution of 1,024 by 768 also preserves the 4:3 aspect ratio.

Adding the $270 8514 Memory Expansion Kit gives you two new video modes: 640 by 480 graphics mode with 256 colors, and 1,024 by 768 graphics mode with 256 colors. As with the VGA, the colors can be chosen from a palette of 262,144. IBM has indicated that the 8514/A includes a hardware assist for lines, fills, and bitblt (bit block transfers), but it stops short of saying it has a graphics coprocessor.

Although you can use any of the four PS/2 monitors with the 8514/A, only the 8514 monitor allows the 1,024 by 768 resolution.

The total cost of the 8514/A, the 8514 Memory Expansion Kit, and the 8514 monitor is $3,110. This is actually not a bad price for a high-resolution color system. Keep in mind that IBM's fully loaded EGA and Enhanced Graphics Monitor combination costs $1,662 and has a resolution of only 640 by 350 with 16 colors.

Does IBM realize that the 8514/A might appeal to a wider audience than just CAD/CAM professionals? Probably not. Although IBM has endorsed *Windows* for OS/2, it still doesn't seem to have grasped the fact that high-resolution big-screen graphics workstations are suitable for *everybody*.

IBM is going to be surprised at the sales of the 8514 system—it should have given this system a proper name.

Charles Petzold is a contributing editor of PC Magazine.

IBM's New Line of Monitors

Model	Price	Screen size (inches)	Description
8503	$250	12	Black and white
8512	$595	14	Color
8513	$595	12	Color
8514	$1,550	16	Color

IBM PERSONAL SYSTEM/2 MODEL 60

The PS/2 Model 60 is IBM's first personal computer designed to be positioned on the floor and used as the base of a multiuser system. $5,295 buys you a 3½-inch microfloppy drive, a speedy 44-megabyte hard disk, eight 16-bit expansion slots, and full-height drive bays that increase the number of available hard disk options. As is the case with the other PS/2 models, the VGA monitor pictured here is an option.

Photograph: Roberto Brosan

The PS/2 Model 60 has the kind of speed and multitasking power that could be the foundation of a small multiuser system.

A multiuser computer system must be able to stand on its own two feet. At least that's one interpretation of the philosophy behind the Personal System/2 Model 60, the machine IBM has designed as a medium-power multitasking, multiuser departmental and small business command center. The tower construction of the Model 60, which stands on two fin-like feet, has ample room for whatever expansion a multiuser machine might need.

Its power—based on a 10-MHz, one-wait-state 80286 microprocessor—makes it the logical replacement for today's AT in tomorrow's shared resource systems.

IBM offers the Personal System/2 Model 60 in two configurations, differing only in the hard disk included. The $5,295 Model 60-041 features a conventional 44-megabyte hard disk; the $6,295 Model 60-071 (not yet available) ups that capacity to 70 megabytes and doubles the disk data transfer rate with a more advanced disk interface. Both include as standard equipment a 1.44-megabyte, 3½-inch floppy disk drive; built-in serial, parallel, and mouse ports; high-resolution graphics; 1 megabyte of RAM; and a keyboard.

The most striking aspect of the PS/2 Model 60—and the design feature that testifies most directly to its multiuser design—is its packaging. While previous PCs have been adaptable to standing on the floor rather than sitting on your desktop (IBM offers edge-mounting cocoons for both the AT and RT), the Model 60 is the first true PC designed solely for vertical installation beside a desk. Standing 23½ inches high, 19 inches deep, and 6½ inches wide with its flat feet extending to a width of 12½ inches, the Model 60 is foremost a deskside (rather than desktop) companion.

All the controls you might normally have to access—the power switch, power and drive activity indicator LEDs, drive slots, and disk-release push buttons—are conveniently arrayed at the top of the tower on its front side. Unlike the edge-mount AT, access to the innards no longer requires coaxing the computer from the security of its protective outer shell, then resting the system unit flat on a desktop. Instead, the left side of the chassis can be pried off with no need to upset the Model 60 or move it from its normal operating position.

The chassis lid is secured for two captive screws with slotted heads large enough to make a penny, nickel, or dime the only tool needed for loosening the cover. A key lock ensures against unauthorized access but affords only physical security. Unlike the AT, the Model 60 lock does not switch off the keyboard. But an electromechanical keyboard lock is unnecessary because the keyboard can be electrically deactivated using a built-in password system.

The Model 60 case is molded from pale gray/beige high-impact plastic and coated with silver-based metallic paint to keep radio frequency interference from its electronics within the limits of FCC Class B certification. The system shell consists of three principal pieces: the main chassis, which forms the right side, top, bottom, and back; the removable left-side access cover; and a decorative, snap-on front panel.

The two feet, somewhat reminiscent of squared-off seal flippers, are bolted to the main chassis, as are all the internal subassemblies. For more compact storage or toting without fear of slicing open your ankles, you can rotate the Model 60's flippers out of the way. When standing, the machine is perfectly stable.

Should you decide to carry the Model 60 with you—for security, to move the machines between assignments in your business, or just to build up your biceps—you'll find IBM has thoughtfully included a full-length handle at the top of the case that folds down flat into a molded recess in the chassis. Though the handle does make the Model 60 more mobile than an AT, for example, at 40 pounds for the chassis alone, it can hardly be classed as portable. A set of wheels and a pull-chain would make more sense for interoffice maneuvers.

POWER PADDLE Beneath the handle, the top few inches inside the Model 60 case are filled by a squat, gamma-shaped power supply in a chrome-plated metal box that extends for the entire front-to-back depth of the system unit. The international orange power-switch paddle extends from the front edge of this subassembly.

As is IBM's practice on all its new personal computers since the XT Model 286, the Model 60 power supply is self-adjusting to whatever voltage is available. This autoranging capability adapts to line currents between 90 to 137 and 180 to 265 volts at line frequencies of either 50 or 60 Hz.

Inside the bottom of the power supply resides a large-diameter cooling muffin fan that sucks air out of the system unit. Compared with previous IBM wind generators, this one is quiet, almost inaudible compared with the constant buzz and grind generated by the spindle motor of the Model 60's hard disk.

The upper arm of the gamma rises over a stack of drive-mounting shelves at the front of the Model 60 case. Two over-and-under bays are allowed for 3½-inch form-factor devices, one of which is occupied by the standard-equipment 1.44-megabyte floppy disk drive. As with the floppy drives of other Personal System/2 models, those of the Model 60 merely slide into place on mounting rails on their bottoms. Each latches securely into place and has a plastic tab to release it underneath. All power, control, and data signals link up through a single-card edge connector at the back of the drive bay.

The decorative floppy disk drive bezel is part of the removable Model 60 front panel rather than part of the drive unit itself. Due to some unexplainable lapse in IBM's normal idiot proofing, you can snap this bezel in upside down should you be inattentive when installing a second drive. Unless you become violent when the slots don't line up, however, the worst possible damage from such a mistake will be little more than temporary frustration.

Beneath the power supply and the floppy disk drive bay is a large chamber that holds both the Model 60 system board, which hugs close to the right side of the case, and two full-height drive bays for 5¼-inch devices. At the bottom corner of the front of the Model 60 case, the combined speaker/battery-holder assembly stands out in a large empty area. This assembly is identical to the one used by the Model 50, equipped with a large, 3-inch loudspeaker and 6-volt Panasonic lithium battery.

PC MAGAZINE FACT FILE

IBM Personal System/2 Model 60
IBM Corp.
Consult your local IBM authorized dealer:
(800) 447-4700
List Price: $5,295
Requires: DOS 3.3, VGA-compatible monitor.
In Short: IBM's 80286-performance-level multiuser, multitasking Personal System/2 Model 60 has eight 16-bit Micro Channel expansion slots, built-in communications ports, and VGA graphics. It's the logical replacement for today's AT in tomorrow's shared resource systems.

CIRCLE **655** ON READER SERVICE CARD

BIG BAY The internal drive bays of the Model 60 may be the best excuse for the larger size of its chassis (when compared with the equivalent-performance Model 50). While the downsized Model 50 is severely limited in the hard disk options available (exactly one when the machine was introduced—an IBM unit that creeps along with a painfully slow average access time of about 80 milliseconds), the Model 60 faces no such constraints.

A steel subchassis screwed beneath its power supply endows the Model 60 with enough space to stock up to four standard half-height drives back to back in two full-height bays, mounted in a manner that matches the style used by the RT. Drives are installed in the steel subchassis by sliding them into place on mounting rails similar in concept but quite different in execution from those used on the AT. Once the drives are in their proper places, they are fastened down by tightening two blue plastic knobs atop each drive bay. The knobs apply screw pressure that lowers a clamp against each mounting rail.

Although the two drives that IBM offers for the Model 60 are both full-height devices, the Model 60 hints that half-height options may be part of its design: a strip of four spade terminals is provided for grounding add-in drives. However, the IBM power supply contains only two power connectors for plugging in additional drives (though a simple wye cable will eliminate any connector shortfall).

One of the internal drive bays is given front-panel access courtesy of a removable plastic blank in the front panel. Besides hard disks, this bay can give safe harbor to a tape backup system or a WORM (write-once, read-mostly) optical disk drive—or even a 5¼-inch floppy disk drive should some enterprising peripheral vendor package the necessities for such a system.

The standard hard disk in the bottom-of-the-line Model 60-041 is a made-in-America 44-megabyte unit that bears the IBM label. Like all the better drives now on the market, it features a voice-coil head actuator and automatically parks and locks its read/write heads when powered down.

Using the industry standard ST-506 interface, the 44-megabyte drive plugs into a proprietary IBM hard disk controller that's currently used only in the Model 60. It handles up to two drives, while the smaller card in the Model 50 can tackle only one. Despite their different physical size and drive-handling abilities, however, these two IBM controllers rely on similar circuitry, mostly hidden inside a square aluminum IBM-proprietary VLSI chip.

The performance of the 44-megabyte drive is commendably brisk (particularly compared with the miniature pig grunting away in the Model 50), turning in an average access time of under 33 milliseconds. To further improve performance, IBM formats the hard disks of the Models 50 and 60 with an interleave factor of 1-to-1 (compared with 3-to-1 for the AT and 6-to-1 for the XT) and adds a limited amount of disk caching.

The 70-megabyte hard disk of the Model 60-071, promised for delivery later this year, should improve further on that level of performance through use of an enhanced small device interface

(ESDI) connection. The ESDI doubles the data transfer rates used in previous IBM personal computers, raising the speed at which a block of data can be moved from 5 to 10 megabits per second. Installing two of these drives will give an IBM-sanctioned Model 60 a system capacity of 140 megabytes.

IN THE CHIPS Underlying the hard disk subchassis and filling the balance of the case of Model 60 is its system board, now sometimes called a *planar* board by IBM and a *motherboard* by stodgy traditionalists.

As with the other models of the Personal System/2, the Model 60 motherboard breaks with IBM's previous design conventions in many ways. Making extensive use of compact surface-mount technology and proprietary VLSI chips, it incorporates all the necessary functions of a complete minicomputer (except for hard disk controller) on a single planar printed-circuit board. Among the standard features in its circuitry are serial and parallel ports, a high-resolution graphics-capable display adapter, a full megabyte of RAM, pointing device (mouse) input port, clock, floppy disk adapter, and a full endowment of expansion slots.

The central processor, an 80286-10, is actually relegated to the bottom right-hand corner of the motherboard. Accompanying it is a socket for an 80287-10 numeric coprocessor. Both of these chips are operated at their full rating of 10 MHz, with one wait state inserted when memory or the I/O system is accessed. Direct Memory Access (DMA) transfers, however, are handled at 10 MHz without the waits.

IBM credits this combination of processor and clock with having twice the speed of the AT. On *PC Magazine*'s benchmark tests, however, its performance turned out to be more in line with what would be expected of such a 10-MHz system: 20 to 30 percent faster than an 8-MHz AT. Disappointingly, the speed-determining 40-MHz crystal is soldered to the system board, precluding all but the most venturesome tinkerers from experimenting with supercharging the system.

The Model 60's standard megabyte of memory is packed off to a distant corner of the system board in the guise of four removable 256K-byte memory modules, each equipped with three IBM proprietary megabit-technology (but not megabit-capacity) memory chips.

The Model 60 hardware allocates 640K of the available bytes to DOS memory and the remaining 384K to extended memory. As with previous IBM personal computers, additional memory can be added on with expansion boards, up to the 16-megabyte addressing limit of the 80286 microprocessor.

The Model 60 hardware allocates 640K of the available bytes to DOS memory and the remaining 384K to extended memory.

Three other memory systems also decorate the system board. Four 32K-byte ROM chips, totaling 128K, fill a row of sockets on the front edge of the board. Eight 4-bit by 64K-bit chips near the center of the board are used for display memory. And 2K bytes of battery-backed-up CMOS RAM permit the nearly nonvolatile storage of system configuration information (in addition to the 64 bytes contained in the clock chip).

Only this last 2K-byte block of memory differs from the standard endowment of the Model 50. According to IBM documentation, one of its principle intended uses is to implement a hardware-based security system—for instance, storing one or more passwords to restrict system access.

Another innovation in the Model 60 and the rest of the Personal System/2 line is its Programmable Option Select (POS) system that eliminates DIP switches and most of the need for the unnerving AT setup utility. The Model 60 is able to detect the options that are installed inside it and configure itself accordingly, storing the setup information in its nearly nonvolatile CMOS memory.

The Model 60 floppy disk control electronics are based on the same chip—the NEC 765—as are all previous PC models. Despite this similarity, the Model 60 is configured to operate only 3½-inch floppy disk drives with formatted capacities of either 720K bytes or 1.44 megabytes using PC-DOS 3.3. Data transfers are made at 250 kilobits per second for the former, 500 kilobits per second for the latter.

A short ribbon cable connects the two floppy disk bays (and hence the disks when installed) to the system board through a small adapter board that might have been designed by Rube Goldberg before he hit his stride.

The Model 60 system board serial port is based on a 16550 UART chip that can operate at up to 19,200 bits per second. In comparison, the serial ports of PCs and ATs are limited to 9,600 bps. (These speeds are the maximum supported by IBM. Standard PC serial ports can achieve higher data rates through sophisticated programming.) Unlike the AT, the Model 60 uses an XT-style 25-pin male miniature D-shell connector for this serial port.

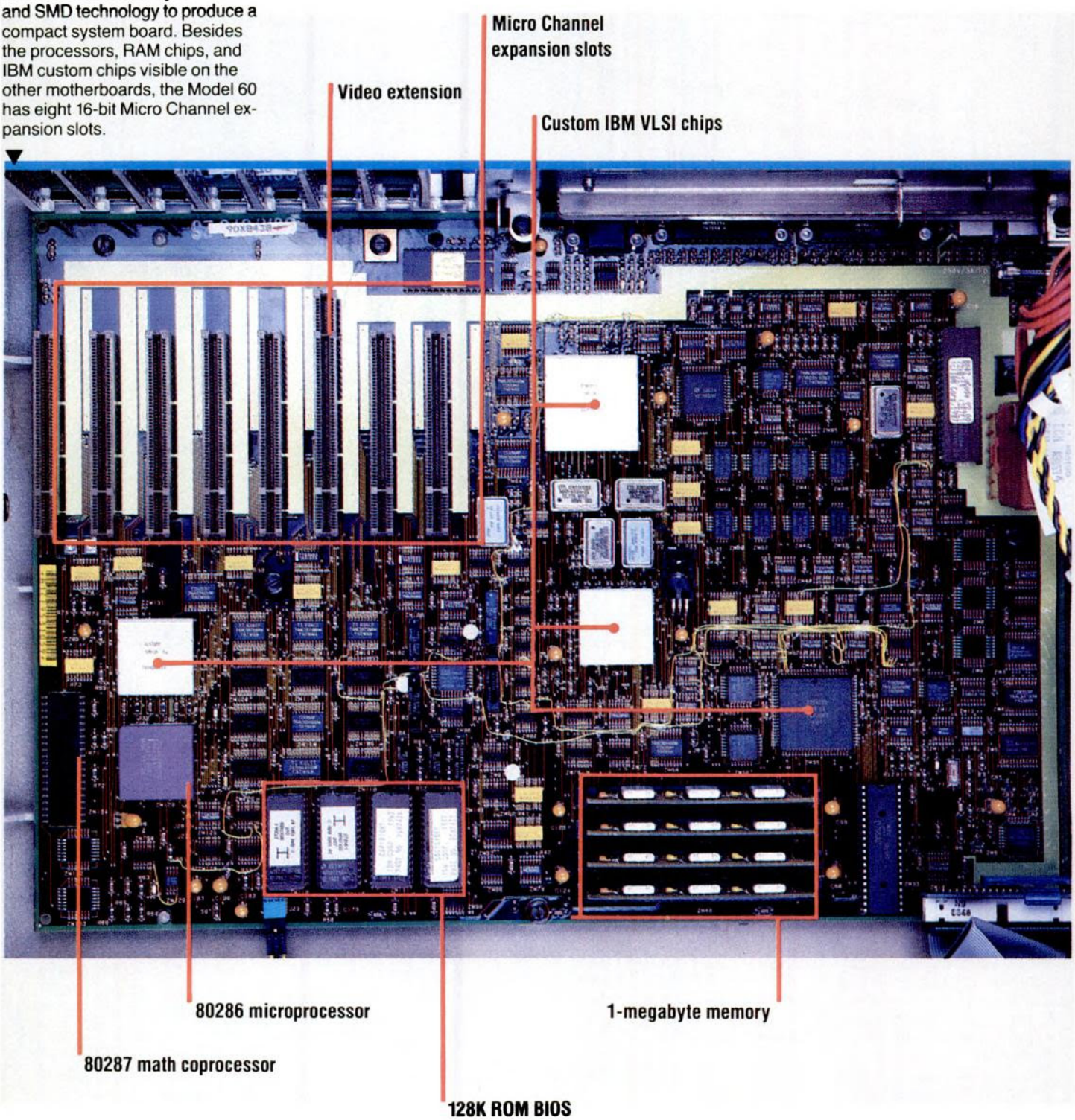
The system board parallel port, which is functionally identical to previous PC printer ports, uses the IBM-standard 25-pin female D-shell connector. This connector, along with the serial jack, two input devices, and one 15-pin video connector, is located in a strip along the rear of the Model 60 chassis, just above the option-retaining brackets of the system expansion slots.

SUPERSEDING BUS Inside these brackets the Model 60 provides eight 16-bit bus Micro Channel slots for internal expansion.

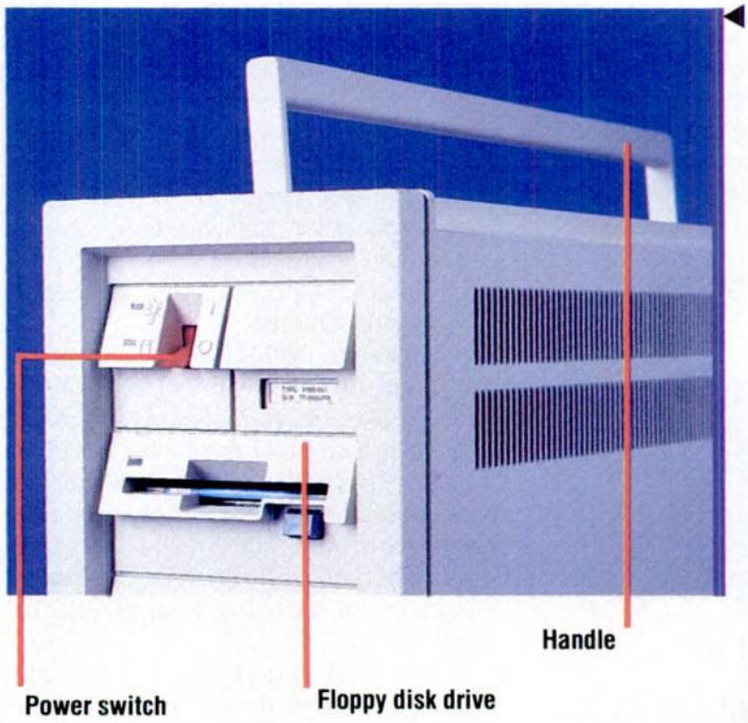
The Micro Channel bus arrangement supersedes and is incompatible with the 8- and 16-bit PC buses used by previous IBM personal computers. PC, XT, and AT expansion cards cannot be used in the Model 60 (or the Personal System/2 Models 50 and 80) because they will not physically fit into the system and are

PS/2 Model 60

Like the Models 30 and 50, the Model 60 relies heavily on VLSI and SMD technology to produce a compact system board. Besides the processors, RAM chips, and IBM custom chips visible on the other motherboards, the Model 60 has eight 16-bit Micro Channel expansion slots.

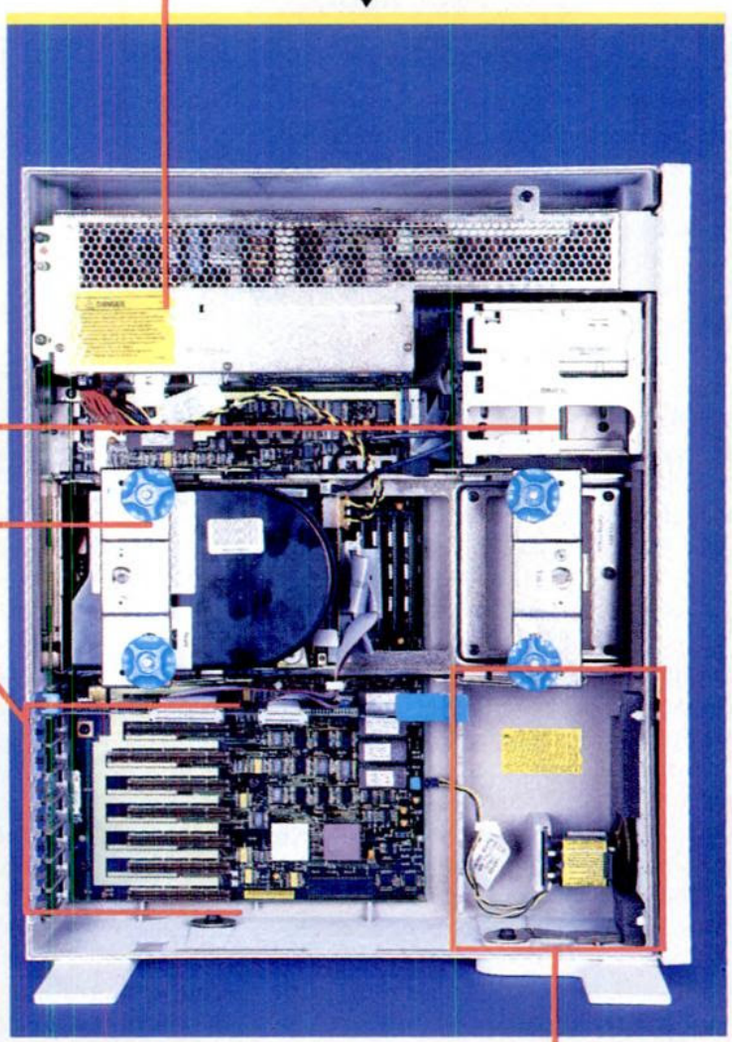


Photographs: Thom O'Connor

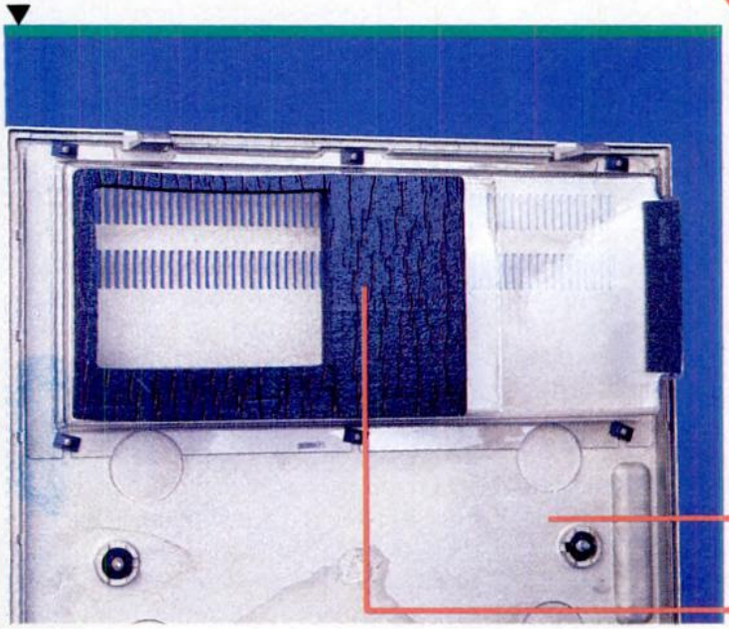


The Model 60 has the first IBM CPU designed to stand upright. Power switch and disk drives are easy to reach, and the handle lets strong users move the machine around.

Inside the Model 60, eight expansion slots share space with hard and floppy disk drives and the power supply. The cooling system (see below) fits over the empty space around the speaker.



The Model 60's cooling system sucks in cool air from outside the CPU and routes it to the top of the expansion card area. Once it has circulated around the expansion cards and drive bays, the air is expelled through the vents near the power supply.



electrically incompatible with it.

Not only is the standard Micro Channel card smaller than PC bus cards (11½ by 3 inches versus 13½ by 4), but the two rows of 58 pins of the Micro Channel bus are spaced more closely (on .05-inch versus .10-inch centers) and the connectors themselves are smaller. The signals assigned to each pin are also arrayed differently.

All eight of the Model 60 Micro Channel slots have access to the outside world through option-retaining brackets, including the single slot that's filled at the factory by the standard-equipment hard disk controller.

One of the slots is singled out for special treatment, boasting an extra 20 pins on the rear end of its system board connector. The extra pins are used for video signals so that add-in video coprocessors can cooperate with the self-contained display system built into the Model 60 motherboard.

The most important differences between the Micro Channel Architecture of the Model 60 (50 and 80) expansion and that of the PC and AT are concealed in its circuitry. The new design allows the Model 60 to handle several system functions more efficiently at the same time (or nearly so). Using a special bus arbitration scheme and up to eight DMA channels simultaneously, the Model 60 can move data between memory, disks, video, and I/O ports without any intervention by the microprocessor.

Note, however, that the multitasking abilities of the Model 60 won't be accessible until IBM's new Operating System/2 is released next year.

The new Micro Channel expansion cards are designed for tool-free installation and replacement. They are secured at the bottom rather than at the top by captive, knurled screws that can be finger-tightened and loosened, or, should they become reluctant, with the same coin used for opening the case.

Although the expansion area inside Model 60 looks capable of holding boards larger than the nominal IBM specifications—the case is a full inch taller than an installed Micro Channel expansion card—that extra space is used by the cooling system. A clear plastic plenum routes the air that's sucked in through the front panel of the Model 60 to the top of the expansion card area. From there, cool air from the outside is forced to flow around the expansion cards back toward the front of the computer, then up past the hard disk drive bays to the suction fan in the power supply, out of which the heated air is vented. Compared with the marginal ventilation of some previous PCs, cooling in the Model 60 system is elegant and effective.

The Model 60 enhanced expansion options as well as the extra 2K bytes of CMOS RAM give it an edge over the Model 50 in multiuser applications.

■ ■ ■ ■ ■

The video system built into the Model 60 system board adds a new acronym to the set display standards: VGA, which stands for Video Graphics Array. The new standard pushes on-screen resolution up another notch to 640 by 480 pixels in graphics modes and 720 by 400 in text modes (forming 80-column, 25-row displays with each character shaped inside a 9 by 16 matrix).

The top graphics resolution allows 16 simultaneous on-screen colors to be selected from a palette of 256 colors or from a degraded two-color (monochrome) mode. A new 320 by 200 graphics mode allows all 256 colors to be displayed on the screen at one time. The text mode color choice is 16.

The VGA system is completely compatible with software written for previous IBM standards including MDA, CGA, and EGA and provides similar on-screen performance. In its 200-line modes, however, the VGA system double-scans each line to increase the apparent on-screen sharpness of the image.

Because the new standard uses a horizontal frequency of 31.5 kHz, a noninterleaved mode-dependent frame rate of 60 or 70 Hz, and analog rather than digital signals, it is incompatible with all previous IBM personal computer displays and all but a few monitors from third-party suppliers. Four new IBM displays match the VGA standard of the Model 60—three color models, with 12-, 14- and 16-inch screens, and one paper-white monochrome.

Under the VGA standard, the color and monochrome monitors can be plugged in interchangeably, with the monochrome units displaying up to 64 shades of gray derived from the green of the color signal. The use of a different connector, one of them with 15 pins, prevents the potentially fatal, inadvertent attachment of an old-style display to the new system.

The VGA system uses a proprietary gate array rather than a video coprocessor. As a consequence, it does nothing to improve display speed over previous IBM systems. It adds only sharpness. Faster video is available using IBM's video coprocessor board, which gives image addressability up to 1,024 by 768 pixels.

Included with the Model 60 is IBM's 101-key enhanced keyboard with a generous 10-foot-long cord. In addition, the Model 60 system unit will support a mouse or other pointing device such as a trackball or touchpad. The odd-sized two-button mouse that IBM offers has a 9-foot-long tail.

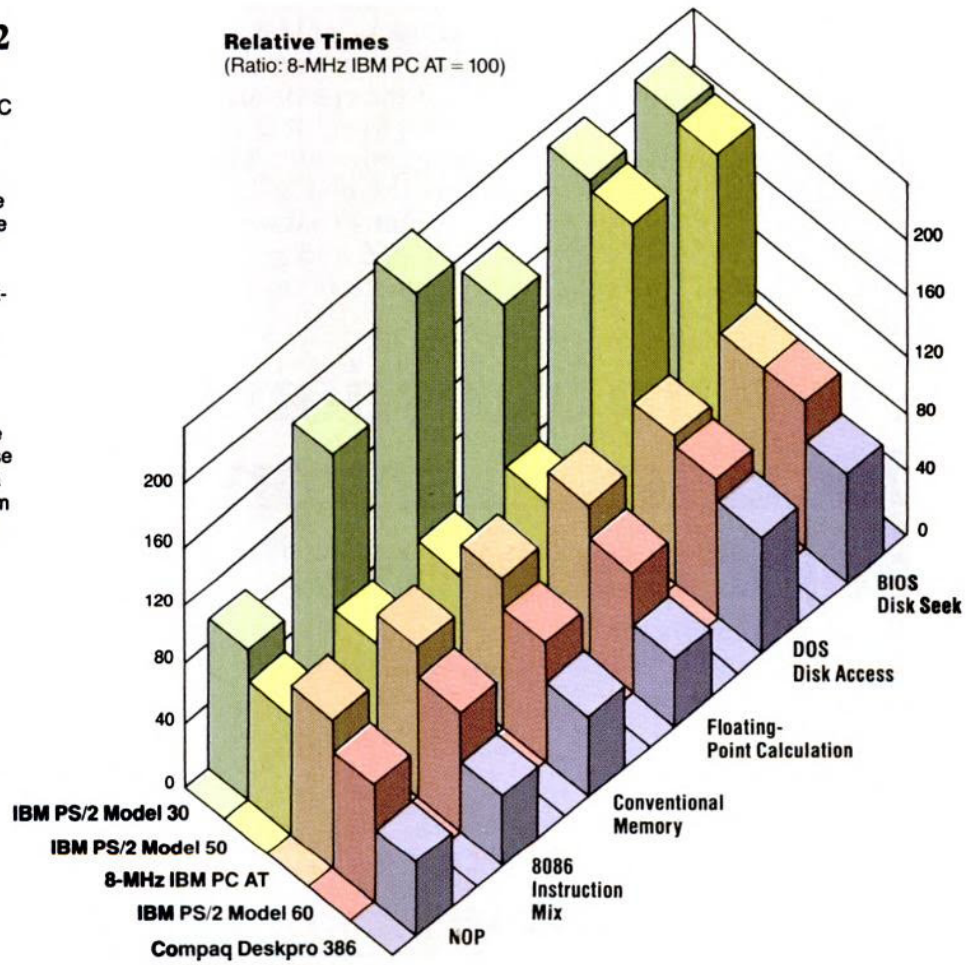
EXPENSIVE EXPANSION The Personal System/2 Model 60 invites comparison with the Model 50. After all, both have the same performance and speed abilities, the same multitasking-oriented Micro Channel expansion bus, and the same built-in improved graphics abilities. You might think that the Model 60 is simply the Model 50 in a bigger box. But for all their functional similarities, the two Personal Systems wander in different directions in search of their own particular audiences.

The Model 50 is a single-user multitasking system with a footprint small

Benchmark Tests: IBM Personal System/2

In terms of operating times, the ancient IBM PC AT is still a viable contender despite the new PS/2 line's advanced technology. The PS/2 Model 30, with its 8086 processor, isn't even as fast as the AT. Although IBM claims that both the PS/2 Model 50 and Model 60 can run up to twice as fast as the AT, in our processor benchmark tests a 20 percent speed advantage was the norm. Performance times for the Compaq Deskpro 386 are included to show the speed of an 80386 processor in relation to the speed of the 80286 processor found in the faster PS/2 models.

Hard disk access results show that the PS/2 series' sluggish proprietary disks do little for the overall performance of the machines. In the case of the Model 60, the hottest setup may well be a hard disk with a 20-millisecond access time from a third-party supplier rather than IBM's AT-level drive with 35- to 40-millisecond access times.



Performance Times
(Times given in seconds except where noted)

	NOP	8086 Instruction Mix	Conventional Memory	Floating-Point Calculation (without coprocessor)	DOS Disk Access (milliseconds)	BIOS Disk Seek (milliseconds)
IBM PS/2 Model 30	4.17	16.53	3.24	67.17	95.73	82.38
IBM PS/2 Model 50	3.35	7.30	1.03	28.34	92.93	81.02
8-MHz IBM PC AT	4.17	8.96	1.32	35.60	42.54	37.19
IBM PS/2 Model 60	3.35	7.25	1.05	28.18	39.58	36.76
Compaq Deskpro 386	2.09	4.23	0.72	15.50	33.32	27.03

The **NOP** benchmark test is designed to measure raw clock speed and memory access time while minimizing differences in microprocessors and the effect of memory caching. This test executes almost nothing but NOP ("No Operation") machine code instructions in a big 128K loop.

The **8086 Instruction Mix** benchmark test measures the time it takes to execute a selected series of processor-intensive tasks. The test program uses 8086 instruction code. These instructions are a subset of the total processor instruction set.

The **Conventional Memory** benchmark test allocates 256K bytes of conventional memory and treats it as a series of 64-byte records. Then, 16,384 random records are read into and written from this memory.

The **Floating-Point Calculation** benchmark test measures processor speed by looping through a series of floating-point calculations, including multiplication, division, exponentiation, and logarithmic and trigonometric functions. The benchmark program uses the floating-point library included with Microsoft C Compiler 4.0.

The **DOS Disk Access** benchmark test measures the time it takes to do a random sector read using DOS. DOS buffers are set at 3, and the interleave factor is left at the drive's default setting. This test adds DOS's overhead to the BIOS and hardware times. The test program performs the sector read 1,000 times within the DOS disk partition. The average result is shown in milliseconds.

The **BIOS Disk Seek** benchmark test measures the time it takes to do a random seek using the disk's ROM BIOS. The test result includes minimal software overhead and may not parallel the manufacturer's claimed average access time. The test program performs 1,000 seeks. The average result is shown in milliseconds.

■ PS/2 MODEL 60

enough to fit into a single desk drawer. The Model 60 enhanced expansion options—more slots and bigger drive bays—as well as the extra 2K bytes of CMOS RAM give it an edge in multiuser applications.

Even more than these features, however, price may be the best indicator of the place the Model 60 fits in the IBM Personal System/2 strategy. Although the Model 60 is a more expensive ma-

Price may be the best indicator of the place the Model 60 fits in the IBM Personal System/2 strategy.

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chine to make than the Model 50, if just for the labor involved, there can hardly be $1,700 worth of difference between the two models. Clearly the pricing of the two machines is more marketing than manufacturing in origin—$3,600 is in the range for single-user computers (a figure close to the price of the original XT, for instance), and $5,400 to $6,400 is in the multiuser range.

Certainly, the extra bucks buy a faster, larger standard hard disk, greater access to other mass storage options, a beefier power supply, and four additional 16-bit Micro Channel expansion slots. But with the difference between 20- and 40-megabyte drives on today's market only about $300 to $400, you end up paying a big premium of more than $300 per slot for a Model 60.

For a single user, those costly slots won't be very useful considering all the features packed onto the Model 60 system board. But for network servers and multiuser systems that need hundreds of megabytes of storage and scads of ports, the Model 60 will serve well.

Winn L. Rosch is a contributing editor of PC Magazine.

BUS STOP

With the arrival of the Personal System/2 line, the PC has grown up. In the 80286 and 80386 PS/2 models, the standard bus has been replaced by sophisticated Micro Channel Architecture (MCA), providing a foundation that will take the machines into the next decade and perhaps beyond.

What was wrong with the old bus? Plenty. It's limited in its transfer rate. It's electrically noisy and tends to radiate RF interference. It's bulky. The sockets and card edge connectors are large and mechanically sloppy. It's graceless at sharing resources. And many of the signals are edge-triggered rather than level-triggered,

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IBM's Micro Channel Architecture replaces inflexible bus systems and brings greater reliability, efficiency, and cooperation to hardware design.

which limits the upper speed of the bus and also contributes to errors.

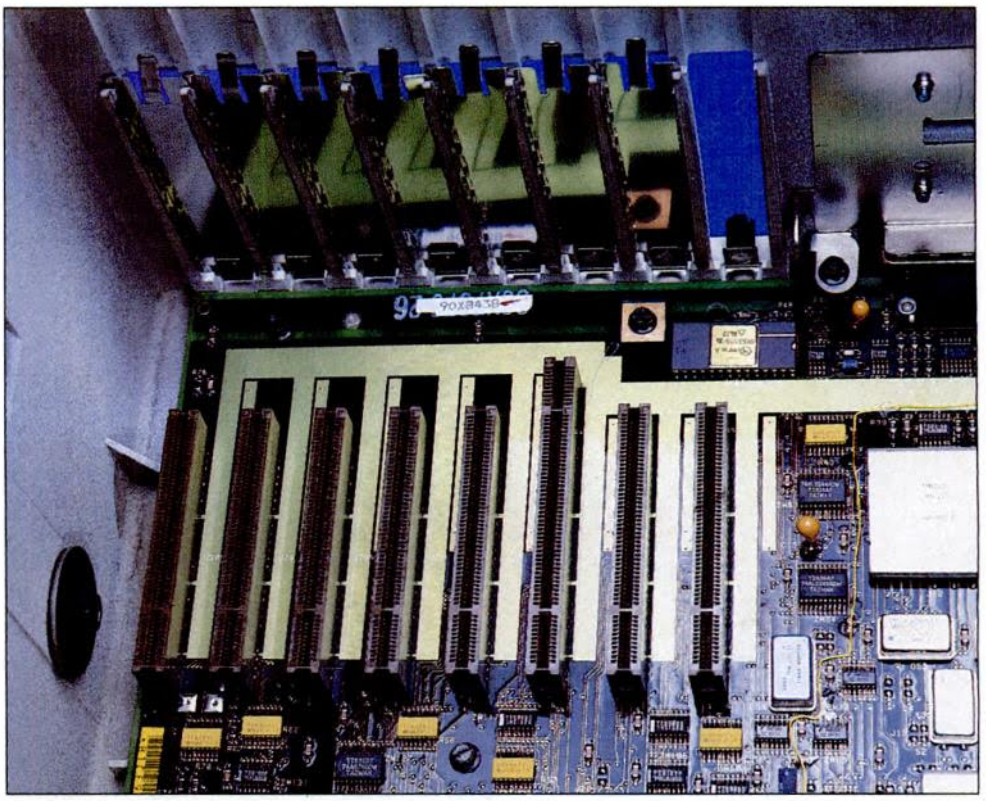
Unlike the PC bus, MCA is not specifically adapted to Intel microprocessors. Instead, it has a set of signals, rules, and protocols that allow multiple, dissimilar microprocessors to share it and work effectively with one another. Some of the other features increase reliability, while others ease configuration and reduce conflicts among devices.

UNIQUE IDENTIFIER CODES For example, MCA requires boards plugged into the bus to have unique identifier codes. The codes are built into the card when they're manufactured. All of IBM's enhanced small device interface (ESDI) hard disk controllers, for instance, have the same code. The 3½-inch disk controller found in the Model 50 has another code. A modem manufacturer might use one code for a 1,200 bits-per-second modem and another for a 2,400.

The device identifier codes are queried during IBM's new Programmable Option Select system (POS), which automatically configures computers in the PS/2 line, each time the machine is turned on. It can, based on the codes, include the necessary configuration files to run the hardware. Since all boards have a unique code, the software can also resolve potential installation conflicts.

IBM has ensured that the codes will remain unique. It has reserved half of them (32,767) for its own use and made the other half available to board manufacturers. IBM is currently the clearinghouse that issues the numbers, but if the job becomes too onerous (or if manufacturers object too strongly to tipping their hand to IBM) the task will be turned over to a third party, perhaps one of the industry standards groups.

The device identifier concept is not new. IBM mainframes had similar features 20 years ago. (MCA has many features adapted from IBM's mainframes and minicomputers. System/370 and Series/1 jocks will recognize much of the terminology and design.) The need, however, is more valid now than ever. Back then, the challenge was to coordinate the activities of a roomful, even a building full of equipment. Detecting errors in outlying devices was critical, as a malfunction could easily pull the whole system down or degrade performance drastically. The number and kind of devices that could be attached, however, were limited.



The new Micro Channel Architecture installed in the IBM Personal System/2 series is a vast improvement over the old PC bus. Each board plugged into the new bus will have a unique identifier code that can instruct the machine to run necessary hardware configuration files.

Photograph: Thom O'Connor

Not so with PCs. Almost any imaginable card could be designed for the new bus. Beyond the usual run of modems, memory, and I/O ports, there are coprocessors, special-purpose graphics boards, speech boards, real-world control boards, raster processors for laser printers, and more. Each board has a unique pattern of machine resource use. One will be heavily dependent on I/O ports. Another will require high-bandwidth memory transfers. Others will severely tax the interrupt service mechanism. And with some, the system will hardly know they're present.

Unique device codes open new fields of opportunity for diagnostics and system-level error detection, correction, and audit trails. The bus provides sufficient logic, for example, to build a truly fault-tolerant PC. Failing devices (cards or the equipment to which they connect) can be switched off the bus and others switched on in their place.

IBM strongly recommends against application software having anything to do with device identifiers, and DOS is utterly ignorant of their presence. This capability is currently a gleam in the eye of some programmer who will turn the Model 60 or the Model 80 into a knockout file server or communications hub.

The possibilities here are best illustrated by the current generation of network file servers. The PC AT is architecturally unsuited to being a file server. Its hard disk data transfer rate is too slow and the interrupt structure is too limited. We've even illustrated the point by putting a PC AT on a 3Com Ethernet network and comparing the AT's local access to its built-in hard disk to that of the shared hard disk. Access to the network drive is noticeably faster.

THE DMA BOTTLENECK Direct Memory Access (DMA), which is supposed to increase performance, is actually a bottleneck in the PC AT. The DMA chip

found in every PC and AT is actually a specialized microprocessor that knows how to do only one thing: move data from one memory location to another. Most computers have them.

The process is simple. You tell the DMA chip how many bytes you want to move, where they are, and where you want them to go. Then just let 'er rip. The DMA chip brings all other processes to a halt as it moves memory. Since it works so fast, in theory, you get the system back before you even know it was gone. In practice, however, long, recurrent DMA transfers have a negative effect on system throughput.

MCA has a solution. It offers eight channels of DMA (sufficient control registers to manage eight DMA transfers at the same time). In addition, it limits the time that a DMA channel can be active to 7.68 microseconds. It forces DMA to share system resources with other operations, including other DMA transfers. This shared activity is called bus interleaving. Even multiple DMA transfers can be interleaved. You can't manufacture clock cycles out of thin air, but overall system performance goes up with this technique.

One of the hallmarks of large mainframe computers is that they have considerably more than one processor. Yes, a single central processing unit bears the brunt of the computing, but it is aided by channel controllers, printer controllers, terminal controllers, and console controllers.

Each controller is a specialized computer, designed to relieve the main CPU of boring, repetitive tasks such as polling printers to see if they're ready to accept more characters. Even details such as printed form layout are typically handled without the knowledge or intervention of the mainframe CPU.

COOPERATIVE PROCESSORS In the Personal System/2 series, IBM uses more cooperative processors in the PC itself. The hard disk controller, for example, has an 8-bit microprocessor perform the drudgery of shuffling bits back and forth on the Micro Channel. Another microprocessor performs the same tasks for the system board's I/O ports.

Some cards have always had some native intelligence. The IBM/Sytek PC Network card, for example, had an 80186 processor, which made it a bit more powerful than its original PC-XT home.

The new bus, with its higher transfer rates, better arbitration, and better status signaling, invites coprocessing and distribution of tasks. You can be sure that future MCA products, especially those from IBM, will be rich in processors.

The Personal System/2 bus invites coprocessing and distribution of tasks.

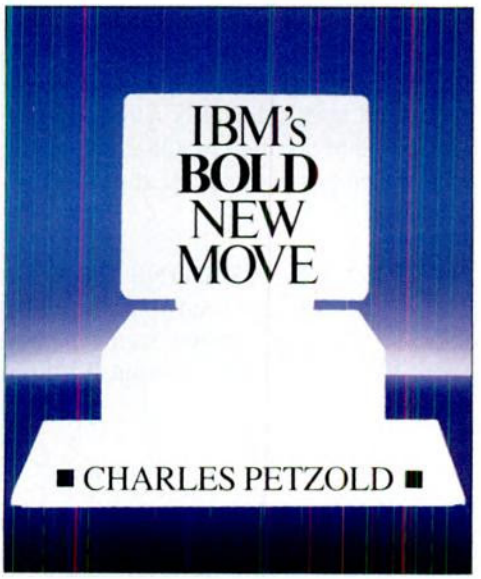
The Micro Channel is also an inviting home for coprocessing. It accepts up to 15 bus masters, so specialized tasks may be carried out by dedicated processors.

Duplicating MCA may be the toughest challenge yet faced by clonemakers. IBM is still espousing open architecture. Indeed, virtually every one of the bus's specifications is published in the exhaustive *Technical Reference* manual. Schematics, however, are conspicuously absent. But the logic that controls the bus is locked away in custom VLSI chips, and there are as-yet uncharted potential interactions with the rest of the system that may make MCA tough to duplicate.

Also, IBM has identified upwards of 100 intellectually protectable concepts in the PS/2 line. It may apply for patents or copyright protection on any or all of them, which will no doubt touch off a wave of lawsuits and counterclaims. In the meantime, however, it may become just plain illegal to clone a PS/2 machine.

Compatible manufacturers continue to do a brisk business, but the balance will inevitably change as the PS/2 series takes hold. IBM has neither missed the boat nor missed the bus. PC

Bill Machrone is editor of PC Magazine.



SMOOTH OPERATOR

Ever since the introduction of IBM's PC AT in 1984, people have been speculating about a new version of DOS that would take full advantage of the protected mode of the AT's 80286 microprocessor. Such an operating system, they said, would allow programs access to 16 megabytes of memory and provide real multitasking.

Three years later, Microsoft's Operating System/2 is finally within sight. Microsoft plans to make an OS/2 Software Development Kit available on August 1, 1987, and IBM has announced

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The key to efficient multitasking, OS/2 will be the foundation of a new generation of computer software.

that it will begin retail sales of OS/2, Version 1.0, in the first quarter of 1988.

As expected, OS/2 multitasks new programs designed for its environment and uses the full 16-megabyte address space of the 80286 microprocessor. OS/2 also includes a DOS-like compatibility environment for running most existing DOS programs. Some people are saying that OS/2's rich and versatile applications program interface (API) will spawn a new generation of personal computer software, and it's tempting to agree.

OS/2 is the first announced product to be developed under the IBM/Microsoft Joint Development Agreement. This indicates a meeting of the minds between IBM and Microsoft concerning the functionality, applications program interface, and user interface of OS/2. Microsoft will also make OS/2 available to other original equipment manufacturers (OEMs).

The IBM version of Operating System/2 will run on all IBM machines built around the 80286 or 80386 microprocessor, including the PC AT, the XT Model 286, and the new Personal System/2 Models 50, 60, and 80. OS/2 will not run on 8088-based machines such as the PC and PC-XT, or 8086-based machines such as the PS/2 Model 30.

As is the case with Microsoft's MS-DOS today, versions of OS/2 will be configured by other OEMs (such as Compaq and Tandy) for their own 80286 and 80386 machines. When sold by OEMs other than IBM, Operating System/2 will probably be referred to as MS OS/2. Microsoft will not itself sell a retail version of the operating system.

Operating System/2 will eventually include a version of *Microsoft Windows* that will be called the "Windows Presentation Manager." Microsoft will be making some changes to *Windows* for its transition to OS/2. These changes will affect *Windows*' visual appearance, the keyboard interface, and (most significantly) the internal graphics interface.

The Windows Presentation Manager is an important component of OS/2 for end users, program developers, and IBM. To IBM, OS/2 and the graphics-based windowing environment of the Presentation Manager are part of IBM's Systems Application Architecture (SAA). This is an attempt by IBM to standardize applications program interfaces and user interfaces across IBM's entire line of computers. OS/2 is the first announced product to be part of this ambitious plan.

DIFFERENT VERSIONS OF OS/2 Part of the confusion surrounding OS/2 results from the various forms it will take. IBM has already announced three different versions of the operating system, and Microsoft has announced MS OS/2 with two components.

> The IBM version of OS/2 will run on all IBM machines built around the 80286 or 80386 microprocessor.

The main guts of OS/2 is called the OS/2 *kernel*. With the exception of low-level device drivers, the kernel will be essentially the same in all OEM versions of MS OS/2. The kernel handles file I/O, keyboard and mouse input, character-mode display output, multitasking, and interprocess communication. Initially, Microsoft will make only the OS/2 kernel available to OEMs. For IBM, this will be OS/2, Version 1.0.

Through the support of *dynamically linkable libraries*, OS/2 lends itself to the addition of various modules that extend the functionality of the operating system. Thus, Microsoft and Microsoft's OEMs (such as IBM) can add features to OS/2 while retaining compatible kernel functions.

One of the most important additions to OS/2 will be the OS/2 Windows Presentation Manager. Microsoft will make this component available to all OEMs, and IBM will include it with their OS/2, Version 1.1. Other OEMs may choose either to wait for the Windows Presentation Manager before selling OS/2 or to sell kernel-only versions of MS OS/2 during the interim. Although OS/2 will run without the Windows Presentation Manager, both IBM and Microsoft consider it an integral part of the operating system.

The second component of OS/2 that Microsoft will offer to OEMs is the OS/2 LAN Manager for local area network support. One interesting feature of the LAN Manager gives OS/2 software the ability to engage in interprocess communication across the network for distributed processing.

IBM, however, will be doing its own major add-ons to OS/2 to create the *OS/2 Extended Edition*. This version will include support for various mainframe communications and local area networks, and will have relational database capabilities based on IBM's Structured Query Language (SQL). Because these additions are originating from IBM, they will not be included in versions of OS/2 sold by Microsoft to other OEMs, or the versions of OS/2 sold by these OEMs to the public.

THE OS/2 COUNTDOWN These various components and versions of OS/2 will probably be released over the next year and half. Based on IBM and Microsoft announcements, the anticipated schedule looks like this:

On August 1, 1987, Microsoft plans to release the MS OS/2 Software Development Kit. With this kit, programmers can begin converting existing programs (or writing new ones) for OS/2.

The OS/2 Software Development Kit includes a beta-release version of the OS/2 kernel, over 2,000 pages of technical documentation, new protected-mode versions of Microsoft's C Compiler, Macro Assembler, *CodeView* debugger, and a full-screen editor, a 1-year subscription to Microsoft's DIAL technical bulletin board, attendance at an OS/2 technical seminar, and a subscription to *Microsoft Systems Journal* magazine.

The admission price for this orgy is $3,000. Direct telephone support costs an additional $1,000 per year. When the OS/2 Windows Presentation Manager and the OS/2 LAN Manager components become available, these updates (and

others) will be distributed without additional cost to purchasers of the OS/2 Development Kit.

In the third quarter of 1987, Microsoft plans to release *Windows*, Version 2.0. *Windows* 2.0 really has nothing to do with OS/2; it runs in real mode under current versions of DOS. However, *Windows* 2.0 is a preview of the look and feel of the OS/2 Windows Presentation Manager.

The most dramatic change in *Windows* 2.0 is the use of *overlapping* rather than *tiled* windows for different applications. The menu works a little differently, and the keyboard interface has been enhanced. Most existing *Windows* programs will run fine under *Windows* 2.0. *Windows* 2.0 does not include the internal changes in the graphics interface that are being made for the OS/2 Windows Presentation Manager.

In the fourth quarter of 1987, Microsoft is scheduled to begin shipping the OS/2 kernel to their OEM customers. OEMs will probably begin selling retail versions of MS OS/2 to users a few months later.

IBM is scheduled to start selling retail versions of OS/2, Version 1.0, in the first quarter of 1988 at a cost of $325. Programmers who balk at Microsoft's $3,000 OS/2 Software Development Kit can get some less expensive technical documentation and abbreviated developer's kits from IBM at this time.

Microsoft expects to begin shipping the OS/2 Windows Presentation Manager to OEMs in the first half of 1988. Beyond that, the crystal ball starts to get a bit hazy. Although IBM has announced OS/2, Version 1.1, and the OS/2 Extended Edition, they put off specifying release dates until the fourth quarter of 1987. IBM's OS/2 1.1 update will be free to registered users of OS/2 1.0.

OS/2 AND THE USER Of course, people don't buy operating systems—people buy applications. The success of OS/2 will ultimately depend on the appeal it has for software developers and the extent to which these developers believe that OS/2 will eventually replace DOS as the standard operating system on 80286 and 80386 machines.

The first time most users will encounter OS/2 is when they are forced to, which is after buying a software package that says "Requires OS/2" on the box.

To the DOS user, much of OS/2 1.0 will be familiar territory. OS/2 uses the same command line interface as DOS. Most of the existing DOS commands have been duplicated. You can run OS/2 programs from the OS/2 prompt just as today you run DOS programs from the DOS prompt. The difference is that you don't have to wait for one program to end before you run another.

OS/2 can maintain something like 16 screen groups, all with different programs running under them.

THE OS/2 SCREEN GROUPS An OS/2 session is divided into several *screen groups*. A screen group is a program (or a group of programs) that uses the whole screen. OS/2 can maintain something like 16 screen groups, all with different programs running under them.

OS/2 lets you switch between screen groups by pressing Alt-Esc. This clears the screen and displays the Session Manager menu. The Session Manager lists all current screen groups identified by the names of the programs currently running in them. You can then use the cursor keys and select a different screen group. OS/2 clears the screen of the Session Manager and displays the screen group of the selected program. You can also bypass the Session Manager and flip between screen groups by holding down the Alt key and pressing Esc twice in succession.

The relationship between the Session Manager and the screen groups is shown in Figure 1.

From the Session Manager you can create a new screen group by selecting the "Start a program" option. This option loads a new copy of CMD.EXE, which is the protected-mode command processor that serves the same function as COMMAND.COM in DOS. From CMD.EXE's prompt, you can run other OS/2 programs.

Most users will find the Session Manager useful for quick *context switching*—to get from one program to another without continually exiting and reloading the applications. This is perhaps the simplest use of OS/2.

Besides context switching, users can also take advantage of multitasking. Each screen group is almost like a separate PC. For instance, a database program can be sorting a lengthy file, while a communications program can be downloading electronic mail, while the FORMAT command can be formatting a diskette, while you're working on a memo.

Of course, if you're already familiar with RAM-resident pop-ups and background communications programs that run under DOS, context switching and multitasking may not appear so revolutionary.

This is true. But there are some very significant differences with OS/2: OS/2 does all these procedures with the help of the 80286 microprocessor, which means that OS/2 does it safely and efficiently. OS/2 takes care of the memory management, file locking, and task isolation necessary under a legitimate multitasking environment. Under real-mode DOS, multitasking is essentially a precarious proposition.

DOS COMPATIBILITY BOX One screen group is called the "DOS Compatibility Box." The word *box* is a misnomer because it sounds like a little window on the screen. It's not. The DOS Compatibility Box is simply a screen group that runs in real mode. It sets forth an environment to run existing DOS programs in the lower 640K of memory. Most existing DOS programs will run in the OS/2 DOS Compatibility Box.

Users can easily switch between the DOS Compatibility Box and protected-mode screen groups using Alt-Esc. Programs running in the protected-mode screen groups continue to run even when

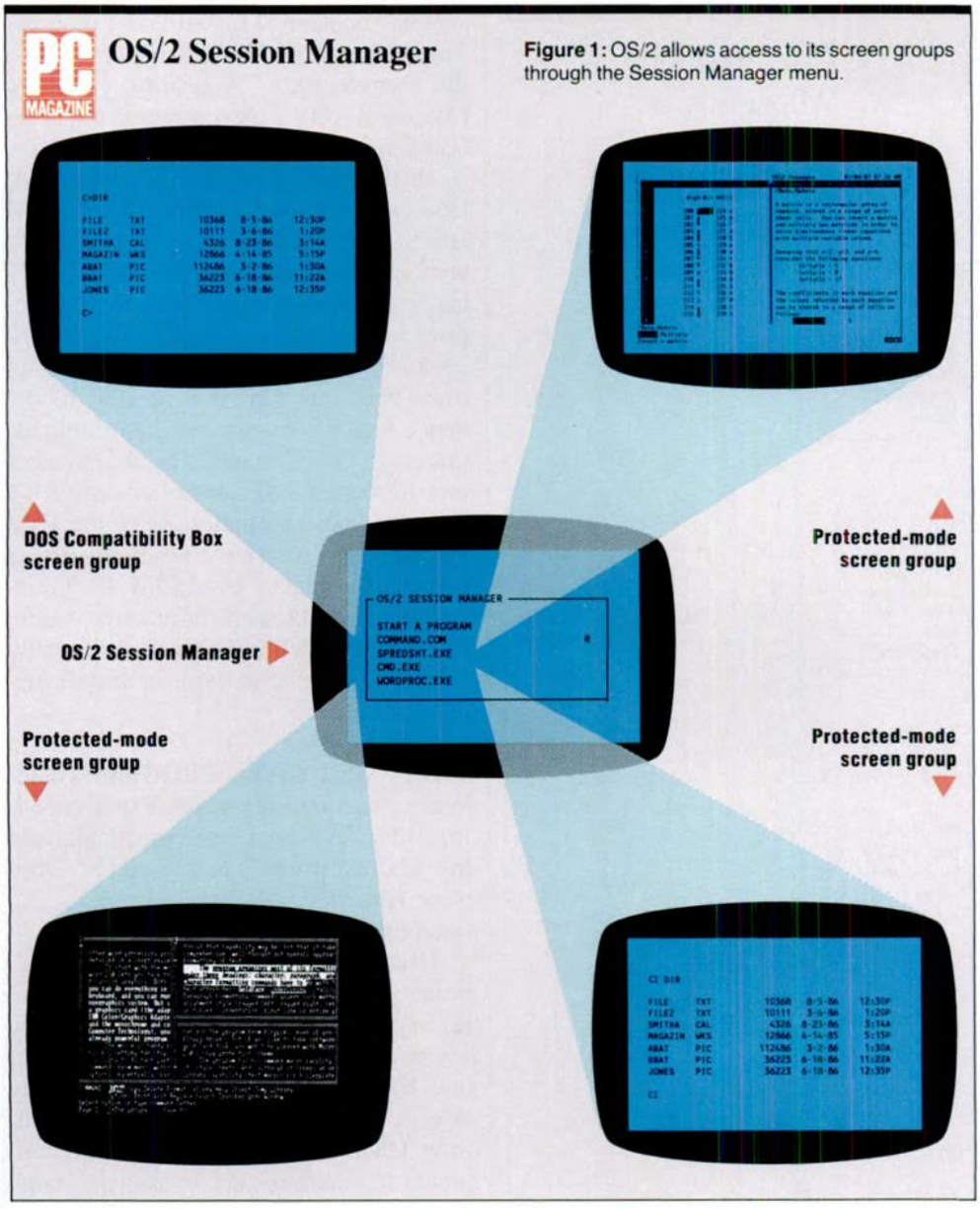


Figure 1: OS/2 allows access to its screen groups through the Session Manager menu.

the DOS Compatibility Box is visible. (OS/2 has to switch back and forth between real mode and protected mode to do this.) However, programs that are running in the DOS Compatibility Box are suspended when the Session Manager or one of the protected-mode screen groups is visible on-screen.

For the most part, existing DOS programs do not gain anything from running in the DOS Compatibility Box over what they can do under current versions of DOS. OS/2 supports only one DOS Compatibility Box and does not attempt to multitask existing real-mode programs. The DOS Compatibility Box is essentially isolated from the protected-mode screen groups. For instance, you cannot pop up a real-mode RAM-resident program while a protected-mode screen group is visible.

However, some protected-mode programs can add a little functionality to the DOS Compatibility Box. One of the programs included with OS/2 is a print spooler that buffers printer output from both the protected-mode screen groups and the DOS Compatibility Box. The spooler is smart enough to separate printer output into jobs and not mix up output from the different screen groups.

OS/2 also guards against some possible conflicts between protected-mode and real-mode programs. For instance, if a protected-mode program is using one of the RS-232 communications ports, OS/2 can make it appear to real-mode programs as if the communications port is not installed. Likewise, if OS/2 detects that a real-mode program is using the communications port, it will make the port unavailable to protected-mode programs.

OS/2 also locks files that either protected-mode or real-mode programs are using so that other programs can't alter them. (This network-type file sharing and locking is absolutely essential in a multitasking environment.)

Normally, OS/2 will allocate the lower 640K of memory for the DOS Compatibility Box and use memory above 1 megabyte for the protected-mode components of OS/2 (as shown in Figure 2). However, statements in the CONFIG.SYS file can reduce the amount of memory available to the DOS Compatibility Box or eliminate it entirely in order to use all system memory for protected mode.

THE ADDITION OF WINDOWS The addition of the Windows Presentation Manager to OS/2, Version 1.1, will add a graphics-based windowing environment to the operating system. The Presentation Manager will itself be a separate screen group that runs multiple programs.

Programs specially written for OS/2 *Windows* will be displayed in separate windowed areas on the screen. Users can switch between programs using the keyboard or a mouse and transfer data among them. Programs written for *Windows* have a consistent user interface and take advantage of *Windows*' device-independent graphics interface.

OS/2 *Windows* will also be able to window most character-mode programs that run under the non-*Windows* OS/2 kernel.

THE LIMITS OF COMPATIBILITY The DOS Compatibility Box is not free of problems. Some of the problems arise because DOS programs must be suspended when the user switches to a pro-

tected-mode screen group. Programs running in the DOS Compatibility Box will not even get any hardware interrupts during this time. This situation has the most serious effect on RS-232 communications programs. These programs will lose incoming data following a switch to a protected-mode screen group.

Programs that depend upon some undocumented DOS function calls and absolute memory locations of internal DOS tables may also stumble. This dependence may affect some network software and some RAM-resident programs that intercept DOS file I/O calls.

Ironically, one of the few programs that do not run in the OS/2 DOS Compatibility Box is *Microsoft Windows* 1.03. It turns out that *Windows* has too intimate a relationship with undocumented DOS function calls. Bad, bad, bad. Microsoft has stated that *Windows* 2.0 *will* run in the DOS Compatibility Box. It had better.

When switching back to a DOS Compatibility Box, OS/2 may not be able to reconstruct the entire previous screen image. This mostly affects programs that use the EGA in graphics modes. OS/2 cannot determine the entire video state because EGA registers are read-only. (Fortunately, IBM has started to build hardware with this problem in mind: all video registers in the new PS/2 VGA video adapter can be read by software.)

PROBLEMS WITH BLOCK DEVICES

Perhaps the most serious compatibility problem between DOS and OS/2 concerns installable block devices, which include some hard disks and tape drives.

The OS/2 protected-mode screen groups and the DOS Compatibility Box share the same file system. Device drivers for block devices have to run in protected mode. If the device driver does not run in protected mode, then the driver cannot be installed for use either in protected mode or in real mode.

While IBM's version of OS/2 will handle standard IBM disk drives, users of some non-IBM block devices on IBM machines may have problems. Users with add-on mass storage devices that require special drivers (usually specified in DEVICE lines of a CONFIG.SYS file) will not be able to install those devices. The driver file will have to be replaced by the manufacturer. A healthy chunk of Microsoft's OS/2 Development Kit is devoted to writing OS/2 device drivers.

When running in protected mode, OS/2 cannot take advantage of ROM BIOS code that normally masks hardware-dependent code from DOS. OS/2 has to duplicate all the ROM BIOS functions in its own drivers. (The PS/2 Models 50, 60, and 80 have ROM BIOS routines that can run in protected mode; hence OS/2 does not need to duplicate this code.) OS/2 may not be able to use a non-IBM hard disk controller card if it's not hardware compatible with the IBM board; it may also have problems with a non-IBM replacement ROM BIOS installed in an IBM controller card. Again, this is an area where the hard disk manufacturers have to provide software updates for users.

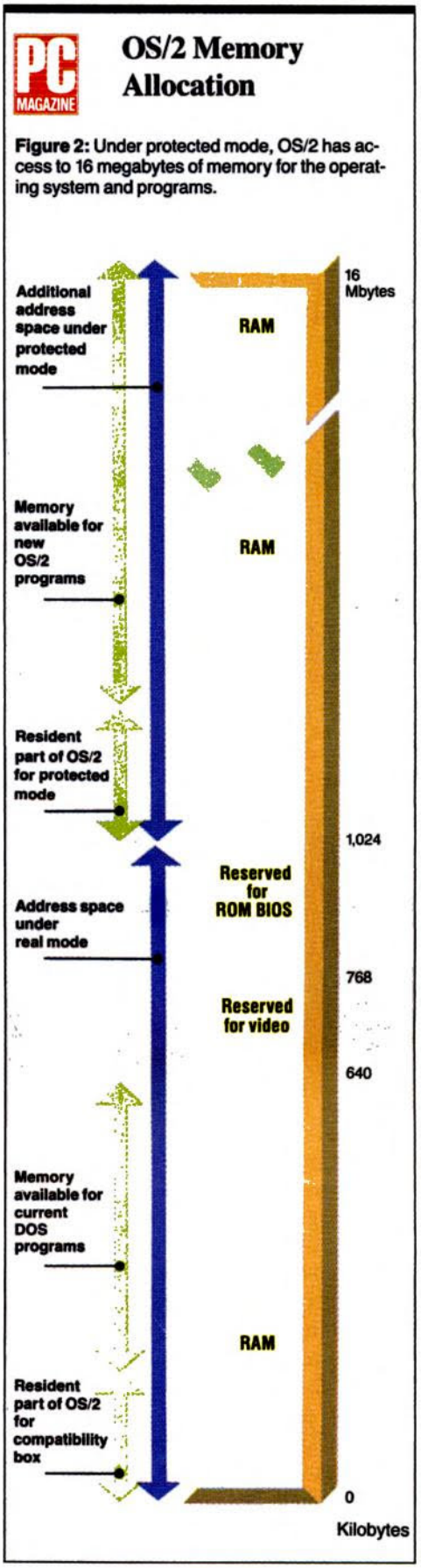


Figure 2: Under protected mode, OS/2 has access to 16 megabytes of memory for the operating system and programs.

WHAT OS/2 GIVES PROGRAMMERS

When programmers whose experience is limited to DOS first crack the manuals of the Microsoft OS/2 Software Development Kit, they will discover what a real operating system is all about.

Briefly, here are some of the OS/2 kernel features:

- In protected mode OS/2 can use up to 15 megabytes of memory (and more if the DOS Compatibility Box is limited in size or eliminated). Protected mode allows OS/2 to move code and data segments in memory and to use the same code segments for multiple instances of a program.
- OS/2 implements virtual memory; hence programs can allocate more memory than is physically present in the machine. OS/2 swaps memory to the hard disk based on a least-recently-used algorithm. In protected mode, the CHKDSK command doesn't even list total memory or free memory space because these figures have much less meaning than under real mode.
- OS/2 implements 80286 memory protection that effectively insulates programs and the operating system from a "runaway program" or any other occurrence that under real mode would probably crash the system.

■ OS/2's memory management includes provisions for shared memory blocks and "huge" memory blocks (blocks that are greater than 64K).

■ OS/2 efficiently multitasks programs. In protected mode, the 80286 hardware performs clean task switches. A program can execute another program in an asynchronous mode; the two programs can then run simultaneously. Programs designed to run in the background can exit back to the parent process and remain resident and running. A new OS/2 command called DETACH can run any program in the background (although programs that write to the display or require keyboard input may not be suitable for such treatment).

■ Programs can set up multiple threads of execution, allowing various sections of the program to run simultaneously. The program can assign the threads different priorities or temporarily suspend them. Threads can synchronize operation with each other through use of semaphores.

■ OS/2 programs can take advantage of system-supported interprocess communication and data sharing, either in the form of a pipe (which is somewhat similar to a DOS pipe) or a queue, which involves shared memory segments and can be priority based. Cooperating programs can synchronize message passing among themselves through the use of system semaphores and signaling.

■ OS/2's file I/O calls support file locking and file sharing. The OS/2 system call to open a file has seven sets of flags that designate various types of sharing modes, access modes, and inheritance modes, and indicate how critical errors should be handled.

■ OS/2 provides system calls to replace the direct access of hardware common in today's DOS programs. The OS/2 kernel does its own RS-232 buffering, has a complete mouse interface, and contains a very rich (and very fast) set of character-mode video I/O routines. (Graphics, however, is a problem. Programs that use graphics are better suited for the OS/2 Windows Presentation Manager.)

■ OS/2 includes a character-device "monitor" system for programs to intercept such things as keyboard input and printer output. Programs running in the background can use this to define hot keys similar to those of today's RAM-resident programs. (However, popping up on top of a running program may be a problem. The program underneath the pop-up is not suspended, as it is in DOS, and continues to run, possibly overwriting the area occupied by the pop-up. Pop-ups are best suited for the Windows Presentation Manager, where *every* program is a pop-up.)

■ OS/2 supports dynamic linking. This allows programs to use shared code stored in external library modules. The code is demand-loaded based on the needs of the program.

■ OS/2's timer facilities allow a program to be suspended and "sleep" for a set period of time. Of course, other threads in the program can continue to run during the suspension.

■ OS/2 includes a screen message facility to obtain text messages (such as "File not found") from a common file. This facilitates the adaptation of programs to foreign languages.

On top of this, programmers can also write applications for the OS/2 Windows Presentation Manager to take advantage of device-independent display and printer graphics, and a wealth of built-in routines for menus, dialog boxes, scroll bars, and so forth.

For compatibility reasons, OS/2 retains the same file system used by DOS. This old file system (the strongest part of DOS) is perhaps the weakest part of OS/2. Under OS/2, we are still stuck with the same 32-megabyte limit on hard disks. Under OS/2, we still have files that are identified by only an eight-character name and a three-character extension. Replacement of this file system now becomes one of the highest-priority enhancements to OS/2.

THE DIFFERENT ENVIRONMENTS

With the introduction of OS/2, programmers will have the choice of five different DOS-derived environments in which to program for the PC and PS/2 machines.

1. The DOS 2.*x*/3.*x* environment: programs that use DOS interrupt 21h and other software interrupts and directly access the computer hardware. These programs will run under current versions of DOS and in the OS/2 DOS Compatibility Box as well.

2. *Microsoft Windows* running in real mode: These programs use the *Windows* API (applications program interface) for most tasks and DOS interrupt 21h for file I/O. They will run under existing versions of *Windows* under DOS 2.*x* and 3.*x* and *Windows* 2.0 in the OS/2 DOS Compatibility Box.

3. OS/2: These programs use the OS/2 API. They cannot run under DOS 2.*x*, 3.*x*, or the DOS Compatibility Box.

4. OS/2 Family API: This is an interesting one. Programs that use only a subset of the OS/2 API (specifically those function calls that can be duplicated in real mode) can be linked with a special library to create a dual-mode .EXE file. When run under protected mode, the program uses the normal OS/2 API. When run under real mode, routines from this special library convert all the OS/2 calls to equivalent interrupt 21h calls, BIOS calls, or direct hardware accesses. These programs will run under OS/2 in protected mode, the OS/2 DOS Compatibility Box, and DOS 2.*x* and 3.*x*.

5. OS/2 Windows Presentation Manager: These programs use the API of OS/2 and the OS/2 Windows Presentation Manager. They cannot run under DOS versions of *Windows*.

The choice between programming for straight OS/2 or the OS/2 Windows Presentation Manager will probably be based mostly on whether the program uses graphics. The straight OS/2 environment is excellent for full-screen programs that do not use graphics. Although graphics applications can be programmed to run outside the Windows Presentation Manager, *Windows* is a more hospitable environment for graphics applications.

The OS/2 Family API will be used mostly for programs that make relatively simple use of the operating system. For instance, the compilers that Microsoft will release for OS/2 are Family applications.

The difference in the graphics interface between DOS *Windows* and OS/2 *Windows* will probably require develop-

ers to maintain separate source code files for these two environments. This is not the way it was supposed to be. *Windows* was supposed to provide smooth sailing between real mode and protected mode. Indeed, *Windows* was sold to software developers partially on the basis of that argument.

The changes that Microsoft is making to the *Windows* graphics interface are required because *Windows* will play a very significant role in IBM's emerging Systems Application Architecture. Essentially, *Windows*' graphics interface will be made compatible with IBM's GDDM graphics system. One long-term advantage is that programmers someday will be able to recompile their OS/2 *Windows* programs to run on IBM systems other personal computers.

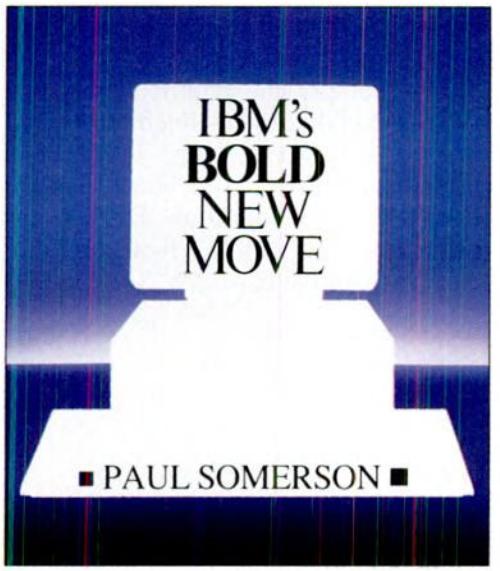
WHAT ABOUT THE 80386? Although OS/2 will run on 80386 machines, it does not take advantage of the 80386's 32-bit addressing space. Even on an 80386, OS/2 is still limited by the 64K segment limit (although programs can get around that somewhat through the use of "huge" memory segments) and a 16-megabyte address space (although the use of virtual memory can make it seem much larger).

The good news is that Microsoft intends to move the OS/2 API into a future 80386 version. Actually its plans are more ambitious than that: Microsoft is hoping that the foundations established by OS/2 will carry personal computer software through the next decade, which means almost through the end of the century. We shall see.

The next year or two should be interesting. Nobody can guarantee that OS/2 will replace DOS as the standard operating system on 80286 and 80386 machines. In fact, a change such as this represents such an upheaval that it's hard to imagine it actually happening.

But what's even harder to imagine is the IBM-compatible personal computer industry limping into the 1990s still burdened by the outdated and inadequate operating system known as DOS. PC

Charles Petzold is a contributing editor of PC Magazine.



DOS LIVES

IBM's recent Personal System/2 press event teemed with exuberant pitchmen preaching how OS/2 would allow true multitasking, solve memory problems, cure warts, grow hair, and assure world peace. DOS 3.3 was tossed off merely as an "interim solution" for serious hardware, and the operating system for a string of dogs including the PC Convertible, Portable PC, and PC*jr*. Even the "IBM Personal System/2 Data Migration Facility," a $33 rubber plug, garnered more attention.

Which is a shame, considering that OS/2—aka DOS 5,

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OS/2 is getting all the attention these days, but there's still a lot of life left in DOS. Version 3.3 offers quite a few new features, including the APPEND command you've been anticipating.

■ DOS 3.3

ADOS, and CP-DOS—won't be ready until next year, won't yet have its sexy *Windows*-like user interface when it first hits the shelves, and will set buyers back a hefty $325. For the vast majority of users the real operating system news is IBM's significantly beefed up DOS 3.3.

OK, Version 3.3 isn't a wholesale redo like the leap from 1.1 to 2.0. But apart from the obvious upgrades, such as understanding the new 1.44-megabyte diskettes, it deftly excises a heap of user headaches and adds a few sizzling new tricks. It also takes up a lot more real estate (see "Comparative Sizes of IBM DOS Versions").

PATH FINDERS The new feature users have been screaming for the longest is APPEND. Since Version 2.0 you've been able to tell the DOS PATH command which subdirectories to check for executable files (ending in .COM, .EXE, or .BAT). But nonexecutable files remained immune to even the most comprehensive search.

DOS executes "internal" commands such as DIR or VER or TYPE directly, since the instructions for these are embedded inside COMMAND.COM. If DOS doesn't recognize the command you typed, it first checks the current directory (if you entered something like CHKDSK) or any directory you may have specified (if you typed something like D:\BIN\CHKDSK). It then looks in each of the subdirectories that you included in your PATH. So if you added a line somewhere in your AUTOEXEC.BAT file that read

```
PATH C:\;C:\DOS;D:\
```

if DOS didn't immediately find the file you specified it would hunt for one by that name with a .COM, .EXE, or .BAT extension in the root and \DOS subdirectories on drive C:, and in the root directory on drive D:.

However, if you needed to find a file that had an extension other than .COM, .EXE, or .BAT, you had to purchase a "path extender" program such as *FilePath* or *File Facility*. Or, if you were working with DOS 3.1 or 3.2, you could use the SUBST command to trick DOS into thinking a subdirectory was actually a "logical" (rather than physical) drive with its own drive letter.

For example, the main *WordStar* 3.*x* WS.COM file always needs to know where you've stored its two .OVR overlay files. If these files were kept in C:\PROGS, you could use DEBUG to patch WS.COM so that it looked for the overlays on drive E:

```
DEBUG WS.COM
E 2DC 5
W
Q
```

and then tell DOS all about it with

```
SUBST E: C:\PROGS
```

(For anything higher than drive E: you also had to add a LASTDRIVE command to your CONFIG.SYS.) If your MEMO file was stored in C:\STAR\WORK and you had used SUBST to turn that subdirectory into F:, you could then type WS F:MEMO.

APPEND makes the process relatively easy—and a lot cleaner. Just follow the PATH command in your AUTOEXEC.BAT file with an APPEND command using similar syntax and telling DOS where your important nonexecutable files are located. If you keep overlays in the subdirectory mentioned above and correspondence with royalty in \KING\LTRS, your APPEND command could be

```
APPEND C:\PROGS;C:\KING\LTRS
```

DOS gives you two ways to keep tabs on your APPEND list. You can start off with an extra APPEND /E command, which loads APPEND strings into your environment and lets you change them with the SET command, just as with PATH. But if you or your programs switch command processors (by loading a secondary one or exiting the one you're currently using), such strings become inaccessible. With long PATH and APPEND strings, you may have to expand your environment size by using the SHELL command. In fact, these days the default 160-byte environment is straining at the seams.

You can also add an additional APPEND /X command to spiff up the way DOS looks for files. Or you can add both /E and /X, but you then have to run APPEND twice—first with any switches and then with the actual list of subdirectories DOS will search.

The DOS manual contains all sorts of dire warnings on using APPEND with BACKUP and RESTORE, running it with ASSIGN, or having it anywhere near the similar IBM LAN commands. And as with any path extender, you have to be careful that you're not accidentally pulling in a long-forgotten file from a distant subdirectory that APPEND knows about but that you don't.

DOS DELIGHTS Other long-sought enhancements let MODE address four serial ports rather than just two (OS/2 can juggle up to eight) and cruise along at up to 19,200 bits per second. With the profusion of modems, mice, oddball printers, digitizing devices, and cheap LANs, this is more than welcome.

And finally IBM has recognized that at least twice a year users need to reset their internal IBM clocks without having to hunt down their Diagnostics disks, figure out which option adjusts the time, and then grind through all the irritating screens necessary. The 3.3 TIME and DATE commands automatically reset IBM CMOS memory to reflect the change.

Another handy little improvement is the newfound ability of ATTRIB to gang-process all files in a directory and any subdirectories hanging off of it, with a simple /S switch. Unfortunately, however, ATTRIB still won't hide or unhide files. But it's now slightly easier to fiddle with large numbers of archive bits to make backups easier or make all the files in related subdirectories read-only to prevent inadvertent deletions or changes.

In earlier DOS manuals, STACKS was stuck on a lonely page way in the back. Under 3.3 it's moved up front where it belongs. Earlier 3.*x* versions had a bad habit of crashing if users banged on the keyboard too rapidly, and you needed to set STACKS properly to make the repair. DOS 3.3 also lets you disable STACKS entirely, if you want. Unfortunately, the explanation isn't unduly helpful.

BIGGER AND BETTER Now that larger hard disks are becoming popular and IBM has introduced drives that can soak up 44, 70, and 115 megs, it has tuned DOS to divide the physical units into smaller "logical" drives DOS can handle. FDISK can now create "extended" DOS partitions in addition to the "primary" ones you were able to carve out previously. Each extended partition can further be subdivided into logical drives 32 megabytes or smaller with their own drive letters.

FDISK assigns drives for you automatically and has priority over other drive-creating devices, such as VDISK, in assigning drive letters.

You can shoehorn hundreds of subdirectories and several thousand files onto a 32-meg drive. And, either by using SUBST to pare down long subdirectory names into single drive letters or by brute-forcing the size of your environment larger with SHELL, you can make your PATH and APPEND /E searches truly formidable.

However, asking DOS to churn through several dozen hefty subdirectories each time it looks for a file can make your system really drag its feet. To expedite things, DOS 3.3 provides a filename cache utility called FASTOPEN. Once you've told FASTOPEN how large a cache to maintain (from 10 to 999 entries, with a default of 34), each time you jump into a subdirectory or open a file, DOS records the on-disk location. Subsequent requests are far faster, since DOS will know exactly where to look.

Since each entry chews up 35 bytes, long searches can slog through FASTOPEN tables as large as 34K, slowing things down. But if you specify too few and exceed the number, FASTOPEN starts tossing the entries for the least recently used files. And this won't work with pseudodrives created by JOIN, ASSIGN, or SUBST, or on networks. But it shows that IBM is finally thinking big.

IBM is also making backups slightly more efficient. DOS 3.3 now lumps all BACKUP data into one large file on the target disk, eliminating wasteful slack space and accelerating the process. An additional CONTROL file tells DOS how to slice up the file later when restoring things. The new BACKUP can log its activity to the source disk and archive your files based on time as well as date. Best of all, it won't restore old IBMBIO .COM and IBMDOS.COM hidden system files on top of newer, updated ones—and it *will* FORMAT disks on the fly if you ask it to. Previous versions forced you to format a tall stack of floppies before you started—and if you ran out in the middle of backing up you were out of luck. However, it does this by running a copy of FORMAT.COM from out of BACKUP.COM, which is a clanky way to go.

IBM has tuned DOS to divide hard disk drives into smaller "logical" drives DOS can handle.

BATCH MAGIC Two overdue DOS 3.3 batch file enhancements should prove popular. The first thing most power users do in a batch file is turn ECHO OFF to stop the batch file's commands from displaying on-screen as they execute. But the ECHO OFF command itself added to the screen clutter. Now, simply by prefacing any command with an @ symbol, you can inhibit its appearance.

This won't prevent DOS from printing messages such as "1 File(s) copied." The way to suppress these is to add a >NUL after any DOS command that would normally generate a message on-screen. If you really want to shut things down, you can sandwich any potential screen-clutterers between the lines

```
CTTY NUL
```

and

```
CTTY CON
```

but be careful. Since CTTY NUL effectively disconnects your keyboard and screen from what's going on, unless you're absolutely certain that the batch file is going to make it back to the restorative CTTY CON line, you're playing with fire.

The other smart 3.3 batch fixup is the ability to CALL an additional batch file, execute it, and then return to the original batch file and continue executing it. Previous editions of DOS let users nest batch files by running them out of additional command processors (with COMMAND /C). But this had environment drawbacks and ate up space.

If you want to have DOS list all the files in a subdirectory for you and then ask whether or not you want to delete each, you can do it with CALL and a tiny ERRORLEVEL setting routine called GETYES.COM that simply stops, watches what you type, and tells the batch file whether you entered a Y (or a y) or not.

To create GETYES.COM, load DEBUG and type

```
E100 B4 00 CD 16 3C 59 74 04 3C
E109 79 75 02 B0 FF B4 4C CD 21
N GETYES.COM
RCX
12
W
Q
```

Then create two small batch files, CLEAN.BAT and a second batch file called CL.BAT that's called by CLEAN .BAT:

```
@echo off
REM CLEAN.BAT
for %%a in (*.*) do call cl.bat %%a
```

```
@echo off
REM CL.BAT
echo Do you want to delete %1 (Y/N)?
getyes
if errorlevel 255 goto doit
echo %1 NOT deleted
goto end
:doit
del %1
echo %1 deleted
:end
```

The (*.*) tells CLEAN.BAT to look at each file in your current directory. If you want to limit searches to .BAK files, you could change what's in between the parentheses to (*.BAK). Each time CLEAN.BAT finds a file matching the wildcard spec, it uses the CALL command to load CL.BAT and pass the name of the file to it.

CL.BAT prints a message on-screen, runs GETYES.COM to let the user answer Yes or No (anything other than a Y or y is treated as a No), and branches accordingly when it reaches the IF ERRORLEVEL test. GETYES produces an ERRORLEVEL code of 255 (hex FF) if the user typed a Y or y, and if CL.BAT sees this value, it jumps to the :DOIT label that expunges the file and then exits, returning control back to the original CLEAN.BAT file that called it.

If the ERRORLEVEL value is not 255, CL.BAT jumps directly to the exit and then back to CLEAN.BAT. In either case, CL.BAT prints a message reporting whether or not it deleted the file. It knows the name of each file because the %1 replaceable parameter temporarily holds the value passed to it (in this case the filename) by %%A in CLEAN .BAT's FOR . . . IN . . . DO command.

You can't do file redirection or piping when you use CALL. But you can still use COMMAND /C if you need batch redirection.

DOS 3.3 also documents environment variables for the first time. You can use these to pass information back and forth from application to application or to see what's going on in your environment.

For instance, if you're currently using a customized PROMPT—and every serious hard disk owner should use some variation of $P to see the name of the current logged subdirectory—you can examine the string that did the customization, by typing SET. You can't just type PROMPT, since that resets the custom prompt to the default C> prompt. But SET displays lots of information you probably don't want, such as the COMSPEC, PATH, and perhaps APPEND list. You could filter out all extraneous information with the command

```
SET | FIND "PROMPT"
```

but that would take time, force you to have FIND.EXE handy, and print out something like PROMPT=$p: when you really wanted to display the information faster and in a different form.

Since PROMPT is an environment variable, you could create a tiny batch file called PROMPTER.BAT that displays the actual PROMPT you're using:

```
@echo off
echo Your prompt is currently %PROMPT%
```

The batch file would substitute the current value of the PROMPT environment variable string in place of the %PROMPT% and print a message like

```
Your prompt is currently $P:
```

A primitive way (without writing any files to disk) to see which users have been on your system is with a LOG.BAT batch file. Just add a line that says simply LOG as the last instruction in your AUTOEXEC.BAT file, and create the following LOG.BAT file:

```
@echo off
REM LOG.BAT
if %1!==! goto oops
if %USERS%!==! goto first
SET USERS=%USERS%;%1
goto success
:first
SET USERS=%1
goto success
:oops
echo You have to specify your
echo initials after %0, e.g.
echo %0 PS
prompt Enter %0 then your initials$_
goto end
:success
echo Welcome
prompt $P:
:end
```

If the user doesn't enter his or her initials, LOG.BAT jumps to the :OOPS label, which prints an error message and then changes the DOS prompt to provide instructions. The %0 is a special replaceable parameter that prints out the actual name of the batch file that's currently running, so if you change the name to something other than LOG.BAT the batch file will automatically figure it out.

If the user did enter initials, LOG .BAT first checks to see whether any other users have logged in. It can tell by examining the %USERS% environment variable; if there isn't yet any value for %USERS%, LOG.BAT sets the USERS variable to the initials just entered. If LOG.BAT finds initials already there, it sticks the new initials at the end, after a semicolon. In either successful case, it then resets the prompt so it doesn't print the nasty instructional message, and exits. You could add an additional command at the end, after successful completion, such as 123 or WP, to run a program.

It's obviously easy to avoid this log-in process by using Ctrl-Break or Ctrl-C to crash out of LOG.BAT or the AUTOEXEC.BAT file that loads LOG.BAT, booting off a floppy instead of the hard disk, or just entering junk when asked for initials. Rebooting or running a SET USERS= command would destroy any existing record. And you'd have to be sure you used the CONFIG.SYS SHELL command to increase the environment size so that it accommodates all potential users' initials. But it works. You can walk over later and type SET and see who's been there.

RED, WHITE, AND BIG BLUE DOS 3.0 to 3.2 came in five international flavors. By executing the appropriate KEYB*xx* command, you could tweak the keyboard into British, German, French, Italian, or Spanish modes. Actually, since you could toggle back and forth between the standard keyboard and the foreign variants, you could adapt the KEYB*xx* command to print just about anything on-screen.

For instance, you could patch KEYBUK.COM (the smallest of the five KEYB*xx* files) so that the

```
QWE
ASD
ZXC
```

block of keys would produce either a single-line box (with lowercase letters) or a double-line box (with capital letters). To try this (with DOS 3.2 on an old AT keyboard), type in the following SCRIPT.KBD file:

```
N KEYBUK.COM
L
E 9AB DA C2 BF
E 9B9 C3 C5 B4
E 9C7 CØ C1 D9
E 9E5 C9 CB BB
E 9F3 CC CE B9
E AØ1 C8 CA BC
N KEYBOX.COM
W
Q
```

For other 3.*x* versions of DOS, replace

the address column directly after the initial Es as follows:

```
3.Ø 3.1 3.2
592 662 9AB
5AØ 67Ø 9B9
5AE 67E 9C7
5CC 69C 9E5
5DA 6AA 9F3
5E8 6B8 AØ1
```

Once you've created the appropriate KEYBOX.COM file, run it. You can toggle back and forth between the normal keyboard and the new one by hitting Ctrl-Alt-F1 and Ctrl-Alt-F2.

With Version 3.3, IBM totally revamps the way DOS handles foreign alphabets. But it does so in the most confusing way possible. First, instead of calling the process something clear and simple like "font loading," IBM insists on referring to it as "Code Page Switching." Then, it forces the user to digest three different and seemingly contradictory chunks of the manual—a whole chapter relegated to the rear between Error Messages and EDLIN, an abstruse few pages under DEVICE in the CONFIG.SYS section, and several other dense dollops under MODE, NLSFUNC, GRAFTABL, KEYB, and CHCP. Manual writers everywhere should be forced to plod their way through to see the ultimate example of how not to explain things. *PC Magazine*'s resident DOS expert Charles Petzold took one long look, shook his head, and said, "Thank God we're Americans."

Code Page Switching will show new fonts only with DOS 3.3 and only on EGA/ECD monitors, PS/2 displays, and IBM PC Convertible LCD screens. (You can print the new character fonts only on IBM Model 4201 Proprinters and Model 5202 Quietwriter IIIs.) If you want to see all the new characters, assuming both that the 3.3 DISPLAY.SYS file is in your C:\DOS subdirectory and that you're using an EGA, first include a line in your CONFIG.SYS file:

```
device=c:\dos\display.sys con=(ega,437,5)
```

Then, create a small SHOWFONT.COM file that will display the high-bit ASCII characters DOS tinkers with, by loading DEBUG.COM and typing in

```
E100 B4 0E B0 84 CD 10 FE
E107 C0 3C FC 75 F8 B0 0D
E10E CD 10 B0 0A CD 10 C3
N SHOWFONT.COM
RCX
15
W
Q
```

Finally, type in the following CODEPAGE.BAT batch file (assuming COUNTRY.SYS is in your C:\DOS subdirectory and that MODE, NLSFUNC, and the SHOWFONT.COM file you just created are in a directory you've included in your PATH):

```
@echo off
nlsfunc c:\dos\country.sys
mode con cp prep=((850,860,863,865) ega.cpi)
echo Hit any key 4 times
mode con cp sel=865 >nul
showfont
pause>nul
mode con cp sel=850 >nul
pause>nul
mode con cp sel=860 >nul
pause>nul
mode con cp sel=863 >nul
pause>nul
mode con cp sel=437 >nul
```

While Code Pages 865, 863, and 860 will be interesting only to residents of Norway, French-speaking Canada, and Portugal, Multilingual CP 850 replaced some of the standard Greek and block graphics characters with things like ®, ©, ¶, ×, ¢, ¾, and ^{1} and ^{3}.

The CHCP command lets you select code pages on a systemwide level (MODE does it at the device level)—and when used without any arguments will report the current code page. GRAFTABL can now load in the new high-bit characters and will also report the current code page. KEYB handles the new keyboard headaches.

IBM prefaces its long appendixlike treatment of the topic with the caveat "You can use code page switching without fully understanding everything about it." After poring over the text, you'll know why this was included.

GOODBYE OLD FRIEND The bad news is that IBM removed all references to DEBUG in the normal DOS manual (even though it's still on the disk) and did away with LINK, EXE2BIN, and VDISK.SYS, which now come with the $85 DOS *Technical Reference* manual only. Serious programmers will want the DOS *Tech Ref* anyway, and LINK often comes packed with compilers these days, but it was a genuine crime to toss the documentation on DEBUG. (And the manual doesn't even mention a single advantage of using ANSI.SYS, also detailed solely in the *Tech Ref*.) Shame on IBM.

With 3.3, IBM defines four new INT 21 functions—Get/Set Extended Country Information (65H), Get/Set Global Code Page (66H), Set Handle Count (67H) (which pushes DOS past the former 20-file-per-process limit and can open up to 255 files at once), and Com-

Comparative Sizes of IBM DOS Versions

DOS Version	COMMAND.COM (bytes)	IBMBIO.COM (bytes)	IBMDOS.COM (bytes)	Total bytes used by system files
DOS 1.0	3,231	1,920	6,400	13,312
DOS 1.1	4,959	1,920	6,400	14,336
DOS 2.0	17,664	4,608	17,152	40,960
DOS 2.1	17,792	4,736	17,024	40,960
DOS 3.0	22,042	8,964	27,920	60,416
DOS 3.1	23,210	9,564	27,760	62,464
DOS 3.2	23,791	16,369	28,477	69,632
DOS 3.3	25,307	22,100	30,159	78,848

This table shows the comparative sizes of all IBM DOS versions. (You can use this chart to look at the size of COMMAND.COM on diskettes formatted with the /S option and determine the DOS version number.) DOS 3.3 is a whopping six times larger than 1.1 and is 13 percent faster than its immediate predecessor.

■ DOS 3.3

mit File (68H) (which "commits" modified file data to disk and updates the directory entry but doesn't close the file).

OK, so DOS is far from perfect. Utilities like TREE and COMP are a disgrace, and too many explanations are opaque. MODE still utterly ignores EGA video enhancements, and the EGA has been superseded by the next-generation PS/2 graphics! The already irksome "Abort, Retry, Ignore?" is now an even more chilling "Abort, Retry, Fail?"—

The already irksome "Abort, Retry, Ignore?" is now an even more chilling "Abort, Retry, Fail?"

■ ■ ■ ■ ■

not much of a choice and about the farthest thing from friendly. At $120 a crack ($75 for an upgrade), it's not cheap.

But there are genuine signs of improvement. DOS 3.3 sniffs out the hardware configuration and sets from 2 to 15 buffers automatically instead of simply assuming every PC and XT user really wanted only 2 and every AT user only 3. Warnings are bolder and a little clearer; the manual properly explains for the first time that the command DEL *filename*.? will eradicate both files with single-character extensions as well as files with no extensions at all. The space-wasting BASIC.COM is gone forever (the BASIC command simply loads BASICA). And enhancements like the CMOS clock-setting DATE and TIME, muted ECHO OFF, 19,200 bit-per-second COM1–COM4, slicker and safer BACKUP and RESTORE, and long-awaited APPEND make it a winner. Still, IBM and Microsoft have a long way to go in adding the kind of power, ease, and flexibility sophisticated users are demanding. PC

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