EDN'S ALL-STAR PC

PART 4:
OPERATING-SYSTEM SOFTWARE

Just as a ballclub needs a pitcher and a catcher, EDN's All-Star PC needs software to be complete. The cardinal component of any software repertoire is the operating system. The All-Star PC uses several.

Operating systems get very little respect from users, probably because they get in your way more often than not. Cryptic commands and mysterious command-line switches make text-oriented operating systems difficult to use. Yet these essential programs define how you interact with your computer. Microsoft's DOS is currently the most popular PC operating system, but it isn't the only player available for high-end PCs like EDN's All-Star PC. Multitasking operating systems, including Unix and OS/2, are waiting in the on-deck circle.

Many people think DOS is getting long in the tooth. DOS and the PC were introduced together in 1981 and both have since evolved. DOS 1.0 mimicked Digital Research's CP/M operating system, which ran on the 8080 μP. But DOS 2.0 gained a character all its own by incorporating hierarchical directories. The most recent release, DOS 4.01, overcomes many of the operating system's lingering limitations. It supports expanded memory, large hard disks, and a limited form of multitasking. The All-Star PC includes DOS 4.01 as one of its operating systems because of the many applications programs available for DOS-based systems.
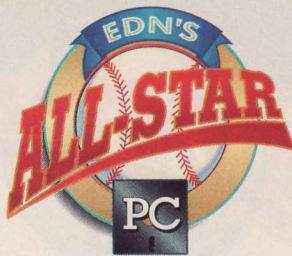
DOS 4.01 allows the All-Star PC to use

STEVEN H LEIBSON,
Senior Regional Editor

the entire 315M bytes of the Seagate Wren Runner hard-disk drive as one physical disk drive. Earlier versions of DOS could handle logical drives no larger than 32M bytes. DOS 3.3 split each of the All-Star PC's 315M-byte Wren Runners into 10 logical drives, a shortcoming that caused problems with some programs. DOS 4.01's solution is much cleaner.
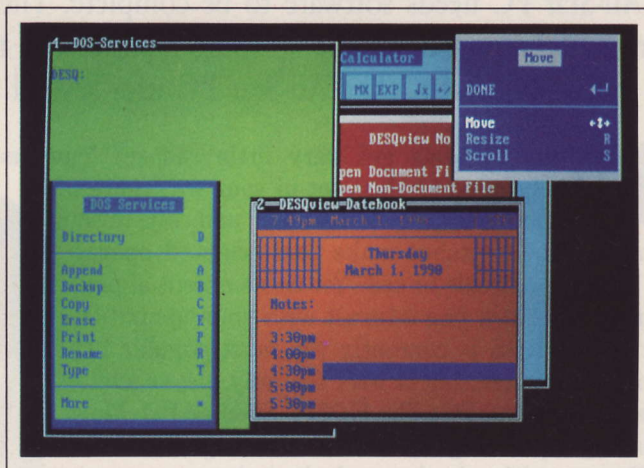
Since DOS's introduction, the industry's definition of just what an OS should provide has evolved. In the heyday of CP/M and DOS 1.0, most PCs had either limited or no graphics hardware. Consequently, the operating systems for these machines provided very little support. Now however, graphics displays are integral to most PCs. Yet DOS still shuns graphics support. It clings to the past because its existing base of applications programs can't take advantage of new graphics services. DOS 4.01 provides a graphics-shell program that creates the illusion of a graphical user interface (GUI), but the applications programs that you activate from that shell must supply their own graphics drivers, like any DOS program. As a result, every DOS applications program looks and acts differently. There's nothing inherently wrong with differentiation, but a wide-open operating environment like DOS extracts a penalty in user inefficiency and in learning time.

Microsoft recognized years ago that DOS was falling short of contemporary operating-system expectancies, so it developed the Win-

dows operating-system shell to add missing features. The earliest versions of Windows provided a standard set of graphics services that allowed applications programmers to produce software with a common look and feel. Unfortunately, Windows can only provide graphics services to programs that are specifically written to make use of them. No software shell can retrofit graphics on a program created ignorant of GUI concepts. But DOS pro-

Though it cannot retrofit GUI standardization to existing DOS applications programs, Quarterdeck's DESQview 386 still manages to provide windowing and multitasking services.

grams still outnumber Windows applications programs by a substantial margin, so most existing PCs currently operate without the Windows GUI. This situation may change however, as more 80386- and 80486-based PCs enter the workplace. Windows/386 version 2.11, the latest and most powerful version of the package, runs DOS applications. With the added hardware boost from the 80386-μP family, it also provides memory management and multitasking services. Thus Windows/386 provides a bridge between existing DOS applications and a GUI-

based OS: DOS plus Windows.

Quarterdeck Office Systems recognized the limitations inherent in DOS and took a different approach to enhancing DOS's capabilities. The company's DESQview 386 operating-system shell for DOS provides multitasking and windowing services like Microsoft's Windows/386. QEMM (the Quarterdeck expanded memory manager for the 80386) is part of the DESQview 386 package; it provides memory-management services for DESQview. With QEMM, you can convert all memory above the first megabyte into so-called expanded memory (called block-switched memory in the days of CP/M). Many DOS programs can take advantage of expanded memory for large data structures, and the DESQview shell uses expanded memory to provide multitasking under DOS. Windows/386 performs similar feats with expanded memory. However, unlike Windows/386, DESQview doesn't bestow a graphics-interface standard upon application programs. Instead, its windows differ greatly in appearance from one to the next, depending on the user interface built into the underlying program.

EDN's All-Star PC runs both Windows/386 and DESQview 386, but it can only run one at a time because both programs want to manage the system's memory, an event that would lead to conflicts if both operated concurrently. To use both, you must keep two different CONFIG.SYS files on your hard disk and place the one you

want in the root directory, then reboot your PC to activate the desired shell program. This procedure lacks any semblance of elegance, but it works.

Concurrency streamlines work

Windows/386 and DESQview 386 make PC users more efficient by allowing many programs to run concurrently. In such an environment, PC users can jump from program to program instantly as warranted by the day's tasks and by those pesky interruptions everyone deals with. Both programs also allow processing for background tasks, so you can initiate a long processing job and then switch to another task while the background processing occurs. Far too many people state that most PC users do not need and cannot take advantage of concurrent-program operation. That's bunk! Concurrent-program operation allows you to leave one task to handle an interruption and later return to the same spot. Everyone deals with interruptions on a daily basis, so it's foolish to say that few can benefit from the advantages provided by programs like DESQview 386 or Windows/386.

Software compilation, for example, greatly benefits from background processing. Software developers have used background compilation on minicomputers and mainframe computers for decades. A multitasking OS allows you to jump from a debugger to an editor to a compiler and back to the debugger. Similarly, a hardware designer can jump from a schematic-capture package to a simulator to a pc-board-layout package to a thermal-analysis package and back again. Engineers can very definitely benefit from concurrent-program operation and multitasking.

But DOS applications aren't really designed for multitasking environments and therefore lack features that could make them even more useful. For example, programs designed for a single-tasking environment aren't likely to contain facilities to communicate with other running programs. Only one program at a time can run under a single-tasking OS, so it would be silly to include such capabilities. Yet real-time communications among programs can be quite useful, particularly for engineering applications.

For example, a schematic-capture program can transmit design changes to a bill-of-materials program to a program that calculates power dissipation to still another program that calculates the project's component cost. The electronic-product-development tools in the latest software release from Mentor Graphics Corp (Beaverton, OR) do exactly that. However these tools, collectively called Software Release 8.0, currently run under

## Accelerating system performance through GUIs

GUIs don't just help users make more efficient use of their machines. They can also make programs run faster through the use of graphics accelerators, such as the NEC Multisync Graphics Engine or the Hewlett-Packard IGC 20 discussed in Part 3. You can't easily boost a computer's overall performance with a graphics-accelerator card if every application program must be aware of the accelerator and know how to use it. Unfortunately, that is what must occur if you use unenhanced DOS.

However, if all application programs use standard graphics services from the OS, then only the operating system needs to be aware of the accelerator. Thus PC operating systems with GUIs, such as DOS with Windows, OS/2 with Presentation Manager, or Unix with Motif, can provide accelerated graphics to all application programs with only one set of display drivers installed in the operating system. An application program need not even be concerned about whether or not a graphics-accelerator card is installed in the system. If an accelerator is present the program will run faster. But that is the only operational difference.
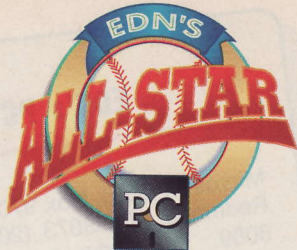
Unix and only on workstation-class computers. Without multitasking, you would need to run each program in turn to compute the various effects caused by the design changes. Because a collection of integrated application programs like Software Release 8.0 promises to provide a large jump in individual productivity, the PC market is girding for the jump to multitasking operating systems over the next two years.

Dueling operating systems

Unix and OS/2 are fighting for the lead as the PC multitasking operating system of choice. Most engineers have at least heard of Unix. Workstation and software vendors like Mentor made Unix the primary operating system for their technical applications. GUIs such as the Open Software Foundation's Motif metamorphose Unix from a hacker's delight into an OS that can be used by people with a wide range of computer skills. Intel claims, based on industry surveys, that almost 60% of Unix-based computer systems shipped annually now incorporate 80286 and 80386 µPs, and that many of those systems are PCs. Minicomputers, RISC-based products, and Motorola 68000-based computers constitute the remainder of the market. PCs are clearly a big part of the Unix world, although Unix currently represents only a small part of the PC's market.

For high-end PC's, OS/2 will be Unix's biggest competitor. OS/2 looks and operates a lot like DOS but provides additional capabilities such as multitasking. With the addition of the Presentation Manager GUI, OS/2 becomes a graphical OS that resembles the DOS/Windows combo. But OS/2 is strictly an OEM
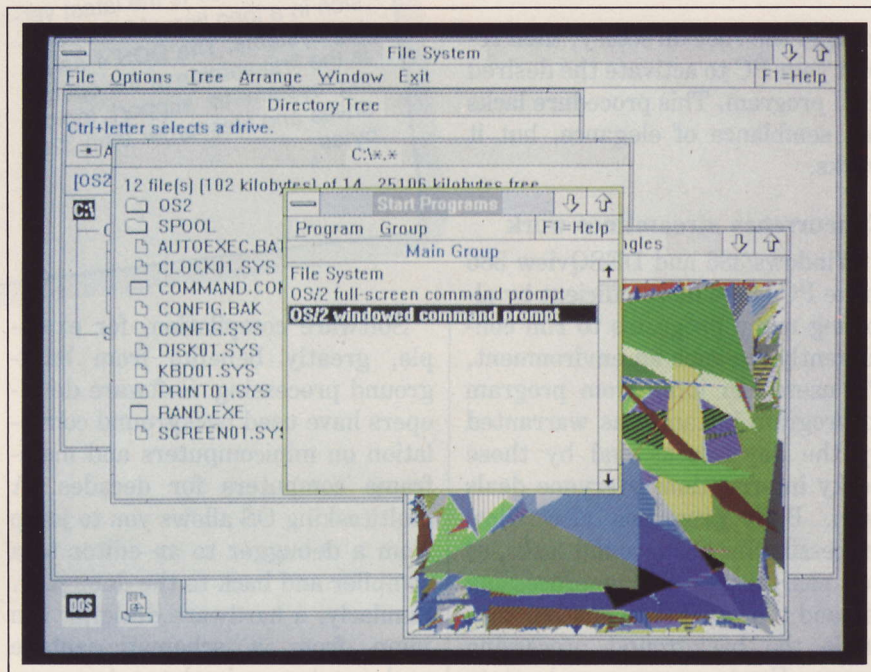
Bearing a strong family resemblance to its cousin, Microsoft Windows/386, the Presentation Manager adds GUI capabilities to Microsoft's OS/2 operating system.

product for Microsoft; the company doesn't sell the operating system to end users, at least not yet. Currently, computer OEMs must use Microsoft's OS/2 development kit to build a custom-tailored version of OS/2 for their specific hardware configurations. Although earlier versions of OS/2 (through version 1.2) run on both 80286-and 80386-based computers, Microsoft's OS/2 version 2.0, currently available only in development-kit form, runs only

on computers that employ µPs from the 80386 family.

In addition to multitasking, Unix and OS/2 provide another sorely needed feature: the ability to use more than 640k bytes of RAM for a program. This long-standing DOS-imposed limitation seemed inconsequential when DOS was first introduced. Compared to CP/M's 64k-byte limit, DOS's 640k-byte ceiling seemed vast. But software developers have made grand extensions to their products since 1981. They have attempted (and often succeeded) to take on tasks never thought possible on a PC. As a result, word processors have evolved into desktop-publishing packages, schematic-capture programs grapple with pc boards of ever increasing complexity, and some PLD compilers now attempt to fit designs into multiple devices. All of these added capabilities demand more

memory, so the 640k-byte barrier, once a liberating factor, has now become a constant stumbling block.

Both Unix and OS/2 circumvent DOS's 640k-byte limitation. By their inherent designs, they make use of the memory above the first megabyte as conventional (not extended or expanded) memory. Because Unix and OS/2 version 2.0 don't run on 8088- and 80286-based machines, they don't limit programs to the first megabyte of memory. In addition, both operating systems support virtual-memory operation, which permits applications programs to run as though there were more RAM in the system than is actually present. Virtual-operating systems load only the parts of a program that are required for immediate operations and leave unneeded sections of code on the system's disk until they are needed. Disk capacity becomes the new limiting factor for program size, and hard-disk drives are getting very big indeed.

Unix for the PC

EDN's All-Star PC runs two flavors of Unix—Xenix and Unix/386. Both are offered by the Santa Cruz Operation (SCO). Xenix is a compact version of Unix designed to operate on 80286- and 80386-based PCs. The stock version supports only two types of hard-disk controllers—the de facto standard Western Digital WD1003 controller for ST-506 hard-disk drives and Adaptec's AHA1540 SCSI-host-adapter family. The WD1003 doesn't work with SCSI-based disk drives, and, as discussed in Part 2, the Adaptec boards conflict with Quarterdeck's DOS-extension products. The solution, for Xenix, is to add a special Xenix driver for the IN-2000. Always Technology, the

vendor that supplied the IN-2000 SCSI host adapter for the All-Star PC, finished a disk driver for SCO's Xenix just in time for this article.

SCO's Unix/386 is part of the company's Open Desktop package, which combines a version of Unix System V version 3.2, a PC version of Motif, and various standard networking and communications programs into one comprehensive product. Open Desktop is a very big operating system by PC standards. To run it, a PC needs at least 8M bytes of RAM and should have at least 100M bytes of hard-disk space available. Unlike Xenix, SCO's Open Desktop package runs strictly on PCs that employ μPs from the 80386 family.

The Open Desktop can share the hard disk with other operating systems, such as DOS and OS/2, through DOS's disk-partitioning scheme. However, you must use the respective operating systems' FDISK programs to activate a partition. The active partition determines which operating system will take over the next time the computer boots. SCO Xenix has a

"DOS" command that is supposed to switch a system over to DOS, but this command didn't work on the All-Star PC. Steven Katz, the vice president of software engineering at Always Technology, surmised that Unix's DOS command failed because it didn't recognize the large DOS 4.01 disk partition as a valid DOS partition. DOS 4.01's disk partition differs from the partitions created by older DOS vintages.

A tenuous, 3-way OS marriage

Trying to get DOS, OS/2, and Unix/386 to coexist on a hard disk on the All-Star PC presented several problems. The first was getting the right disk drivers for all three operating systems. OS vendors write their disk drivers for the PC's lowest common denominator: the

WD1003. Any deviation requires a hard-disk driver to link the operating system to the "foreign" controller. The All-Star PC's IN-2000 incorporates a BIOS ROM that provides its own DOS driver, so no extra software is needed. Always also supplied a loadable driver for Xenix because Xenix does not use the BIOS ROM's disk-access routines. Because OS/2 and Unix also won't make use of the IN-2000's BIOS ROM, they too require disk drivers. As the deadline for this article approached, it appeared that Always Technology would not be able to supply OS/2 and Unix drivers for its board in time for this project.

Fortunately, Perceptive Solutions Inc (PSI) had just completed its first production run of Hyperstore 1600 disk controllers. The Hyperstore 1600 is a caching disk controller with interchangeable media adapters. It can operate ST-506-,

ESDI-, and SCSI-based hard disks. The controller board accepts 4M bytes of dynamic RAM (DRAM) for its disk cache and employs a Zilog Z280 µP for SCSI and cache control. An auxiliary memory board can boost the controller's cache RAM to 20M bytes. The Hyperstore 1600 operates in either a native SSP (standard-storage-protocol) mode or a WD1003 emulation mode. PSI says that its SSP mode is slightly faster than the WD1003 mode. But, any PC operating system can use the emulation mode without additional disk drivers. The major drawback to emulation is that the WD1003 register-set definition limits the hard-disk capacity to two 450M-byte drives. Fortunately, that limitation presented no problems for the All-Star PC's two 315M-byte drives.

Though installing the Hyperstore 1600 presented few problems, there was one tough nut that had to be cracked—a conflict between the Hyperstore 1600's integral floppy-disk controller and the Compaticard IV card from Microsolutions, which was already in the All-Star PC. You can't disable the Hyperstore 1600's floppy-disk controller (although you can move it to a secondary address, which also conflicts with the Compaticard IV). As a result, the final configuration gives control of the All-Star PC's two 5¼-in. floppy-disk drives to the Hyperstore 1600 and retains the Compaticard IV for the two 3½-in. floppy-disk drives. In this configuration, the Hyperstore 1600 uses the primary floppy-disk-controller address, and the Compaticard IV occupies the secondary address.

Tape-drive control became a problem when the Hyperstore 1600 entered the mix. Because I would

EDN's PC All-Stars — Hyperstore 1600 Disk Controller

Perceptive Solutions Inc, 1509 Falcon, Suite 104, DeSoto, TX 75115. (214) 224-6774. FAX (214) 228-1430.

Circle No. 653

STATS:
BUS: IBM PC/AT
MEDIA ADAPTERS: ST506, ESDI, SCSI
MAXIMUM NUMBER OF MEDIA ADAPTERS: 4
MAXIMUM ON-CARD MEMORY: 4M bytes
MAXIMUM OFF-CARD MEMORY: 16M bytes
OPERATING MODES: WD1003 emulation, native SSP
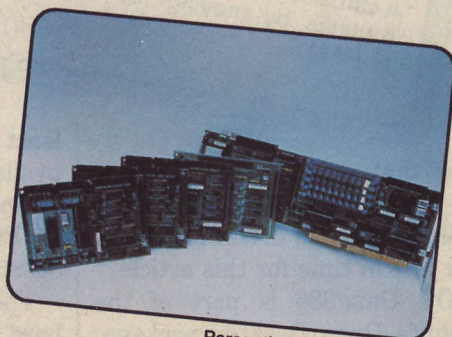
Perceptive Solutions Inc

BIO: The Hyperstore 1600 combines flexible disk interfacing with intelligent caching on one PC/AT expansion card. Through WD1003 emulation, the disk controller offers wide compatibility with any PC operating system.

EDN's PC All-Stars

The Santa Cruz Operation (SCO), Box 1900, Santa Cruz, CA 95061. (408) 425-7222.
Circle No. 654

BIO: SCO's Open Desktop rolls all of the most contemporary Unix utility programs (operating system, graphical user interface, and network services) into one package for high-end PCs.

STATS:
PROCESSOR REQUIRED: 80386 family
OPERATING SYSTEM: Unix System V/386 Release 3.2
GRAPHICAL USER INTERFACE: X Window with Motif
NETWORK SERVICES: TCP/IP, NFS
RECOMMENDED MEMORY: 8M bytes RAM, 100M bytes disk
GRAPHICS-CARD SUPPORT: EGA, VGA, Hercules

be switching between the IN-2000 and the Hyperstore 1600, the All-Star PC needed a new tape-backup scheme. PSI has not yet developed tape drivers for its SCSI controller, and the Novastor tape-utility program supplied with the IN-2000 only works with the IN-2000. The addition of a third SCSI host adapter, Future Domain's TMC-860, solved the problem. Future Domain introduced drivers for the Sytos tape-backup program late last year and supplied that software for the All-Star PC project.

Sytos from Sytron Corp (Westboro, MA) is a general-purpose tape-backup utility. The Future Domain drivers link Sytos and the TMC-860 to the All-Star PC's Exabyte EXB-8200 cartridge-tape subsystem. Packing three SCSI host adapters into one PC is hardly an efficient configuration. One SCSI controller should be able to control all of the All-Star PC's SCSI-based mass-storage devices, but the TMC-860 is a bit slow for the Wren Runner disk drives, the IN-2000 has a limited repertoire of OS drivers, and the Hyperstore 1600 lacks tape drivers. The vendors of these SCSI host adapters will undoubtedly solve most of these problems in the near future, but for now, the All-Star PC must rely on the services of several SCSI host adapters to ac-

complish all of the project's goals.

Using either the IN-2000 or the Hyperstore 1600, DOS 4.01 and Windows/386 loaded easily. However, while using the Hyperstore 1600 to load either SCO's Open Desktop or Microsoft's OS/2 version 2.0, the All-Star PC locked up shortly after beginning the installation. As it turned out, neither problem was related to the Hyperstore 1600. Unable to solve the Unix and OS/2 installation problems alone, I took the All-Star PC and Steven Katz to Colorado Springs to visit Ron Sartore at Cheetah's R&D labs.

Sartore solved the Unix/386 problem in less than a day. Early in the installation process, Unix/386 tries to gauge the size of a PC's memory. When it tried to read the first byte of the 17th megabyte, the All-star PC's memory subsystem refused to complete the memory-bus handshake and the system froze. A new address-decoder PLD cured that problem, and we loaded SCO's Open Desktop without further trouble.

OS/2 version 2.0 also didn't like the All-Star PC's configuration and refused to load. However, in this case the PC's hardware wasn't freezing; the processor continued to execute code, but externally, the PC was dead and wouldn't load OS/2 from the floppy. The same problem appeared when we tried to load
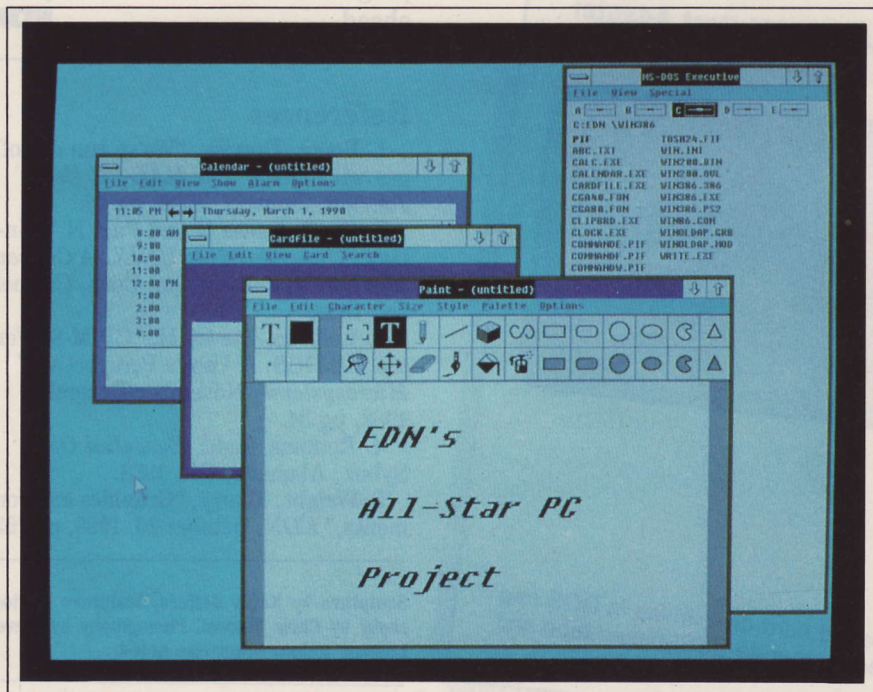
With the proper display drivers, a high-resolution graphics accelerator like the NEC Multisync Graphics engine allows Microsoft Windows/386 to throw a lot of information onto the screen quickly.
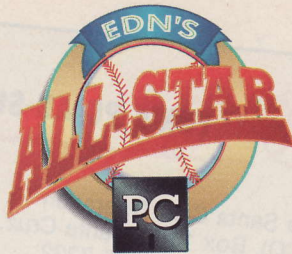
EDN's PC All-Stars — OS/2 Version 2.0

Microsoft Corp, Box 97017, Redmond, WA 98073-9717. (206) 882-8089.

Circle No. 655

STATS:
PROCESSOR: 80386 family
FILE SYSTEMS: DOS or high-performance file system
GRAPHICAL USER INTERFACE: Presentation Manager
RECOMMENDED RAM: 4M bytes min
GRAPHICS-CARD SUPPORT: CGA, EGA, VGA
NETWORK SERVICES: LAN manager (optional)

BIO: OS/2 is the next step on DOS's evolutionary ladder. It offers multitasking and a standard graphical user interface. In addition, version 2.0 breaks away from the 80X86 family's segmented architecture and instead supports one large, linear memory model and virtual-memory operation.
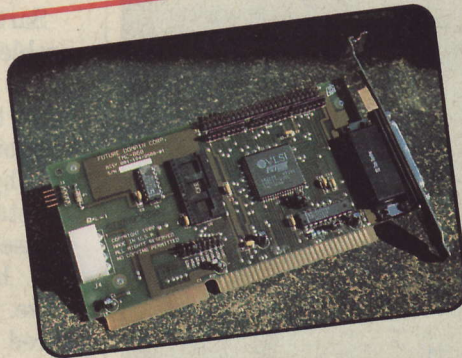
EDN's PC All-Stars — TMC-860 SCSI Host Adapter

Future Domain Corp, 2801 McGaw Ave, Irvine, CA 92714. (714) 253-0400.

Circle No. 656

STATS:
BUS: IBM PC/AT
PERIPHERAL INTERFACE: SCSI
MAXIMUM NUMBER OF PERIPHERALS SUPPORTED: 6
SCSI I/O CONNECTORS: 1 internal, 1 external
BIOS: DOS INT13 driver, can be disabled
ADDITIONAL DRIVERS: Sytos, Unix

BIO: The TMC-860 can control SCSI-based hard-disk drives in DOS and Unix environments and can also be used to operate SCSI-based tape and optical-disk drives.

OS/2 version 2.0 on a Cheetah system using a genuine WD1003 disk controller, again exonerating the Hyperstore 1600. It was probably a bit of a reach to expect that this pre-release version of OS/2 would run on the All-Star PC's complicated configuration, but we made the attempt anyway. By then time had run out, so we took a fall-back position. OS/2 version 1.1 loaded without any problems.

High-end PCs based on Intel's 80386 μP family give you many operating-system alternatives. For today's PC software, such as the engineering packages to be discussed in Part 5, DOS is the clear operating system of choice. However, the advent of multitasking, virtual-operating systems such as Unix/386 and OS/2 version 2.0 will allow software developers to create more powerful, interrelated sets of application programs for PCs in the years ahead. **EDN**

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