Mini-Micro Systems

A CAHNERS PUBLICATION

MARCH 1982

Surveying teleprinters and modems . . .

. . . in a DATACOMM SPECIAL

Voice processing with Centigram's 'studio'

The AT & T divestiture: an analysis

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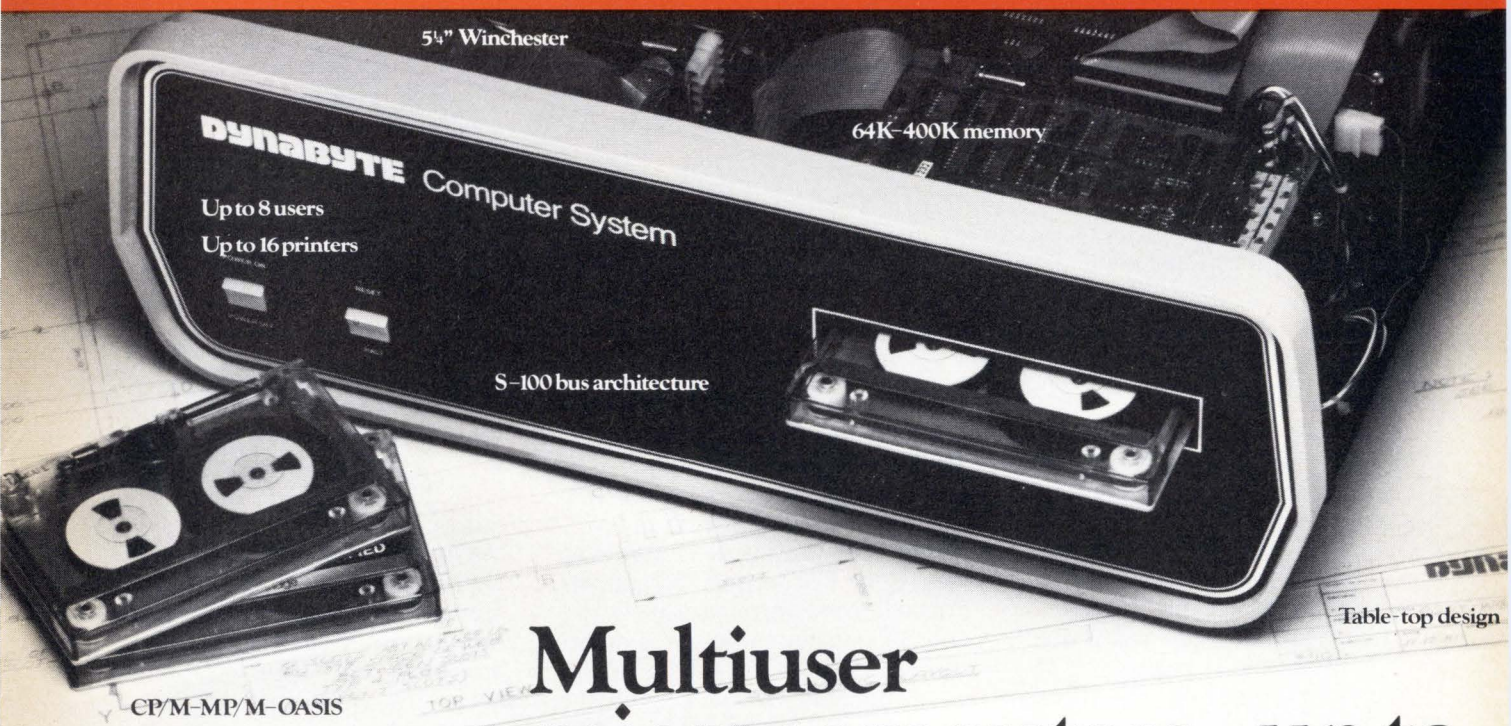
CIRCLE NO. 2 ON INQUIRY CARD

Product Highlight: Dynabyte 5710



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CIRCLE NO. 3 ON INQUIRY CARD

*5710-A2-64K, 12MB Winchester/17MB Cartridge Tape—$8,995 (list)
5710-B2-64K, 19MB Winchester/17MB Cartridge Tape—$10,450 (list)

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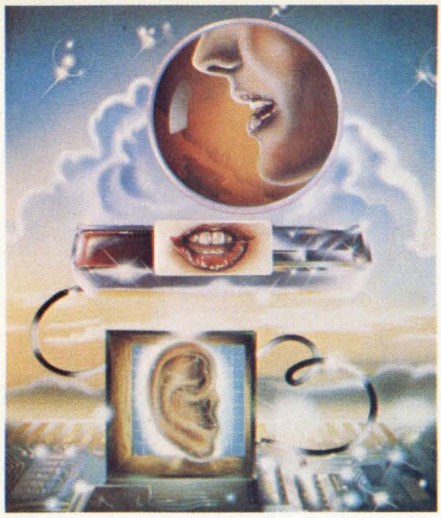
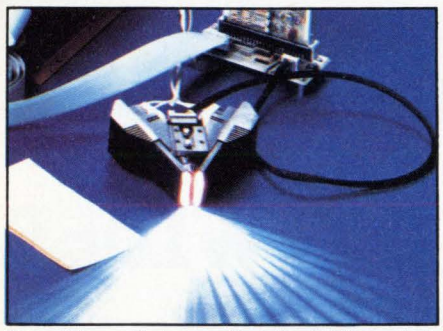
Business Computers



Centigram's VoiceWare development system is a μc-based "digital voice studio" with all the hardware and software facilities needed to create real-time, high-quality voice capabilities for virtually any application (see p. 183). Cover art direction by Vicki Blake; painting by Roger Leyonmark, Boston.



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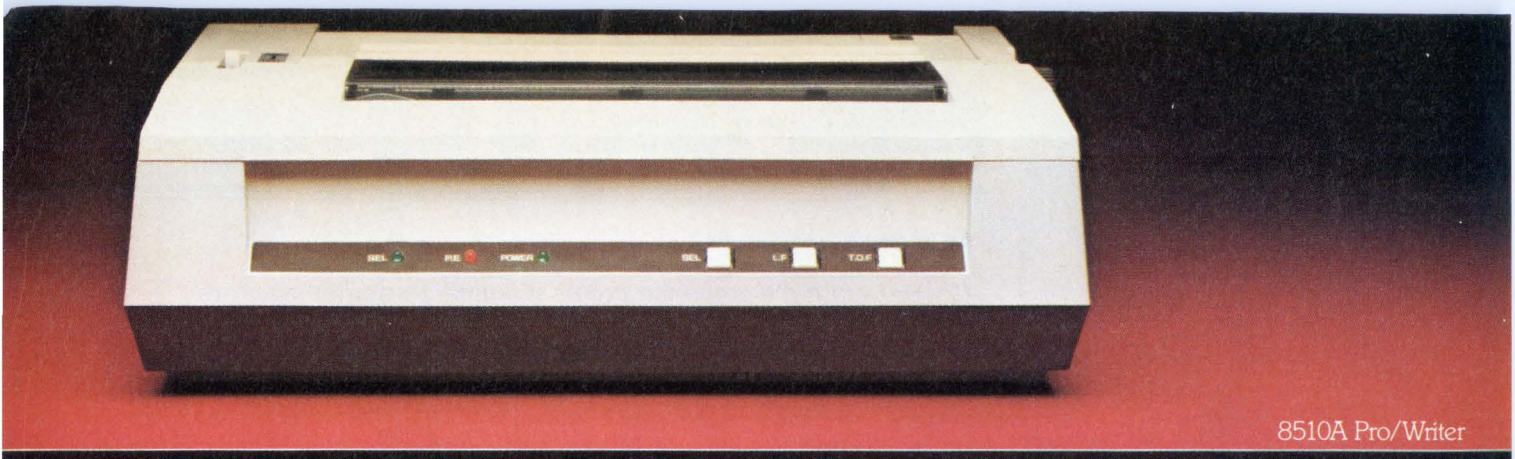
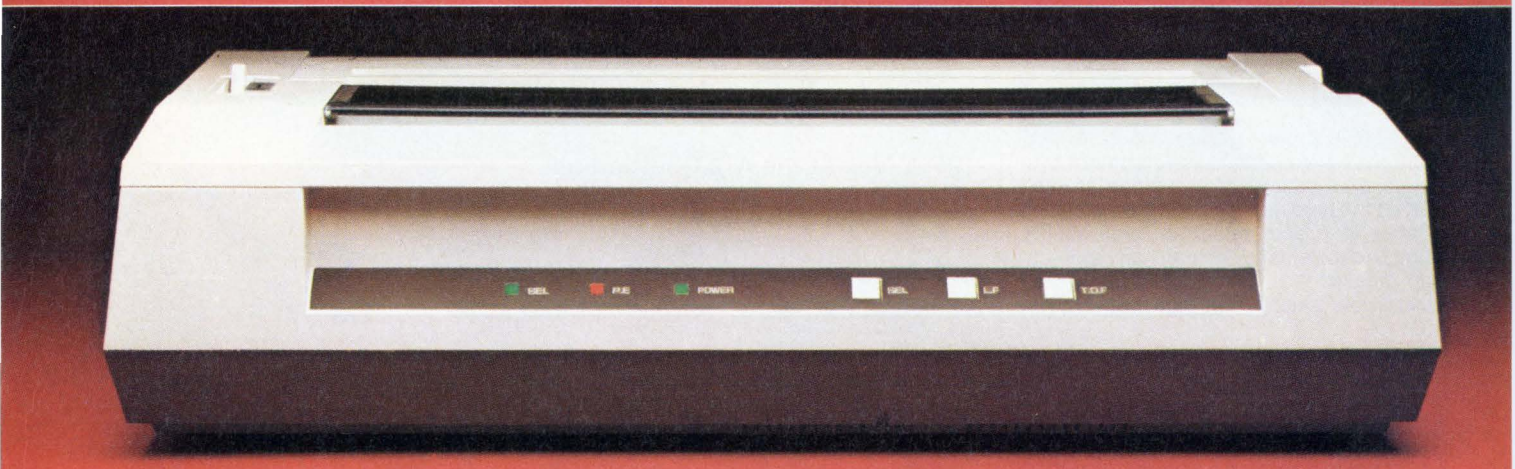


8510A Pro/Writer



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Breakpoints

HEWLETT-PACKARD PUSHES INTO FACTORY-AUTOMATION MARKET

This month, Hewlett-Packard Co.'s, Data Systems Division, Cupertino, Calif., introduced high-performance minicomputers and μcs, both performing in excess of 1 million instructions per sec. Targeted at what may be its single biggest source of revenue in future years—factory-automation applications—the HP 1000 A-Series includes two models—the A600 μc and the A700 minicomputer. Prices start at $3400 and $9700, respectively, and OEM discounts are available. Both A-Series computers can have as much as 4M bytes of main memory and as much as 200M bytes of mass storage. The systems can include a computation acceleration processor consisting of three new chips using H-P's CMOS/SOS technology. The chips are a floating-point processor, a scientific instruction set and vertical instruction-set firmware, and are housed on one board. The CAP board executes a typical mix of 234,000 floating-point instructions per sec. The products incorporate 64K RAMs from multiple Japanese suppliers. A Paraphraser can also be included in the system. Available for about $4000, it enables users to write in a Pascal-like language. This is for OEMs that still microcode H-P software to boost CPU application speed. After debugging, the Paraphraser programming is put into PROM and shipped with the system. The company is competing directly with Digital Equipment Corp., placing the new products in what H-P feels are holes in the price/performance curve of DEC's 32-bit minicomputers. Other targeted competition is upward moves from μc manufacturers.

FIRST ETHERNET PRODUCTS FROM DEC ARE DUE SOON

Digital Equipment Corp. is on the verge of announcing its first products based on the Ethernet local-area networking standard. Of the three companies backing Ethernet—DEC, Xerox Corp. and Intel Corp.—DEC has been the least visible in its Ethernet development program over the past two years. The company's low-key approach had led to some speculation that DEC was having second thoughts about its initial Ethernet support. Such speculation was put to rest recently with C. Gordon Bell, DEC's vice president of engineering, saying that Ethernet will constitute one of the key components in computing's fifth generation, and compared Ethernet's likely influence on this generation to the influence that the Unibus standard had on the minicomputer generation. Bell says many DEC customers plan to install Ethernet systems, and he predicts the installed base of about 100 networks will grow into the thousands.

DEC's initial Ethernet offerings will work within the Digital Network Architecture environment, effectively permitting the higher level DECNET protocols to run on the baseband coaxial Ethernet LAN. The projected DEC introduction of Ethernet products in 1983 (MMS, October, 1981, p. 90) earlier seemed to indicate that the company would wait to incorporate Intel's planned Ethernet chip set in its first products. However, because the Ethernet chips aren't scheduled for introduction until this year, DEC's upcoming products will be based on board-level controllers. Bell indicates the products will be systems oriented, being more sophisticated and containing more intelligence than the DEC-compatible Ethernet controllers offered by Interlan, Inc., and 3Com Corp.

HIGH-LEVEL PROGRAM DEBUGGER DUE FROM INTEL

This month, Intel Corp. plans to introduce a symbolic, high-level program debugger for use on its Intellec μp development systems. Called P-Scope, the debugger operates on stand-alone or networked Intellec systems, and cuts program-development time by a factor of 10, says Tal Hurant, product marketing manager for Intel's development systems. "P-Scope is to debugging as compilers are to programming," he says. With P-Scope, users can debug program statements, procedures and variables in high-level languages such as PLM, Pascal or FORTRAN, rather than dropping to Assembly language to trace the instructions. The debugger's command language is similar to Pascal/PLM. P-Scope permits users to trace procedure entry and exit, to handle variables of any legal type, to write command procedures

that "patch" code and to single step by statement. Selling for less than $2000, P-Scope will include a built-in screen editor and an on-line help function.

GRID SYSTEMS READIES POWERFUL PORTABLE

GRiD Systems Inc., Mountain View, Calif., will reveal the results of two years of secret development—a portable personal/professional computer—at this year's National Computer Conference. According to one report, the GRiD entry will be based on an MC68000 16-bit μp and bubble memory. Features are expected to include advanced graphics, support of bisynchronous communication to mainframes and touch-screen technology.

WYSE WILL UNVEIL FIRST 16-BIT TERMINAL

Wyse Technology, San Jose, Calif., will announce what may be the industry's first 16-bit, μp-based intelligent terminal next month—the second product offering from the seven-month-old company. Incorporating an Intel 8088 μp, the WY-200 provides 16-bit internal data paths and 8-bit I/O paths. Although the first version will include 16K bits of memory, future models will offer 64K bits. The WY-200 has a 24-row × 80- or 132-column display format and can be operated in horizontal and vertical split-screen modes. Features include forward and reverse word wrap and block-character transfer between split screens. Shipments will begin in June, and price is $1295 for single quantities.

MICROPRO TO GO PUBLIC, IBM PERSONAL COMPUTER COMPATIBILITY IMMINENT

MicroPro International Corp., San Rafael, Calif., which moved into the limelight with other independent software houses that received venture capital, revealed recently that it plans to go public this fall or next fall, depending on the company's needs. Company president Seymour Rubinstein says he will continue with the company as long as he can make a contribution that is appreciated. He also says MicroPro will offer its application software products independently this month, including WordStar, for use on the IBM personal computer. That product now uses EasyWriter as a mid-level word-processing application offering.

BELL LABS' 32-BIT CHIP READY FOR PRODUCTION

Bell Labs is ready to turn the final version of its 32-bit μp chip, the Bell Mac 32A, over to Western Electric Corp., the manufacturing arm of American Telephone & Telegraph Co. Using Bell's proprietary CMOS technology called Domino CMOS, the chip provides full 32-bit data and address paths and can support C language as well as Western Electric's UNIX operating system. The initial version of the Bell Mac 32A was announced last year. No announcement has been made about which the chip will first be used in.

NEC TO FOLLOW ON 16-BIT PERSONAL COMPUTER LEAD

More powerful μcs are expected this year, following early leads by Tandy Corp.'s Radio Shack division and International Business Machines Corp. NEC Information Systems, Inc., Lexington, Mass., is expected to bring its N5200 model 5 16-bit μc to the U.S. this year, although exactly when is unknown because documentation and software for U.S. distribution are still being developed. The N5200 is part of an office-automation system introduced last summer in Japan. The 8086 μp-based μc has 256K bytes of memory, a 12-in., 80-column display for 2000 characters and 8-in. dual-sided, double-density disk drives with a total of 1M byte of memory each. The system is expected to incorporate the CP/M operating system. The Japanese model displays Chinese Kanji characters, which may indicate a high-resolution screen. Price is expected to exceed $4000, not including a printer.

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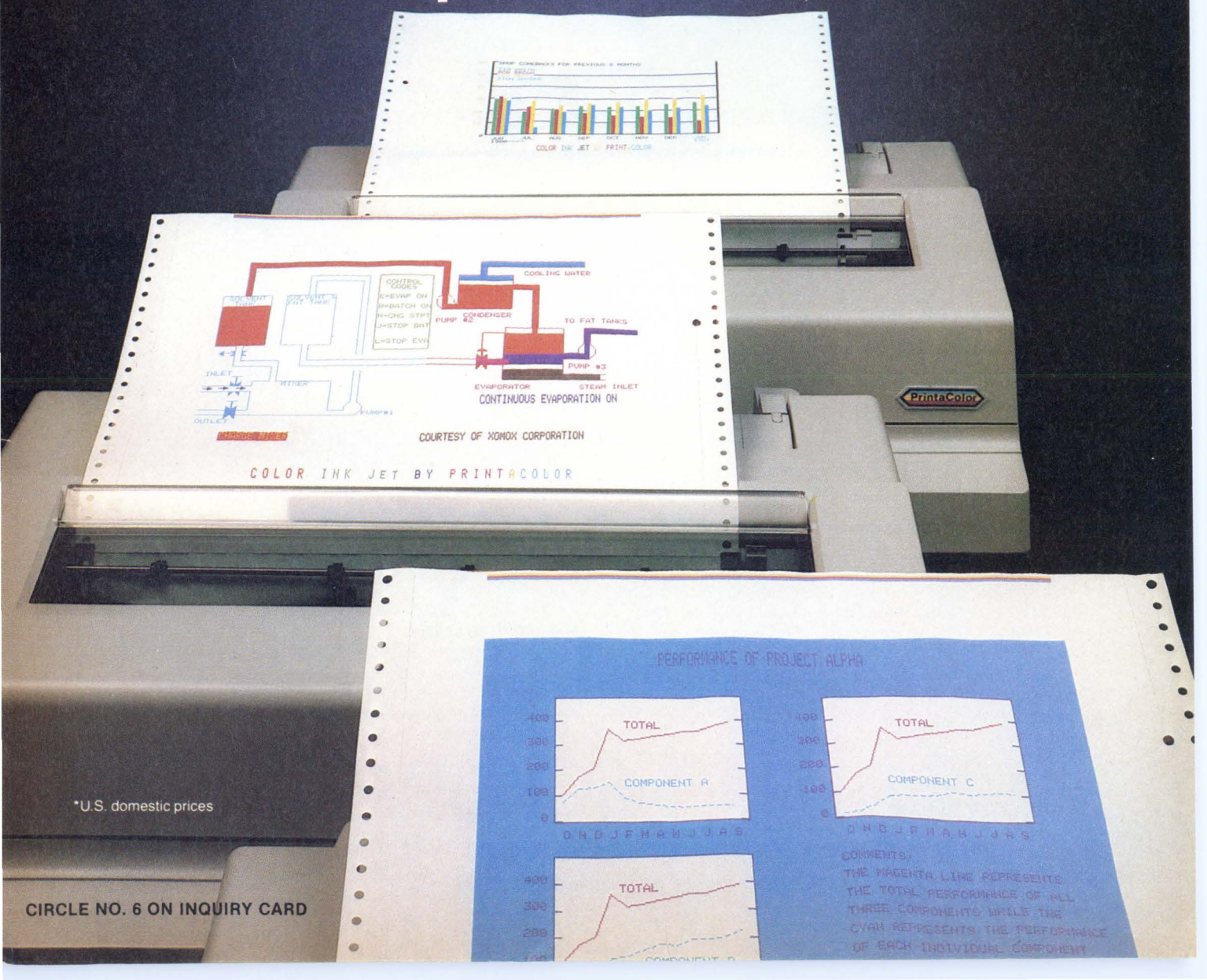

*U.S. domestic prices

CIRCLE NO. 6 ON INQUIRY CARD

Breakpoints

SKY ADDS NUMBER CRUNCHER TO PRODUCT LINE

Sky Computer, Inc., Lowell, Mass., makers of a Q-bus compatible floating-point array processor, the Skymnk-Q, will expand its offerings in April to include Skymnk-V, a Versabus-compatible product. The new number cruncher will be priced at about $4000 for quantities of more than 100 and, like the Skymnk-Q, will be targeted at seismic-exploration, image-processing and CAD applications. This spring, the company will further enhance its high-performance product line with a dual-ported memory system for use on Q-bus computers, as well as a data-acquisition subsystem for high-performance A/D and D/A 12-bit resolution. Both products will sell for about $4000.

FRANKLIN ACE 100 RUNS APPLE II + SOFTWARE

Pennsauken, N.J.-based start-up Franklin Computer Corp. has temporarily shelved plans for an integrated small-business system to take advantage of the void left by Apple Computer, Inc.'s exit from the mail-order market. Franklin's new Ace 100 personal computer runs Apple II + software without modification, says the company. The machine includes 64K bytes of main memory, a 10-key numeric pad and a cooling fan. Suggested retail price is $1595, several hundred dollars lower than a comparable Apple. West Coast distribution will be handled through Tarzana, Calif., start-up Superior Computer Distributors, and a dealer network is being established to handle the Ace east of the Rockies. The company says dealer margins will be in the 40-percent range.

INTEL MICROSYSTEM GROUP TO UNVEIL DBMS HARDWARE

Watch for Intel Corp.'s year-old Commercial Microsystems Operation to unveil database-management system hardware within the next several weeks. The Phoenix-based group and Intel's DBMS software division, MRI, Austin, Texas, are jointly developing the hardware/software system. The DBMS hardware is said to be the first of several system-level products that will introduced by the Phoenix group before mid-year.

ZILOG FOUNDER FAGGIN IN NETWORK START-UP

Zilog, Inc., founder Federico Faggin, who left the Exxon Enterprises affiliate last year, is back as president of start-up Waynet, Inc., San Jose, Calif. As its name implies, the firm will offer networking hardware and most probably software, says vice president of marketing Sam Badawi. Badawi says Waynet is still hardening its product plans. It isn't clear whether the network will be broadband or baseband, but Badawi expects an introduction by the end of this month.

SONY CONTINUES WITH 3½-IN. DISK DRIVE

Despite speculation among some participants in the disk-drive industry that Sony Corp.'s 3½-in. floppy-disk drive has encountered manufacturing problems and might be canceled, a company spokesman says there are no plans to kill the product. When the high-density, 135-tpi drive was released in December , 1980, by the company's Data Products division, many observers questioned Sony's ability to produce the innovative technology in quantity. The product was scheduled for evaluation last summer, and for production volumes late last year (MMS, April, 1981, p. 17), but has slipped slightly past those dates. The drive has been in evaluation sites since November. In early November, Sony was instructed by its Tokyo parent to hold the drives for several weeks because of a noise problem that required an engineering change. Sony claims the problem has been solved, and that there are no manufacturing problems. In October, Sord Computer Systems, Inc., Tokyo, Japan, became one of the first vendors other than Sony to incorporate the drive in a μc system—the M23

Mark 1. A source close to Sord speculates that the company has not received drives in quantity to date.

RANDOM DISK FILES

Former **Dastek Corp.** principals Jay Dee Shiverdaker and John Mittelsted are back in the disk-drive business with a Los Gatos, Calif.-based company called **Peripheral Systems Corp.** The company plans to introduce a 450M- to 500M-byte, 14-in. Winchester this quarter, with production quantities scheduled to be shipped 60 to 90 days later. The hardware will be based on conventional Winchester heads—as opposed to thin-film read/write head technology of the type developed by Dastek for its 4830 series 14-in. drives (MMS, July, 1980, p. 28)—and will incorporate a proprietary SMD-compatible intelligent interface. Pricing information is unavailable. Meanwhile, reports are circulating that Dastek is planning to revitalize its high-end thin-film Winchester business, and will set up a separate manufacturing facility to handle drive production in Milpitas, Calif., some 10 miles north of its original facilities in Los Gatos. Thin-film head production will continue in Los Gatos.

Said Iftikar, the **Seagate Technology** co-founder who left the Scotts Valley, Calif., 5¼-in. Winchester pioneer this year, plans to reenter the OEM disk-drive business with a low-cost, less-than-5M-byte drive using thin-film media, 3¼ to 4 in. in diameter. Iftikar's company, dubbed **Syquest, Inc.,** is headquartered in Fremont, Calif., and plans to manufacture its own disk. Introduction is set for the Comdex show in June.

Also planning to unveil high-capacity 5¼-in. Winchesters at NCC are Newark, Calif.-based **Evotek Corp.** and **Micropolis Corp.,** Chatsworth, Calif. Evotek plans to show a line of 6M- to 50M-byte hardware incorporating microstepper actuators and thin-film media. As the 55XX series, the drives will be tied to 5-MHz Seagate-compatible controllers; as the 58XX series, they will be running off a proprietary 8-MHz controller. Prices for the lower capacity drives have not been finalized; pricing for the four-platter, 50M-byte device is said to be around $1500 in 1000-lot orders. Micropolis, meanwhile, plans to have working models of a 30M- to 50M-byte, 5¼-in. Winchester line on display in Houston. Details are sketchy, but evaluation versions reportedly will be shipped during the first quarter of next year. Micropolis will also display a new line of high-capacity 8-in. Winchesters (MMS, November, 1981, p. 10), including a 135M-byte device using a proprietary company interface as well as higher capacity hardware using SA1000-class or ANSI interfacing. The five-platter drive will be available with SMD interfacing early next year. Pricing is unavailable. Micropolis also plans to use NCC to debut a new line of 1M-byte, 5¼-in. floppy-disk drives with 6-msec. access time. Dubbed the FD115 series, the drives are essentially lower capacity versions of the company's 2M-byte FD 1117 announced last year. Evaluation versions of the 2M-byte drive are now being shipped.

Sources close to **Shugart Associates** report that the Sunnyvale, Calif., Xerox subsidiary will pull the plug on its 3.3M-byte, single-platter SA602 5¼-in. Winchester because of a lack of market response, and will instead concentrate its efforts on the two-platter, 6M-byte SA604 and the three-platter, 10M-byte SA606. Shugart plans to move more than 30,000 of these drives this year. The SA602 will be shipped only in evaluation quantities, however.

Chatsworth, Calif.-based **Micro Peripherals, Inc.,** will begin evaluation shipments of its year-old, two-platter model 10 5¼-in. Winchester this month. MPI put the hardware on hold after its announcement last year to develop hybrid circuits for the drive electronics and to perfect an intelligent interface that, one source says, permits the device to work with higher performance controllers as they become available. Due next year is a 25M-byte, two-platter version. MPI's 14M-byte drive is priced at $1200 in 500-lot quantities.

The first portable tester for 5¼- and 8-in. Winchesters is due to appear this month from Santa Clara, Calif., start-up **Qubex Corp.** Called the QA-2000, the 8X3000-based device is designed for incoming hardware inspection at user sites and to handle overlapping tests on as many as four Seagate ST-506 or Shugart SA1000-compatible drives. The QA-2000 generates test patterns for a number of functions, including sequential and random seeks, worst-case seeks and bad-track detection.

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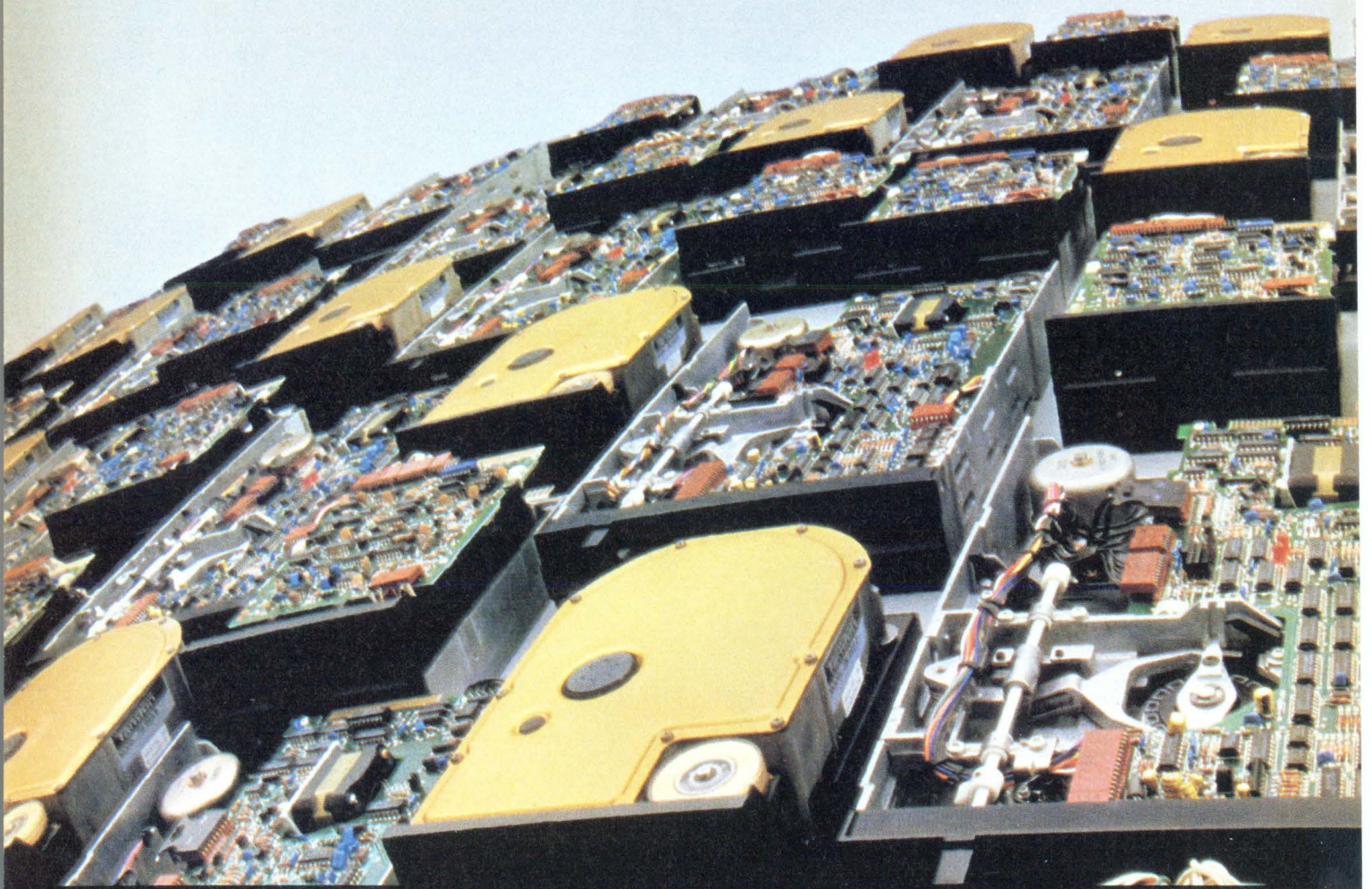

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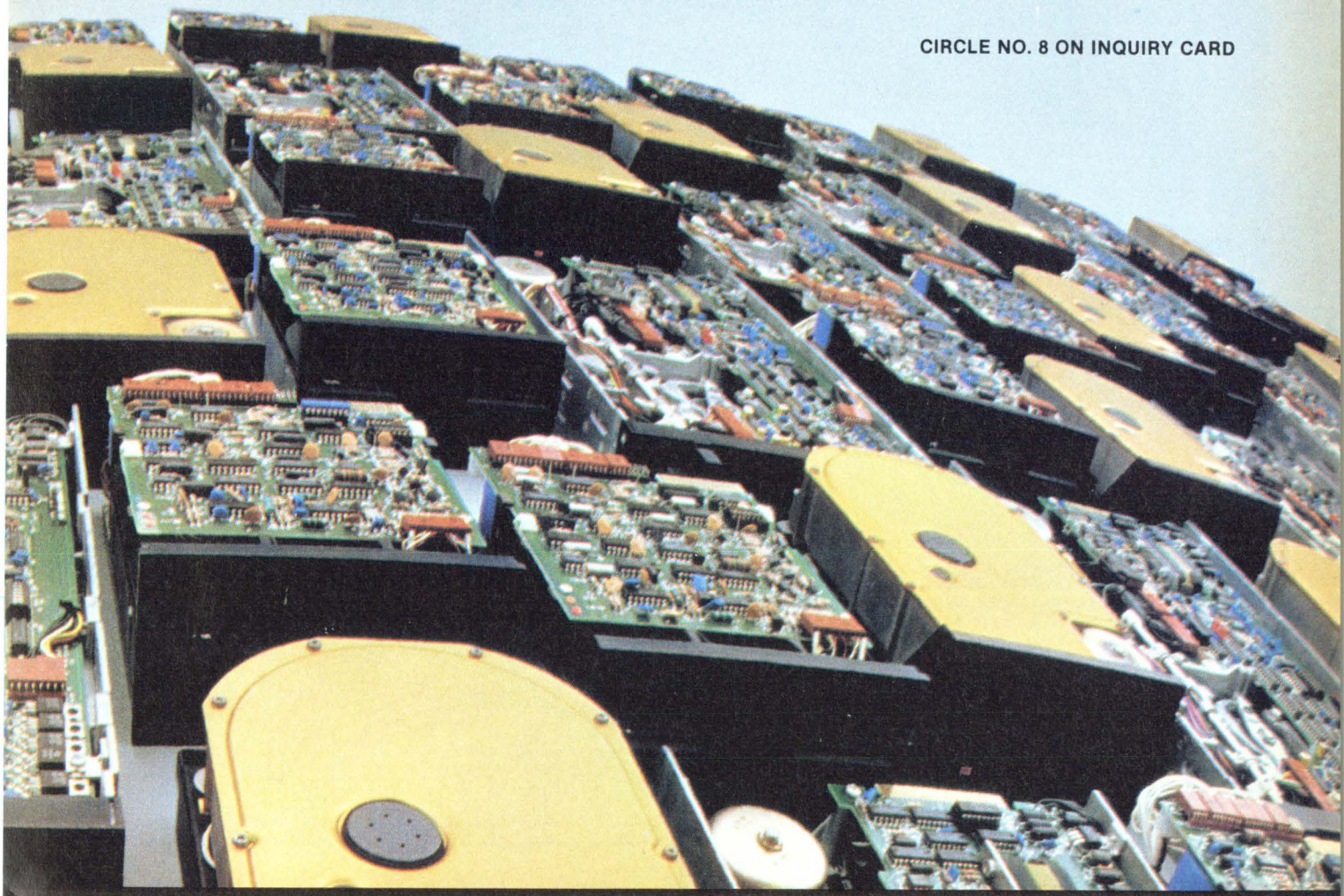

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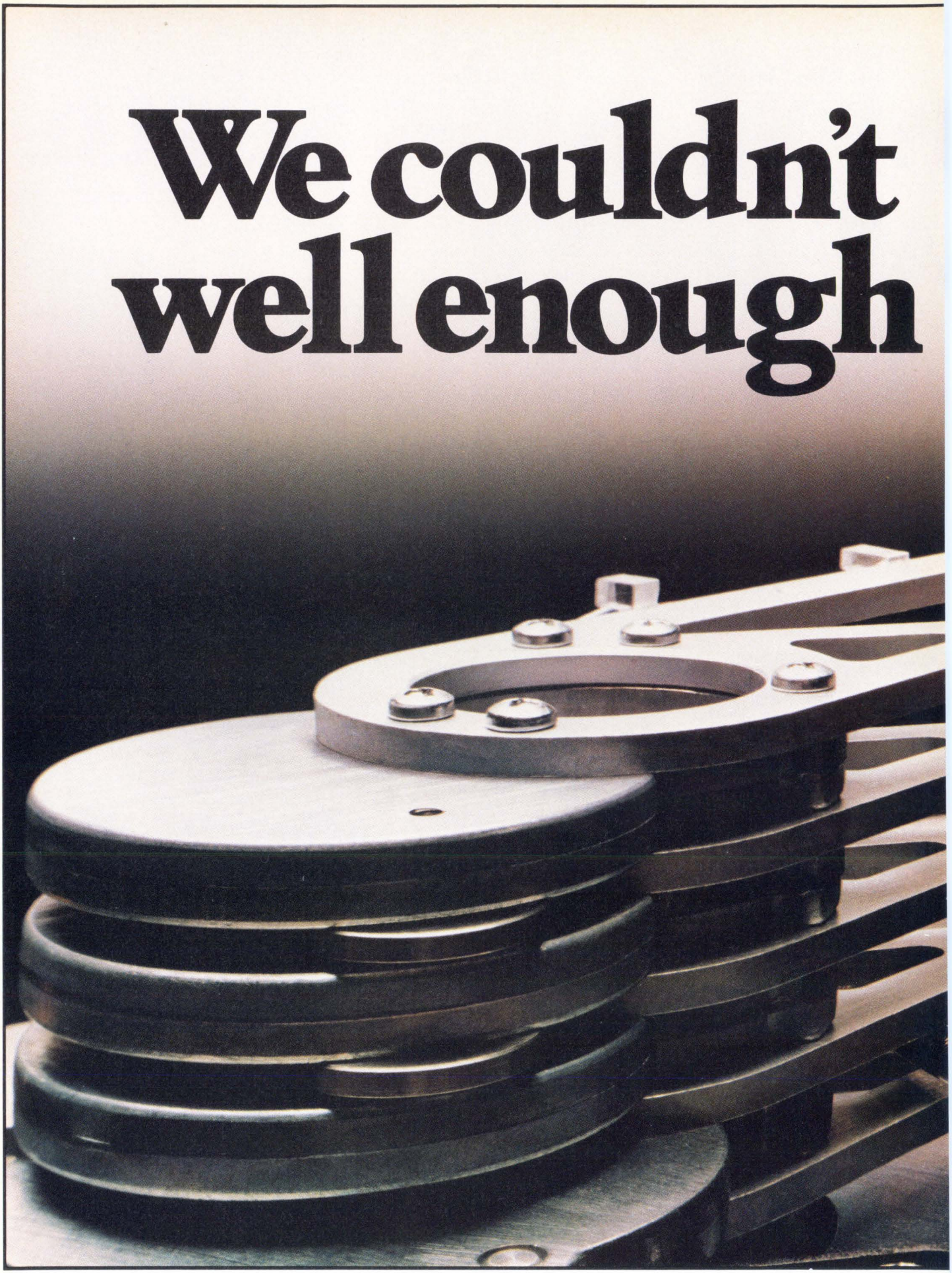
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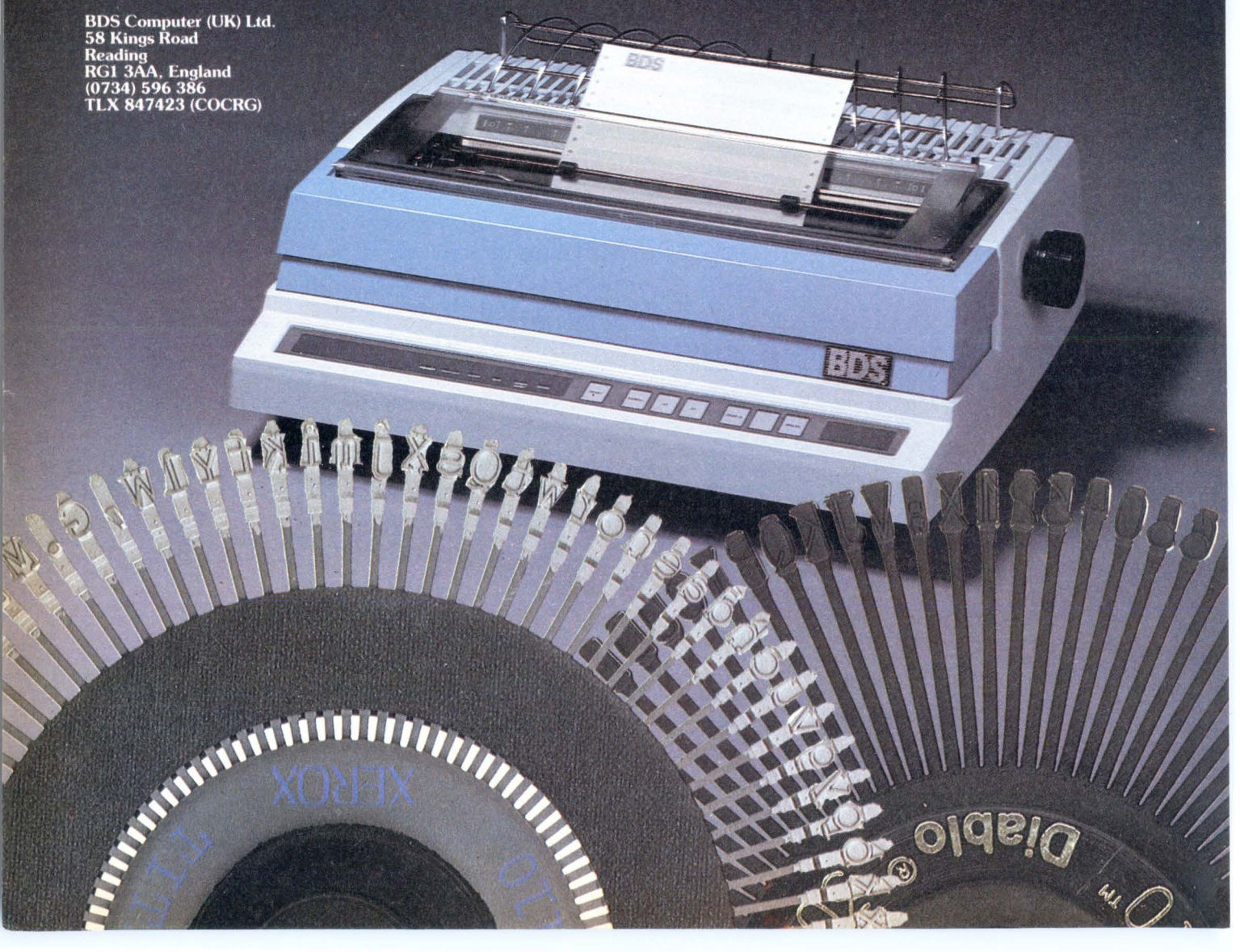


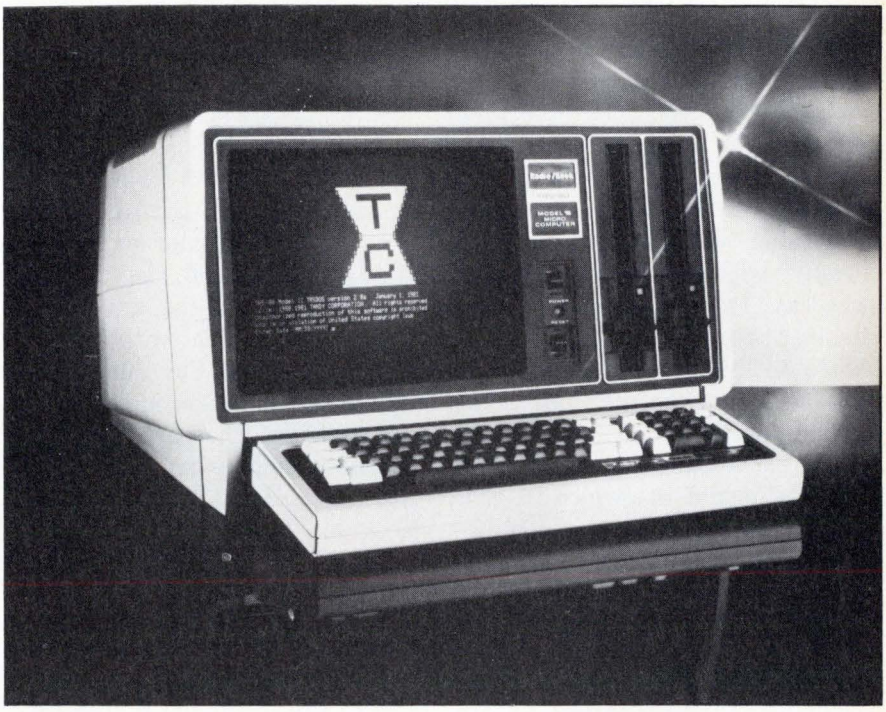
TRS-80 model 16 may grab lead in personal computers

Tandy Corp.'s 16-bit personal computer has arrived, bringing a new dimension of power and an extended upgrade path that many industry observers say will solidify the number-one position held by Tandy Corp.'s Radio Shack division in small-business systems and aid the Fort Worth, Texas-based company's progress in the Fortune 1000 market. But despite the inevitability of the move to 16 bits, the additional power may not be required.

The TRS-80 model M16 will be available in the second quarter of this year in two versions, both with 128K bytes of main memory. A version with a 1.25M-byte, 8-in. slimline disk drive is priced at $4999; a two-drive version is $5798. The system memory expands to 512K bytes, in 128K-byte increments. Asynchronous and bisynchronous communications are included, as is compatibility with the ARCNET local network. A hard-disk port for as many as four Radio Shack 8.4M-byte Winchester-disk drives is optional, and a second iteration of the TRSDOS operating system that supports three users will be available in June (see "A look at Tandy's 16-bit computers," p. 18).

Although industry analysts correctly speculated that the new Tandy entry would be based on the 68000, the inclusion of a Zilog Z80A both surprised and impressed many observers.

"We took a hard look at the higher price we'd have to charge for a dual-processor machine before deciding that compatibility with existing model II software made it worthwhile," says Dr. John Patterson, Tandy's vice president for R&D. He also says the tricky architectural problem of designing in the Z80A to run alone in one mode or as the I/O processor in the 68000 mode was complicated further by the marketing department's desire for an upgrade kit that would allow model IIs to become model 16s (except for a bus-width limitation that would allow the direct addressing of only 256K bytes). But industry observers agree that any small performance trade-off is more than offset by the benefits of upward compatibility. Owners of model IIs have become likely customers for the $1500 upgrade kit, prospective model II customers can be enticed with the possibility of future conversion, and model 16 purchasers can run the existing model II software, which makes the temporary dearth of software that uses the 68000's full potential easier to bear.



Tandy's first 16-bit μc, *based on a Motorola MC68000 μp, can include as many as three terminals, and can be expanded for a total of 512K bytes of memory.*

Much emphasis is placed on μc market leader Tandy beating second-place Apple Computer, Inc., to the 68000 punch. Interestingly, some industry observers think Apple's first 68000-based machine, code-named Lisa, is ready for introduction, although sources close to Apple say Lisa's announcement is not imminent. Lyndon Berkheimer, analyst for Dean Whitter Reynolds Inc., San Francisco, agrees that Lisa will remain in the confines of Apple's Cupertino, Calif., R&D facility awhile longer.

"It would not be wise for Apple to rush its 16-bit machine out into the market, primarily because the dealers would then assume the Apple III really was a turkey and drop it right away," Berkheimer says. "The main problem Apple has over the next few months is getting the dealers up to speed on the new Apple III software. They don't want to divert their dealers' attention

with a 16-bit μc that the market isn't really screaming for. There's enough function on the 8-bit Apple III to take care of anybody's needs."

Dataquest analyst Skip Bushee agrees that 16 bits may not be necessary. "The difference between an 8- and a 16-bit machine is largely emotional," he says. "It's like what happened in minicomputers. H-P and few others said you don't need 32 bits because you can do everything you need much more cheaply with 16. But companies such as Prime Computer and Perkin-Elmer Corp. sold a lot of people on the idea you *had* to have 32. The same kind of thing could happen here."

Despite this sentiment, Bushee says, the model 16—which he calls the most powerful personal-computer/small-business system and compares in performance to Digital Equipment Corp.'s Datasystem 150 or Data General Corp.'s Enterprise 1000—does not have more horsepower than needed for many applications. "If you try to support multiple users on an 8-bit processor, for example, you'll grind to a halt," he says. He also points to Tandy's bit-mapped graphics and computation of a matrix on VisiCalc-like software as typical applications in which 16 bits are noticeably superior.

Even the International Business Machine Corp. personal computer, which had been considered the performance leader among the major entries, is not a true 16-bit machine (the 8088 processor on which it's based has 16-bit internal registers but communicates to the world via an 8-bit bus), and the first software available for it doesn't use even the full pseudo-16-bit capability. This has led Tandy's vice president Jon Shirley to discount the IBM personal computer as competition for the model 16, saying comparable performance is not achieved in the IBM line until the two-user Datamaster with 6.6M bytes of on-line storage and 256K bytes of memory, which sells for approximately $25,000 without printers or application software. A comparable model 16 for three users with an 8.4M-byte Winchester sells for less than $12,000, without printers or application software.

"The model 16 is ideal for the small business with big plans," says Shirley. He says small business is the primary customer for the model 16, and to that end, the first model 16 software will be a version of COBOL compatible with model II COBOL, followed in June by an integrated small-business accounting package. The package's shared database enables an entry via the order-entry system to change the inventory and accounts receivable automatically, which in turn update the general ledger.

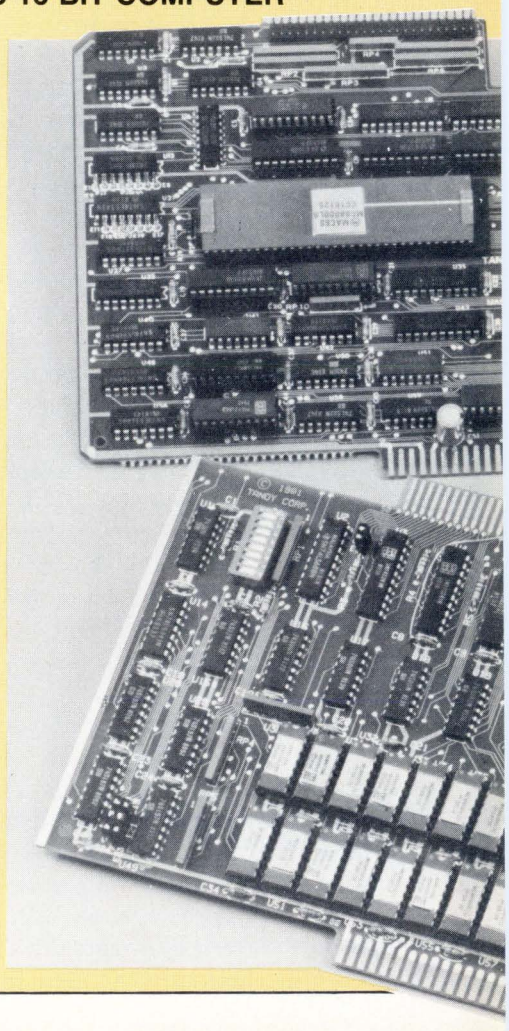
One market participant praises Tandy's model 16 accounting package as a good software start, but questions Tandy's decision to retain the form and function of the TRSDOS operating system used on models I and II.

"As long as Tandy stays with TRSDOS instead of going to a high-capability operating system such as UNIX, they're restricting themselves," says Bruce Baillio, director of marketing support for Wicat Systems, which is taking a strictly OEM approach with its 68000-based entry. He doesn't view

A LOOK AT TANDY'S 16-BIT COMPUTER

The Tandy Corp. model 16's increase of power over earlier TRS-80 computers results from its MC68000 CPU, a 16-bit μp that handles 32-bit-wide data internally. Although the MC68000 directly addresses 16M bytes, the model 16's minimum main memory of 128K bytes is expandable to no more than 512K. Memory boards for the model 16 hold 256K of RAM, so the second 128K is just a set of RAM ICs selling for $499. The third 128K includes a second memory board selling for $699, and the last 128K is another set of RAM ICs priced at $499. A model 16 with full memory and two on-board 8-in. disk drives sells for $7495. The model 16, including full memory, an 8.4M-byte Shugart Associates SA-1000 Winchester-disk drive that Radio Shack began shipping in December, 1981, and a Tandon slimline 1.25M-byte floppy-disk drive for backup, is priced at less than $10,000.

The model 16's high-resolution green CRT monitor has a variety of video attributes and four cursor types. An optional graphics board priced at $499 generates a 640 × 240



Upgrades to a 16-bit system *are done by adding an upgrade board set priced at $499 to the TRS-80 model II.*

the model 16 as competition for Wicat's WS-150 because the Wicat System is higher end. "But I'm glad Tandy's focus isn't on OEM sales," he says, "because the $5000 price for their low-end configuration is a good one." Wicat does have a slight price advantage where the two lines intersect, he says. A 256K five-user system, with a 10M-byte Winchester is only $8500, compared to $10,000 for the three-user, 256K model 16 with 8.4M bytes.

Although Gnostic Concept analyst Jean Yates says Tandy's OEM organization is growing very fast and suspects it will be a major outlet for the new machine, Tandy's director of OEM sales, Carroll Reeves, says he recognizes that Tandy's main strength is in retail. He believes an OEM discount that reaches 20 percent or more will help the model 16 find its share of buyers among OEM system houses that want 16-bit turnkey solutions, as will what Radio Shack calls the model 16's assembly-language development facility.

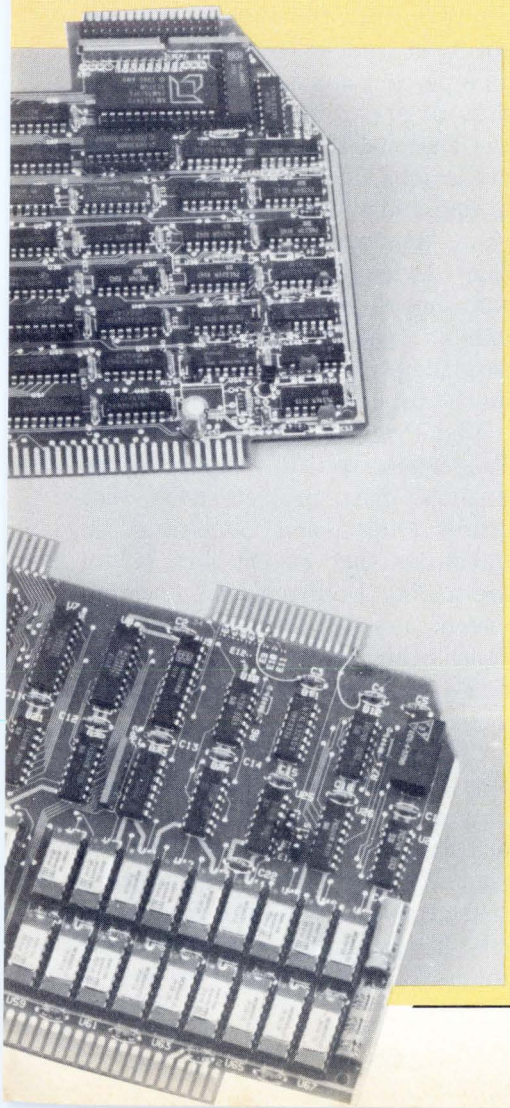
But Reeves doesn't see OEM sales as critical to the success of the model 16, and Tandy president John Roach agrees. "Vertical distribution is an interesting market for us, but not necessarily a high-growth piece of business. We think 60 high-quality OEM houses would be satisfactory," says Roach.

A more important market, says vice president for computer marketing Ron Stegall, is the Fortune 1000 companies. He says Tandy is planning data-communications management seminars in every major city in the U.S. to demonstrate model 16 features that satisfy the needs of a large data-processing department. Those needs include networking (as many as 255 model IIs and model 16s can be linked via Tandy-supported ARCNET, which is licensed from Datapoint Corp.) and IBM compatibility (via built-in SDLC protocol capability that allows linking to mainframe under SNA). Yet Stegall too recognizes the importance of the Radio Shack outlets and says the Fortune 1000 marketing plan uses that broad base of distribution, service and customer support.

Customers would not take kindly to waiting in line behind someone buying batteries to see a $5000-plus product demonstrated, nor would the average Radio Shack clerk be capable of a sophisticated explanation of the model 16. Thus, the new computer will be sold only through the 245 dedicated Radio Shack Computer Centers and the approximately 450 Radio Shacks with computer departments.

Some observers question the wisdom of reducing the number of the more than 6000 Radio Shack stores that are credited with making Tandy the leader in μc sales. But Gnostic Concepts' Yates disagrees. "Tandy hasn't had that much success selling computers through the ordinary, full-line Radio Shack outlets anyway," she says. "The TRS-80 model I was an exception because it was a computer for hobbyists. Tandy's real success with μcs is due to the computer centers and an extensive advertising campaign."

If Yates is right, the competition should be wary. Tandy plans to add 10 computer centers a month for the foreseeable future. —*Kevin Strehlo*



individually addressable bit map and adds 11 high-level BASIC graphic commands that are also accessible via supplied subroutines by Radio Shack Assembly Lanuage and via the model 16 FORTRAN and COBOL compilers that will be available by year-end.

Hardware multitasking memory management and two built-in serial ports will support two additional terminals on all model 16s with the June release of the second iteration of the model 16 TRSDOS operating system. Radio Shack's new DT-1 terminal, which is based on an 8-bit μp, is intended for use with the model 16, although its $699 price, serial and parallel ports and keyboard-selected protocol to emulate the Televideo 910, Lear Siegler ADM-5, ADDS 25 or Hazeltine 1410 terminals should make the DT-1 popular in other applications.

Support for bisynchronous communications for mainframes, including the IBM standard protocol SDLC used in SNA, will be available during the third quarter of this year. Available during the second quarter is the ARCNET local network, licensed from Datapoint Corp., which links any combination of as many as 255 model IIs and model 16s (with each model 16 supporting as many as three users).

Real-estate developers put money on computer marts

Boston-based Leggatt, McCall and Werner, Inc., plan a $60-million mart *to be called the International Information Center. The 535,000-sq.-ft. center will house as many as 250 showrooms and a conference hall.*

Three real-estate developers are betting big bucks that computer vendors are ready for new marketing tools that could serve as cost-effective alternatives to trade shows and direct sales.

The new tools—large-scale computer merchandise marts—are being touted as offering a referral center where, under the same roof as their competitors, vendors can demonstrate products and generate leads for their distribution networks.

"We're offering a year-round trade show," notes Bill Winsor, general manager of Dallas-based Infomart, under development by the Trammel Crow real-estate family. "This is not a cash-and-carry retail center. No one is going to drop some bucks on a counter and walk out with a computer in their hands. This is a channel for channels—a referral center," he says.

Besides Infomart, groundbreaking will begin this spring for another mart in Dallas, the International Information Center, as well as one in Boston, BOSCOM. All three are scheduled for completion in 1983.

The marts will accommodate 200 to 300 vendors' showrooms and will include conference and exhibit halls where seminars will be held on a revolving basis to attract buyers from vertical markets. Infomart developers are extending the concept to include an office tower, a hotel, an apartment tower and three movie theaters on their complex for use by both buyers and sellers.

The marts are expected to attract vendors of various sizes and makeups, including large data-processing OEMs, resellers and independent service and support organizations. While both the Infomart and the International Information Center hope to attract both large- and small-volume customers, BOSCOM will appeal primarily to large-volume wholesale buyers.

Infomart's Winsor says that, because of the downward migration of computer prices and the upward migration of applications, the computer industry needs the mart concept to reach an expanding and diverse customer base.

"We're offering a converging focal point for the industry where a vendor can reach unsophisticated and sophisticated buyers under one roof," says Winsor. He adds that access to the Infomart complex will be controlled so that low-volume buyers—end users—will be directed toward low-volume sellers, and large-volume buyers—resellers—will be directed toward OEMs.

Winsor does not foresee marts replacing trade shows for a few years, and says that trade shows are "one of the most cost-effective mediums for displaying products." He adds, however, that trade-show prices are escalating and may soon become too expensive for many vendors.

According to a study by Exhibits Surveys, Inc., the average cost per sq. ft. of trade-show space is rising 13.6 percent annually from $8.50 in 1979 to $11.75 in 1981. A booth at the National Computer Conference or Comdex show cost $15 per sq. ft. in 1981 and will cost $17 a sq. ft. this year. "For $25 to $30 yearly—less than twice the going rate for NCC—we're offering a permanent exhibit space," Winsor says. He says the price is flexible, depending on the total space commitment.

Dan Prigmore, president of FMR Properties, Inc., developers of the BOSCOM mart project, adds that trade shows are becoming so numerous that buyers and sellers are having a difficult time deciding which shows to attend. Further, considering the costs they entail, trade shows are inefficient business vehicles, he says.

"It's interesting to walk through NCC and watch what happens," says Prigmore. "A vendor's best customer ends up talking to a model in hot pants, while his best salesman is tied up with a computer freak who has no intention of buying anything."

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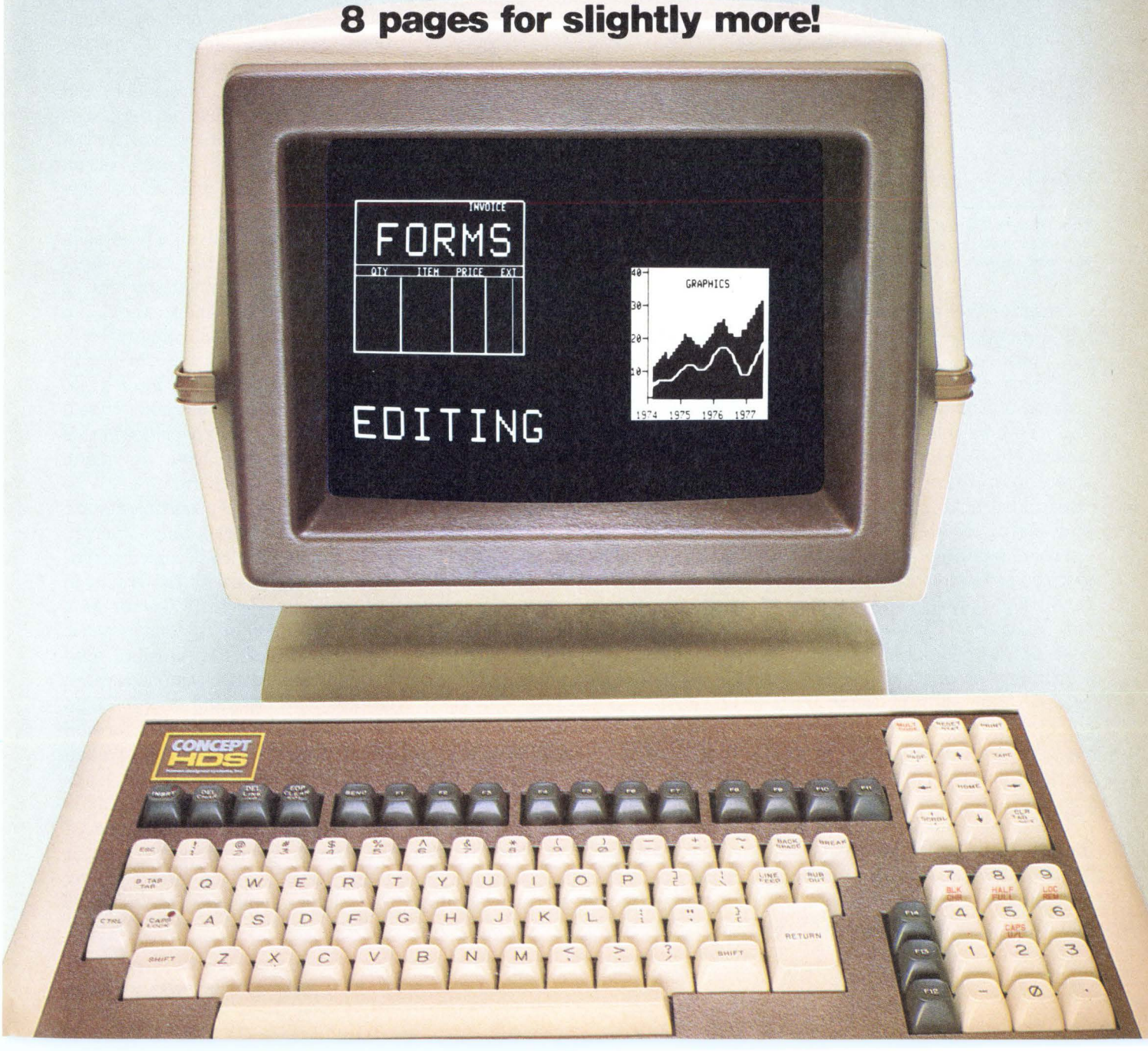

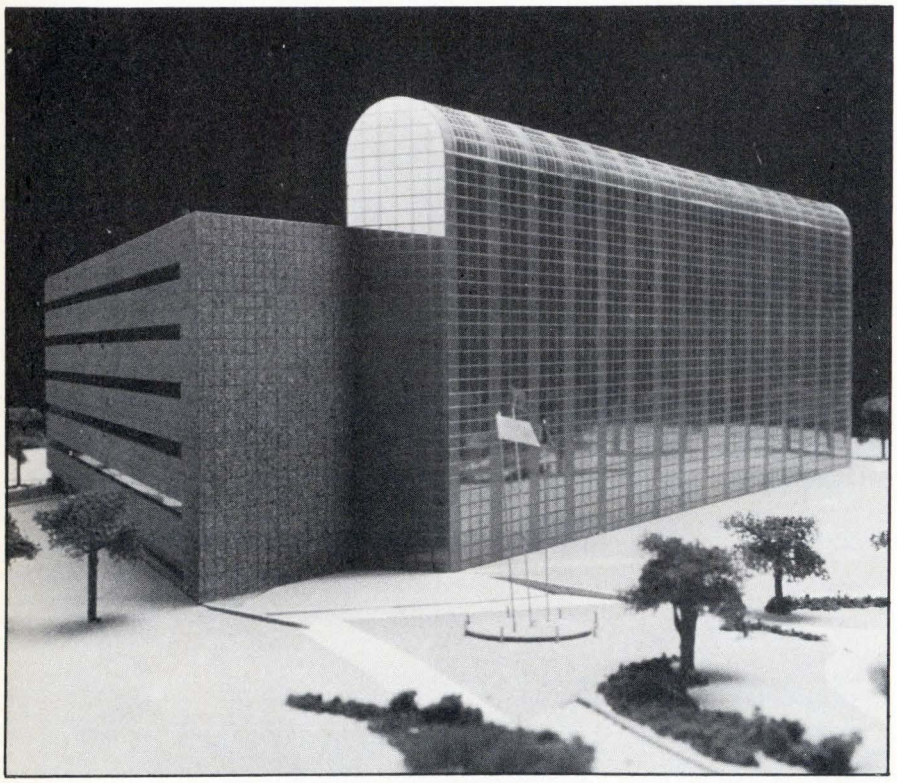

The Trammell Crow Co., owner of the Dallas Market Center, *is beginning a $50-million project to build the Infomart, a six-story, 1-million-sq.-ft. structure that will accommodate 200 vendors' showrooms and a 202,000-sq.-ft. exhibit hall.*

Despite the arguments against trade shows posed by mart developers, however, Sheldon Adelson, president of the Interface Group, sponsor of Comdex, says that marts will never be able to supplant trade shows. "The industries that are in some of the most successful trade marts also have some of the most successful trade shows," says Adelson, pointing to the apparel and gift-product industries. "People attend trade shows to feel the pulse of the industry. That's particularly true of the computer industry, in which new products and companies are evolving so fast. Why should someone go to a trade mart to see 200 companies when he knows that he could go to a trade show and see three or four times that number?"

But Adelson adds that even more important to many people is "the opportunity trade shows provide for a vendor or a buyer to take a trip and write it off as a business or tax deduction."

Whether the industry will support one, let alone three, merchandise marts is a matter of speculation. The developers have not yet announced any space commitments from vendors, although all three say they are in negotiation.

BOSCOM's Dan Prigmore says he is confident that the industry can handle as many as five computer marts around the country. Infomart's Winsor, however, says that two in the same town present a difficult challenge. "It's going to be a race to round up tenants," says Winsor.

Leggat, McCall and Werner Ventures, Inc., developer of the International Information Center, Infomart's Dallas competition, was first to announce its project. But each developer of the three marts claims the concept as its own.

One test of the concept's viability may come from the Business Computer Center that opened in Chicago's Merchandise Mart last January. That center, smaller than the Dallas and Boston projects, houses showrooms for seven major vendors, including Digital Equipment Corp., Texas Instruments Inc., Control Data Corp., Honeywell Information Systems, Monroe Systems for Business, Apple Computer, Inc., and 3M Co.

Besides drawing on the estimated 1 million buyers who do business in the Merchandise Mart each year, the vendors also hope to attract customers by individually and jointly sponsoring monthly educational seminars aimed at specific professional markets.

Kenneth Olsen, president and chief executive officer of DEC, sees his company's participation in the Business Products Center as an "experiment that will infuse new ideas into the industry." He says that the primary advantage of such centers, compared to retail outlets, is that they provide buyers a one-stop facility where they can learn about and shop comparatively for computer products. Olsen will not comment on DEC's interest in the larger projects, but adds, "We'll have quite a bit of experience in this place before we have to make decisions on the others."

Such wait-and-see sentiments are echoed by Charles Clough, corporate marketing vice president of TI. The company uses its showroom in the Business Products Center as a learning center for customers and a support vehicle for dealers and distributors, rather than as a retail outlet. "Our learning center could be considered a more direct form of advertising in which we'll be eyeball to eyeball with our customers," says Clough. He adds that TI is interested in mart projects and, if the company commits to one, it would structure its showroom along the same lines as the Chicago facility.

—Frank Catalano

Most small system users think all micro-
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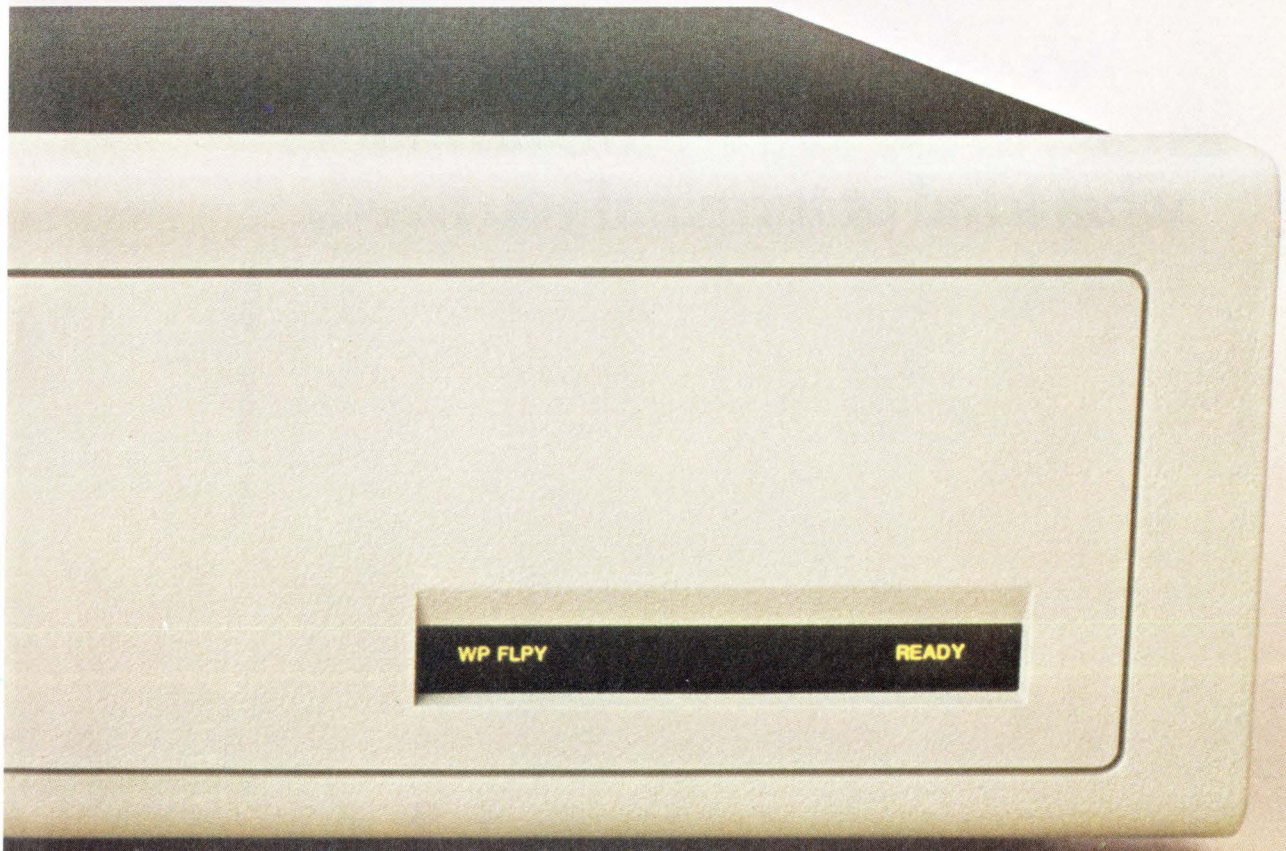

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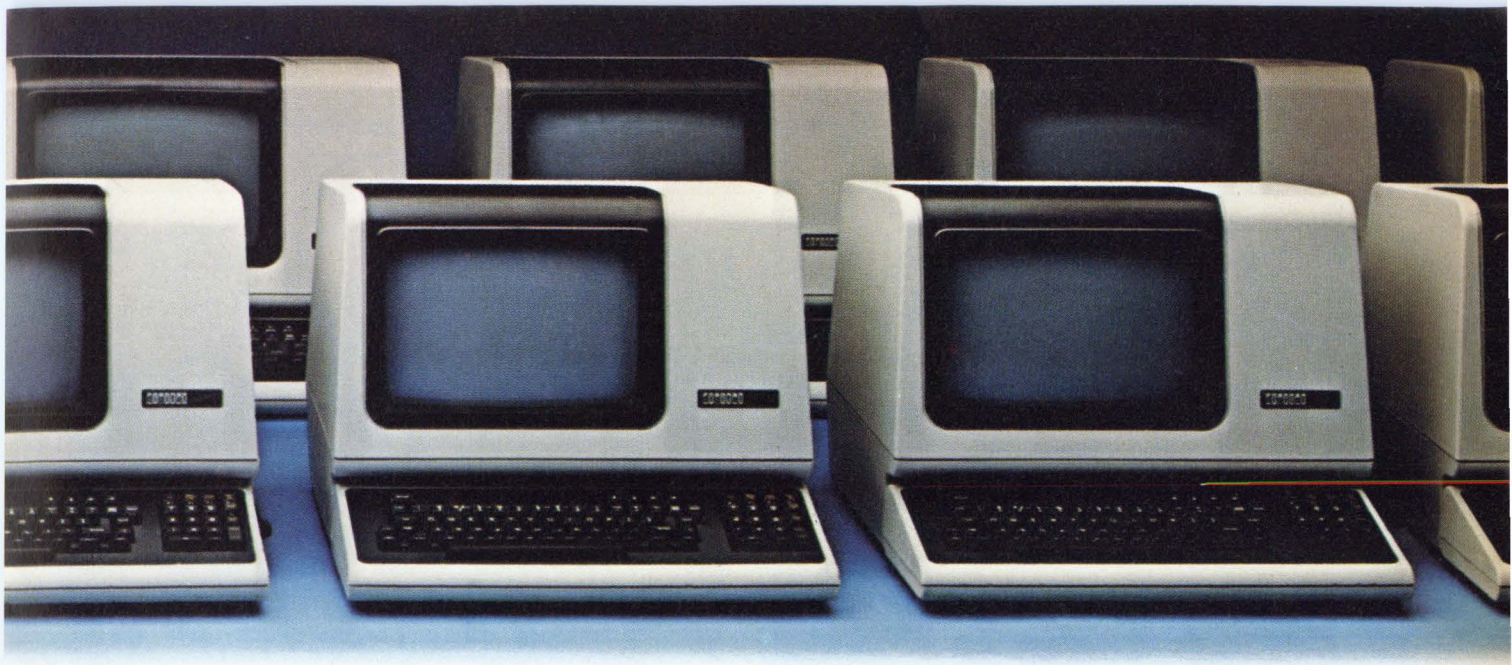

Up until now if you wanted VT100 quality in anything other than a VT100, you had two choices: Do without, or settle for something less.

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You can buy the VT125 as a complete terminal package. Or you can buy it as an option for the VT100 you already own.

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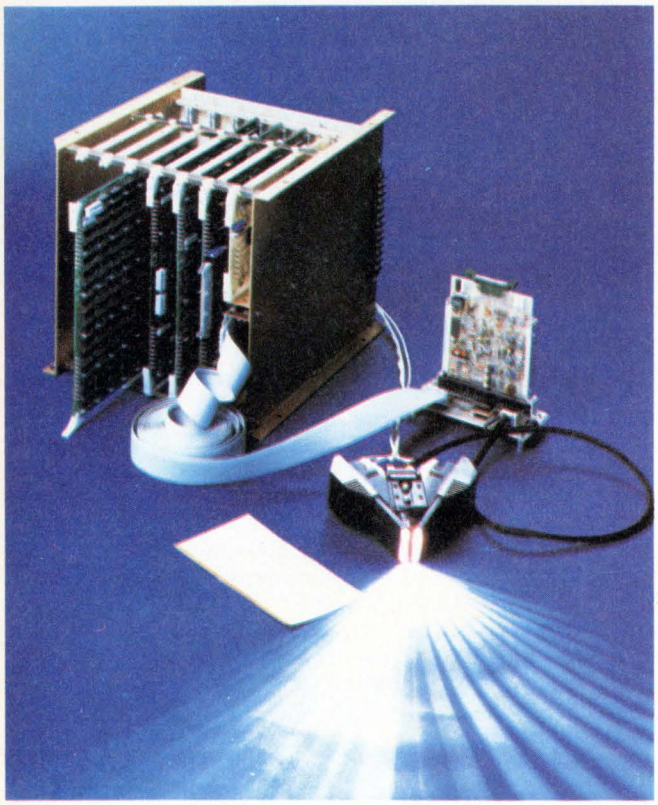
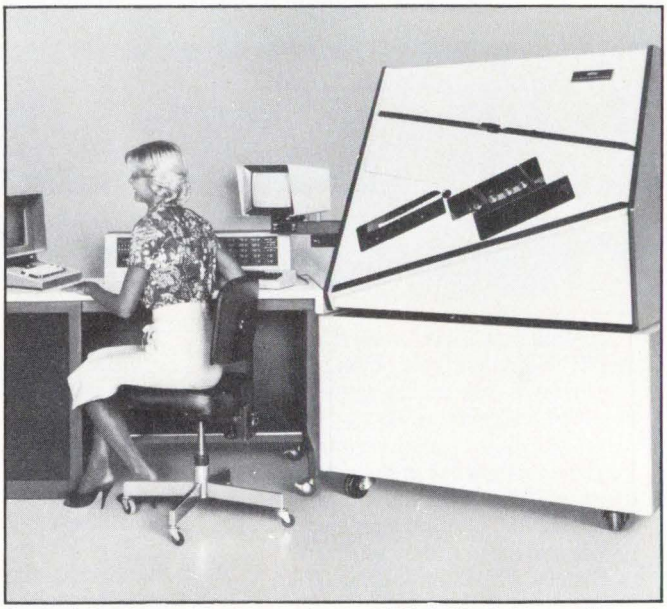
CIRCLE NO. 14 ON INQUIRY CARD

Lower priced products may rejuvenate OCR market





Optical Business Machines, Inc.'s DPS OCR *(left), configured with a 32-bit Perkin-Elmer minicomputer, is said to have more functionality than dedicated OCR systems. Prices range from $149,000 to $179,000 for basic configurations of 16- and 32-bit versions, respectively. Input Business Machines, which takes a more limited functionality, has kept prices low for some of its systems by incorporating a low-end OEM product called OCRL (right). In quantities of hundreds, OCRL sells for $3000 to $6000.*

The high price of optical-character-recognition (OCR) products has been as big a stumbling block to end-user acceptance of the technology as is pronouncing its name. The biggest users have been Fortune 500 companies and the federal government, which use OCR in large data-processing environments to relieve hefty data-entry bottlenecks.

Two firms have recently joined the ranks of those trying to lower the cost of OCR use by offering systems configured around minicomputers and μcs; the firms may thus expand the applications of OCR.

Optical Business Machines, Inc., Melbourne, Fla., has teamed with Perkin-Elmer Corp. to release two versions of OBM's DPS minicomputer-based OCR product line this month (MMS, January, p. 9). Input Business Machines, Inc., Rockville, Md., will introduce a low-end, turnkey inventory-control ticket-reading system at next month's Hanover Fair in Germany. That system is configured around a Digital Equipment Corp. LSI 11/23 μc, and initially is targeted for sale in Europe. This year, Input will also begin shipping the first end-user OCR system, the Input 20, under its own label in the U.S.

Some industry watchers expect that even with lower prices, OCR's market share will not increase quickly. OCR has grown slowly compared with other computer peripherals, says Kenneth G. Bosomworth, president of International Resource Development, Inc., Norwalk, Conn. One reason for the market's slow growth is that OCR competes with direct on-line data entry.

"At one time, McDonald's (restaurant) read cash register receipts optically. Now its point-of-sale cash registers are on-line. That pattern of source data entry is true of a lot of applications," Bosomworth explains. Yet, he sees a long-term future for OCR in the slow-growing computer-input market, in which the technology traditionally has been strong. IRD estimates for OCR products shipped in the U.S. this year indicate that of a total market of $315 million, $170 million in equipment was used for computer input. Another $85 million in equipment went to word-processing applications, while $40 million went to newspapers and other specialty markets, and $20 million went to electronic-mail functions.

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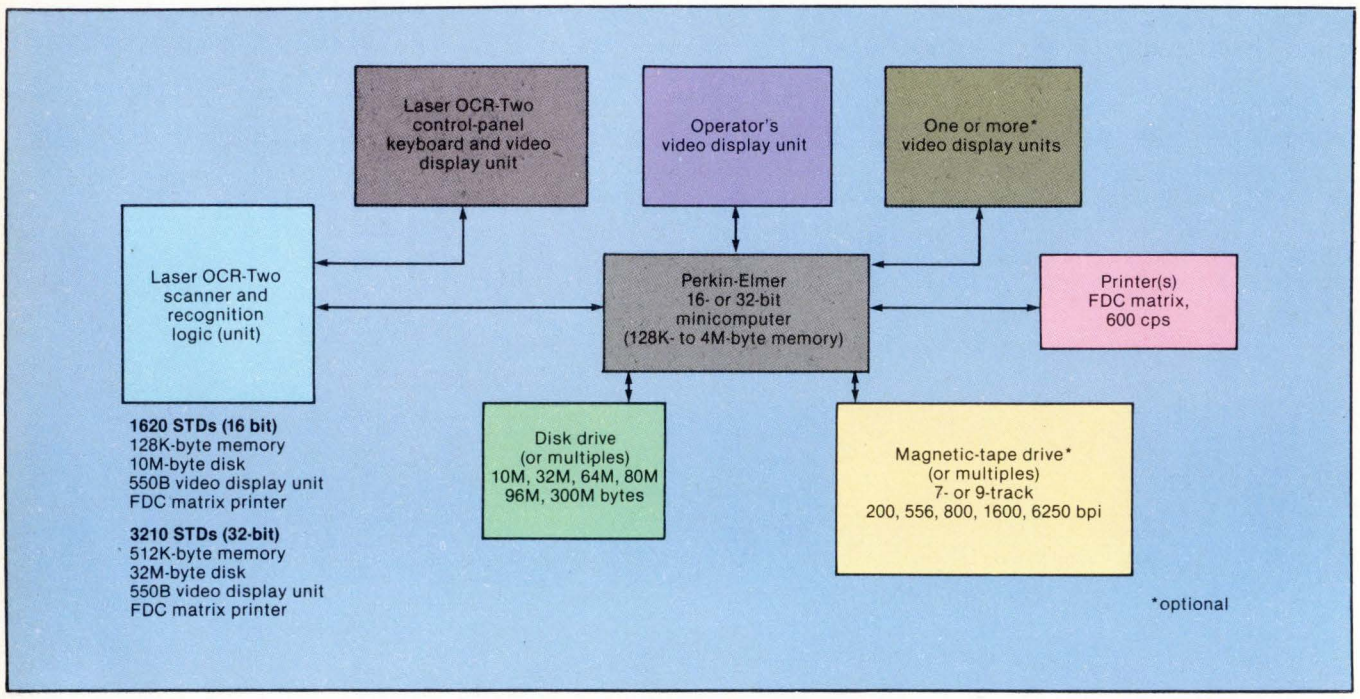

Optical Business Machines, Inc.'s DPS minicomputer-based OCR products.

market with two new OCR systems with output capabilities. Its top-end system can be used for tasks other than OCR, whereas most competitive systems are dedicated to scanning, the company claims.

Two versions of the DPS minicomputer-based OCR system are available, priced at about $149,000 and $179,000, respectively, for basic configurations. The low-end system is comprised of an OBM Laser OCR-Two scanner, Perkin-Elmer's model 1620 16-bit minicomputer with 64K bytes of memory, a 10M-byte P-E M46-710 Vanguard cartridge disk system, operating-system software, a Florida Data Corp. matrix printer, a P-E model 550B keyboard and terminal to control OCR functions and a 1600-bpi magnetic-tape unit. The high-end system has many of the same features, except it is based on P-E's 3210 32-bit minicomputer with 0.5M bytes of memory and has a 32M-byte disk drive. COBOL is included in the operating-system software. Options include the magnetic-tape unit, as many as 63 more terminals and as many as four scanners for faster reading. Applications software is priced separately. OBM delivers and supports the complete system.

The Laser OCR-Two has two M6800 μps, one to control document handling and recognition and one for data editing and reformatting for magnetic-tape output. The device scans paper from 2.9 to 8.5 in. wide and 2.5 to 14 in. long.

The high-end product is distinctive in its flexibility, the company claims, most notably in that it does not have to be used as a dedicated OCR machine. On the 32-bit system, the operating system uses 110K to 115K bytes, leaving about 385K bytes for the user. Of the 385K bytes, the OCR scanner requires about 35K to 100K bytes per task, says William E. Lohne, a senior sales engineer at P-E who helped OBM configure its first DPS system. This still leaves room for the user to do data-processing tasks. On the 16-bit system, almost all memory is used by the operating system and the scanner.

Competitive systems, such as Scan-Optics, Inc.'s 1750 office-product scanner and Scan-Data Corp.'s model 2280, typically are dedicated to OCR functions. The 1750, which is based on a 16-bit Hewlett-Packard Co. HP 1000 minicomputer, includes 64K bytes of memory, as many as four floppy-disk drives and a control display terminal, and is priced at $79,347. Applications software from Scan-Optics is priced separately, as are a printer and a magnetic-tape unit. Scan-Data's model 2280, which is based on a DEC PDP-8 computer, includes an 8.8M-byte disk drive, one to two CRT terminals, an OCR system transport and scanner, user software, operating system, a tape drive and a line printer. It is priced at $225,000.

Although OBM supplies application software for an added price, Lohne says, software for one of the first applications sold for about $20,000. That application, at the Federal Aviation Administration in Atlanta, uses an early version of the DPS to process payroll forms. The forms previously were submitted

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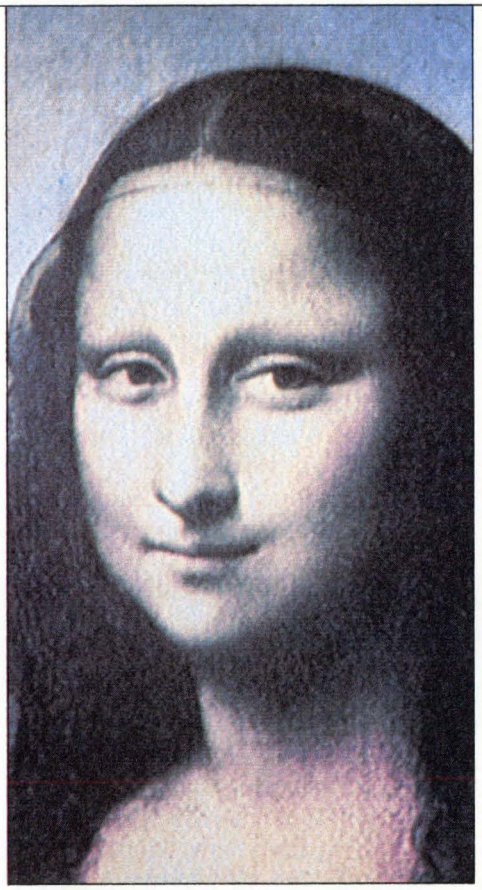

Image of Mona Lisa processed by Combined Logic Research, Hollywood, CA, on a COMTAL Vision One/20 using histogram equalization and function memory modifications for brightness, contrast and color correction.

☐ Image Resolution and Bit Depth ☐ Number of Images (i) & Graphics (g) In Typical Configuration			Function Memory Processing	Small Area Processing	Real-Time Arithmetic	Dual User Capability
Image Display/ Processing	8000-R Model 30	512^2 x 8 3i, 4g				
	8000-R Model 65	1024^2 x 8 3i, 4g				
Stand-alone Image Processing	VISION ONE/10	512^2 x 8 4i, 4g				
	VISION ONE/20 Model M8	512^2 x 8 7i, 8g				
	VISION ONE/20 Model M10	512^2 x 8 15i, 8g				
	VISION TEN/24	1024^2 x 8 4i, 8g				
	VISION ONE/12	256^2/512^2 x 12 3i, 12g/1i, 4g				
Image Input	Digital Video Input Processor	Acquires and digitizes filmed images illuminated by a light table; integrates as many as 256 frames; images can be transferred to a VISION ONE/20 or host computer.				

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COMTAL

CIRCLE NO. 17 ON INQUIRY CARD

biweekly, entered by keypunch operators onto tape and then onto a minicomputer.

Tom Holmes, general manager at OBM, says that ideally, a scanner running at 400 cps could scan 12,000 machine-print characters in 30 sec. (about 195 cps for hand-print characters). A key operator entering the same information typically keys in 11,000 to 12,000 characters per hour.

Input is targeting the inventory-control market with its as-yet-unnamed ticket-reading system. The system uses an expanded version of Input's RIT 5000 (remote intelligent terminal), a high-speed batch reader that scans more than 100 price tickets per min.—about 2000 cps. The RIT 5000 reads tickets specified by the National Retail Merchant Association to help track retail-store inventory. Dennison Manufacturing Corp. sells a version of a configured RIT 5000 system in the U.S. and Canada.

In Europe, Input will sell its system, configured with the RIT 5000, a DEC LSI 11/23 μc, a CRT terminal, a ticket printer, a 10M-byte hard disk and applications software, for about $50,000, says company president Gary J. Murphy. The company may reconfigure the system for the U.S. in a version that would not compete with Dennison's.

Input will move into end-user systems in the U.S. this year with the Input 20 shared-resource system. The Input 20 hand-fed terminal communicates with a controller that includes an M6800 μp and a low-end OCRL reader. OCRL is typically an OEM product for Input that reads as many as four lines of information that are a total of less than 6 in. high. In quantities of hundreds, the OCRL is priced at $3000 to $6000, depending on speed. As many as 16 Input 20s can be linked to the controller via 300-bps, twisted-pair cable, and the controller can be linked to a host minicomputer or mainframe. CRT terminals or cash registers can be linked to the Input 20. A minimum configuration with five Input 20 units and a controller is priced at $10,000.

While the Input 20 is a pre-production product, Murphy says, one major utility company in New York is considering using one. The company may use it to handle utility bills paid at a payment window. "It could take two to four days until these are input into computer, and the company could inadvertently shut off someone's electricity in the meantime," says Murphy.

Murphy finds some potential customers suspicious of Input's relatively low prices. "User education and understanding of the general public are still the big challenges of the OCR industry," he says. "Only a minute part of the population understands OCR," he says. —*L. Valigra*

Pertec reenters Winchester market with 8-in. drive

Pertec Computer Corp., which launched a 20M-byte, 8-in. Winchester more than three years ago but which was never able to land a major account for the drive, has decided to reenter the market for small rotating memories with a line of redesigned hardware offering capacities ranging from 33M to 84M bytes.

Called the TrakStar series, the new hardware is the same physical

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(404) 952-0919

Arlington, Texas
(817) 261-5312

Burlington, Massachusetts
(617) 273-5955
(617) 229-2800 (OEM)

Rocky River, Ohio
(216) 333-3725 (Cleveland)
(412) 261-0406 (Pittsburgh)

Livonia, Michigan
(313) 525-8240

Dysan Flexible Diskettes are also available from all ComputerLand Stores, Sears Business System Centers, and independent computer outlets nationwide.

For the location of the Dysan sales outlet nearest you, contact Dysan at:
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Toll Free: (800) 538-8133;
Telex 171551 DYSAN SNTA;
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DID YOU KNOW THAT THE BEST MEDIA AVAILABLE IS NOW AVAILABLE NEAR YOU?

Well, it is.

For years, we've been supplying discriminating data processing professionals worldwide with the finest magnetic media made anywhere... Dysan diskettes, mini-diskettes, disc packs, disc cartridges and single rigid disks.

Is there any reason why **you** should have to settle for second best?

Now you can buy Dysan precision diskettes and mini-diskettes direct from the Dysan sales office or authorized dealer near you. And they're not just any diskettes. They're certified 100% error-free both on **and** between the tracks to insure you of flawless performance. That means no lost data. No need to re-program. Or de-bug again. Dysan diskettes work the first time, every time. Think about how much time, energy and aggravation you can save.

Why wait for problems to occur to convince you that a bargain diskette is really no bargain? Call the Dysan office nearest you. Or stop in your nearest authorized Dysan dealer. Once you experience the Dysan difference you won't settle for anything less.

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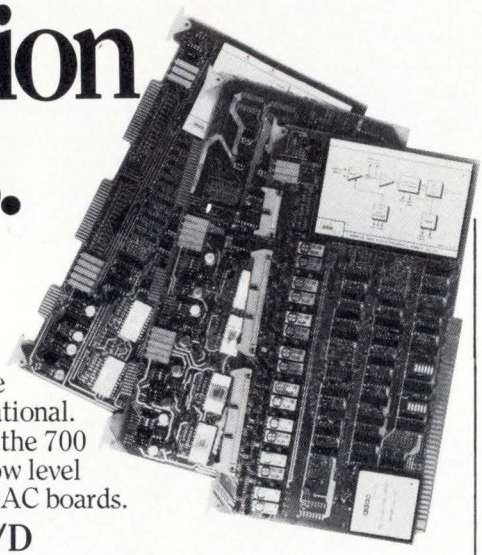
CIRCLE NO. 18 ON INQUIRY CARD

The designers' choice for MULTIBUS compatible data acquisition systems.



The ADAC 700 series of data acquisition systems plug directly into the same card cage as computers from Intel and National. Mounted on a single PC board, the 700 series includes both high and low level analog to digital systems and DAC boards.

710 Series Low Level A/D

- Withstands common mode voltage to 250 V
- Digitizes outputs from bridges, thermocouples, and other low level transducers
- Gain amplifier with system cold junction compensation can be programmed channel to channel
- 8 or 16 differential inputs per card
- 12 bit resolution

735 Series High Level A/D

- 16 to 64 single ended or pseudo differential inputs
- Jumper selectable for 8, 16 or 32 differential analog inputs
- 12 bit high speed analog to digital converter
- Up to 2 channels of 12 bit digital to analog converters
- Bus interface includes software choice of programmers control or interrupt

735 DAC Series

- Up to 4 channels of 12 bit DACs
- 2 scope/recorder per control circuit
- 8 discrete digital outputs with 8 current sinks
- 8 discrete digital inputs

Send for full technical data to:

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CIRCLE NO. 19 ON INQUIRY CARD

Mini-Micro World

size as an 8-in. floppy-disk drive and will begin shipping in evaluation quantities this quarter. This time, says Darell Meyer, product planning and marketing manager at Pertec's Woodland Hills, Calif.-based Peripherals Division, the company is determined to do it right. "We were among the first to announce and the last to deliver," he concedes.

Pertec's first 8-in. hardware was announced during the halcyon days of small Winchesters—early 1979 and up through the 1979 National Computer Conference in New York. But the hardware never got a proper hearing before the OEM marketplace, says Newark, Calif., industry consultant Andrew Roman. "Pertec dropped the ball," he says. "They never ironed out the interface issue and stuck to a proprietary design until it was too late." Moreover, he says, Pertec never had an aggressive marketing strategy. The result: "No one could really evaluate the drive," he says, adding that by his calculations, fewer than 500 were built, of which very few got onto the open market.

Later, the Pertec drives were equipped with an ANSI interface, but by then it was too late. "The 20M-byte drive looked ideal when Pertec first introduced it," Meyer says. "But not anymore. The 5¼-in. Winchester came along, and now 30M bytes is considered the bottom end for an 8-in. device."

With Pertec's new hardware, the D8033 (33M bytes), the D8067 (67M bytes) and the D8084 (84M bytes), the company addresses the interface issue by announcing that the drives will be equipped with an ANSI interface. As far as the second issue—lack of marketing strategy—is concerned, the company has a firm idea of where it wants to see the drives installed. First of all Pertec is looking at single-user desk-stand systems and multi-station word-processing systems

What would you say to the world's most intelligent off-the-shelf voice terminal?

"Take a LETTER to Interstate"
"ADVANCE cutting tool 0.28 inch"
"HEMOGLOBIN NORMAL"
"TRACK target, sector 2, zone 8"
"Test fixture 82 OUT of tolerance"
"DELETE graphic segment F29"
"PART number 63527"
"The CHECK is in the mail!"

That's all it takes: a check for $5,295 to enter the realm of voice command, control, and data entry. A billion-dollar segment of the data-processing industry by the end of the decade.

Interstate's VRT101 voice-intelligent terminal gets you there fast. No hardware interfacing—unless you want to talk to another computer over a standard RS-232C data link. No time-consuming software development—the terminal's CP/M™* operating system allows you to choose from hundreds of commercially available application programs, utilities, and programming aids. Or write your own applications in FORTRAN or BASIC.

At run time, just substitute spoken words for keyboard entries; CP/M's console command processor can't tell the difference. Any spoken words you choose. Up to a hundred learned words or phrases can be stored in a separate voice-recognition unit for instant access. Store even more on flexible or hard disk, or download them from terminal memory.

The Interstate VRT101 converts your words into ASCII character strings—as you define them—with over 99% accuracy. And displays each entry on the screen for verification. It's a completely interactive process. In real time. In your "natural" language.

So give us a call today. Our VRT101 voice-intelligent terminal is waiting to hear from you. Interstate Electronics Corp., P.O. Box 3117, Anaheim, California 92803. Call Toll Free (800) 854-6979, in California (800) 422-4580. TWX 910-591-1197, Telex 655443, In the U.K. Telex 82431.

P.S. For your own wall size "What Would You Say?" poster, write to us on your company letterhead.

INTERSTATE ELECTRONICS CORPORATION
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Your single source for Voice Terminals, Plug-in Modules and IC Chips.

*CP/M is a Registered Trademark of Digital Research, Inc.

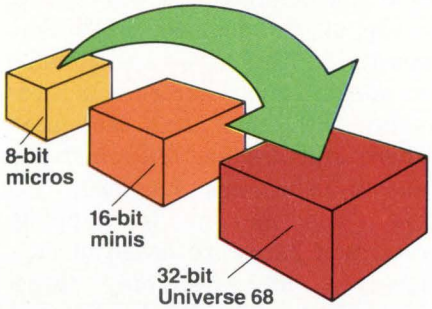
CIRCLE NO. 20 ON INQUIRY CARD

Universe 68 leapfrogs the 16-bit minis.

CHARLES RIVER
DATA SYSTEMS

Introducing the first 32-bit supermicro for OEMs

Our new Universe 68 computer system offers powerful 32-bit architecture, a microcomputer price, the programming efficiency and portability of a UNIX-like operating system, and the refreshing experience of working with a computer supplier whose business practices are actually designed to make life easier for OEMs.



Jumping over outmoded 16-bit architecture

Built around the Motorola 68000 microprocessor, the Universe 68 system is a 32-bit supermicro that leapfrogs conventional 16-bit minicomputer technology. It has directly addressable, non-segmented address space of 16 million bytes, compared to the 64-kbyte limitation imposed by 16-bit architectures.

That means greater functionality per dollar, increased program development efficiency, and power to tackle demanding new applications.

The Universe 68/10 computer system

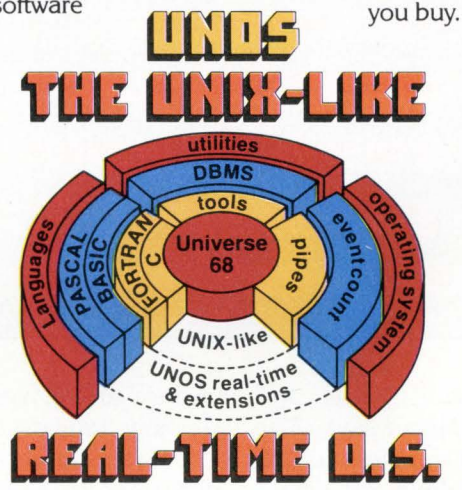
Outhopping supermini prices

The Universe 68 gives you 32-bit performance at micro prices – –while the big frogs in the minicomputer pond are still offering 32-bit technology only in expensive "superminis." A Universe 68/10 with 32-bit processor, 256 kbytes of memory, floppy disk, and Winchester disk sells for under $20,000. Order ten, and the unit price drops to $16,860, including system software.

Springing past conventional system software

UNOS, our UNIX-like operating system, is part of the new generation of more flexible, easier to use software written in the high-level systems programming language C. To help OEMs develop products faster and less expensively, it incorporates UNIX features (such as "pipes," I/O redirection, and hierarchical files), plus portability that conventional systems software can't match.

To its UNIX-like base, which supports FORTRAN and C languages, UNOS adds PASCAL and BASIC, an expanded data base management system (DBMS), and an array of run-time oriented, real-time transaction processing capabilities, including a highly sophisticated "Eventcount" process synchronization mechanism. These extensions can be the key to implementing real-time and information systems applications.



Croaking obsolete business practices

OEMs often find computer suppliers tough to deal with. Bundled hardware and software limit flexibility in configuring systems, while proprietary busses and assembly-language software can lock you in to one vendor.

We're out to change all that by offering OEMs a choice. You can buy complete systems from us, and just add application software. Or buy some components from us, and go elsewhere for others. You can even buy UNOS from us and run it on someone else's hardware. And by building the Universe 68 computer around standard, non-proprietary technology like VERSAbus, SASI bus, and the 68000, we've made second-sourcing easy.

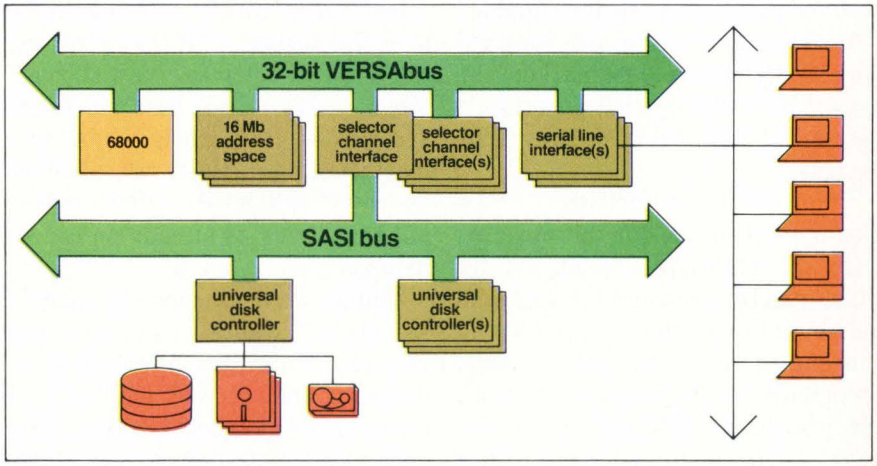
We've also introduced a more sensible approach to discounts. We give you discount credit for everything you buy. Our software discounts are based on how many licenses you buy, not in one year, but over *twenty* years. And they cut deep – all the way to 98%. We think this honestly reflects our costs: software development costs are almost entirely loaded at the front end, and support costs fall quickly once an OEM has gained experience.

Swallowing up the competition

If you need 32-bit power at a micro price and you can't wait for the minicomputer giants, you should know more about the Universe 68 computer and UNOS. For full information, call or write Charles River Data Systems, 4 Tech Circle, Natick, MA 01760, (617) 655-1800.

With the price/performance story we have to tell, we're ready to make a megasplash in the minipond.

The Universe 68 system takes advantage of standard building blocks, such as the 68000 microprocessor, 20-megabyte-bandwidth VERSAbus, and SASI bus.



UNIX is a trademark of Bell Laboratories. VERSAbus is a trademark of Motorola.
SASI bus is a trademark of Shugart Associates. UNOS is a trademark of Charles River Data Systems.

CIRCLE NO. 21 ON INQUIRY CARD

PERTEC'S 8-IN. 'TRAKSTAR' SPECIFICATIONS			
	D8033	D8067	D8084
Unformatted capacity (bytes)	33.71M	67.29M	84.11M
Transfer rate	8.5M bps		
Positioning time Track-to-track Average Maximum		10 msec. 45 msec. 80 msec.	
Rotational speed	3600 rpm		
Recording density	8204 bpi using MFM encoding		
Track density	476 tpi	952 tpi	952 tpi
Tracks per surface	476	950	950
Number of disks	3	3	3
Number of data surfaces	4	4	5
Bytes per track	17,708		
Bytes per surface	8.42M	16.82M	16.82M
Platter size	210 mm.		
Dimensions	4.65 × 8.58 × 14.31 in.		

where the application load will continue to grow, Meyer says. Also on the list are process-control houses and vendors of small-business systems.

Pertec's drives are now undergoing a shakedown cruise at a number of beta test sites including Pertec's Data Systems Division (the old Computer Machinery Corp.) and at Omnidata Corp., a Westlake Village, Calif., vendor of small systems, which, like Pertec, is a subsidiary of Germany's Triumph-Adler. Triumph-Adler is also scheduled to receive some hardware, Meyer says, but he stresses that the Peripherals Division is not interested in being solely a captive supplier. "The TrakStar drives are designed specifically for the OEM market," he says. "We estimate that less than 5 percent of our total business will be captive."

Production quantities of the 33M-byte drive are due this quarter, with the 67M-byte version set for third-quarter 1982 and the high-end 84M-byte device due in quantity by the end of the year. The company reportedly is building a clean room and production-line capability at its nearby Chatsworth "ironworks" that one company source says could produce 4000 drives per month. The company intends to have 3000 to 5000 TrakStar devices in the field by the end of the year.

Getting this hardware to market will be the responsibility of a restructured sales force with account managers responsible for Winchester sales to the existing Pertec customer base. New business will be in the hands of what Pertec executives call "silver bullets"—drive specialists that work on a national basis out of Pertec's Woodland Hills peripheral headquarters. Meyer calls these people "super hotshots" whose job is to disclose business to the regular sales force, which will then take over the business. "If they don't sell the TrakStar drives, they starve," Meyer says. The first of these specialists, Ray Christensen, formerly marketing vice president at nearby Woodland Hills drive maker SLI Industries, is already on board, he adds.

Things may not move as quickly as Pertec wants, however. Jim Porter, Mountain View, Calif., industry analyst and publisher of *Disk/Trend Report* forecasts that only 16,000 8-in. drives in the 30M- to 200M-byte range will be shipped in 1982 by all U.S. OEM vendors; only 39,000 will be shipped next year. Based on these figures, it may be some time before Pertec will be able to use all its planned production capacity for this hardware. Roman too wonders about Pertec's decision to go with the ANSI interface: "There still are not enough drive vendors using this standard," he says, "and no one is shipping production hardware based on it." Moreover, he says, only three independent controller houses are offering controllers equipped with this interface, and none, he says, are doing it with much enthusiasm.

Meyer feels otherwise, and points out that Pertec is already working with a number of controller vendors, including Emulex, Interphase and Xylogics, and that other companies are expressing interest in entering the market.

Pertec also feels that the market for high-end 8-in. hardware will receive a boost with the anticipated introduction of an 80M-byte pack drive and a 160M-byte fixed drive this year by Control Data Corp. (MMS, September, 1981, p. 10). Both drives reportedly will use 230-mm. ("9-in.") media and will be equipped with a new intelligent interface standard that could replace the ANSI design in higher cost, more performance-oriented systems. "We will be looking into the use of an intelligent interface," Meyer says, adding that Pertec has designed the TrakStar drives to go up to 160M bytes.

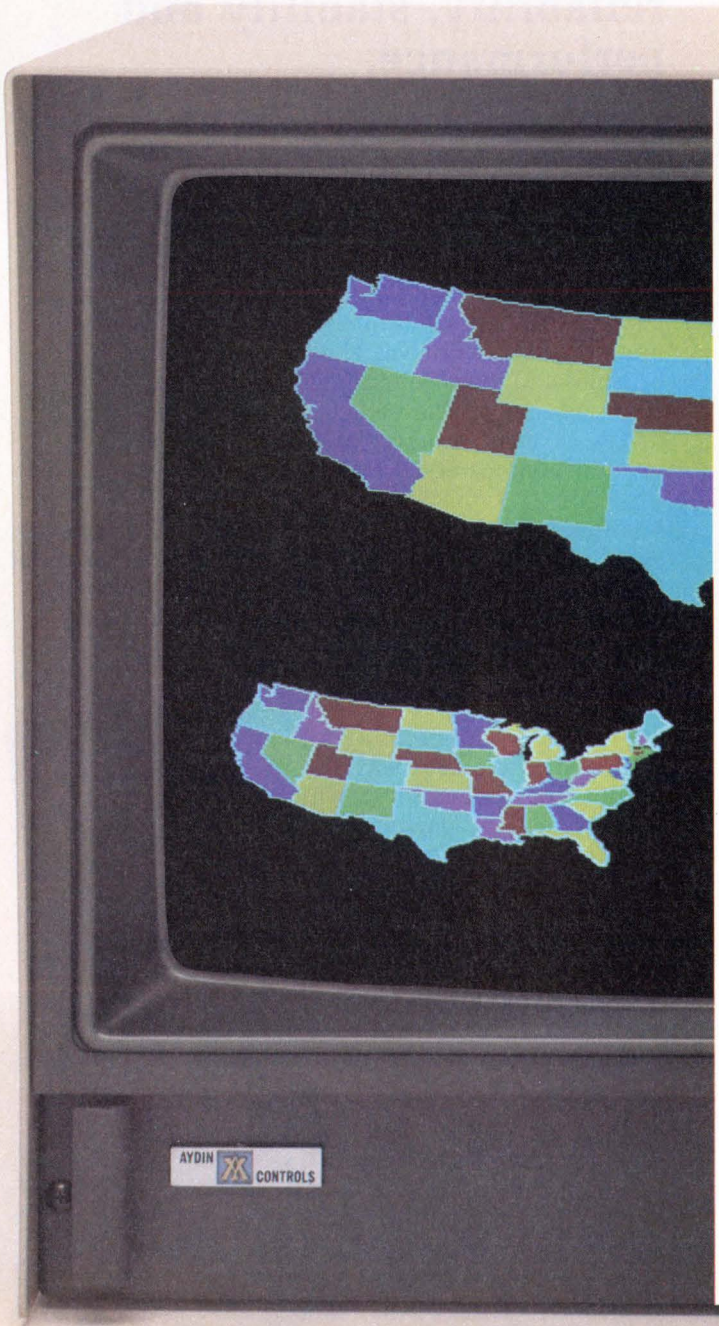
Pertec has priced the soon-to-come 33M-byte version of its TrakStar lines at less than $2000 in 1000-lot orders. The 67M-byte device goes for $2340 in similar quantities, the 84M-byte drive at $2550. The company will continue to support its original 20M-byte drive until this September, and is moving to convert the existing customer base run to the new product line.

—John Trifari

Made in USA

Aydin Patriot™ Color Monitors

Aydin Controls introduces its American-made, in-line gun, high resolution Patriot Series of Color Monitors.



Aydin Controls, a leader in high resolution color display terminals, now manufactures Patriot™, its own in-line gun series of color monitors. The Patriot series will supplement Aydin's well known family of delta and in-line gun monitors.

Patriot's 13-inch Model 8810 and 19-inch Model 8830 both offer the latest state-of-the-art features plus all of the advantages of American technology and manufacturing. Patriot features high video bandwidth, wide horizontal line rates, fixed convergence, excellent high voltage regulation, modular construction, analog or TTL inputs and rack mountability. The Patriot Series can be customized to fit special needs.

Patriot monitors provide outstanding performance at an attractive price coupled with an 18-month OEM warranty; off-the-shelf availability; quick delivery of spare parts; and fast, reliable service. For more information contact Aydin Controls, 414 Commerce Drive, Fort Washington, PA 19034. Tel: 215-542-7800 (TWX 510-661-0518).

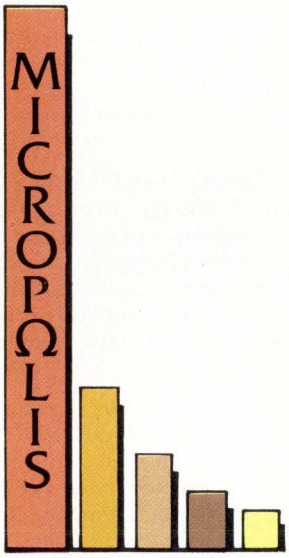
AYDIN CONTROLS

CIRCLE NO. 22 ON INQUIRY CARD

Some plain high performance

FACT: We've delivered more 45 Mbyte 8" Winchesters than all the competitors put together.

A 50,000 square foot plant with the finest clean rooms money can buy is totally dedicated to producing high capacity, high performance drives. Plant capacity exceeds 2000 drives monthly. Availability questions about high capacity, high performance 8" Winchesters are a thing of the past. The only question left is - how many would you like — and when.



COMPETITORS

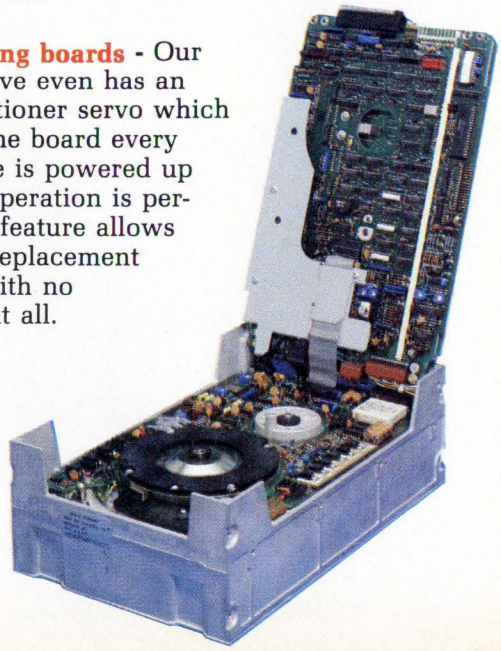
FACT: Micropolis drives are engineered for reliability, stability and performance.

We pay close attention to the clean area, but there's more. Designed in are features which make ours the most reliable, stable high performance 8" Winchester on the market.

• **Quartz locked direct drive motor** - A unique Quartz crystal speed control circuit holds rotational accuracy to better than 0.5%, which allows 5% more data on the drive. The high efficiency brushless dc motor eliminates two main shortcomings of line voltage induction motor/belt drives - excessive power and heat, and double inventorying for 50/60 Hz requirements.

• **Fail-safe braking mechanism** - Micropolis doesn't agree with those who feel it's good engineering to let the head slow the disk by friction. Instead, we extend the life of our disks by including a spring loaded brake that stops the motor in seconds.

• **Self-adjusting boards** - Our intelligent drive even has an adaptive positioner servo which recalibrates the board every time the drive is powered up or a restore operation is performed. This feature allows quick board replacement in the field with no adjustments at all.



FACT: Critical components start out only in the clean room.

Recording heads, platters and voice coil positioner start out in the clean room and are never exposed to contaminated air. They're completely sealed in the lower half of the drive with pure air circulated through a 0.3 micron life-time filter. All active components are kept out of this sealed area, resulting in a clean area MTBF of 25,000 hours. Some manufacturers include active components in the sealed area, creating nightmares for field service.

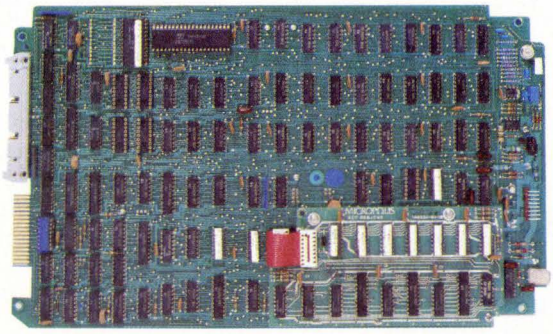
facts about 8-inch Winchesters

• **Truly balanced positioner** - A balanced rotary voice coil mechanism combines with a closed loop servo to continuously monitor head position, removing the danger of off-track writing inherent in stepping motor systems. Also, drives using non-rotary voice coils or stepper positioners are vulnerable to even very low levels of shock and vibration.

• **Latches and locks hold head in place** - Heads always land in the non-data area and are latched in a safe position even when the drive is moved from desk to desk. A special lock protects against higher shocks during shipping and is unlocked manually for installation.

FACT: Micropolis' optional Intelligent Controller can save you time and money.

Why spend valuable development time and money designing a controller from scratch when we've already done it for you. Our Intelligent Controller board fits inside the drive, gives you 922 Kbyte data transfer rate, sophisticated EPM data separation, up to 1 Kbyte of buffering and 5 bits of error correction.



Even with all of this, the controller costs less than $400 in OEM quantities. As a further economy, each master drive with Intelligent Controller can handle up to three additional slave drives. Drive interfaces are also available for SMD, ANSI and SA 1000.

FACT: Militarized computers use our drive.

Thanks to our inherent reliability, customers such as Rolm Computer and Miltope Corporation buy Micropolis drives for their militarized computer systems. Solid, rugged construction means long life and low maintenance costs in your less hostile environment.

FACT: On the horizon, 90 and 180 Mbyte 8" Winchesters.

We're at 45Mbytes and climbing. We plan to introduce three more 8" models by the end of 1982 with storage capacities of 60Mbyte, 90Mybte and 180Mbyte. The new models will help maintain our leadership position in the high capacity, high performance over-30Mbyte market.

If a solidly engineered high performance 8" Winchester plays a role in your design plans, phone or write for more "plain facts".

MICROPOLIS™

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Chatsworth, CA 91311
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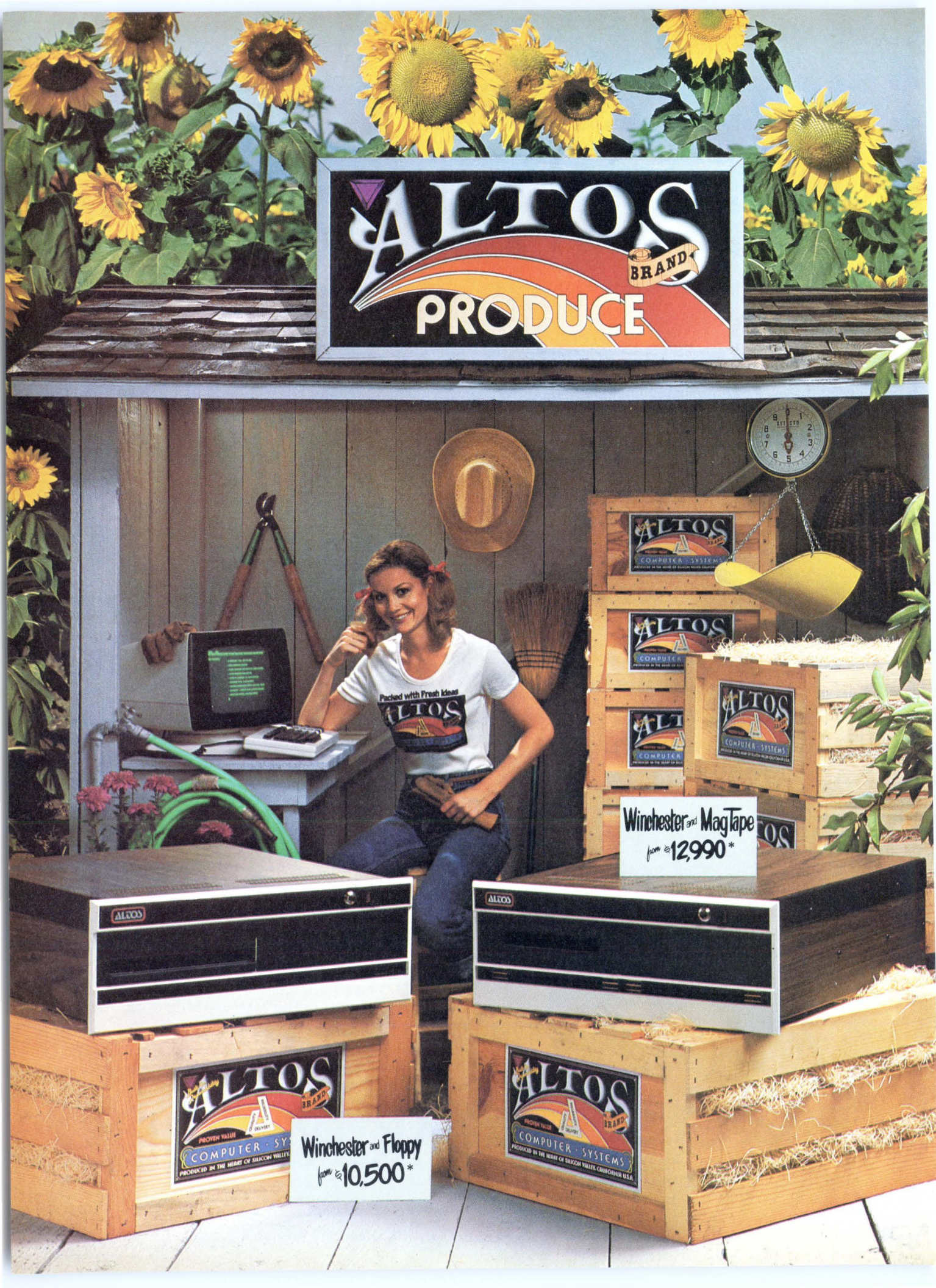
Growth positions available for talented people.

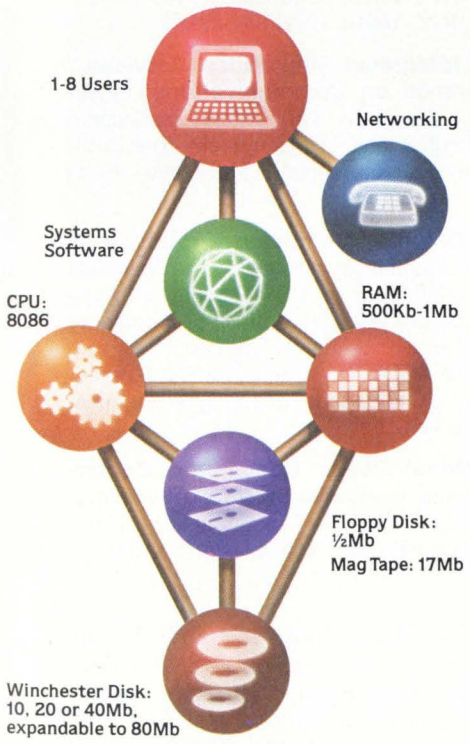

ALTOS
BRAND
PRODUCE
Packed with Fresh Ideas
ALTOS
Winchester and MagTape
from $12,990*
Winchester and Floppy
from $10,500*
COMPUTER · SYSTEMS

HIGHER YIELDS

With the new Altos 8086, eight-user, 16-bit microcomputer family.

Altos, the multi-user networking and communications company, lets you enjoy a more profitable yield. Now you can effectively accommodate up to 8 users, with true multi-tasking, on your microcomputer system and get 16-bit 8086 multi-user performance and features at an 8-bit system price.

With the Altos ACS8600 family, you can perform bigger, more complex computer tasks. With a larger word size for more powerful instructions and direct addressing of more memory, you can do more jobs faster. And you can now handle complex mathematical problems, large data base searches and other demanding applications in far less time.



With the 16-bit ACS8600 family you'll get a unique set of features:

- Multiple processors (Intel's 8086, 8089 and optional 8087 math chip)
- Direct addressing from 500 KBytes to one megabyte using 64K MOS RAM memory chips
- Error detection and correction
- Proprietary memory management
- Full communications support (Async, Bisync & Networking)
- Integrated Winchester—10, 20 or 40 MBytes, expandable to 80 MBytes, with floppy or mag tape backup
- Multibus™ expansion interface
- Easy conversion of ACS8000 8-bit software and files to 16-bit ACS8600
- Four operating systems: CP/M-86,™ MP/M-86,™ OASIS-16 and XENIX™ (UNIX™)

Take a closer look at these features. Multiple processors work together to share the workload for faster execution and response time. A unique memory management system subdivides up to one megabyte of memory, automatically giving each user the maximum available memory. Error detection and correction reduces system errors. Full communications facilities support asynchronous and synchronous protocols to allow complete networking capabilities. In fact, every Altos computer has the capability to handle network data rates up to 800 Kilobaud.

Integral data storage includes a choice of 8-inch floppy disks or magnetic tape backup option, plus a choice of Winchester hard disk capacities from 10, up to 80 MBytes. A Multibus™ expansion interface allows the implementation of Ethernet,™ SMD mass storage, A-to-D converters, IEEE-488, digitizers and a 9-track tape drive.

The proven OEM supplier. The Altos ACS8600 family joins a growing family of field-proven products. In just four years, we've shipped more than 15,000 systems to our OEM customers.

Harvest a higher profit yield with Altos' 16-bit capabilities. Call our toll free number or write Altos Computer Systems today for product information and OEM pricing. (European Head Office) 39 Champs Elysees, 75008 Paris, France, (33-1) 225-9342, Telex 280888 MAISAL PARIS. (World Headquarters) 2360 Bering Drive, San Jose, CA 95131, (408) 946-6700, Telex 171562 ALTOS SNJ or 470642 ALTO UI. East Coast (201) 228-5748.

Packed with Fresh Ideas

ALTOS
COMPUTER SYSTEMS

800-538-7872
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*ACS8600-10 and ACS8600-10 MTU single unit retail prices.

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CP/M-86 and MP/M-86 are trademarks of Digital Research, Inc.
OASIS-16 is a product of Phase One Systems, Inc.
XENIX is a trademark of Microsoft and is a microcomputer implementation of the UNIX™ operating system. UNIX is a trademark of Bell Laboratories.
Ethernet is a trademark of Xerox Corp.
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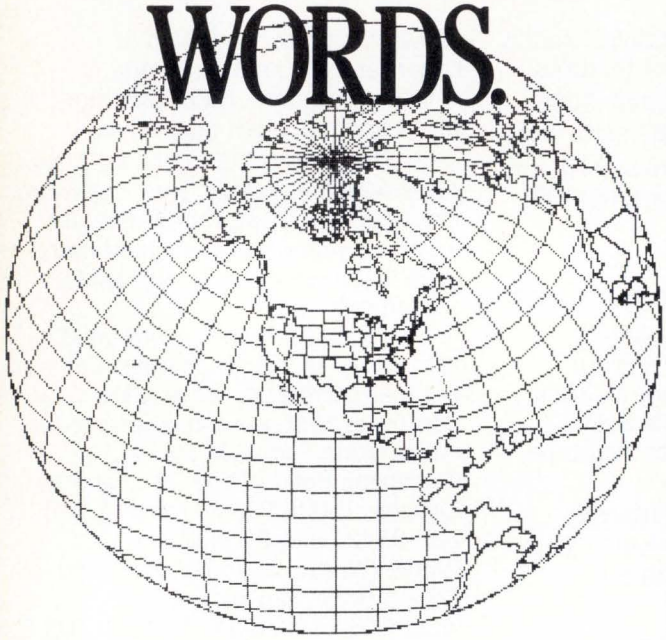
CIRCLE NO. 23 ON INQUIRY CARD

SOMETIMES, A PICTURE IS WORTH A THOUSAND WORDS.



Q160 from CDI. The high-resolution thermal graphics printer the world's been waiting for.

Standard Features:

160 cps. high speed, bidirectional printing
5 x 10 alpha-numeric dot matrix characters
Upper & lower case, true descenders
80/132 column printing
Software/switch-selectable functions

Optional Features:

High resolution (512/1024 per line), dot addressable graphics
Custom or dual fonts
APL font
Serial interface
Also available in receive only terminal

For more information on the Model Q160 graphics printer and the Model 2100 receive only terminal, call Richard H. Leeman, OEM Product Manager, at (800) 225-1229. (In Massachusetts call (617) 273-1550). Computer Devices, Inc., 25 North Avenue, Burlington, MA 01803.

We travel in the best companies.

COMPUTER DEVICES INC.

CIRCLE NO. 24 ON INQUIRY CARD

Calendar

MARCH

22-24 Information Systems Education Conference, Chicago, sponsored by Data Processing Management Association Education Foundation. Contact: Dr. Stephen B. Weiner, Program Coordinator, 12611 Davan Dr., Silver Spring, Md. 20904, (301) 622-0066.

22-25 Interface '82, Dallas, sponsored by *Business Week* and *Data Communications* magazines. Contact: Peter B. Young, The Interface Group, P.O. Box 927, 160 Speen St., Framingham, Mass. 01701, (800) 225-4620.

22-26 WCGA '82 "Computer Graphics for Design and Construction Productivity" Conference, Washington, D.C., sponsored by World Computer Graphics Association Inc., The Building Research Advisory Board of the National Academy of Sciences in cooperation with the International Planning Committee and others. Contact: Exhibit Coordinator, WCGA, 2033 M St., N.W., Suite 250, Washington, D.C. 20036, (202) 755-9556.

23-25 SOUTHCON '82, Orlando, Fla., sponsored by the IEEE Region Three; the Atlanta Section of the IEEE; and the Dixie, Sunshine and Piedmont Chapters of the ERA. Contact: Dale Litherland, Director of Education, Southcon '82 Professional Program Committee, Suite 410, 999 N. Sepulveda Blvd., El Segundo, Calif. 90245, (213) 722-2965.

24-26 Second National Symposium on EDP Quality Assurance, Chicago, sponsored by U.S. Professional Development Institute. Contact: U.S. Professional Development Institute, 12611 Davan Dr., Silver Spring, Md. 20904, (301) 622-0066.

25 ANSI 1982 Public Conference, New York, sponsored by the American National Standards Institute, Inc., and the Association Francaise De Normalisation. Contact: Priscilla F. Trias, ANSI, Inc., 1430 Broadway, New York, N.Y. 10018, (212) 354-3315.

29-31 "Implementing Integrated Information Services," National Conference on Communications, Washington, D.C., sponsored by *Infosystems* magazine. Contact: U.S. Professional Development Institute, 12611 Davan Dr., Silver Spring, Md. 20904 (301) 622-5696.

29-31 Aerospace & Defense Computer Exhibition & Conference, Los Angeles, sponsored by the Technical Marketing Society of America, the Technology Transfer Society and the Los Angeles Council of Engineers and Scientists. Contact: Aldie S. Thomas, Program Director, Aerospace & Defence Computer Conference, 5959 W. Century Blvd., Suite 1016, Los Angeles, Calif. 90045, (213) 645-1921.

29-31 Fourth International Power Conversion Conference, San Francisco, sponsored by Intertec Communications Inc. Contact: Intertec Communications Inc., P.O. Box 2889, Oxnard, Calif. 92034, (805) 985-1595.

MARCH 30-APRIL 1

INFOCOM '82, Las Vegas, Nev., sponsored by the IEEE Computer and Communications Societies. Contact: Dr. Basil Maglaris, Publicity Chairman, Department of EE CS, Polytechnic Institute of New York, 333 Jay St., Brooklyn N.Y. 11201, (212) 643-2380.

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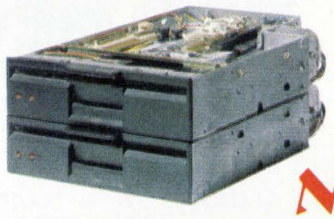
The new NEC FD 1165 diskette drive.



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Half the space/twice the capacity. Boost your profit margins and add new capabilities to your system with NEC's new Model FD 1165 diskette drive.

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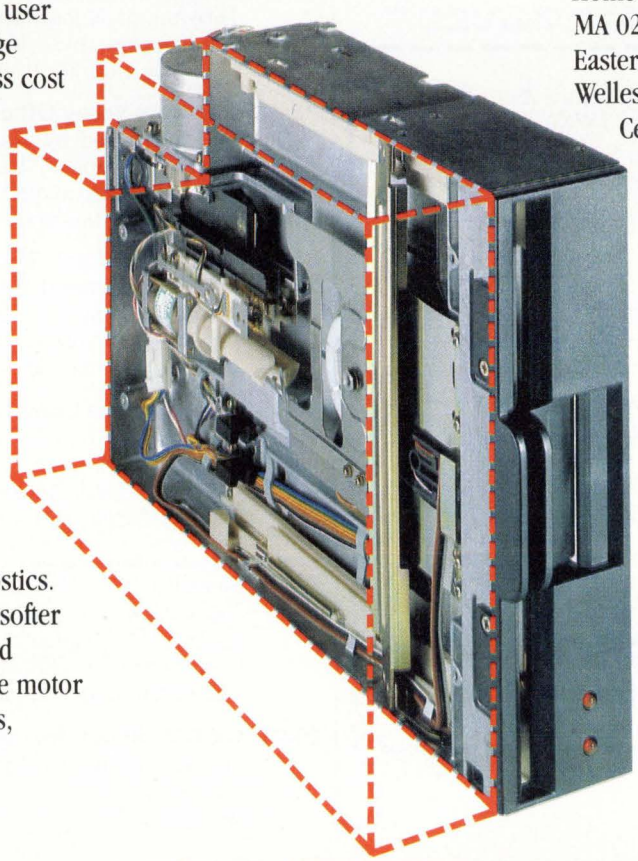
West Coast Office: 8939 S. Sepulveda Blvd., Suite 330, Los Angeles, CA 90045, (213) 670-7346



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CIRCLE NO. 26 ON INQUIRY CARD

Calendar

MARCH 30-APRIL 1

Third Annual International Naval Technology Exposition, Chicago, organized by the Cahners Exposition Group. Contact: Cahners Exposition Group, 222 W. Adams St., Chicago, Ill. 60606, (312) 263-4866.

APRIL

1-2 **Computer Exposition for Small- to Mid-sized IBM System Users,** San Francisco, sponsored by the Association of Small Systems Users. Contact: Paul Nelson, Dolby Laboratories, 731 Sansome St., San Francisco, Calif. 94111, (415) 392-0300.

2-4 **Eighty/Apple Computer Show,** New York. Contact: Ken Gordon, Kengore Corp., 3001 Rt. 27, Franklin Park, N.J. 08823, (201) 297-2526.

4-7 **ACCESS '82, Deltak International Training Conference,** Chicago, sponsored by Deltak International. Contact: Sharon A. Stahlheber, Corporate Communications Associates, 799 Roosevelt Rd., Bldg. 6, Suite 315, Glen Ellyn, Ill. 60137, (312) 790-1225.

5-7 **Third Annual Office Automation Conference '82** San Francisco, sponsored by the American Federation of Information Processing Societies, Inc. Contact: AFIPS, 1815 N. Lynn St., Arlington, Va. 22209, (703) 558-3620.

6-8 **Computerized Office Equipment Expo/Midwest '82,** Rosemont, Ill., organized by the Cahners Exposition Group. Contact Cahners Exposition Group, 222 W. Adams St., Chicago, Ill. 60606, (312) 263-4866.

12-16 **Viewtext '82 Conference,** New York, sponsored by Information Gatekeepers, Inc. Contact: Ellen Bond, Director of Expositions & Publications, Information Gatekeepers, Inc., 167 Corey Rd., Suite 111, Brookline, Mass. 02146, (617) 630-2022.

13-14 **Delaware Valley Office Systems Expo,** Philadelphia, Pa., sponsored by National Trade Productions, Inc. Contact: Joseph P. Rubel, National Trade Products, Inc., 9418 Annapolis Rd., Suite 206, Lanham, Md. 20706, (301) 459-1815.

15-18 **Second Annual Southwest Computer Show & Office Equipment Exposition,** Dallas, produced by National Computer Shows. Contact: National Computer Shows, 824 Boylston St., Chestnut Hill, Mass. 02167, (617) 739-2000.

16-17 **Small College Computing Symposium,** Fargo, N.D., sponsored by North Dakota State University, College of Engineering and Architecture. Contact: Sandy Sprafka, North Dakota State University Computer Center, Fargo, N.D. 58105, (701) 237-8685.

19-23 **12th Conference on Computer Audit, Control and Security,** New York, sponsored by the EDP Auditors Foundation and the Automation Training Center. Contact: D. Eugene Shaeffer, EDP Auditors Foundation, Education Office, P.O. Box 2051, Winter Park, Fla. 32789, (305) 628-5515.

20-22 **D-COM Show for the DEC-Compatible Market,** Boston, sponsored by D-COM, Inc., Contact: Ron Davies, D-COM, Inc., 7312 Burdette Court, Bethesda, Md. 20817, (301) 469-7650.

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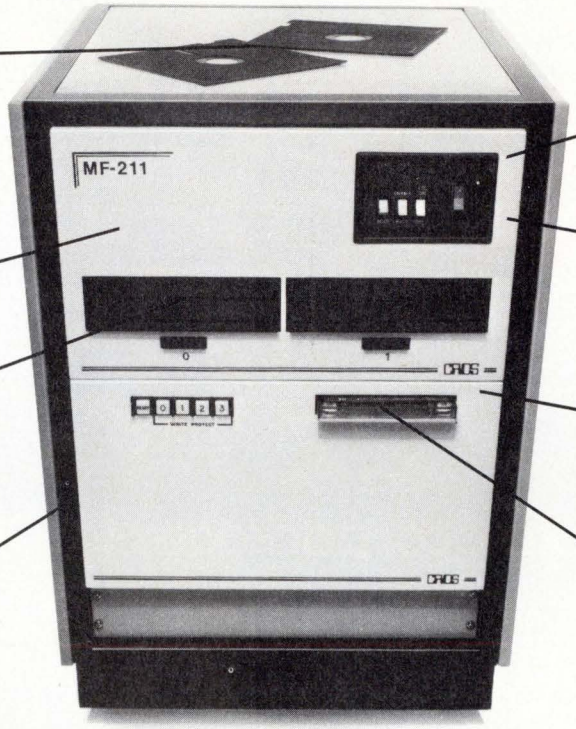

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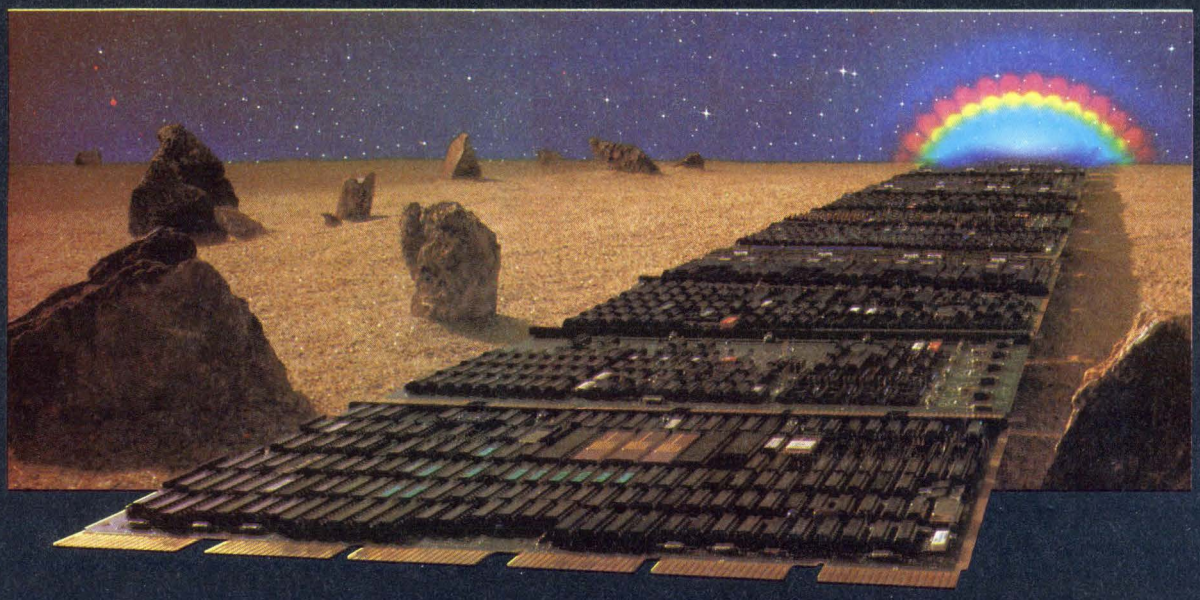
CIRCLE NO. 27 ON INQUIRY CARD

UNLEASH THE POTENTIAL



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We offer the IF-11/X.25 in two versions. One, with LAP and BSC control characters, operates up to 9.6 Kbps. Another, using LAP-B and HDLC standards, operates up to 56 Kbps.

ACC's User Mode X.29 software package is offered separately. It interfaces 32 PDP-11 terminals to our IF-11/X.25, making your message sending direct and simple.

3270 Our IF-11/3270 allows you to link a PDP-11 or VAX to one or two remote IBM 370-type mainframe computers. You can cluster up to 32 DEC VT-100 (or other ANSI-compatible) terminals with your DEC computer, or have a stand-alone configuration without it.

From a terminal, you can access the DEC processor, access either of the remote 370 mainframes, or transfer data between them. Under your control, our IF-11/3270 can switch display from normal DEC operation in an RSX environment to emulation of a standard intelligent IBM 3270 terminal.

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3780 Our IF-11/3780 attaches to your DEC PDP-11 or VAX, emulates IBM 2780 or 3780 Remote Job Entry stations, and sends data to one or two remote IBM 370-type mainframes. Since you'll transfer data to our IF-11/3780 by fast DMA, and process the 2780/3780 protocols with it, your DEC resources are virtually unaffected.

The vast array of available UNIBUS peripherals gives you great flexibility. You can input a job from a peripheral, process it on the DEC computer, then queue it for input to the 370s. Output from the 370s can be stored on disk, processed if desired, then printed or otherwise handled at your, not the system's, convenience.

U200 Link a PDP-11 or VAX to two remote Sperry Univac 1100 mainframe computers with our IF-11/U200. It enables you to cluster up to 31 DEC VT-100 display terminals or small printers with the DEC computer. Or you can cluster them in a stand-alone configuration without it.

Since protocol processing is handled by the IF-11/U200, and since computer access is on a high-speed Direct Memory Access (DMA) basis, the unburdened DEC computer continues to be available for everyday tasks.

Users at their terminals can access the PDP-11 in a normal RSX-11M environment, switch at will to a remote Univac 1100 mainframe under Uniscope 200 emulation and, when needed, can initiate data transfer between the two computers.

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March 22-25, 1982, Dallas Convention Center, Dallas, Texas

CIRCLE NO. 28 ON INQUIRY CARD

Tentative agreement would boost ailing Centronics

An agreement in principle, announced in late January, would provide Centronics Data Computer Corp. with a $25-million cash infusion and with the printer business of Computer Peripherals, Inc., a joint venture of Control Data Corp., NCR Corp. and International Computers Ltd. Published reports indicate that Robert Howard, chairman and chief executive officer at Centronics, would step down from his management position once the deal is complete, but none of the parties involved will comment on management changes stipulated in the agreement.

In exchange for the CPI printer business (with a book value of $28 million) and the $25 million, Centronics would issue approximately 4.9 million shares of its common stock to the venture partners (the company has 6.1 million shares outstanding). CDC, which holds 60 percent of CPI and would be the sole contributor of the $25 million, would end up with about 35.5 percent of the expanded Centronics and would be able to appoint three of Centronics's nine board members. NCR and ICL, each holding 20-percent shares of CPI, would each hold about 4.7 percent of Centronics.

Lawyers for all the companies were drawing up a definitive agreement as this issue went to press. Once complete, this agreement must be approved by the boards of each company and by the Centronics shareholders. Because all the boards had approved the agreement in principle, no major barriers are expected on that front. As for the Centronics shareholders, "They should be overjoyed," says William Easterbrook, an analyst with Kidder, Peabody & Co., Inc. "I imagine they would have thought they were at the brink of bankruptcy unless they got such a deal."

Centronics has suffered from management turnover and poor profitability for some time. The Hudson, N.H., firm, which has had three presidents in as many years, posted a net loss of $24.5 million on revenues of $123.9 million for the year ended June 30, 1981. The profitability picture improved somewhat during the first quarter ending September 30, 1981, however, when Centronics lost $2.7 million on revenues of $29 million.

Despite the bleak profitability background, the three investor companies think the cash and CPI's printer line can turn Centronics around. "We're always concerned about investing in something that on the surface does not appear to be a successful business concern," says William F. Buster, senior vice president for the development and production group at NCR and a CPI board member. "If we had been concerned to the point that we did not think the Centronics problems could be turned around and the company made successful, we would not have participated."

Kidder, Peabody's Easterbrook speculates that CDC also would not have made the agreement until there was little danger of adverse effects to its own profitability. "I would expect to see at least a break-even operation straightaway from the new Centronics, and possibly something better than that," he says.

To assure itself that the expanded Centronics will be properly managed, CDC will most likely appoint a new Centronics chief executive officer, Easterbrook believes. He says he's 99-percent sure this post will be filled by Thomas Kamp, president of CDC's Peripheral Products division. "Kamp is well-rounded, seasoned and did a good job for CDC," Easterbrook says. The companies involved, however, refuse to comment on this appointment, or how the agreement would affect either Howard or John Tincler, Centronics president.

Adding CPI's printer business to Centronics's would provide better economies of scale for printer production and would give Centronics a much broader product line, Easterbrook says. CPI, which did about $100 million in revenue selling to its three owners last year, produces 300- to 1200-lpm band printers and 1200- to 2000-lpm train printers. Some product overlap exists because Centronics markets 300- and 600-lpm band printers.

NCR's Buster says the CPI band printers are both cost and performance effective, whereas, "The higher performance Centronics product lines are relatively obsolete and are not profitable for Centronics." However, Jeffery Weinstein, vice president and general counsel of Centronics, says the company does not plan to discontinue any of its band products. "CPI's (low-range) products are complementary with ours, even though they do have the same speed range," he says.

The venture partners say the combined strength of the low-end Centronics matrix printers and the higher speed CPI line printers make the proposed agreement attractive. Buster sums up by noting, "We, as any other large company with a diverse product line, have to have a full range of printer products."

This is also the rationale at England's ICL, which already buys some Centronics matrix printers. In May, 1980, however, ICL entered a contract with France's Societe Nouvelle Logabax to buy at least $20 million of that company's 100-cps matrix printers. Because

that contract is still in effect, it's unclear how much business ICL could give the expanded Centronics. ICL already buys 300- and 600-lpm printers from CPI, and it's assumed the merged companies would continue to supply ICL with these units.

Weinstein says a date has not yet been set for Centronics shareholders to vote on the final agreement, but he expects the process to be completed by April. He doesn't expect any drastic changes in the Centronics sales force or methods of distribution if the agreement is finalized. "Our emphasis has always been in the OEM and distributor markets and in the end-user market, both in the line-printer business and the matrix-printer business. So this arrangement would fit in well with the planned strategy that we've had for some time now."

If the arrangement is approved, 950 of CPI's employees at plants in Rochester, Mich., and Stevenage, England, would become Centronics employees. A CPI plant in Valley Forge, Pa., that produces magnetic-tape and card products would not be affected by the arrangement.

—Dwight B. Davis, with contributions by Keith Jones

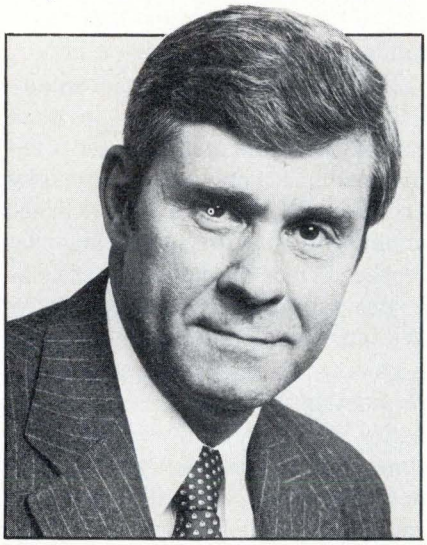
Prime's Henson redirects office automation, communications

Prime Computer Inc. is beginning to show the imprint of its recently named president, Joseph M. Henson. Henson, an ex-IBM executive named to the Prime post in December, has indicated that several of the corporate strategies undertaken during the reign of Kenneth Fisher will be redirected or abandoned. Henson came to Prime following a five-month search, during which the company had an interim acting president after Fisher's abrupt resignation in July, 1981.

Uncertainty arose in the financial community after the departure of Fisher following rumored, but unconfirmed, disagreements between Fisher and the company's chairman David Dunn.

Some actions taken by Henson that appear to reverse Fisher's moves include a decision to reconsider backward integration and to continue buying, rather than building, peripherals. The company is also reassessing its office-automation strategies and will add emphasis to the company's communications capabilities.

"My goal for Prime is to enhance and capitalize on the strengths that we have and our reputation for quality in the market. We have a lot of things going for us. We're also dealing with some problems, some of which are also opportunities," Henson told a group of financial analysts at a conference entitled "The Second Industrial Revolution: Innovation Through Technology" in San Francisco in January.



Prime's new president Joseph M. Henson: *"My goal for Prime is to capitalize on the strengths that we have and our reputation for quality in the market."*

The company has continued to outperform previous fiscal results. In the latest reported quarter (the fourth quarter, ended Dec. 31, 1981), Prime showed an earnings increase of 4.4 percent to $10.4 million, or 35¢ a share, as compared to $10 million, or 33¢ a share for the comparable quarter a year earlier. Revenues were up 17 percent to $99.6 million compared to $85.3 million a year earlier. For the fiscal year, the company reported a net of $36.6 million or $1.25 a share, which was up 21 percent from the $31.2 million, or $1.07 a share for 1980. Revenues were $364.7 million, which represented a 36.3-percent gain over the $267.6 million of the previous year. This quarter (the company's first quarter) also appears promising.

"There is a dichotomy as we look at the first part of 1982," Henson said at the conference. "We read of a slowing down of the economy and yet the forecast for the first quarter of 1982 is the best we have had in terms of business volumes, and the outlook is very favorable."

J. Terence Carleton, an analyst with Kidder, Peabody and Co., estimates that Prime will show a net income of $11.2 million or 36¢ a share on revenues of $105 million for the company's first fiscal quarter.

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CIRCLE NO. 29 ON INQUIRY CARD

has enjoyed a prominent position in the 32-bit superminicomputer market, which is projected to show continued fast growth. Research firm International Resource Development Inc. estimates that 2000 32-bit minicomputers were shipped in 1981 with a total value of $300 million. The number of units shipped will increase to 4400 with a total value of $660 million by 1983, according to the firm. Competition however, in the 32-bit market, is also increasing.

Henson cited several reasons for his optimism about Prime's continued success in the 32-bit market. He said the company will continue to expand its market geographically while increasing the number of salesmen in the field. In addition, there will be greater concentration on penetrating large accounts. The company recently received an order from the Pitney Bowes Corp. for 107 systems, 30 of which have been installed with the remainder due before year-end, Henson said. Prime will also increase its end-user market and develop more third-party affiliations, he said.

"We're going to be increasingly examining connections with resellers and other vehicles for acquiring application code, which we hope to acquire on a proprietary basis," Henson said.

Henson has also initiated new order-flow procedures that will see the salesmen running "12 30-day races instead of four 90-day races," he said.

If the order flow can be smoothed, he said, the company will have "the manufacturing capacity to double and perhaps triple volume without significantly adding to fixed assets."

The company is also reexamining how it addresses several of its markets. "We have an office-automation package, and we have more than 100 users," Henson said. "We have some highly satisfied users and some not as well satisfied. We encountered some technical stability problems, and we are busy at work back in our labs correcting those software deficiencies. Meanwhile, we are revisiting the long-range office-automation strategy."

Henson also noted that the company should "focus on areas that are most complementary to our core hardware and software technologies —electronic filing and electronic-mail distribution—that capitalize on our communications and networking capabilities." In discussing Prime's future, he added, "We may reach the decision that connectivity to word processors from companies such as International Business Machines Corp., Wang Laboratories, Inc., Digital Equipment Corp. and Xerox Corp. is the way for us to be involved in office automation without entering the word-processing-station business."

—Eric Lundquist

BOX SCORE OF EARNINGS

This table, which appears every month, lists the revenues, net earnings and earnings per share in the periods indicated for companies in the computer industry and computer-related industries.

Company	Period		Revenues	Earnings	EpS
Alpha Microsystems	9 mos	11/30/81	19,278,950	944,286	.41
	9 mos	11/30/80	15,532,620	833,847	.47
Advanced Micro Devices	9 mos	12/27/81	206,384,000	5,836,000	.36
	9 mos	12/28/80	229,073,000	19,507,000	1.23
Analogic	year	7/31/81	82,860,660	8,797,265	1.07
	year	7/31/80	67,010,421	6,029,896	.88
Astrocom	9 mos	9/30/81	3,659,470	(60,725)	(.05)
	9 mos	9/30/80	2,996,791	(437,858)	(.34)
Burroughs	12 mos	12/31/81	3,405,428,000	148,926,000	3.58
	12 mos	12/31/80	2,902,356,000	81,972,000	1.99
Cipher Data Products	6 mos	12/31/81	19,608,000	765,000	.23
	6 mos	12/31/80	9,186,000	(247,000)	(.09)
Data General	12 weeks	12/19/81	183,500,000	14,900,000	1.40
	12 weeks	12/20/80	156,000,000	13,800,000	1.29
Harris	6 mos	12/25/81	818,876,000	43,633,000	1.40
	6 mos	12/26/80	734,195,000	54,949,000	1.79
Honeywell	12 mos	12/31/81	5,351,200,000	259,300,000	11.38
	12 mos	12/31/80	4,924,700,000	288,900,000	12.92
Intel	year	12/31/81	788,676,000	27,359,000	.61
	year	12/31/80	854,561,000	96,741,000	2.21
Lear Siegler	3 mos	12/31/81	361,718,000	19,470,000	1.18
	3 mos	12/31/80	379,230,000	19,048,000	1.19
Monolithic Memories	12 weeks	12/20/81	13,385,000	183,000	.03
	12 weeks	12/21/80	21,920,000	2,734,000	.42
NCR	12 mos	12/31/81	3,432,701,000	208,234,000	7.72
	12 mos	12/31/80	3,332,370,000	254,686,000	9.51
Ramtek	6 mos	12/31/81	21,089,000	15,211,000	.45
	6 mos	12/31/80	1,187,000	940,000	.35
Scan-Data	9 mos	9/30/81	9,314,143	(2,583,723)	(1.02)
	9 mos	9/30/80	10,301,494	(1,706,281)	(.77)
Software AG Systems Group	6 mos	11/30/81	11,082,000	1,022,000	.17
	6 mos	11/30/80	9,216,000	1,468,000	.32
STSC	3 mos	11/30/81	7,255,000	(216,000)	(.10)
	3 mos	11/30/80	6,787,000	(317,000)	.18
Sykes	9 mos	11/30/81	31,744,651	5,921,944	.47
	9 mos	11/30/80	15,780,074	1,995,090	.18
Timeplex	6 mos	12/31/81	15,027,000	527,000	.13
	6 mos	12/31/80	13,456,000	1,067,000	.29

New VISUAL 300. Now let's compare flexibility and price.

Before you buy one more video terminal compare the new VISUAL 300.

The microprocessor-based VISUAL 300 combines a highly comprehensive command set with traditional VISUAL ergonomic design. The result is a terminal built for flexibility and superior productivity. And at surprisingly low prices.

Of the terminals in its class only VISUAL 300 offers so many standard features including:

- Flexible block mode transmission parameters
- Programmable non-volatile function keys
- Split screen
- Full editing
- 12″ or 14″ non-glare screen
- Non-volatile set-up modes for selection of terminal parameters, eliminating cumbersome switches.

Call for full details on the VISUAL 300 . . . the new standard of comparison for video terminals.

Service available in principal cities through Sorbus Service Division of Management Assistance Inc.

AN APPLES-TO-APPLES COMPARISON OF FEATURES.

	VISUAL 300	TeleVideo® 950
ANSI X3.64 Specified	STD	NO
Block and Character Transmit	STD	STD
Solid State Keyboard	STD	NO
Programmable Non-Volatile Function Keys	STD	NO
Video Attributes Require No Display Space	STD	NO
Non Glare Screen	STD	STD
Smooth Scroll, Slow Scroll and Jump Scroll	STD	NO
Audible Key Click	STD	STD
Non Volatile Set-up Modes, "Menu" Style	STD	NO
25 Status Line	STD	STD
Split Screen	STD	STD
Line Drawing Character Set	STD	STD
Block Graphics	STD	NO
Sculptured Keycaps, Matted for Low Glare	STD	NO
Paging	OPT-8 Pgs.	OPT-4 Pgs.
Full Editing	STD	STD
Programmable Non Volatile Columnar Tabbing	STD	NO
Choice of Typomatic/Non Typomatic Keyboard	STD	NO
14″ Screen	OPT	NO
Independent Xmit/Receive Rates	OPT	NO
N-Key Rollover	STD	NO
CR New Line Mode	STD	NO
Foreign Character Sets	OPT	NO
User Programmable Non-Volatile Answerback, 32 Codes	STD	NO
Screen Brightness Control from Keyboard	STD	NO
XON/XOFF Flow Control, Split for Xmitter and Receiver	STD	NO

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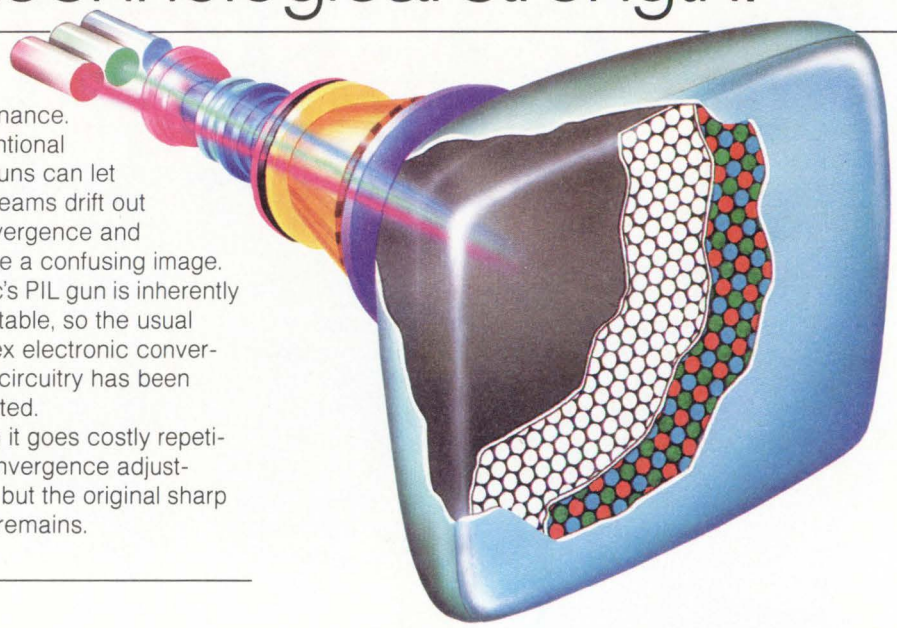
CIRCLE NO. 30 ON INQUIRY CARD

CONRAC SERIES 7211.

A display of technological strength.



No other display performs like the high-resolution Conrac 7211 because no other display is built like it. Simply put, this Conrac monitor can give you and your system a technological edge.

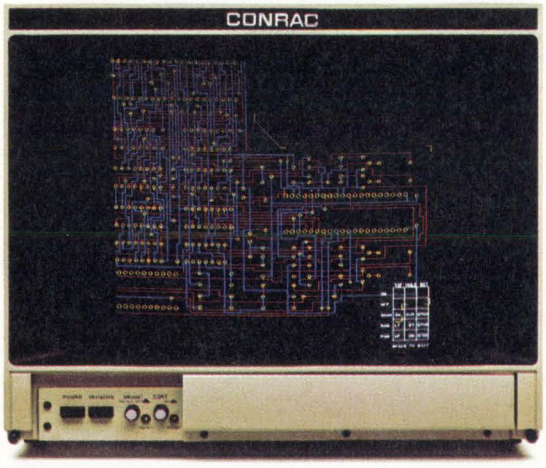
Conrac's Precision In-Line Gun: For a clear picture with color convergence locked in. Conrac's Precision In-Line Gun hits your targets for easy setup and minimal maintenance. Conventional delta guns can let color beams drift out of convergence and produce a confusing image. Conrac's PIL gun is inherently more stable, so the usual complex electronic convergence circuitry has been eliminated.

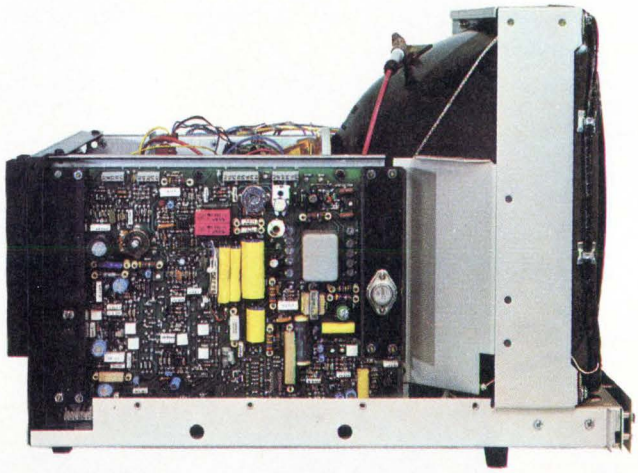
With it goes costly repetitive convergence adjustments, but the original sharp image remains.

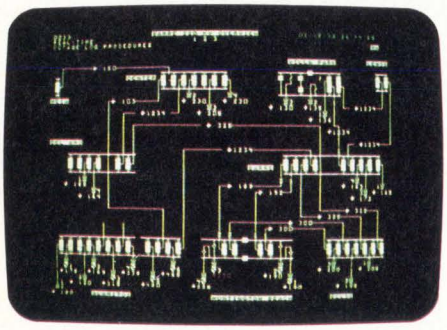
Form factor: The practical side of Conrac displays. Space savings speed system integration. Besides 17.5″ and 15.75″ standard front panel heights, the 7211 is available with no front panel and remote controls, reducing front height to 14 inches.

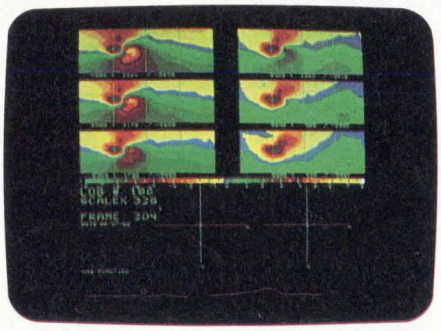
Its low-profile design is ideal for tapered cabinets. And to fit into your manufacturing plans, you can order the 7211 in 13″ and 19″ models, in cabinet, chassis-only, and rack-slide versions.

See how the 7211 can improve your image. CAD/CAM, process control, image processing — any application can benefit from the finer quality graphics you see on a 7211.

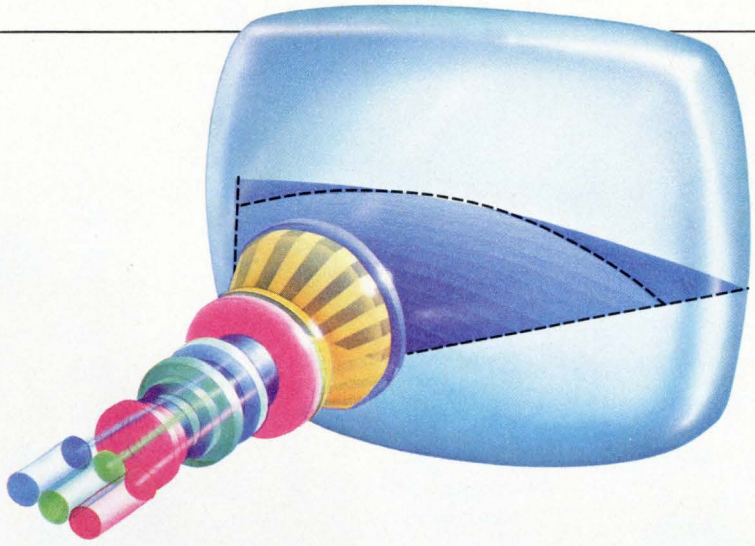




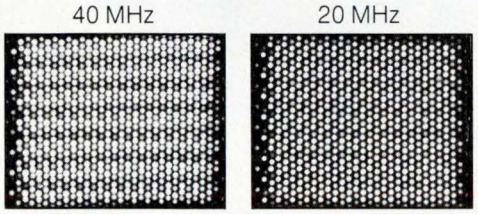




CONRAC

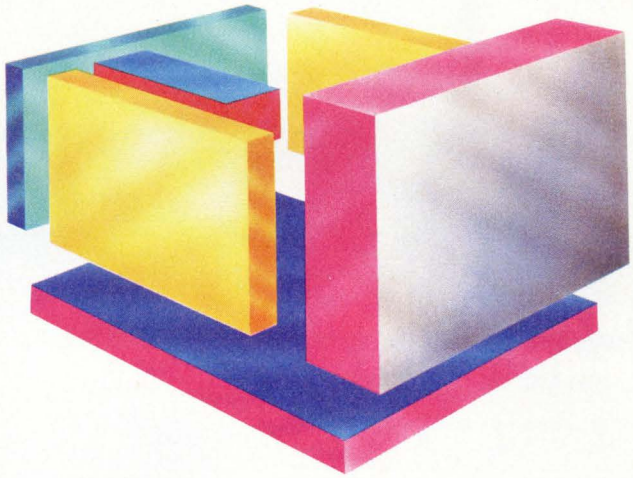


Dynamic focus: Clearly a Conrac edge.
This Conrac strong point assures center-to-edge image focus for ultimate clarity. Simpler display designs pretend the tube's screen is a concentric circle, with an equal radius from center to edge. The Conrac gun automatically compensates for the different gun-to-screen distances that are actually found in modern tubes. The end product is a consistently sharp image across the entire screen.

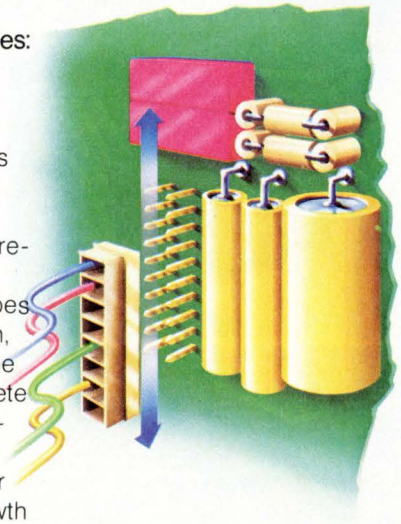


A wideband video amplifier: Conrac's dedication to detail.
The 7211 has twice the usual video amp bandwidth, reaching up to 40 MHz (-3 db). This capability means you can easily accommodate deflection rates from 64 down to 27 μsec. Result: you get all the performance you've built into your system onto the screen. No more problems with soft edges, poor resolution, and the resulting operator fatigue. Even 8-bit microprocessors can benefit from this enhanced image quality.

Modular electronics: No one gets rich servicing Conrac monitors.
Our modular electronics speed field maintenance. Just trace the problem to the circuit card or module level, remove the old PCB card, then plug in a new one. Less hardwiring in our display means less hard work for your technicians.



Selectable scan frequencies: Conrac put in a plug for economy and flexibility.
The 7211 will operate at all horizontal scan frequencies from 15 kHz to 36 kHz — in one convenient package. You select between three preset ranges by changing a jumper plug. Fine tuning does the rest. With this approach, you order and inventory one CRT display for this complete range of scanning frequencies. The 7211 selectable scan frequencies also offer the end user a built-in growth path to higher system capabilities.



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DG offers second supermini operating system

Data General Corp. has added a second operating system aimed at real-time processing and high-throughput dedicated operations to its MV family of 32-bit Eclipse computers.

Advanced Operating System/ Real-Time 32-bit (AOS/RT32) joins the current Advanced Operating System/Virtual Storage (AOS/VS) operating system.

The two operating systems are compatible. AOS/RT32 is a memory-resident subset of AOS/VS and uses only the subsystems needed to support real-time applications. Programs operating on AOS/RT32 are written and tested under AOS/VS and allow applications to be written in DG's 32-bit languages, including FORTRAN 77, PL/1, DG/L and Macroassembler. AOS/RT32 requires an Eclipse MV system with at least 256K bytes of memory, a CRT console and a system magnetic-tape boot device. DG officials claim they are one of the only firms offering a 32-bit real-time operating system and a compatible general-purpose operating system for the same computer. Christine Wallis, manager of software planning and support at the company's Technical Products Division, says that, while AOS/VS is aimed at interactive environments having multiple terminals, AOS/RT32 is aimed at dedicated or control environments in which a system must respond rapidly to external events. Applications suited to real-time operating systems include CAD/CAM, automated test equipment, process control and data acquisition, Wallis says.

Wallis expects the system to be attractive to OEMs who want the power 32-bit systems can offer but without compromising the performance of their previous real-time systems. A real-time operating system provides rapid task and process context switching and fast response to high-priority events such as user device interrupts. The high throughput is a result of the rapid processing of critical system calls.

Speed and performance comparisons between programs running under AOS/VS and AOS/RT32 are difficult because of the different nature of the applications that would run under the operating systems, DG officials say. Under AOS/RT32, average task-rescheduling time is less than 500 μsec., and average interrupt latency is less than 100 μsec.

AOS/RT32 is an embedded operating system, which means that the memory contains only one physical copy of the AOS/RT32. The system uses a ring-oriented architecture, with the system residing in the innermost ring (ring 0) and the user in the outermost ring (ring 7). The user cannot access the system except as provided by the system itself.

The real-time operating system supports as many as 64 parallel processes, each with as many as 32 tasks on the appropriate hardware configuration. Each task or independent execution path within a process shares an address space with all other tasks in the process. Tasks can execute independently or interact using task calls for execution control, communication and synchronization.

AOS/RT32 is priced with or without disk support. The operating system is available now with delivery set at 90 days after receipt of order.

For the operating system without disk support the initial license fee is $5000, and subsequent license fees are $3000. The minimum equipment configuration to support the operating system without the disk includes an MV computer with at least 256K bytes of memory, a dual-mode or streaming-tape drive and a CRT or hard-copy terminal.

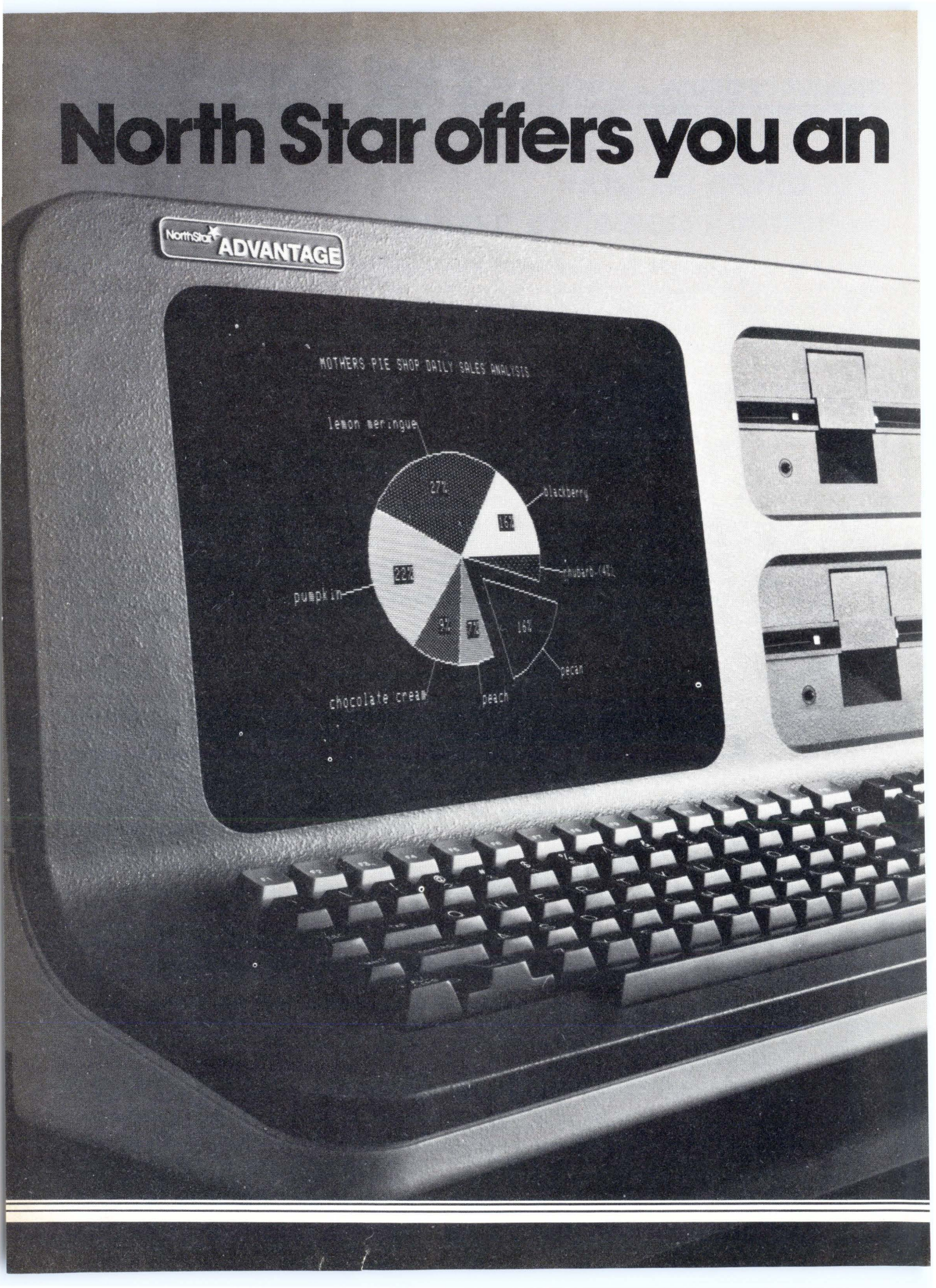
The system with disk support carries an initial license fee of $5500 and a subsequent license fee of $3500. The minimum configuration to support the system with a disk includes an MV computer, a 256K-byte memory, a 50M-byte disk, a removable hard disk or a dual-mode or streaming tape drive and a CRT or hard-copy terminal. DG's AOS/VS operating system carries an initial price of $13,000 and a subsequent fee of $3900. *—Eric Lundquist*

Companies pave way for Winchester LSI-11 market

In moves that could signal the beginning of a large potential market for Seagate Technology's ST-506 interface, a pair of Southern California controller houses have introduced 5¼-in. disk controllers and subsystems that emulate Digital Equipment Corp.'s 3330-1-technology 14-in., 5.2M-byte RL01 or 10.4M-byte RL02 disk-cartridge drives.

Distributed Logic Corp., Garden Grove, Calif., has introduced its model DQ 604 quad-board Winchester controller. The offering interfaces two Seagate or Seagate-compatible 5¼-in., 6M-byte ST-506 drives and is designed for use with DEC

North Star offers you an



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The ADVANTAGE is fully CP/M® compatible. Neither IBM nor Apple provides this ability to run the broadest range of industry-standard applications. In addition, only North Star offers 10 application packages for word processing, financial analysis, accounting and data base management.

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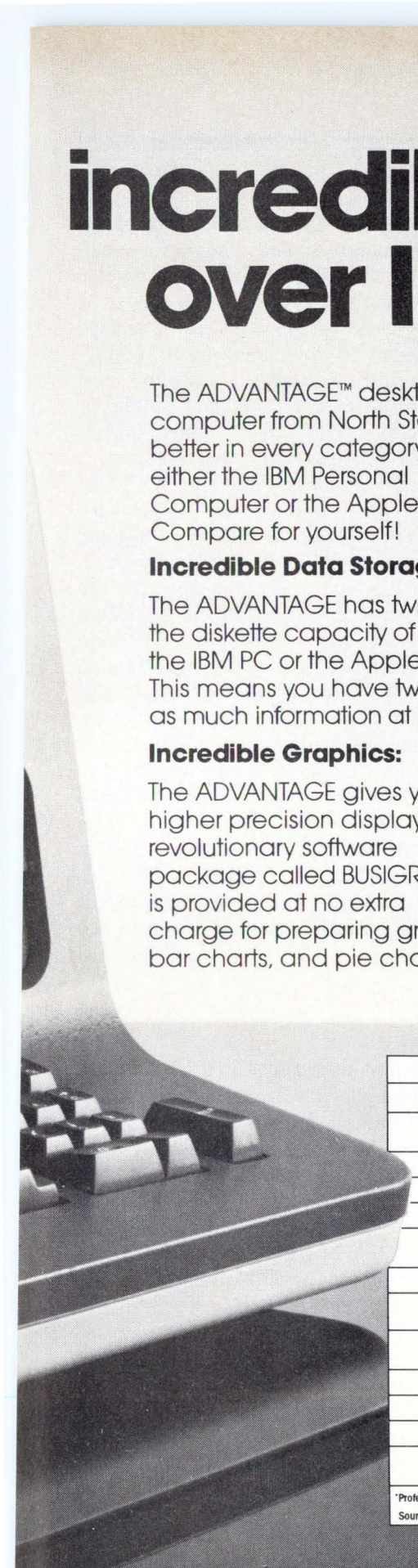

THE INCREDIBLE ADVANTAGE COMPUTER COMPARISON CHART*

	NORTH STAR ADVANTAGE	IBM PERSONAL COMPUTER	APPLE III
MICROPROCESSOR(S)	Z-80A Central processor 8035 Auxiliary processor	8088 processor	6502A processor
GRAPHICS DISPLAY RESOLUTION	640 x 240 pixels	640 x 200 pixels	560 x 192 pixels
DUAL FLOPPY DISC CAPACITY	720K bytes	320K bytes	280K bytes
CONVENIENT DESKTOP PACKAGE*	Yes, all in one enclosure	No, 3 enclosures	No, 3 enclosures
BUSINESS GRAPHICS SOFTWARE INCLUDED?	Yes	No	No
CP/M COMPATIBLE?	Yes	Partial	No
LANGUAGES SUPPLIED BY MANUFACTURER	Graphics BASIC, PASCAL, COBOL, FORTRAN, C	BASIC, PASCAL	BASIC, PASCAL
APPLICATIONS S/W PACKAGES SUPPLIED BY MANUFACTURER	10 packages	5 packages	5 packages
SELF-TEST DIAGNOSTIC	Yes	Yes	No
NATIONAL ON SITE SERVICE	Yes	No	No
MANUFACTURER SUPPLIED PRINTERS	Letter quality/matrix (136 columns)	Matrix (80 columns)	Letter quality/matrix (80 columns)
RETAIL PRICE PER KILO-BYTE OF DISK STORAGE	$5.55	$11.17	$15.57

*Professional configuration: Dual Floppy Disks, Monochrome Display, Keyboard, CPU, 64K bytes (or minimum) RAM Memory, and Printer Interface.

Source: Dataquest and Manufacturer's Literature, November 1981.

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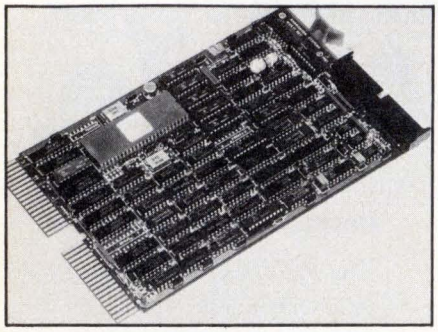
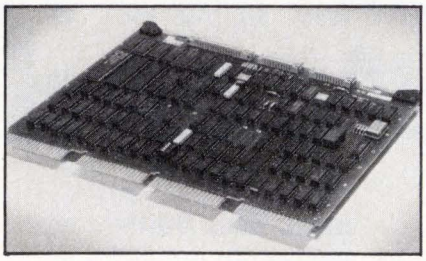


Andromeda's WDC-11C dual-width controller *allows Winchesters to emulate DEC's RK05 or RL01/2 drives and floppies to emulate RX02 drives.*

Q-bus-based LSI-11, -11/2 or -11/23 μcs. The controller board, based on an Advanced Micro Devices dual 2901 bit-slice μp plugs, into a Q-bus slot and operates under DEC's RT-11 operating systems using standard RL01/RL02 drivers.

Also included is an on-board multiple-device hardware bootstrap, a full-sector data buffer and a microdiagnostic self-test card. For $2050, a customer receives a PC-board assembly, a user manual and diagnostics on magnetic tape or floppy disk. Integration and cabling are extra.



Dilog's DQ 604 quad-board Winchester controller *interfaces two Seagate ST-506-or ST-512-compatible drives to DEC LSI-11, -11/2 or -11/23-based systems.*

A similar offering from Canoga Park, Calif., Andromeda Systems emulates DEC subsystems. As the WDC-11C, the dual-width controller board allows emulation of DEC's 2.4M-byte, 5¼-in. RK05 or 14-in. RL01/2 Winchester-disk drives. The device also emulates DEC's 5M-byte RX02 floppy disks. Based on a Signetics 8X300 μp, the Andromeda offering also provides an on-board ROM boot for system initialization. The module plugs directly into the Q-bus backplane of an LSI-11, and is compatible with DEC operating systems.

The WDC-11C supports Seagate's 5¼-in. ST-506, Quantum Corp.'s 10M- to 30M-byte, 8-in. Q2000 series Winchesters and Shugart Associates 5M- and 10M-byte 8-in. SA1000 series Winchesters. The device is also compatible with any standard single- or double-sided 8-in. floppy, including Shugart's SA800 and SA850, and any standard single- or double-sided 5¼-in. floppy, including Tandon Corp.'s TM100 series.

As a subsystem, the WDC-11C, designated the Mini Winchester Disk System 5, offers a Tandon Magnetics 0.5M-byte floppy at a single-unit price of $4050. As the MWDS-5/.5 subsystem, it includes a Texas Instruments Inc. 5M-byte Winchester and a 0.5M-byte Tandon floppy for $5160 in single-unit quantities. The MWDS-12.5/.5 includes a 12.5M-byte Winchester from Computer Memories Inc. and a 0.5M-byte Tandon floppy for $6660 in single-unit quantities. The WDC-11C controller sells for $2000 in single-unit quantities. Deliveries have begun, and Andromeda says it has an order backlog of 400 to 500 units. —*Nancy Love*

CRT controller chip set may reduce display prices

Just when it looked as if the prices of video-display terminals couldn't get any lower, a new CRT controller chip set from Signetics Corp. may drop prices further while adding to the hardware's capabilities.

The Sunnyvale, Calif., semiconductor maker's four-chip set includes the SC2670 display and graphics controller, the SC2671 keyboard and communications controller, the SC2672 programmable video-timing controller and the SC2673 video-attributes controller. Signetics officials say the devices are the first full implementation of a CRT controller in LSI. Further, the company claims that the four devices will cut in half the number of ICs needed to build a μc-based video-display terminal.

In quantities of 100, the four components are priced at less than $58. Using the four parts, Signetics believes, a complete controller for a low-end display can be built with fewer than 15 devices. The company compares this to other CRT controller chips that, in some cases, require as many as 40 other components.

Competition for the Signetics chips is expected from National Semiconductor Corp.'s DP8350, Intel Corp.'s 8275 and 8276 and Standard Microsystems Corp.'s 5027. A source at National says that an 8350-based display controller can be designed with about a dozen parts. However, he adds that Signetics's approach could have an advantage over National's in the area of video attributes.

The Signetics chip set includes smooth-scroll, thin-line and block graphics; interlaced and non-interlaced operation; variable cursor types; composite or separate sync; reverse video; highlighting; underlining; and four roll-over modes. The chip set also implements split screen in hardware. Additionally, the devices permit double-height character rows, partial screen scrolling and multiple

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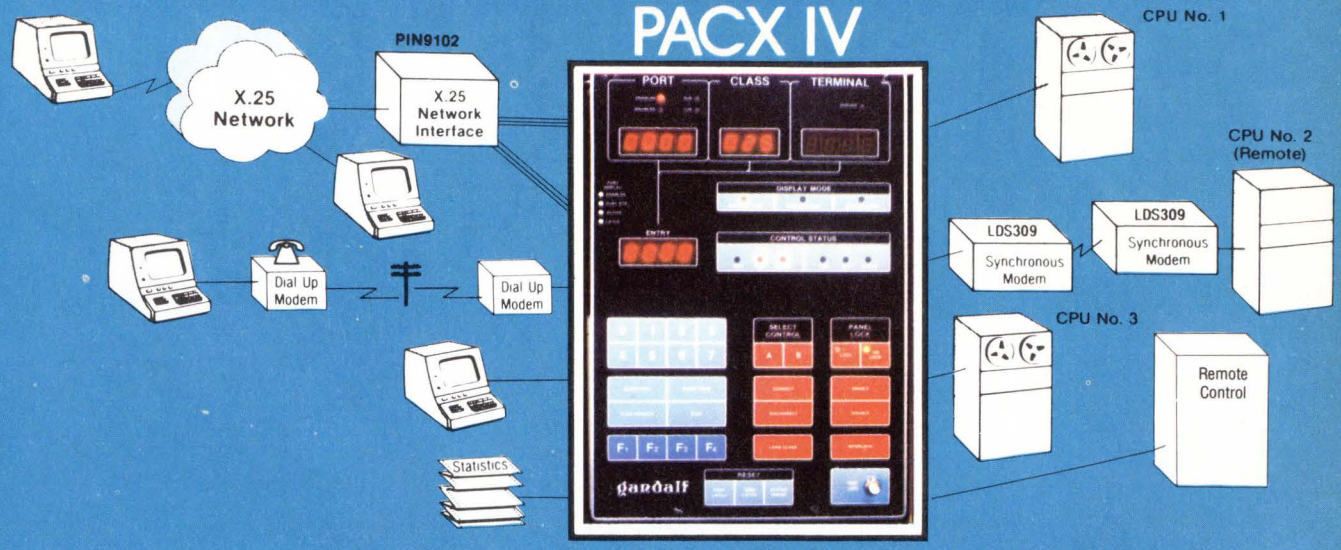

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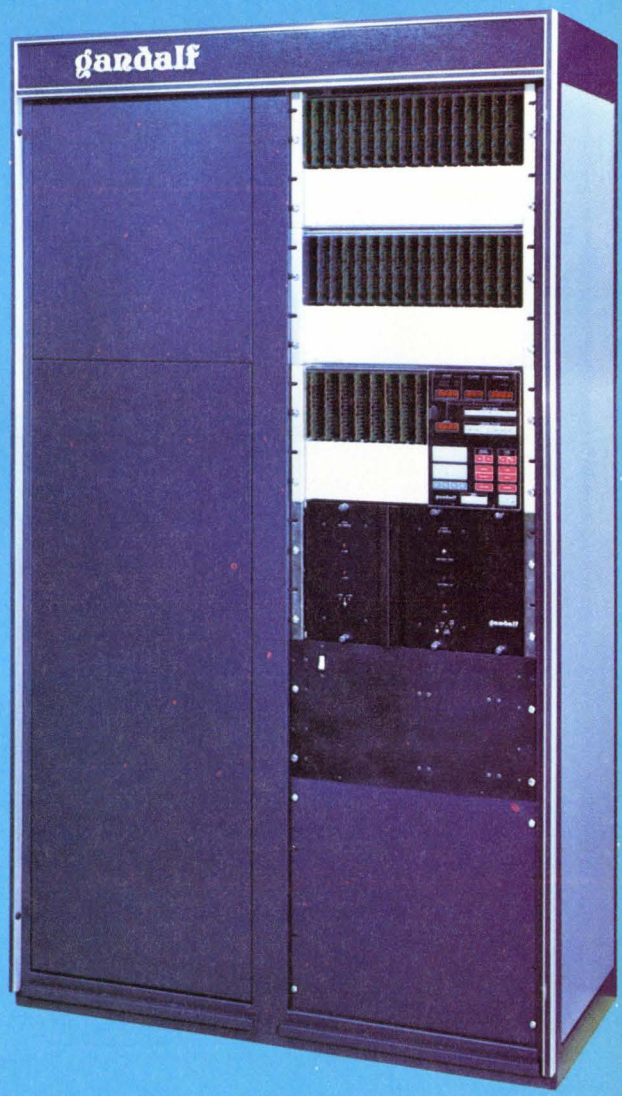

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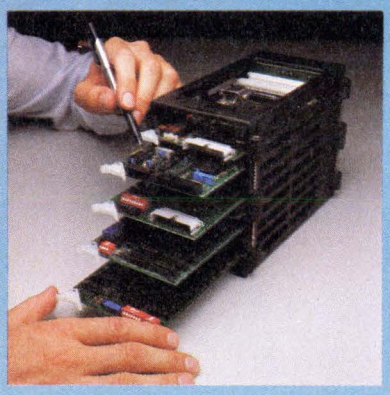

To further reduce your RM 65 investment, Rockwell also offers several economical development systems, including one based on our AIM 65 Microcomputer. With a price tag typically under $1,500, an AIM 65-based system is feature-for-feature the lowest cost development tool available for any board-level microcomputer product line.

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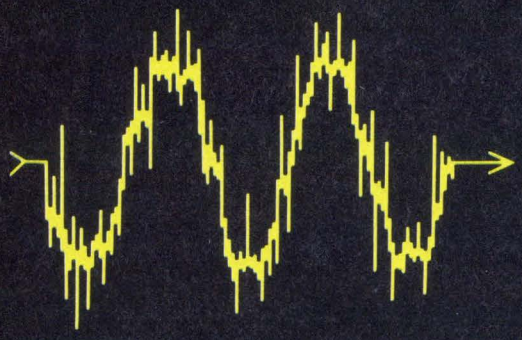

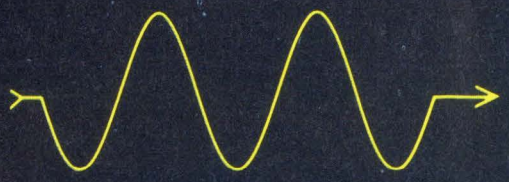

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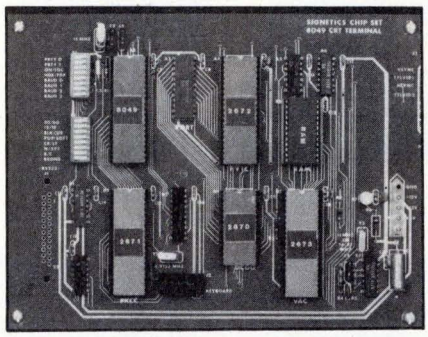
page buffers. Signetics plans to extend the chip set this year to include components for a full-color display.

What effect the devices will have on the price of finished video displays isn't clear. Alex Goldberger, Signetics's application manager for the μp division, doesn't think the impact on price will be dramatic. Price difference between Signetics's 15-chip implementation and those using more devices could be as little as $10 because of the low cost of ICs, he explains. But even a small drop in the price of goods for a display, especially at the low end, could set off a round of price cutting for finished products.



Signetics Corp.'s new four-chip set *includes the SC2670 display and graphics controller, the SC2671 keyboard and communications controller, the SC2672 programmable video-timing controller and the SC2673 video-attributes controller.*

An executive at a San Francisco Bay Area video-display maker, whose firm is evaluating the Signetics devices, is cautious about the effect of so small a drop in the cost of goods, however. He agrees with Goldberger that the impact on the price of the finished display will be slight. But he says that if his company could save $5 to $10 on a terminal, he would reevaluate the end-user price based on what the competition is doing.

The chip set is available now. Signetics is talking with several U.S. semiconductor vendors with hopes of securing an alternate source for the devices by the second quarter of this year. —*Larry Lettieri*

Media-independent network addresses μc users needs

As μc systems make rapid inroads into companies that once owned minicomputers and mainframes, the need to link the ubiquitous small computers into local-area networks (LANs) is mounting. A new company—The Desktek Group, Mountain View, Calif.—recently joined the small group of firms addressing the μc networking market. Consisting of both board- and system-level products, Destek's network interfaces are said to operate over virtually all types of communications media and, through a multiplexed interface, can bring the cost of linking components to the network to less than $230 per connected device.

Other companies selling networking equipment to μc users include Tandy Corp., Nestar Systems, Inc., and Corvus Systems, Inc. (MMS, November, 1981, p. 22). Cost per connection into these firm's networks ranges from about $400 to more than $650, and each company's interfaces support only one type of medium. John R. White, Destek's president, charges that vendors usually offer one network configuration to which all users must conform. To enable Destek customers to select from various network capabilities, the firm's products operate over baseband coaxial cable, baseband twisted-pair wire, broadband coaxial cable or phone lines. The company plans to include fiber-optic cable in those options eventually.

The Destek Group was founded in 1980 as an R & D limited partnership. As such, "shares" of the company are placed through a California brokerage firm. The limited partners essentially provide the firm with funds and contract with Destek to develop technologies. In return, the limited partners receive a percentage of sales when products are sold. Along with its main Mountain View offices, which focus on semiconductor technology, Destek operates an Acton, Mass., branch that works on networking and system software. The company will subcontract with other firms for high-volume manufacturing.

Supporting data-link rates as high as 2M bits per sec., Destek's networking products can tie virtually any μc systems at the physical and data-link levels of the International Standards Organization's networking architecture. In a multiplex configuration, the products permit different processors running different operating systems to share resources and exchange messages, White claims.

Central to Destek's network is a logic board containing an 8-bit μp CPU, PROM-based network-control software, a RAM buffer, a timer, an RS232C I/O port and a general parallel I/O port. The company's first board product, the NIB-S100 series, plugs directly into any S-100 bus, and includes baseband RG-59U coaxial cable connectors. (Companies offering S-100-based μc systems include North Star, Vector Graphics, Dynabyte and Cromemco.) Although the S-100 processor uses the direct bus connection to communicate over the network, rather than the serial or parallel I/O ports, a user can retain these ports on the NIB-S100 board to connect additional peripherals to the processor.

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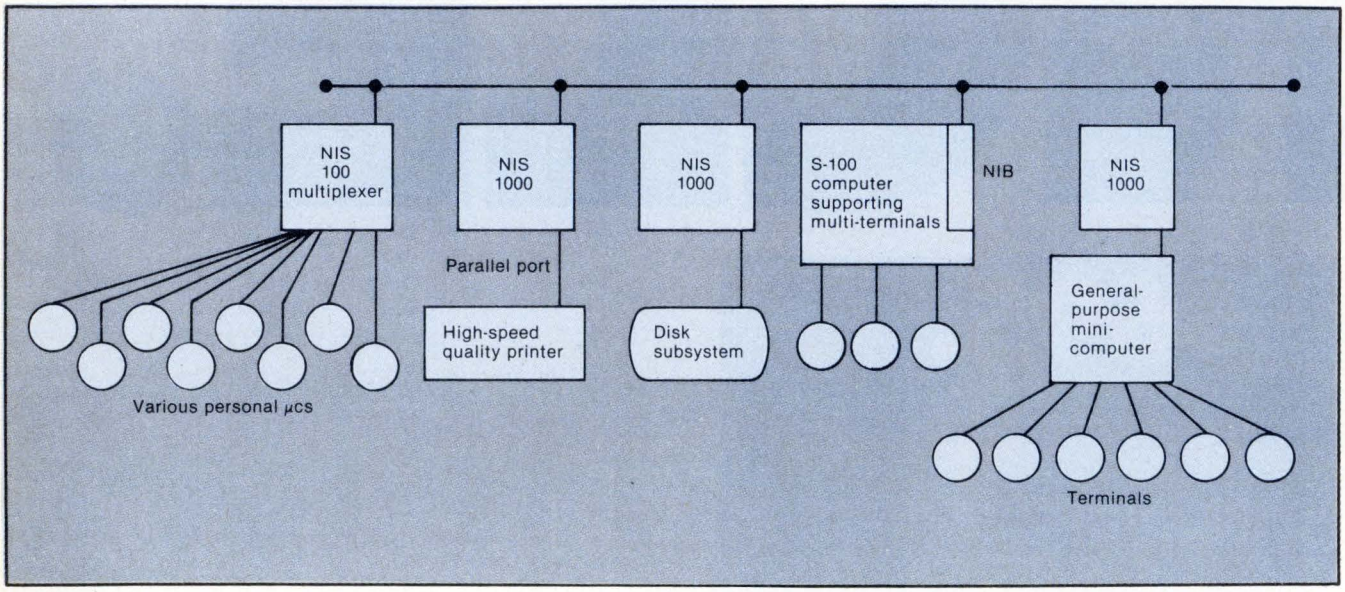

A theoretical Destek network *could combine several implementations of its interface products. Shown is a single NIB-S100 board attached directly to an S-100 processor's bus and four system-level NIS-1000 configurations—a multiplexed version supporting several systems through a single box, and three basic NIS systems providing a parallel or a serial I/O port.*

Destek plans to introduce other board-level products that will link directly to other popular μc bus architectures. But for now, owners of non-S-100 systems must link to the network through the firm's system-level products, the NIS-1000 series. In its basic configuration, the NIS-1000 consists of a module containing a network logic card—essentially the same as the NIB-S100 board—and a power supply. The processor communicates data over the network through the RS232C port on the logic board.

With a higher level version of the NIS-1000 system, users can link as many as 10 processors and/or peripherals to the network through a single box. This version contains the standard logic board with one parallel and one serial port, plus a second card consisting of eight additional serial ports. A third card, which functions as a controller for the multiplexed NIS-1000, holds a Z80 processor and RAM.

The central logic card in all of Destek's board- and system-level interface products remains essentially the same. William Northup, director of network development, says only the PROM-based logic and the media connections are likely to vary from network to network. Variations in the logic are minimal, he says, and would occur primarily to route data to and from I/O ports, depending upon the interface configuration.

The main function of the logic—network control—would remain constant in every interface, Northup says. This control handles block transfers of data from network devices, provides acknowledgement for received transmissions and supervises media access of network components. Destek's products will initially support only a carrier sense multiple access (CSMA) method, although the firm plans to include a token-access approach later. With CSMA, network devices "listen" to communications traffic in an attempt to ensure the link is clear before accessing the network.

The standard Destek products incorporate baseband coaxial connectors, which can be linked to the cable through a transceiver or, to avoid the transceiver's extra expense, can operate in a daisy-chain configuration, with the coaxial cable connected directly into and out of the interface board. Northup says this method is best suited for smaller networks of about six to 10 components.

Customers who wish to run their networks over twisted-pair baseband wires can specify such connectors for their interface boards. For users preferring broadband media, Destek offers separate boards containing RF modems and connections for single- or dual-cable systems. Another board option incorporating a 300-, 1200- or 2400-bps modem enables communications over phone lines. Finally, Destek eventually will offer connections for fiber-optic links. Northup admits μcs will probably never require the huge bandwidth promised by fiber optics, but he says some installations could require the noise immunity inherent in fiber technology.

Prices for the standard NIB-S100 board with baseband coaxial start at $795. A low-end, two-port NIS-1000 system begins at $1500; a multiplexed version with eight additional serial ports and another controller board is $2295. OEM discounts are offered for the products, which are available immediately.

—Dwight B. Davis

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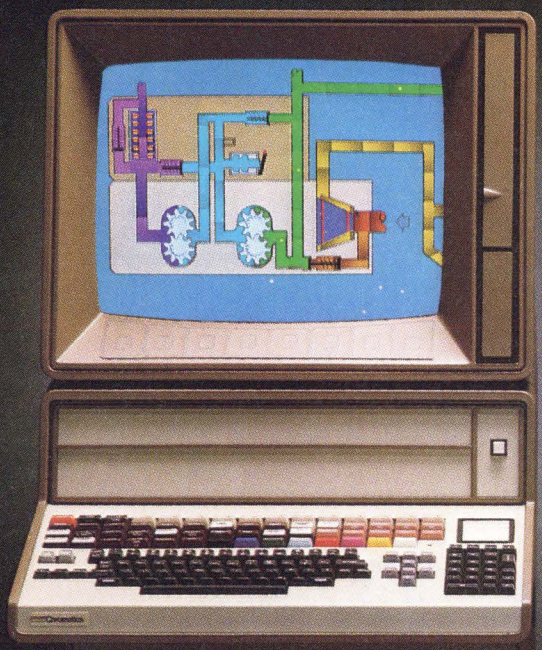

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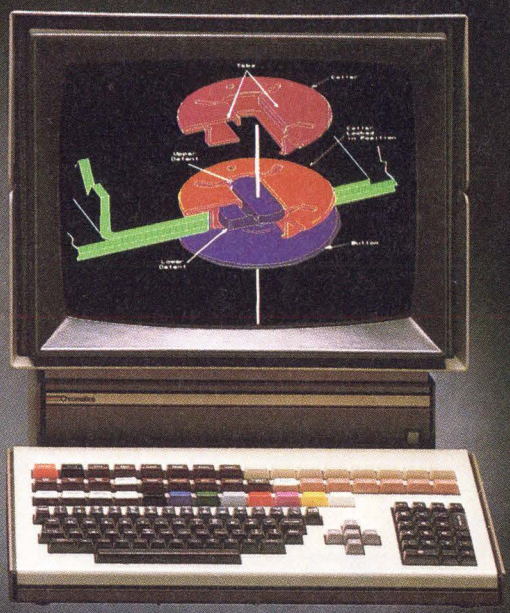

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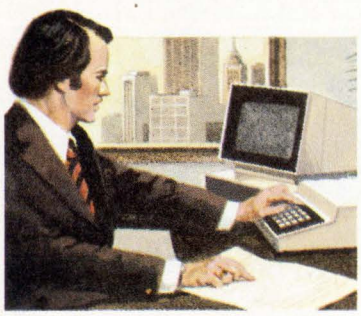

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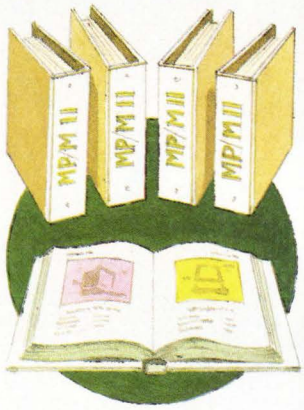

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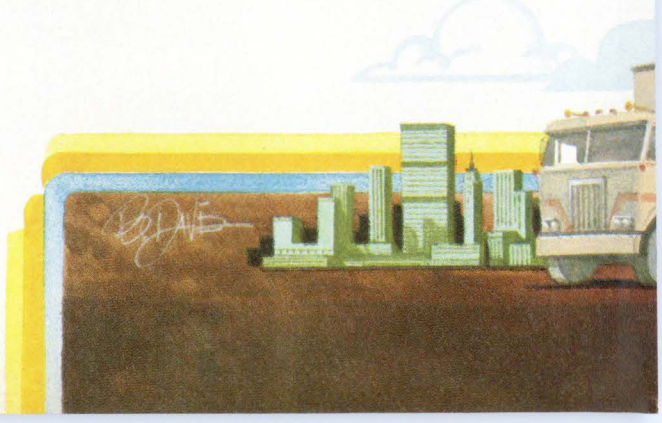

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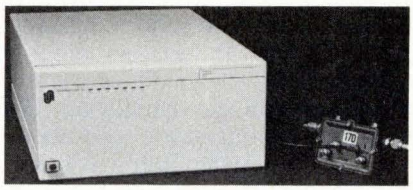
Ungermann-Bass adds broadband to Net/One

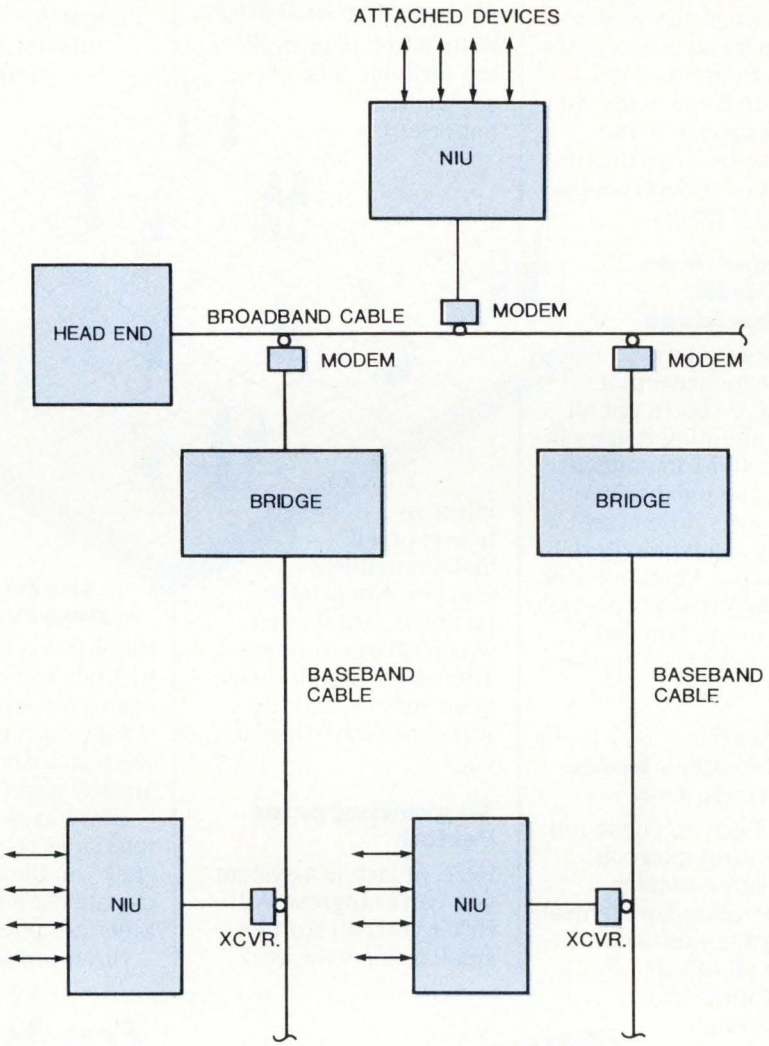


The Ungermann-Bass broadband implementation *of Net/One uses standard CATV industry components. Above is a network interface unit connected to a standard CATV tap.*

Although the Net/One local-area network developed by Ungermann-Bass, Inc., has been shipped as a single-channel baseband system since its July, 1980, introduction, the Santa Clara, Calif., company managed to avoid becoming a polarized participant in the baseband-versus-broadband debate that started about a year ago. Unlike some participants in that debate, Ungermann-Bass always believed room existed for both technologies in the market, and the firm designed its Net/One to eventually support broadband as well as baseband transmissions. This month, Ungermann-Bass has announced its first broadband products.

Because Net/One is modular in design, only two elements (aside from the cable) must be changed to convert a baseband system to a multi-channel broadband system. A small "encoder/decoder" board in the network-interface unit (NIU) is exchanged, and an RF modem replaces the baseband transceiver. The baseband and broadband configurations are functionally identical, with both hardware and software for the two systems completely compatible.

Because both systems are compatible, users can combine baseband and broadband networks in their facilities. Broadband could be used where CATV cables are already installed or where video integration is desired, and baseband could operate in applications requiring greater flexibility, lower costs and higher speeds. (A baseband Net/One can operate at 10M bits per sec., while the maximum broadband rate is 5M bps on one of five standard 6-MHz channels.)



Net/One systems use baseband or broadband *transmission media. Ungermann-Bass's bridge products allow any number of Net/One systems to be interconnected.*

The broadband configuration can function with a single mid-split cable or with dual coaxial cables, using a vestigial sideband (VSB) amplitude modulation scheme that is similar to the technique used for normal television transmission. All operating frequencies and parameters are compatible with the EIA standards for broadband local-area networks.

A single NIU can be equipped with both baseband and broadband network interfaces, permitting users to build bridges between the two types of networks. This bridging capability, along with Net/One's internetwork protocols permits easy communications between network nodes miles apart, the company says.

Ungermann-Bass offers the same selection of protocols, device interfaces and user programmability for baseband or broadband media. Because the systems are virtually identical, costs are comparable, except for the higher price of RF modems compared to baseband transceivers. First deliveries of the broadband product will begin in mid-year.

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One of a company's biggest problems can be getting the right hand to know what the left hand is doing. Now, with the HiNet Local Computer Network, you can install a computer system that puts each person in touch with what everybody else in the office is doing. It's the best way yet to get everybody working together.

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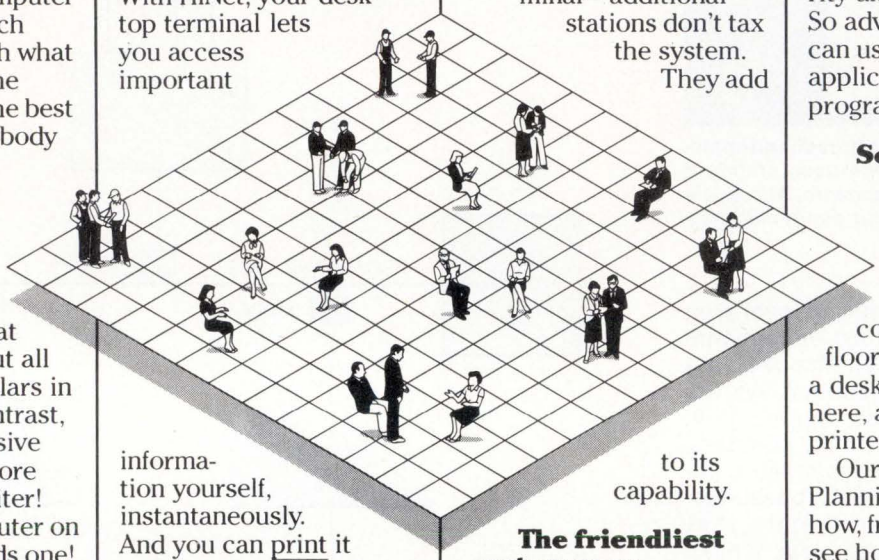

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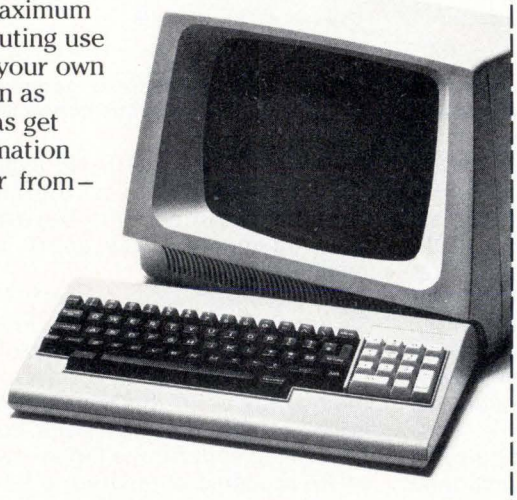

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Racal-Milgo announces token-passing network

Any communicating device with an RS232 interface can be connected to Planet, a 10M-bps token-passing ring local-area network. Planet was introduced in Europe by Racal-Milgo, Ltd. The two-cable, redundant LAN will be available to U.S. customers by sister company Racal-Milgo, Inc., but the timing of a U.S. debut is not decided. Both companies, along with Racal-Vadic, Inc., belong to the data-communications division of Racal Electronics Ltd., the billion-dollar British-owned communications conglomerate.

Development of Planet is based at the Reading, England, laboratories of Racal-Milgo, Ltd., and headed by software manager Dr. Malcolm McConachie. He lists several reasons why his company opted for a token ring approach over a bus architecture such as Ethernet, a contention baseband bus.

"A ring can be reconfigured much more easily than a bus-based LAN," McConachie declares. "On a ring, each node actively regenerates the information packet as it passes around, so the location of a break can be detected easily. In Planet, the ring can be reconfigured immediately using two cables running in parallel." A break in the ring can be bypassed, even if both cables are cut, by diverting the information packet from the first cable along the second cable so it reaches the next node on the ring the long way around. The packet can then continue around the ring along the first cable. The ability to reconfigure is a function at each node by the terminal access point (TAP), a black box that can interface one or two RS232 devices with the ring. McConachie points out that accidental breaks to LAN cables are more common than users imagine. He sees Planet's instant reconfigurability as being of greatest value in "planned-outage" situations, in which the ring must be cut to add a new node or replace equipment at an existing node. Each Planet ring accommodates as many as 512 nodes in theory, although 50 to 100 is expected to be the normal range of node populations, so node changes or additions could be frequent.

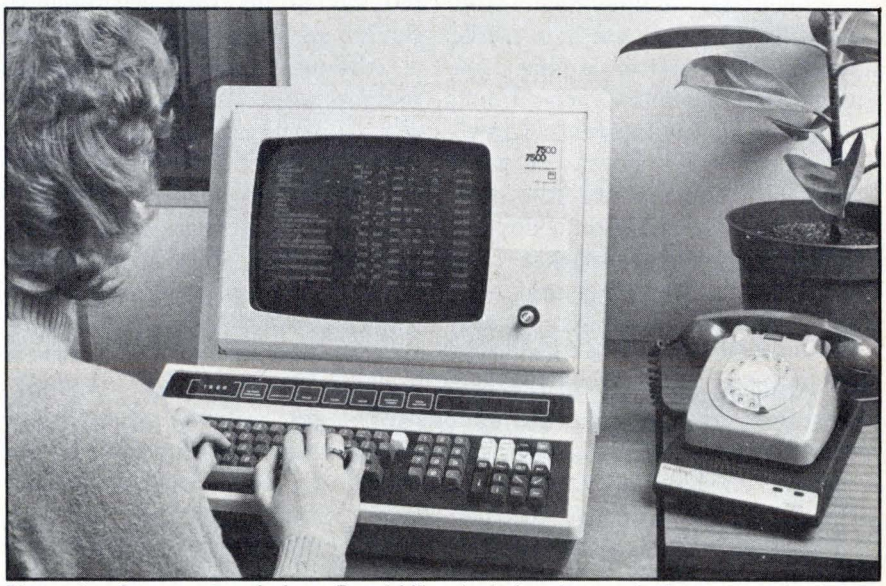
McConachie says twisted-pair wires and optical-fiber cables are feasible alternatives to coaxial cable for implementing the ring.

With a token ring, packets continuously travel around the network in one direction. When a packet is filled by a node, the token bit in the packet header is changed to "one" to indicate "full." A user can fill the packet only when the contents have been copied by the destination node and the packet has been returned to the sender. The token bit is then changed to indicate "empty." Thus, there is no contention between nodes for the network. A μp-based control terminal, or administrator, occupies one of the nodes and monitors the number of packets in the ring, thus detecting if one is lost. The administrator also checks that the token bit is empty; if not, the administrator empties it. Users must program how to retransmit.

Racal-Milgo has opted for a packet that can hold 2 bytes of user information, an optimal capacity for Planet's wide range of potential users. The packet has 7 header control bits, including the token bit, and these are followed by 16 address bits, the 16 bits of user information and three trailer-control bits. The small amount of user information compared with the size of the control information leaves only 4M bits available to the user of the 10M-bps raw data stream.

Planet's small packets minimize the buffer requirements at each node and the transit delay caused by extensive buffering.

One potential problem with ring networks is that the cable forming the ring could be the incorrect length to accommodate one or several packets traveling around



Planet local-area network *from Racal-Milgo includes the terminal access point (under telephone), which can link one or two RS232 devices to the other devices on the ring network.*

the ring at once. With Planet, this problem has been eliminated by an electronic ring-closure mechanism, one of the functions incorporated into the ring administrator. The administrator acts as a private-branch exchange, providing functions similar to short-form dialing and alternative call routing. The administrator also maps the names of user devices to the relevant physical addresses of all the TAPs assigned to the network, enabling TAPs to be moved between the cable-access points (CAPs).

The administrator's software handles several types of connection between TAPs. Connections can be permanently fixed, preassigned but able to be changed and switched, that is determined by the terminal at a TAP like a switched call from a telephone. A connection may also be broadcast from one terminal to multiple fixed connections.

McConachie points out that the Planet administrator establishes virtual circuits rather than handling datagrams as does a packet-switched network. This is a key difference between Planet and the Cambridge Ring token-passing ring network developed at Cambridge University, England. Multiple Cambridge Rings are linked by satellite in an experimental project called Universe (MMS, September, 1981, p. 88).

Future plans for Planet will include multiple inter-ring connect —connecting rings by attaching nodes on each ring to nodes on an adjacent ring. Remote terminals or Planets can also be connected. Another likely future enhancement is multiple-channel broadband operation.

Bob Germon, the company's product marketing manager for Planet, says his company does not plan to sell devices for connection to a Planet ring. Racal-Milgo offers only the hardware and software that comprise the ring. This includes the administrator, the TAPs, the CAPs and the signal-carrying medium. Germon estimates that Planet's per-node price will average about £500 (less than $1000); the larger the number of nodes,the lower the cost per node. Attachments to Planet could include computers, data terminals, word processors, digital telephones, facsimile machines and copiers.

—Keith Jones

Gulf Computer Exhibition attracts 3184 attendees

Although the major oil companies have spearheaded the use and advancement of large-scale computers and some word processors throughout the Middle East, most growth in computer use is in public administration and in trading companies that dominate non-oil and non-banking commerce. Knowledgeable users request hands-on experience—a departure from standard batch-processing procedures.

That burgeoning market was evident at the first trade exhibition and conference on computers held for the Arab countries bordering the Arabian Gulf. Held in mid-December at the International Trade Center, in Dubai, the Gulf Computer Exhibition attracted 46 exhibitors from Canada to Japan and 3184 attendees, while the Gulf Computer Conference drew 150 delegates from as far as Syria and Egypt.

Saudi Arabia dominates the market for U.S. computer companies in the Gulf. The country's direct imports are not great—about $40 million for 1980 according to British statistics—but the additional revenues earned from facilities management, training, software and support is many times that.

In these services and in the drive to replace expatriate data-processing professionals with Arabs, outsiders are striking a balance between business profits and exploitation. Middle Eastern users want to have more control of computer equipment and its use.

"The days of the never-ending facilities management contract are over," said Kevin Hughes, international director of U.K. software house Computer Resources Ltd. In a controversial presentation to the Gulf Computer Conference, he said that the quality of some of the programming staff coming to the Gulf and the quality of the applications they are writing are lamentably low. The result has been monolithic and unamendable programs developed by foreign suppliers. The exploitation has extended to hardware as well, the Middle East sales manager of a major telecommunications company said. He accused expatriate staff of indulging in technology for its own sake and asking for equipment which the suppliers cannot yet produce.

With the Middle East market fast maturing, such examples are becoming rare. In the dominating Saudi market, the government and public services are the big purchasers, and software is the key to sales. IBM, which sells in Saudi Arabia through the locally owned Saudi Business Machines (SBM), is not pushing systems much below the System 34, but recognizes its best prospects for moving hardware are through software vendors.

The market for small systems is relatively immature. ICL, which has

"Adding manpower to a late software project makes it later."

Brooks' Law: *The Mythical Man-Month*

Don't waste man-months: Try CRTFORM.

Programming deadlines aren't met by adding more programmers to the job, but you can increase productivity, and reduce errors, by giving programmers the tools they need.

CRTFORM is a program which produces an interface between the programmer and the end user. It saves time by:

- Gathering application program specifications.
- Providing friendly and consistent runtime communication with the end user.
- Implementing CRT screen handling code.
- Assuring programmers that the information which they receive is correct.
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The CRTFORM system contains:

- A forms manager that manipulates a random access file of input specification forms.
- An editor that creates and modifies the specification forms.
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- A terminal-independent runtime module in the machine language of your host processor.
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CRTFORM is available for most micros and minis running under the CP/M-80, CP/M-86, UCSD, RMX-86 and Apple Pascal operating systems. Statcom will soon be releasing CRTFORM under UNIX for both the 68000 and Z8000 processors.

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Dubai's minister of finance and industry, *Sheikh Hamdan al Rashid bin Maktoum (center), meets with European and Arab visitors at the recent Gulf Computer Exhibition in Dubai.*

Middle East sales of about $9 million, used the Gulf Computer Exhibition to launch its Perq μc for engineering applications requiring high-quality graphics. Built by ICL under license from the Three Rivers Computer Corp., Perq includes a black-on-white screen and is targeted at oil companies.

Sales of small data-processing systems accounted for about 40 percent of the total $4-million revenues earned in the U.A.E. by Wang Laboratories, Inc., in 1981, and customization is the key to success. "You can't sell off the shelf like you can in Europe or the U.S.," commented Carl Bistany, head of the Emirates Computer Co., the exclusive Wang agent in the U.A.E. "The market is not ready for it, especially because of the high turnover of personnel," he said.

Systime, the U.K. vendor of Digital Equipment Corp.-based minicomputer systems, had the same experience. "The lead time for sales is an average eight to 12 months," said general manager Frank Harrison. "In Europe, it's an average three to five months."

Vendors have conflicting opinions about whether software should be written for the Arabic-speaking market. Although Arabic has been necessary in the government sector, vendors have until recently been able to use simple amendments to English-based systems. Packages such as payroll must be rewritten to accommodate Arab names (each employee's name usually consists of at least five words), dates (written right to left, and on a different calendar) and deductions (no tax, no pension or sick-benefit contributions). In the trading sector, English is more acceptable.

—Simon Timm

(Editor's Note: Simon Timm is chief editor and publisher of *Computer Weekly*, a British newspaper for computer users and suppliers, and of *Middle East Computing*, a new journal for computer users and suppliers throughout the Middle East. Both are published in London by IPC Business Press.)

British, other Europeans laud information technology

As part of its commitment to "the sunrise industries of the future," and in an attempt to decrease Britain's 11-percent unemployment rates, the Conservative government is spending about $500 million to promote information technology—data processing, the electronic office and communications. To underline its commitment, the British government has declared 1982 "Information Technology Year" (IT '82), and has announced an extensive program of events and projects.

Britain's goals are to increase public and industry awareness of the importance of adopting computer-based techniques and to strengthen the country's information-technology industries, including microelectronics, fiber optics and computer services.

IT '82 is the brainchild of Kenneth Baker, Minister of State for Industry and Information Technology. Baker's title reflects a status not enjoyed by any other industrial activity monitored by the government's Department of Industry. Baker is the second-ranking minister in the DOI.

More than $200 million of the money will be used for the Microelectronics Industry Support Program (MISP) and the Microprocessor Applications Project (MAP). MISP is intended to help IC manufacturers meet the needs of industry, especially the need for custom chips, and to support the infrastructure industries supplying equipment materials and services to chip manufacturers. MAP is aimed at educating and encouraging engineers and managers throughout industry to incorporate microelectronics into their manufacturing processes and products and, thus, remain competitive with foreign

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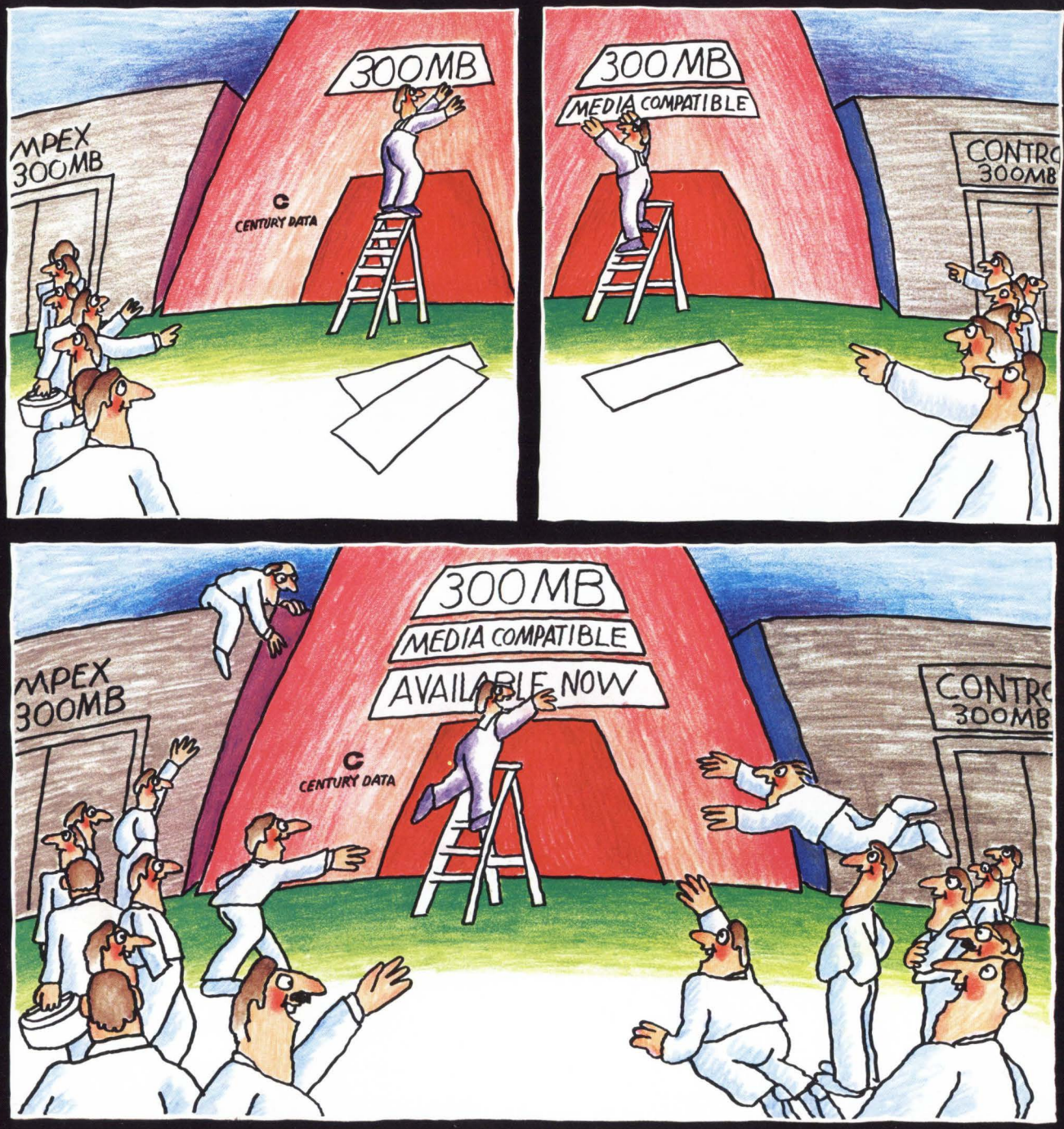
Century Data Systems
A Xerox Company

Drives for the 80's



Century Data's new T306 disk drive: It's what a lot of 300 MB-removable users have been waiting for.

If removable-pack disk drive users have needed anything, it's been a new reliable source for media-compatible 300 MB drives.

Introducing the Trident T306—ready for shipment today and well worth the wait. Because it's more than a match for any other removable-pack drive on the market.

Take the way our design attacks the problem of head crashes:

Continued on next page

"The last thing we ever needed was a spare Trident."

Tom Amerson, President
Consultant Field Engineering
Mission, Kansas

At Century Data, we always knew the quality of our Trident removable-pack disk drives could speak for itself. But a lot of Trident users are speaking up, too.

For instance, there's Tom Amerson, president of Consultant Field Engineering, an independent service company that maintains over 200 brands of computer equipment.

Mr. Amerson is also chairman of the board of IASCO, the International Association of Service Companies, a new organization that seeks to establish standards for the industry.

He has a lot to say about Tridents:

"Tridents are terrific. Three years ago, we bought a spare drive for one of our customers. But we never used it because the Tridents it was backing up never broke down.

"That isn't really unusual for a Trident, though. In the last six years, I haven't seen more than one head crash in a Trident. Which is something I sure can't say about other manufacturers' drives.

"Overall, Tridents are just amazingly reliable. In fact, we don't do much business writing service contracts on them. Most people would rather just call us once a year for maintenance. And really, that's about all the attention a Trident needs."

Needless to say, Mr. Amerson likes our Tridents a lot. We think your customers will like them, too. Why not give us a call, today, and get the details.

T306

Continued from first page

a catamaran head shape significantly improves aerodynamic performance.

And Century's special air filtration system helps eliminate contaminants that could cause a crash in the first place.

What's more, Trident T306 is quiet. Very quiet, in fact. Our design meets not only the NC55 quietizing standard for office environments, but even exceeds this standard.

We think of it as the Rolls Royce of disk drives. Quiet. Reliable. But with no price penalty.

We've been making removable-pack drives for 13 years—tens of thousands of them and there's plenty more where those came from.

In fact, new assembly and test facilities have significantly increased our Trident production capacity.

No other manufacturer has achieved our level of reliability because no other can match our design, engineering, manufacturing and testing capability and technology.

Put your order in today for the no-wait drive with maximum up-time. Trident T306.

Something few repairmen will ever see: Inside a Century Data Trident.

There are a lot of reasons why we call Tridents reliable. But basically, it's because we designed them right the first time.

And we manufacture them in an exacting way. In fact, every Trident that leaves our facilities is virtually a Winchester. If you never remove the disk pack, it's a Class 100 clean room environment inside.

These 50 MB through 300 MB drives are engineered for what you need. Lower maintenance costs over the life of the product. And easy maintenance when it is needed.

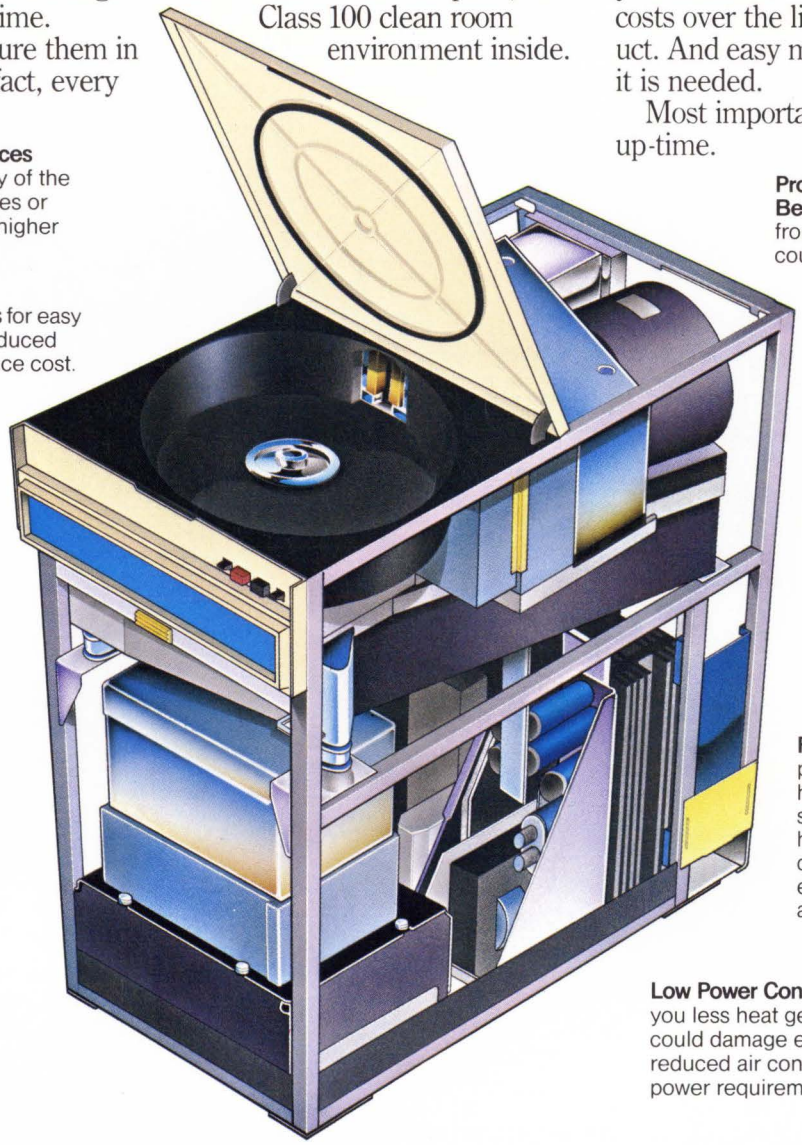
Most important: maximum up-time.

Parallel Disk/Head Surfaces assure far greater stability of the head over uneven surfaces or dust particles, providing higher data integrity.

Hinged Major Assemblies for easy maintenance, giving a reduced downtime and maintenance cost.

Advanced Seal Design keeps out airborne contaminants during repair or routine maintenance (other drives violate the purified-air section of their drives even for a head cleaning).

More Thorough Contamination Control has been a major goal at Century, and we've designed an absolute filtration system that removes particles to 0.3 microns. Air flow is routed in a full 360° pattern to purge all internal areas of contaminants (air leaves through a single port rather than the common method of air leaving the drive anywhere through several holes in the housing).



Protected Carriage Bearings are isolated from air movement that could dry out the lubricant.

Tunnel Cover over carriage acts further to keep contaminants out of the airstream, in effect creating an enclosed Winchester environment.

Symmetrical Carriage and Way is assured by a proven, high-precision tri-rail positioning and stabilizing system, giving the highest level of data integrity.

Rigid Deck Plate assures perfect alignment of head, carriage, disk, and spindle (other drives have flexible or independent support of these elements—a less reliable design).

Low Power Consumption gives you less heat generation that could damage electronics, plus reduced air conditioning and power requirements.

SMD-compatible 200 MB Tridents: Available now.

As modern office equipment grows more sophisticated, floor space grows more valuable. So when we developed our new Trident T202 removable pack drive, we decided to think small.

The result is a compact, low-maintenance 200 MB drive that not only saves floor space, but also makes a perfect plug and media-compatible replacement.

Being small has other advantages, too. It uses less energy.

Century T202. The only thing big about it is the way it performs.

We've packaged the ultimate mass storage breakthrough for microcomputers.

Maximized system performance. Minimized system overhead. A strong growth path for future data storage needs.

These are the ideals that the Marksman T-Series is designed to meet—a complete mass storage system of Winchester drive, streaming ¼" cartridge tape drive, intelligent and composite disk/tape formatter.

Enter a new era of mass data storage with T-Series. Easily integrated into bus structures such as S-100 or Multibus (with a simple host adapter) and operating system environments such as CP/M, MP/M, UNIX and others.

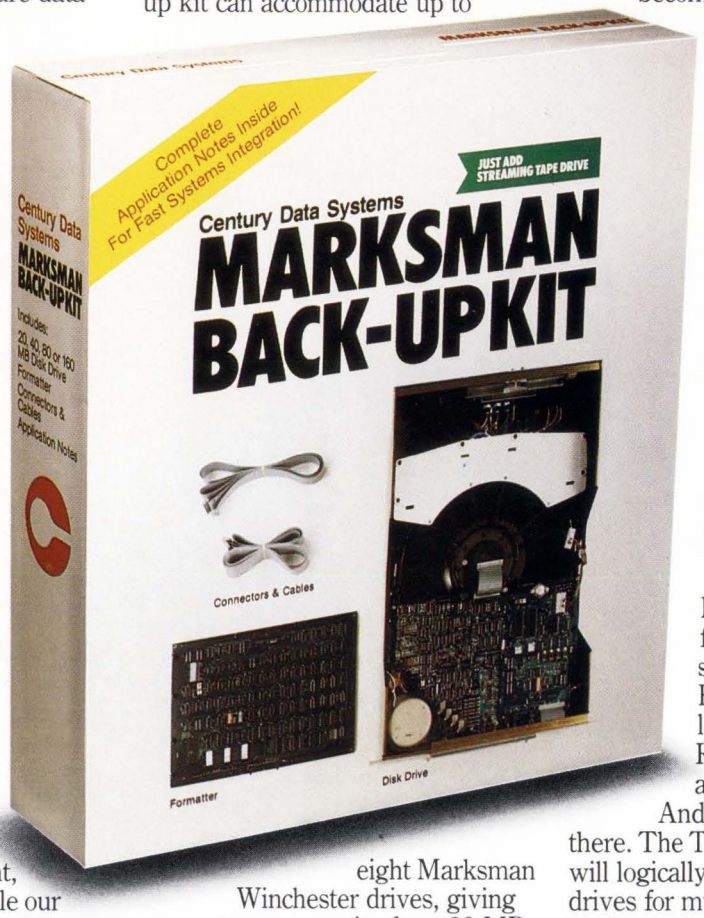
Plug our system into your system for mass storage that gives you extreme reliability, has the highest cost efficiency, and Winchester/tape file loading and unloading without downtime for the operator.

The secret is transparent, prioritized commands. While our new T-Series Marksman is fully or selectively backing up data onto ¼" streaming tape, direct requests from the CPU for access to data files on the disk can be given higher priority. The user is unaware of any time lapse as the back-up function is interrupted, the user's data need is fulfilled, and the back-up function is resumed, without further host system intervention.

Marksman Winchester.

The Century Data Systems back-up kit can accommodate up to eight Marksman Winchester drives, giving you a storage capacity from 20 MB to 160 MB per drive, enabling a total capacity as high as 1280 MB.

Plus, you get the reliability and random-access speed of Winchester, for the most user-friendly mass storage system available today.



1/4" Streaming Tape.

The Marksman T-Series ties into what may be the ultimate Winchester back-up device—¼" streaming cartridge drives. They are fast becoming recognized as the ideal sequential-data drive available today. Because dump/restore and program entry could never be performed as inexpensively and quickly before.

No other back-up drive has the cost-efficiency, speed and large removable capacity of ¼" streaming tape.

In fact, cost per megabyte never looked so good.

Ultimate Marriage.

From one up to eight Marksman drives, and from one up to four streaming tape drives. High data integrity and low cost per megabyte. Reliability. Non-stop user access to data files.

And the story doesn't end there. The T-Series formatter board will logically partition Marksman drives for multiple users. Each user is given continual access to dedicated files, and each user can interrupt a dump/restore command, which will resume after the request for data is completed.

Just fill out the coupon below, or give us a call for further information on the maximized storage system of tomorrow. Available today.

For the full Story of the Century: Just check the information you want, and we'll send it to you right away.

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companies. According to the DOI, about 160,000 attendees have visited MISP workshops and seminars. The program also provides financial support for about 600 projects involving the application of μps and for 2250 feasibility studies. It also sponsors Microtrain, a mobile exhibition and seminar, which has attracted about 25,000 visitors.

Additional programs are aimed at the fiber-optics, robotics and CAD/CAM sectors of the information-technology industry. Over the next five years, $50 million, of which 25 percent will be company grants, will go to fiber-optics. The money will be used for R & D, plants and buildings and feasibility studies.

The $20 million for robotics covers aid for development projects by robot manufacturers and grants towards consultancy studies commissioned by potential users. The $10-million CAD/CAM program is aimed mainly at educating potential users.

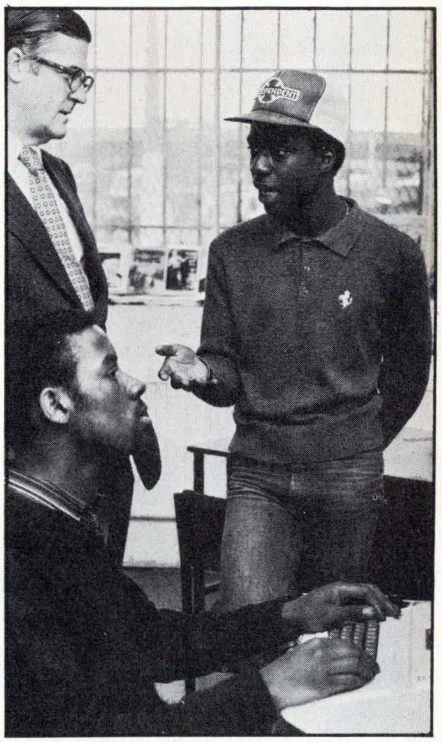
One of the most important programs is "Micros in Schools," which aims to provide every secondary school with at least one μc by year-end. Although many schools have had computers for some time, nearly 2000 will use part of the government's 50-percent grant toward their first systems. This year, the government expects to extend the plan to primary schools. It also intends to open information-technology centers in 20 high-unemployment urban locations. These centers are intended to train young adults in basic electronic and programming skills.

The most impressive measures to boost information technology are in communications. The government will contribute about $150 million—around one third of the cost—toward the LSAT, an advanced telecommunications satellite with on-board switching between multiple spot beams. It will carry a payload of equipment for sending high-speed digital communications to small-dish earth stations as well as TV broadcasting equipment. Scheduled to go into orbit in 1986, LSAT will be shared with Canada, Italy and several small European countries.

The government has also given its blessing to Mercury, a privately operated network that will provide high-speed digital communications between London and several major provincial cities using fiber-optic cables along rail tracks. Aimed mainly at business rather than domestic users, Mercury will carry high bit-rate information, such as video, facsimile and high-speed electronic mail. With its enthusiasm for the project, the government is underlining its wide-ranging policy of liberalizing public telecommunications. State-owned common carrier British Telecom is losing its monopoly over telephone sets, modems, telex machines, automatic branch exchanges and similar equipment. Moreover, the government plans to license third-party operators that want to use British Telecom's physical network to run value-added services such as high-speed facsimile and electronic mail. With project Mercury, the government is licensing a completely separate physical network.

Videotex, a communications technique that turns a standard color-TV receiver into a terminal, is more advanced in the U.K. than it is elsewhere. As part of IT '82, the government will also encourage greater use of videotex by establishing private interactive videotex systems in government departments.

Through the state-owned National Physical Laboratory, the government is collaborating on developing Project Hermes, an electronic document-delivery services, which will transmit between facsimile and teletext terminals. Teletext high-speed telex service is scheduled to be offered publicly this year by British Telecom.



Kenneth Baker, Britain's Minister of State for Industry and Information Technology (l.), *talks to two students at the Notting Dale Information Technology Center in London. This is the first of 20 such centers to be opened by the British government as part of Information Technology Year 1982.*

The DOI also supports research on using electricity mains as a two-way information carrier for home meter reading and energy management. Field trials will start this year in about 1000 London and Milton Keynes homes. The government expects the signaling system to provide remote reading of electric and gas meters; improved control of energy; and the detection of gas leaks, fraud and vandalism.

Other events planned for IT '82 include traveling exhibitions intended to present information technology to the general public and a program of open-house days in businesses, commercial enterprises and hospitals to display IT '82 projects. The climax of the year will be a conference in London with delegates from all over the world.

—Keith Jones

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The 10½ Commandments.

Revelations don't come easy. But they do come fast. And the computer industry is no exception.

That's why the first reaction to our Cynthia D100 Series 10½" disk drives was almost universally... "Holy Moses!"

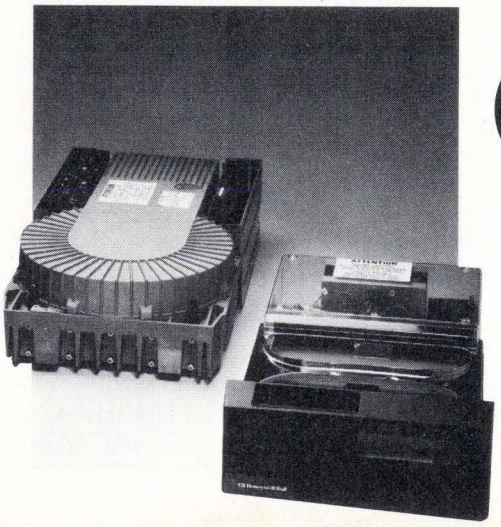
But, when you think about it, every industry standard began as a new standard. From 14" to 5¼". The 10½" is no different.

Actually, the 10½ Commandments are really a compendium of critical considerations, specifically: when you need the power and performance of a 14" drive in a package ⅓ the volume, specify Cynthia; when you need a more efficient use of surface storage space than an 8" drive, specify Cynthia; when you need an optimal-sized drive for high performance, highly reliable stand-alone systems, specify Cynthia. Amen.

What it all comes down to is the fact that Cynthia D100 Series 10½" disk drives are proving to be the optimum answer in a myriad of minicomputer and distributed processing applications. In fact... we've already shipped over 12,000 units to satisfied customers in the United States and throughout the world. It's this unique combination of proven product experience, together with the technological achievements of our parent company, Cii Honeywell Bull, that have made us the recognized leader in 10½" technology.

Sure, our Cynthia D100 Series disk drives may not be what you've previously considered "industry standard." But when you consider the inherent advantages of the 10½" format, together with technological advances like our patented embedded servo design, you may find that this new standard may be an infinitely better standard. It's easy to find out. Just call us at (415) 856-8181. Or drop us a line.

Cynthia Peripheral Corporation... we're setting new standards in disk drive technology.



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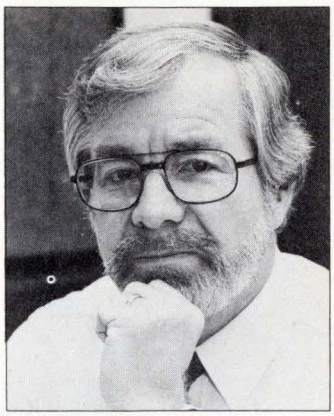
Editorial

Eye to eye with Japan, Inc.



George Sollman has been watching developments in Japan for most of a decade. He is vice president for marketing at Shugart Associates, the Sunnyvale, Calif., manufacturer of disk drives, and has worked at Control Data Corp. While his earlier interest in Japan was sparked because Japan looked like a highly attractive market for peripheral products, his view has changed to one of concern as he helps Shugart prepare for world-wide competition with Japanese companies.

In the OEM disk-drive business, "This is the year when Japan, Inc., looks us in the eye to see who blinks," Sollman says of the U.S. market. "We're concerned about it, but ready," he adds. We think that Shugart's efforts to prepare for this competition, as outlined by Sollman and earlier by James Campbell, Shugart president (MMS, July, 1981, p. 99), are worth noting for possible emulation by any manufacturer of computer hardware facing similar competition.

Since assuming the presidency at Shugart, Campbell has hammered away at the need for manufacturers to provide product quality and reliability. Sollman also recognizes the quality issue, but cites several other Shugart efforts that make a lot of sense. For example, more than 40 of the company's middle managers (about 25 percent of Shugart management) have visited several Japanese manufacturing plants "to see how they do things," Sollman says.

Some other recent Shugart moves aimed at making the company more competitive include:

- A "share" committee intended to boost Shugart profits, and to foster more widespread employee sharing in those profits;
- Improved material-transport mechanisms on the production floor, including what may be the disk-drive industry's first robot to perform highly repetitive assembly operations;
- Better inventory management, which includes more frequent shipments from suppliers so that Shugart can maintain a lower parts inventory and lower taxes on that inventory;
- Imposition of higher quality standards on parts suppliers, including warnings and disqualification when warranted.

Shugart's Campbell and Sollman don't want to be the ones who blink in the face of heightened competition from Japanese vendors; we think they're on the right track.

Lawrence J. Curran
Editor-in-chief

ACCE
EVERY

Why this operating system?

Ask the leading independent software vendors. They know Intel's iRMX 86 well enough to know it's an industry standard; that it allows them to plug into VLSI technology, and to design in a heap of high-performance features.

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How marvelous? iRMX 86 has two to five times the multitasking talents of any other microcomputer operating system. So users can perform various chores simultaneously—with blazing, realtime system response. Thanks to ultra-fast context switching, task synchronization and memory-based message passing.

And iRMX 86 even supports multiprocessing. Not only overseeing our 8087 numeric processor and 8089 I/O processor, but going even further. Often helping a whole team of 8086, 8088 microprocessors and 8087, 8089 processor extensions work together. While you're reaping the rewards of multiprocessing performance—without

PTED WHERE.

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Most importantly, iRMX 86 is the only operating system taking full advantage of VLSI—already putting its advanced architectural virtues into silicon.

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And when it's time to tie into a communications network, you won't have to get tangled up writing complicated software: built-in software drivers are already in place. In fact, iRMX 86 is the only microcomputer operating system to support Ethernet,* the de facto standard for local area networks.

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Microfocus	CIS COBOL
Digital Research	CBASIC
Intel	FORTRAN Pascal PL/M Macroassembler

Incidentally, all these features are available for $130/unit in OEM quantities. Plus all are backed by extensive documentation, development tools, workshops, field support, software maintenance, and a company name that's liable to turn up anywhere.

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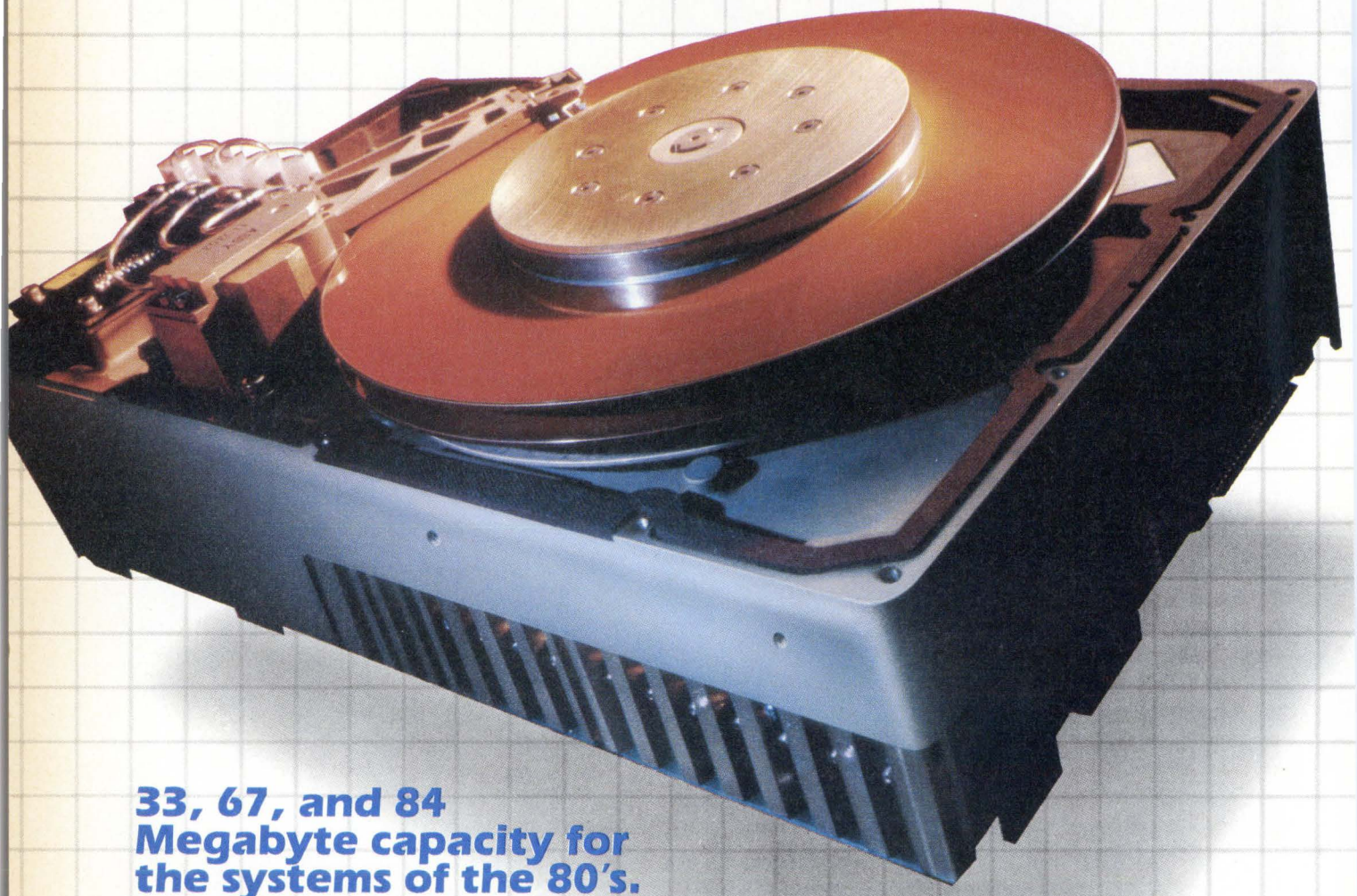

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CIRCLE NO. 45 ON INQUIRY CARD

CONTROLLER AVAILABLE

To the editor:

It was with interest that I read about Storage Technology Corp.'s new entry into the OEM disk-drive market with the model 8775, a 675M-byte, 14-in. Winchester-disk drive (MMS, December, 1981, p. 34). I would like to clarify a misleading statement made in that article, however. The statement in question was, "No controller is available for the new drive," indicating that there is no way of supporting the new disk drive when it becomes available.

MiniComputer Technology has a line of emulating and non-emulating disk controllers for Digital Equipment Corp., Data General Corp. and Perkin-Elmer Corp. minicomputers. All of these controllers were designed with 11-bit cylinder addressing capability in the expectation that track densities would eventually exceed 2^{10}. Not only do our controllers support cylinder addressing of 2^{11}, but total product support is also provided by our formatting software.

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Arthur H. Roshon
Engineering Vice President
MiniComputer Technology
Palo Alto, Calif.

(Editor's Note: The story was accurate at the time it was reported. The STC source to whom the statement in question is attributed explains that several companies had expressed an interest in developing a controller for the 8775, and STC supplied the specifications. But when the story was reported, no known controllers were available.)

FLAT CRTs ARE HERE

To the editor:

I read with interest the article on flat-panel technology (MMS, December, 1981, p. 125), which provided a reasonable survey of the present technology. I must, however, take exception to the quote attributed to Larry Tanns of the University of California at Los Angeles and subsequently used as a page header in the article: "There's one feature that a CRT cannot have...a CRT cannot be flat."

Oh really? Great Britain's Sinclair Research, Ltd., is already marketing its Microvision 2700 flat-CRT television in a 1-in.-thick package.

Fred H. Karr
Technical Specialist
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CIRCLE NO. 47 ON INQUIRY CARD

Software-in-silicon boosts system performance, cuts programming time

By Larry Lettieri
Associate West Coast Editor

Whether called software-in-silicon, firmware or silicon software, it's the stuff from which tomorrow's systems will be made. Integrating elementary, redundant software functions, such as floating-point routines, memory management or interrupt controls into a semiconductor chip is what silicon software is all about.

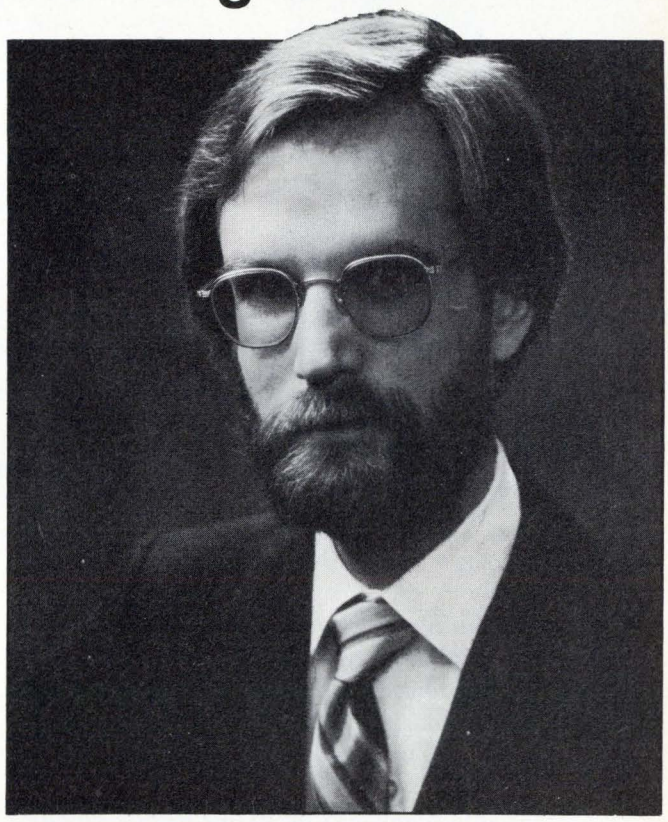
What form it will take is the subject of different definitions. A BASIC interpreter ROM for a personal computer or video games sold as they are in ROM could be called silicon software within a broad definition. A second view restricts the definition to software building blocks acting as stand-alone components from which system software can be built.

Whatever the definition, some experts contend that once the technology is firmly established, software will be a component similar to a memory device or a μp. System performance will be improved as a result. Bob Waites, manager of R&D at Hewlett-Packard Co.'s Cupertino, Calif., IC division, says, "How silicon software is implemented is not the issue. Rather, what is important is how many tasks can be done at once."

What will happen, says John Shea, president of Technology Analysis Group, a San Jose, Calif., consulting firm, is that "relatively redundant software, software that once consumed too much of a programmer's time, will be cast into silicon, allowing software-development engineers to concentrate on the applications programs needed to fulfill the system's requirements."

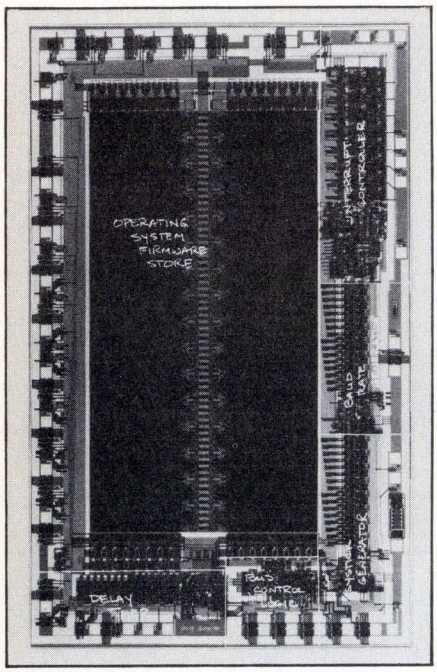
How successful this approach to software will be is difficult to determine. Silicon software is considered a part of the total systems-software market that Peter Cunningham, an analyst with market-research firm Input, Inc., Palo Alto, Calif., projects as a $9.5-billion industry by 1985, with software for μps accounting for the greatest share. Using Input's figures, Colin Hunter, co-founder of Hunter & Ready, Inc., a Palo Alto, Calif., company offering operating systems on silicon for 16-bit μps, estimates that the potential market for silicon software will reach $5 billion during the latter half of this decade.

More standard software operations will be offered on semiconductor devices as system needs become better understood. Hunter & Ready co-founder Jim Ready compares silicon-software solutions to μps. "The μp was shown to be a way around all the multi-chip logic being used. It turned out to be a better way to manage the complexity of a design." Ready says the same situation exists today in software. Programmers are "replicating well-known operations, which could be replaced with a single component." He says people want off-the-shelf software building blocks that operate in a machine-independent setting and that can be hooked up with other off-the-shelf components to build a complete operating environment.



James F. Ready, vice president of Hunter & Ready Inc., *says programmers are replicating well-known operations that could be replaced with a single component.*

At Intel Corp., which introduced a silicon version of its RMX-86 operating system in September, 1981, silicon software means two things. Bob Patterson, marketing manager for μp products, says that, at a basic level, silicon software is "the actual implementation of software into hardware so that the device becomes an extension of the processor." At a higher and perhaps ideal level, the concept includes software that has been optimized for implementation into VLSI components, Patterson says. Patterson says the limitations lie in the



DIGITAL RESEARCH, INTEL STRIKE DEAL IN SILICON

So far, the operating systems that have made their way into silicon have been real-time, multitasking products aimed at the industrial market. But last November, Intel Corp. and Digital Research, Inc., struck a deal that would put CP/M-86, Digital Research's 16-bit commercial operating system, onto the semiconductor maker's 80130 operating-system processor. The CP/M-86 device will be sold by Intel's Software Distribution Operation, Santa Clara, Calif.

For the Pacific Grove, Calif., software firm, the arrangement adds a new dimension to its marketing. Most significantly, says director of marketing John Katsaros, "Putting CP/M-86 into silicon and having Intel sell it gives us the opportunity to get into markets we haven't been in before. We'll get a chance to see how CP/M does outside the personal-computer market," he says.

CP/M-86 will be the first Digital Research product to be put on the 80130. If that is successful, Katsaros says, 8-bit CP/M and MP/M-86, the company's multiprocessing system, will be next.

Intel's 80130 (the RMX-86 in silicon) *is the first in a series of building blocks designed to extend the processor's capabilities, say company officials.*

process technology, not in the imaginations of designers.

Intel and Hunter & Ready view the software component as a building block for a total system: "We think the critical concept represented is the idea of a software building block," says Ready. "That is, a piece of software that can be connected in a number of ways to other pieces of software in a variety of custom system designs, without having to modify the building block itself." Similarly, he explains, a hardware VLSI component can be used in a number of designs with other chips with no modification.

Intel's Patterson agrees: "Silicon software is more than just software in ROM. The 80130 (Intel's RMX-86 in silicon) is the first in a series of building blocks designed to extend the capabilities of the processor."

Software-in-silicon is not a totally new idea. Besides the applications mentioned, software routines have been embedded in a variety of peripheral controller chips for some time. These functions were once stored in RAM and are now embedded in silicon. They are well-established routines that don't require source-code modification to operate. Only external parameters are changed to match a system design.

Hunter & Ready's VRTX, written for Zilog, Inc.'s Z8000 16-bit μp, has since been adapted to Motorola's M68000 and Intel's 8086. It is a real-time, multitasking operating-system kernel supplied on two PROMs. Ready says each version of the kernel has an identical set of real-time system functions that provide a programmer a standard interface, independent of any μp architecture.

Being processor independent, VRTX can be used in various applications without changing the source code, Ready says. The operating system essentially adds 22 high-level instructions to the instruction set of the μp. A user-supplied configuration table provides the link between VRTX and the application environment. These are the only parts of VRTX that need to be customized, says Ready.

Key to VRTX's flexibility, says Ready, are the presence of hooks in silicon within the system. These hooks allow a user to initialize special devices at system start-up time and to perform special servicing at each task. "Other operating systems don't have this option," Ready claims. Lacking such hooks, he adds, users cannot tailor these operating systems to other machines or applications without reaching into the source code. "This is expensive and risky," Ready says.

Hunter & Ready supplies additional packages that contain the initialization routines and interrupt handlers for programmable chips, such as timers and serial-I/O devices. The company also has language-interface libraries permitting VRTX system calls to be made from programs written in high-level languages such as C or Pascal.

Intel's 80130 operating system processors are two two-chip sets containing a standard 8088 or an 8086 μp, plus the operating-system component. Unlike VRTX, a ROM-only operating-system processor includes on-chip programmable interrupt controller, timers and baud-rate generator. However, Intel's 80130-based operating system, unlike VRTX, is machine-dependent. Additionally, the 80130 must be designed into a system with

thought to specific pin-outs and addresses.

The iAPX 86/30 and 88/30, as the chip sets are called, provide 35 operating-system primitives in hardware, which create, manipulate or delete system data types to add interrupt control, message passage, memory management and task synchronization to 8088- or 8086-based systems.

Intel's Patterson says the 80130 design is a test device "to judge how the concept is accepted." With the device, Intel hopes to get into applications other than process control, the company's traditional market for the RMX-86 operating system. Patterson thinks it's possible to bring real-time solutions to applications such as video terminals.

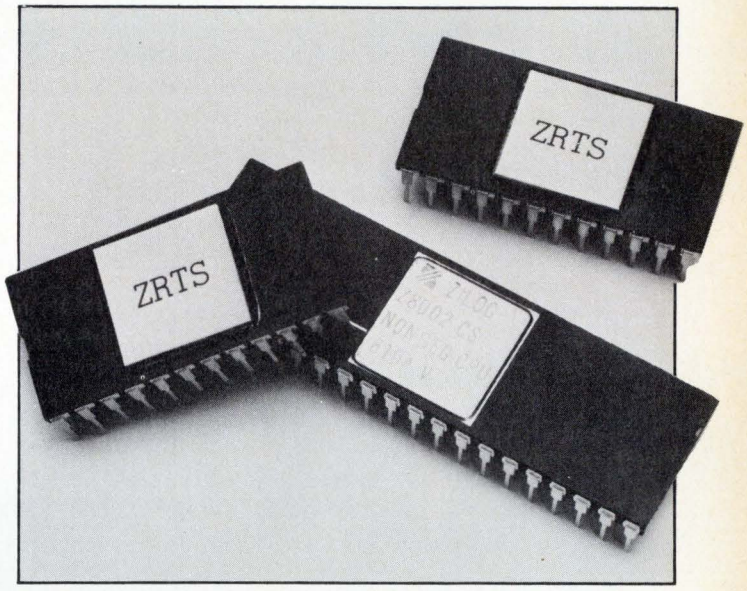
Not everyone is as enthusiastic about silicon software as Hunter & Ready and Intel. Among those wondering about the validity of the approach is Paul Allen, co-founder and executive vice president of μc software house Microsoft, Inc., Bellevue, Wash. The concept may make sense for a small set of fairly well-defined applications, Allen says, such as a floating-point routine in ROM. It's possible to make a case for applications such as Intel's 80130 in a large set of identical systems, he says. But Allen cautions that programs are subject to change. "You're always fixing bugs or adding features," he says.

Allen thinks there may be a different reason for the growing interest in silicon software. "Chip makers are seeing that the value being added to systems is coming from software. As a result, hardware sales, as a percent of the total volume, are slipping. One way to recapture some of those dollars is to put software into silicon."

One semiconductor maker prescribing caution is Zilog. Bernard Peuto, director of component design engineering at the Cupertino, Calif., company, thinks there will always be limitations to putting anything but the most basic, standard software into silicon. "The more fixed software becomes," Peuto says, "the greater are the problems of support and maintenance."

Zilog's approach to the software problem is to provide what Peuto calls a tool kit for users to design custom operating systems. The company's ZRTS 8000 software package is its first such product.

ZRTS is a set of components including an operating-system kernel and a system configuration language, not unlike Hunter & Ready's VRTX. But VRTX is sold only as ROM, while ZRTS is available on diskettes so customers can get to the source code to do customization. The kernel can be loaded into PROM, thus becoming embedded in silicon. But Peuto questions whether it's worth freezing these functions on a chip. "System expansion is the crucial part of an operating system," he says. "If it's in silicon, you've limited the development potential."



ZRTS 8000, Zilog's real-time software package, *is available in PROM sets (pictured above) and on diskette for the Z8001 and the Z8002 CPUs.*

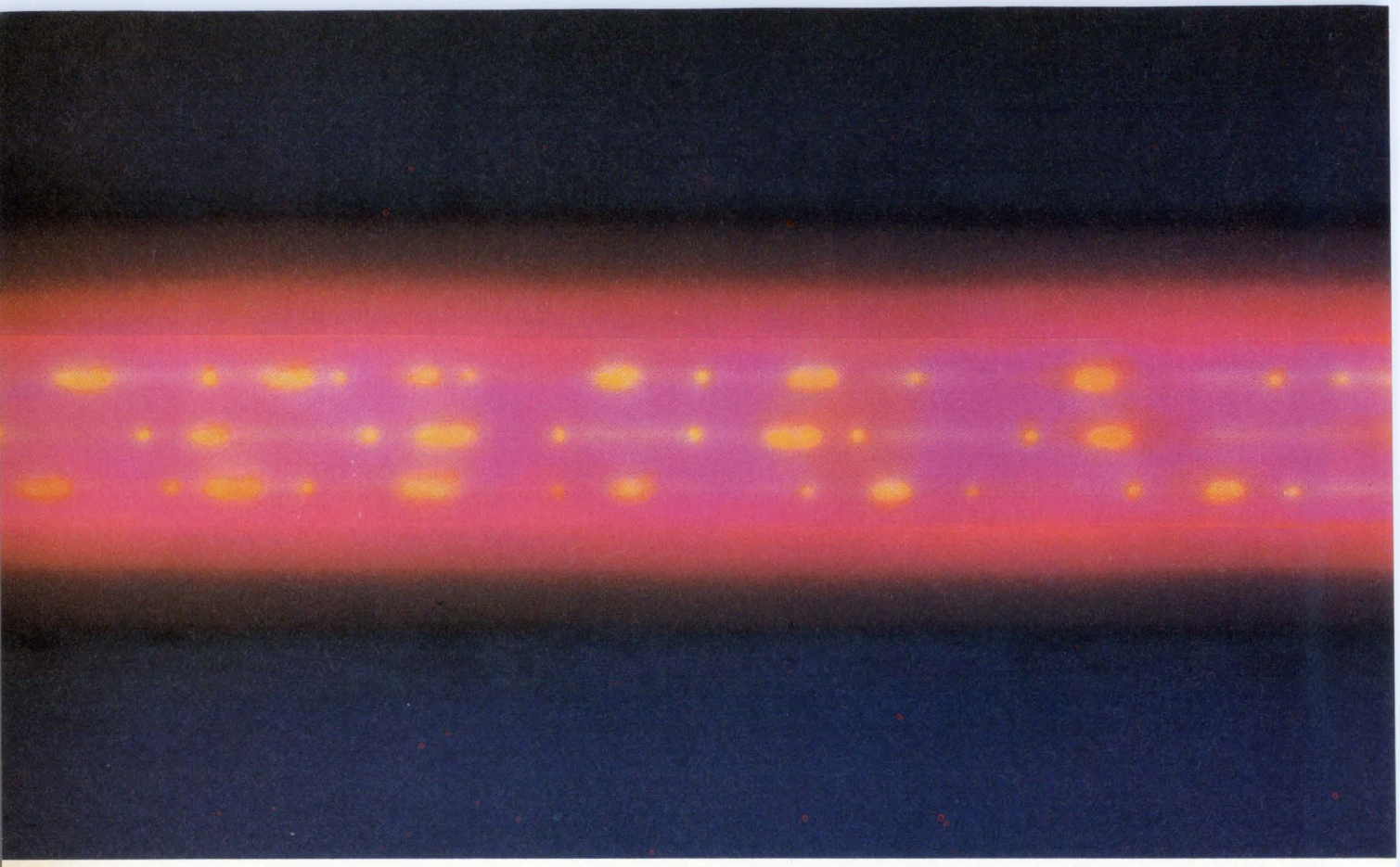
Nonetheless, interest in silicon software is growing. Intel has selected the next operating system to be embedded into its 80130, Digital Research Inc.'s CP/M-86 (see "Digital Research, Intel strike deal in silicon," p. 94). Hunter & Ready is talking with National Semiconductor Corp., and it's expected the company will write a version of VRTX for the semiconductor maker's NS16000 processor.

The 16000 is expected to include some operating-system functions in one of its later versions. Subash Bal, product marketing manager for the device, says it makes sense to put the kind of functions related to fast, interrupt-driven processes on the chip.

Motorola is reportedly readying a co-processor for its 68000 family that is a silicon implementation of the IEEE's fast floating-point processor standard. A source at the company's Austin, Texas, facility says the announcement is due this spring.

The potential for silicon software is considerable. The number of products will continue to grow and will probably include high-level languages such as Ada and FORTH compilers, as well as applications programs, says TAG's Shea. Shea is also looking for developments in telecommunications, specifically data-encryption software. Ready says, "There are many high-level sets of functions, such as networking, that, if generic enough, could be put in ROM."

ROM is the standard way to implement silicon software. Ready believes that ROM will be sufficient for quite some time because μps will remain as they are for the foreseeable future. ■



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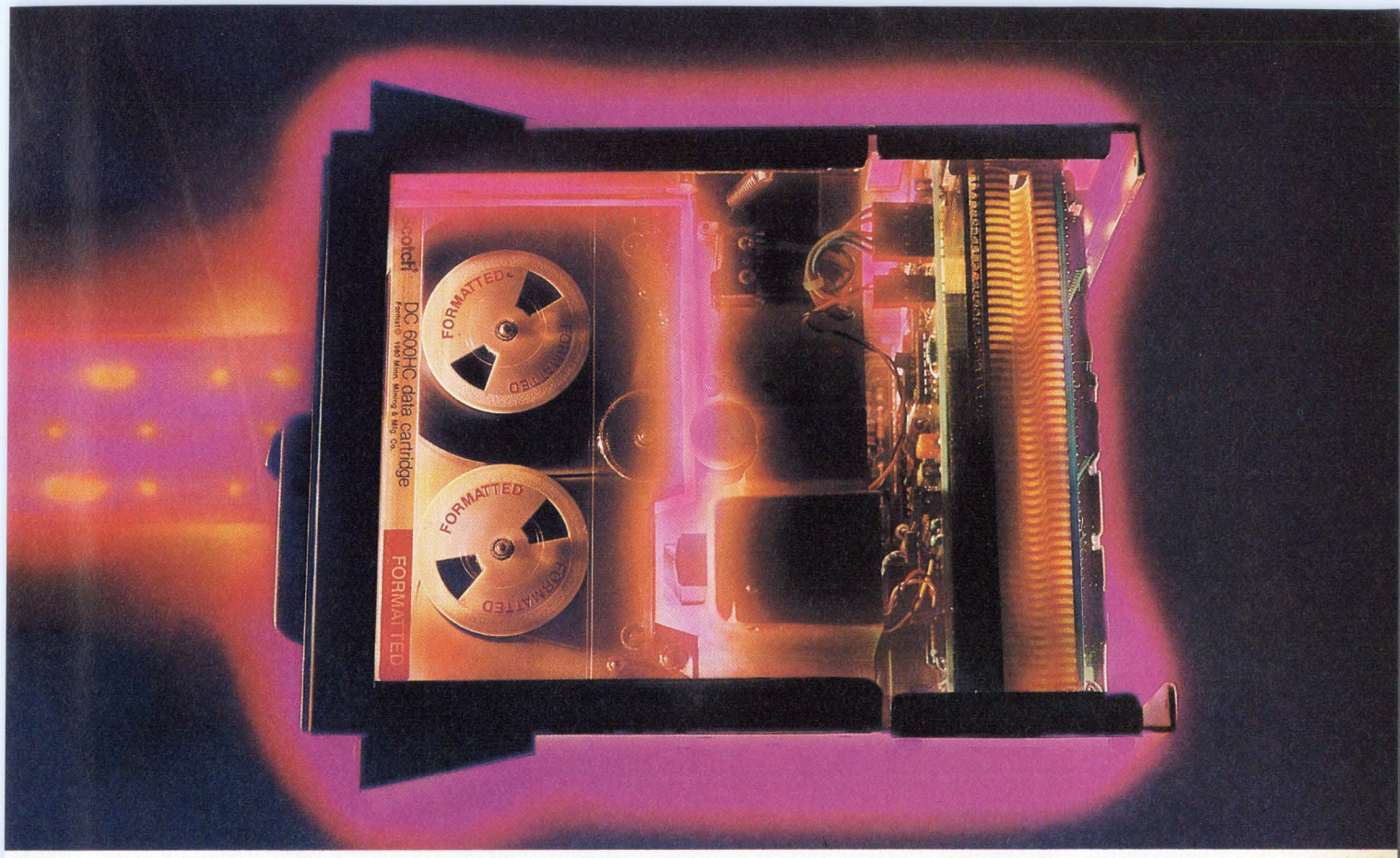

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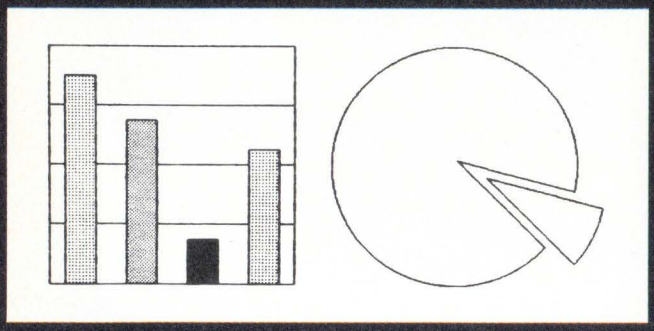

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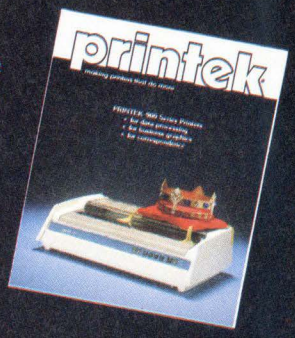

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CIRCLE NO. 49 ON INQUIRY CARD

1982 outlook is cautiously optimistic

By the *Mini-Micro Systems* staff

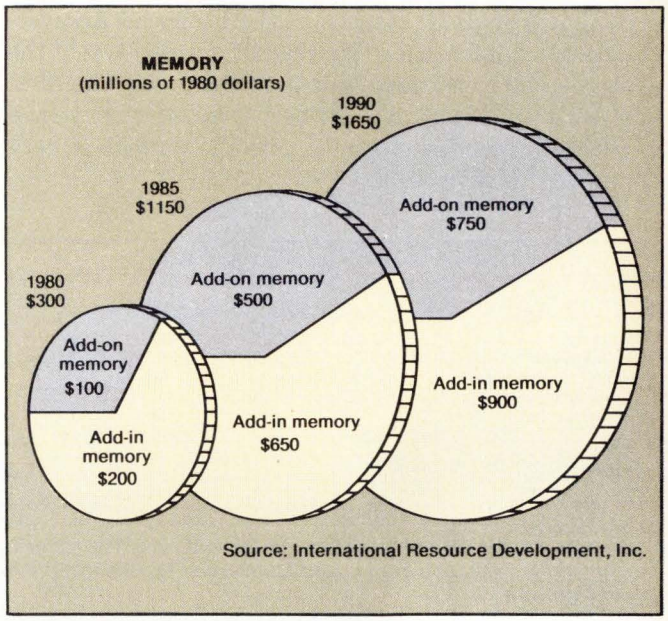
As the first quarter of 1982 unfolded, the economic uncertainty reverberating throughout the general economy reached the computer and computer-peripherals industries. But as the economic downturn forced some companies to shorten workweeks and initiate layoffs, other companies steamed profitably ahead with their balance sheets intact and seemingly impervious to recession.

Honeywell Information Systems handed out layoff notices and Data General Corp. saw a continued decline in orders for the traditional product lines, but Digital Equipment Corp. continued to report strong earnings. While financially troubled printer maker Centronics Data Computer Corp. sold a 45-percent control of the company to Control Data Corp., companies in the disk-drive market forged powerfully forward. Two legal events also fed the uncertainty marking the first half of 1982, as AT&T was unleashed from its regulatory harness, and International Business Machines Corp. no longer found itself encumbered by a federal antitrust suit.

For third-party resellers and their vendors, the problems of maneuvering a business through a recession is perhaps more difficult than for a company whose wares move directly from manufacturing to end users.

"The OEM pipelines tend to be rather long," says David Stein, executive vice president of the Gartner Group research firm. "If you are a large OEM you have to make commitments to shipments at least a year in advance. When the business turns down and you can't sell your end-user product, it means you have a lot of inventory. Until business turns around and picks up again, the OEMs live off their inventory and stop taking delivery. The OEM business will not turn around until the big OEMs not only have drained their inventory, but are convinced business will be there to warrant going out and making those big-volume commitments again," Stein says.

Several computer company executives, including Hewlett-Packard Co. chairman David Packard, believe the turnaround could occur this summer. "I think the economy will continue to be sluggish for the first quarter, maybe pick up a little bit in the second quarter and could be fairly active toward the middle and through the end of the year," Packard said at a Financial Analysts Federation conference in San Francisco in January.



The memory market will grow a total of 450 percent *by 1990, but there will be no significant shifts in the market shares of add-in and add-on memory devices.*

The following summaries show how the small-computer and peripherals markets are shaping up for the next three quarters of 1982 and beyond, and provides several research organizations' market estimates.

Minicomputers—32-bit units continue strong

The small-computer industry is showing a divided response to the recession. The μc business appears to be holding up well, and high-end minicomputer lines, mostly systems using 32-bit-wide data paths, also seem to be doing well. Slowdowns have occurred in the middle, more traditional lines of the minicomputer suppliers.

At DG's annual meeting in January, company president Edson D. de Castro told the company's shareholders that: "Orders for our 32-bit line are vigorous, but do little more than offset declining orders in our traditional lines. Since margins are highly sensitive to volume, they are not likely to show marked improvement until shipments show strong growth over preceding periods." The strength of the 32-bit market over the traditional lines prompted de Castro to say somewhat wistfully, "If I had one thing to do over again, we would have been in the 32-bit market about three years earlier."

De Castro's view of the continued strength of the 32-bit market was echoed by Prime Computer, Inc.,

president Joseph M. Henson at the Financial Analysts Federation conference. "We read of a slowdown of the economy, and yet (our sales) forecast for the first quarter of 1982 is frankly the best forecast we have had in terms of business volumes, and the outlook is very favorable," Henson said.

DATA COMMUNICATION SHIPMENTS FORECAST*

(millions of 1980 dollars)

	1980	1982	1985	1990
Modems	$200	$350	$400	$600
Multiplexers	100	200	300	800
Acoustic couplers	25	15	15	10
Concentrators	30	20	10	5
Processors/controllers	15	80	200	500
TOTAL	$370	$665	$925	$1915

*Data communication equipment used directly in general-purpose minicomputer and μc configurations

Source: International Resource Development, Inc.

Shipments of data-communication equipment will rise *steadily through 1990, with processors and controllers experiencing the greatest growth.*

Research firm International Resource Development Inc., Norwalk, Conn., estimates that 2000 32-bit minicomputers were shipped in 1981 with a total value of $300 million. The number of units shipped will increase to 4400 with a total value of $660 million by 1983, according to IRD.

While many firms in the computer industry have reported slowdowns in sales and earnings, industry leader DEC continues to report substantial revenue and earnings gains. In the most recently reported quarter (the company's second fiscal quarter ending Dec. 26, 1981), the firm's net income rose 42 percent to $99.1 million on a 27-percent increase in revenue to $965.8 million as compared to the same quarter a year earlier. Stephen C. Dube, a stock analyst with Dean Witter Reynolds Inc., San Francisco, believes DEC's major focus for the current fiscal year will be "to keep demand high enough to absorb the available inventory. Until recently, the company's concern was to build enough capacity to capitalize on the incremental demand expected when the worldwide economies again move into high gear."

"We're being very cautious, very conservative in our planning," says DEC president Kenneth Olsen. One of the most obvious effects of the recession on DEC, Olsen says, is that delivery times have dropped from more than one-and-one-half years on some products to almost immediate delivery. Olsen says he has seen some slowdowns with DEC's third-party vendors, but the end-user business has remained strong.

In a preliminary report on a survey of independent sales organization conducted recently by *Mini-Micro Systems* and Bache Halsey Stuart Shields Inc., Bache analyst Donald H. Brown said that ISOs expect a continuing explosion in demand for very small computers, while the outlook for larger systems is uncertain. An analysis of data supplied by 153 firms projects a 26-percent increase in deliveries for the first quarter of 1982 as compared to the final quarter of 1981. A total of 87 percent of the shipment increase comes from systems valued at less than $32,000. Shipments of systems selling for more than $32,000 are projected to show a 6-percent gain. Nine percent of the respondents considered their inventory position too high, while 18 percent considered theirs too low. The firms analyzed in the survey listed $32.3 million in shipments for the final three months of 1981. "For the investor, the preliminary results show that a scaling back in expectations for the traditional minicomputer suppliers may be warranted," Brown stated.

μCs expected to make quantum leap

Despite the recession, the μc market will continue to follow what Gnostic Concepts, Inc.'s analyst Jean Yates calls an "initial quantum leap gross curve" in 1982. "It's a classic case," Yates says. "Anytime you get a technological breakthrough that significantly improves productivity, you get growth rates that defy normal market behavior."

For forecasting purposes, Yates defines μcs as systems built around a single-chip CPU, including CRT terminal, disk storage and printer as well as software, service and supplies. Gnostic expects that, thus defined, the μc market will reach $6.4 billion in 1982, up from a 1981 figure of $4.9 billion, for a growth rate of 30 percent. This market, which includes rack- and desk-mounted scientific systems, portable and hand-held computers, and desk-top small-business systems, will reach $12.2 billion in 1985, says Yates.

Yates sees the personal-computer segment growing particularly fast. "An incredible amount of pressure to create smart kids is driving the general-consumer portion of the μc market," she says. Dataquest's David Crockett agrees that personal computers are the fastest growing segment, but cites a different reason: "People buy one to try at home," Crockett says, "with the notion that they could upgrade it later for business use."

Dataquest forecasts that the market for personal computers, defined as systems selling for less than $5000 including CRT terminal and disk storage, will grow from a 1981 market of $1.24 billion to $2.11 billion, for a 70-percent growth rate, despite the recession. As Gnostic's Yates notes, "Families are buying low-end μcs even though it's a sacrifice because parents perceive the importance of computing to their kids' future. They think the industry is recession proof and push computers as a good career opportunity."

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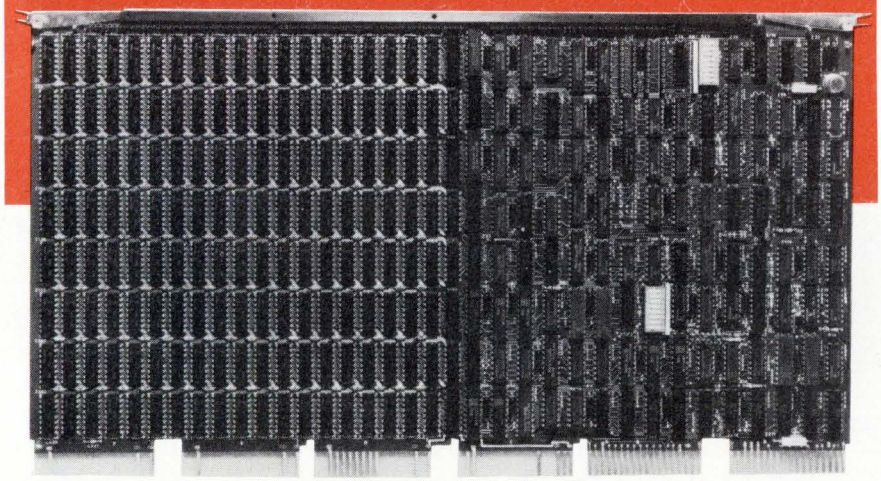

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PDP-11	DR-114SP	hex	256 KB
PDP-11	DR-214SP	hex	1.0 MB
PDP-11	DR-144S	hex	256 KB
PDP-11	DR-244S	hex	4.0 MB
VAX®-11/750 PDP-11/70	DR-175S	hex	256 KB
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CIRCLE NO. 50 ON INQUIRY CARD

The Interpreter

Dataquest predicts growth of small-business μcs, defined as systems in the $5000 to $15,000 range, from $1.19 billion on 1981 sales of 165,000 units to $1.65 billion on 1982 sales of 200,000 units. This more than 38-percent growth rate, slower than that for personal computers, reflects recessionary pressure. "Because of the recession," Crockett says, "people take a harder look at the $5000-and-over system and often postpone purchase."

PERIPHERALS MARKET GROWTH
(millions of dollars)

	1980	1990	Total growth
Mass-storage devices	$1000	$2670	167%
CRT terminals	650	3450	430%
Printers	560	1185	111%
Datacomm equipment	370	1915	417%
Memory products	300	1650	450%
Data-entry devices	240	1730	620%
TOTAL	$3120	$12,600	303%

Source: International Resource Development, Inc.

Shipments of peripherals for minicomputers and μcs will triple *by 1990, with data-entry devices showing the greatest growth.*

SHIPMENT FORECAST FOR 32-BIT SUPERMINICOMPUTERS

	1981	1983	1985	1990	Cumulative (1981-1990)
Units shipped	2000	4400	7400	23,700	102,200
Value of shipments (millions)	$300	$660	$890	$1775	$10,013
Average unit value (thousands)	$150	$150	$120	$75	—

Source: International Resource Development, Inc.

Shipments of 32-bit superminicomputers will increase *fivefold by 1990, with the average unit price dropping 50 percent.*

Crockett notes that Dataquest has in the past underestimated the μc market by 10 to 15 percent. "We've underestimated both the buying public and the number of participants. Literally every computer company and many office-equipment companies are trying to enter this segment," he says. "Mainframe and minicomputer companies, for example, want to extend their line downward to retain account control."

One beneficiary of that trend is Convergent Technology, Inc. Vice president of marketing Pauline Lo Alker says μp technology is evolving so rapidly that many large companies have taken the OEM route to enter the μc market. Convergent, for example, is selling its 16-bit Winchester-disk-based work station to several large computer companies, including Burroughs Corp. and NCR Corp. "Instead of 'OEMing' chips, as they did in the '70s, big companies are OEMing computers," she says. This trend will help the market continue its rapid growth, which Alker says tops 35 percent.

On the financial side, securities analyst Linden Berkheimer of Dean Witter Reynolds Inc., who follows Apple Computer, Inc., and many μc peripherals manufacturers, expects μc company stocks to rise in 1982. He points out that Apple is selling about 14 times its projected earnings of $1.50 a share—earnings that should rise to $2.50 a share next year. He sees Apple's earnings multiple reaching 20, which is what such peripheral vendors as Tandon Corp. and Seagate Technology are selling for. "For a company such as Apple whose earnings are 50 to 70 percent, an earnings multiple of 20 is not unreasonable," Berkheimer says.

Mixed forecast for peripherals

The outlook for the peripherals market, which is tied in many ways to the fortunes of the computer market, is continued growth throughout the year. However, neither all companies nor all sections of the peripherals industry are expected to enjoy the benefits of those projections.

IRD projects that overall printer shipments will increase from $560 million in 1980 to $780 million in 1982. The projections show growth in teleprinters, character printers and medium-speed line printers, while shipments of high-speed line printers are expected to decline.

Shipments of dumb CRT terminals are projected to grow from $200 million in 1980 to $400 million in 1982. Intelligent terminal shipments are expected to grow from $450 million in 1980 to $700 million in 1982. Add-in memory shipments are forecast to grow from $200 million in 1980 to $450 million in 1982, and shipments of add-on memory are projected to grow from $100 million in 1980 to $300 milllion in 1982.

"The peripherals business depends more on what segment the companies are serving that on anything else," says Dean Witter Reynolds's Berkheimer. "The companies serving the μc business are still seeing pretty good order growth. As you go up the scale in computer size, you get increasingly weak." Berkheimer sees continued pricing pressure on the low end of the printer business and continued strength in data-storage devices. But he doesn't foresee the June upturn predicted by other analysts and economists. "We always know the economists are wrong; we just don't know if they are wrong on the short side or the long side. Given the nature of the recession and the timing, it just doesn't seem conceivable that we are going to get out of this thing in 1982," Berkheimer says.

The dumb-terminal market has witnessed the same kind of price cutting that has happened in the low-end printer market, with dumb terminal prices moving to the $500 range.

One of the most promising segments of the CRT-terminal market is low-cost, color raster-scan units. The Yankee Group, a Boston-based consulting group,

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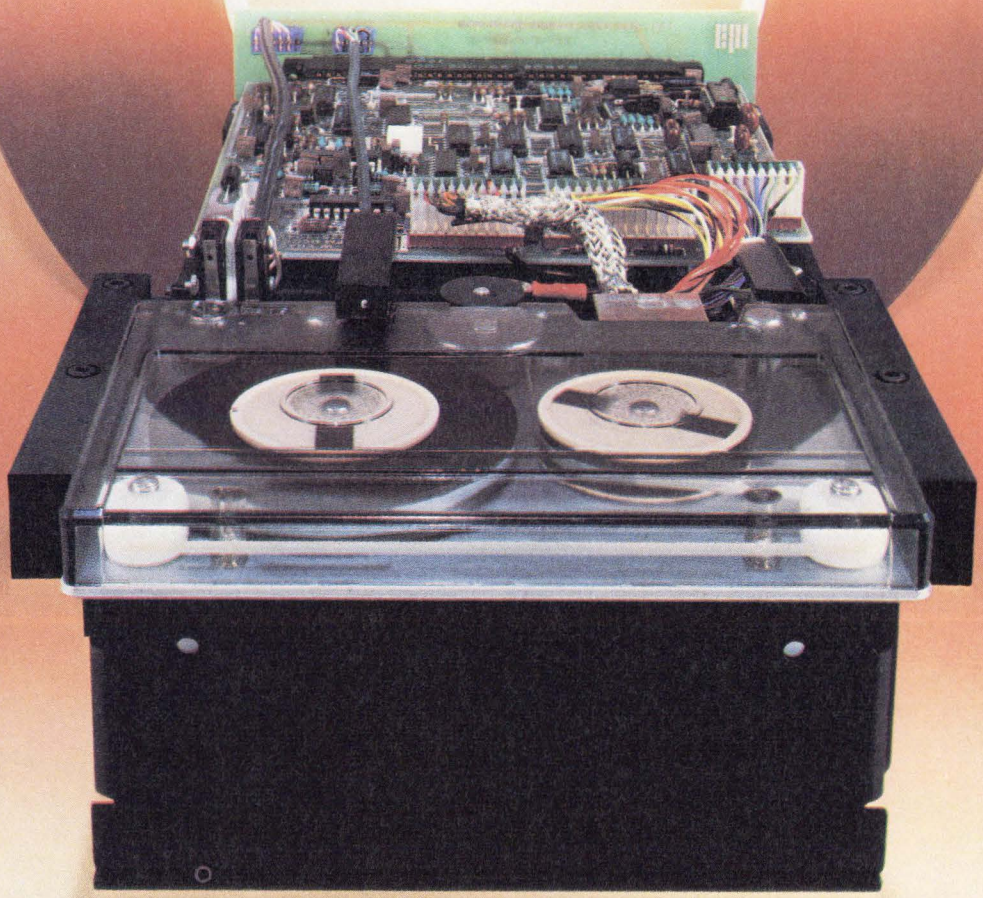

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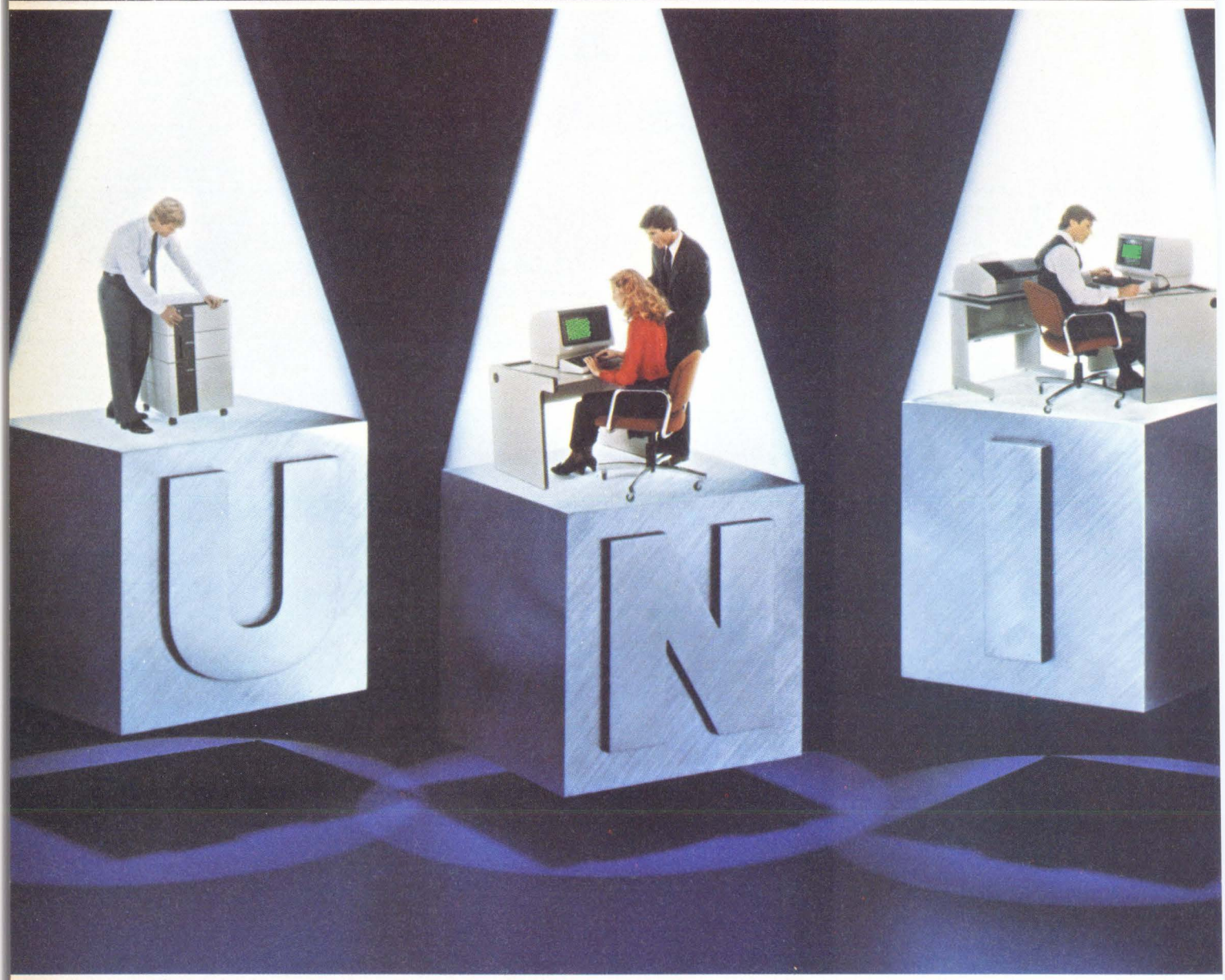

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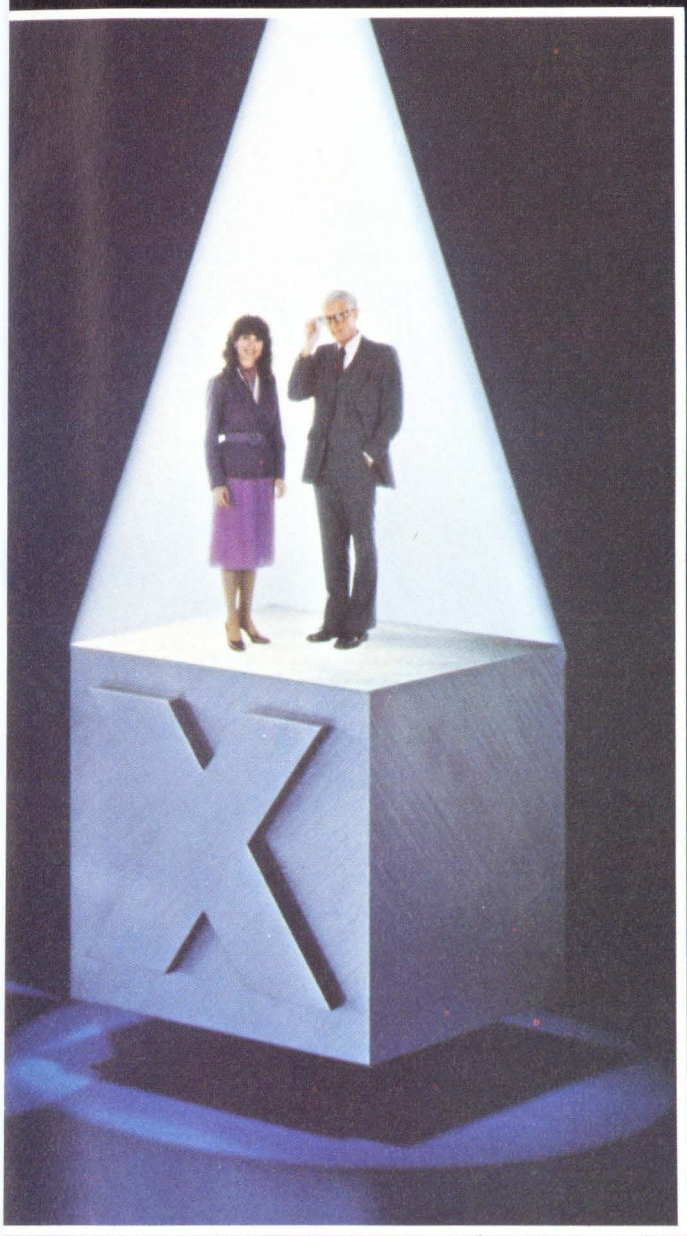

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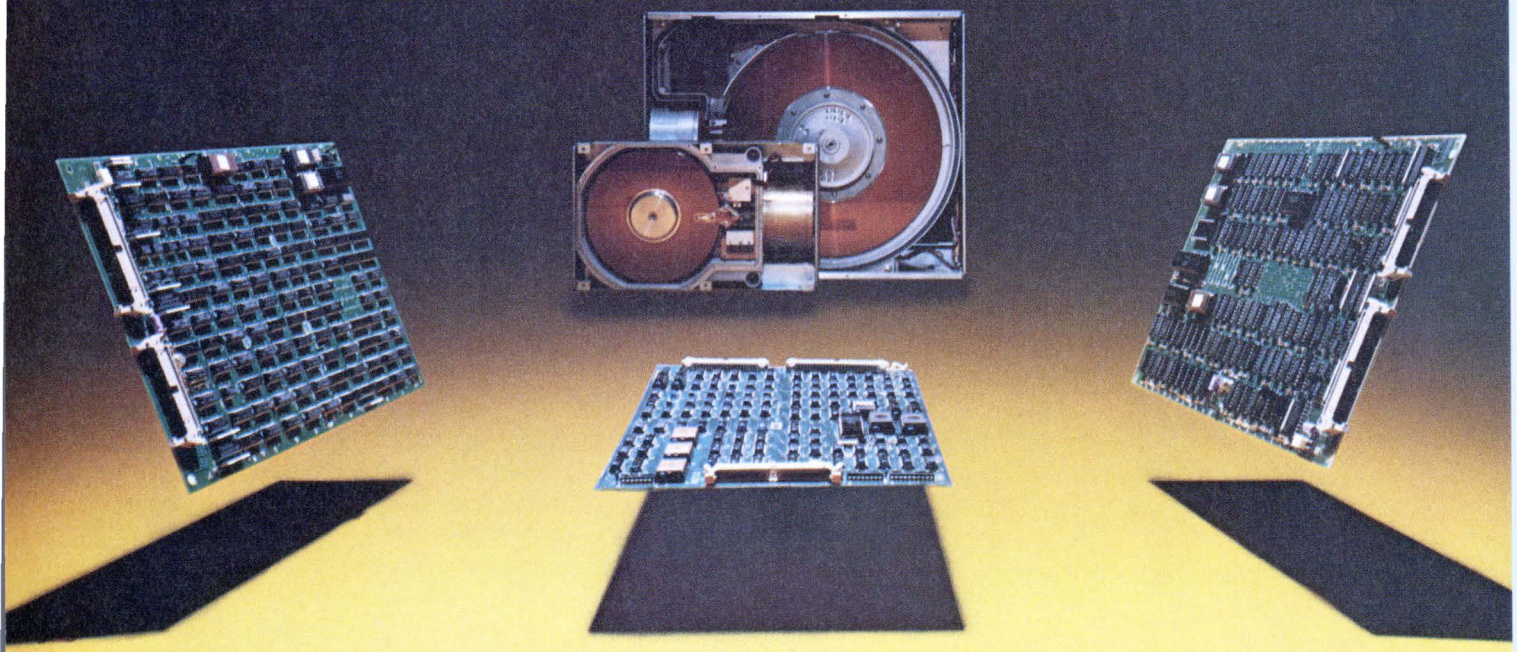

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estimates that the number of color raster-scan displays will increase 80 percent over the next four years from 50,000 installed units in 1981 to an estimated total of 250,000 in 1985. By 1986, about 85 percent of all graphics terminals will include color capabilities, says Wendy Abromowitz, an analyst with Venture Development Corp., Wellesley, Mass.

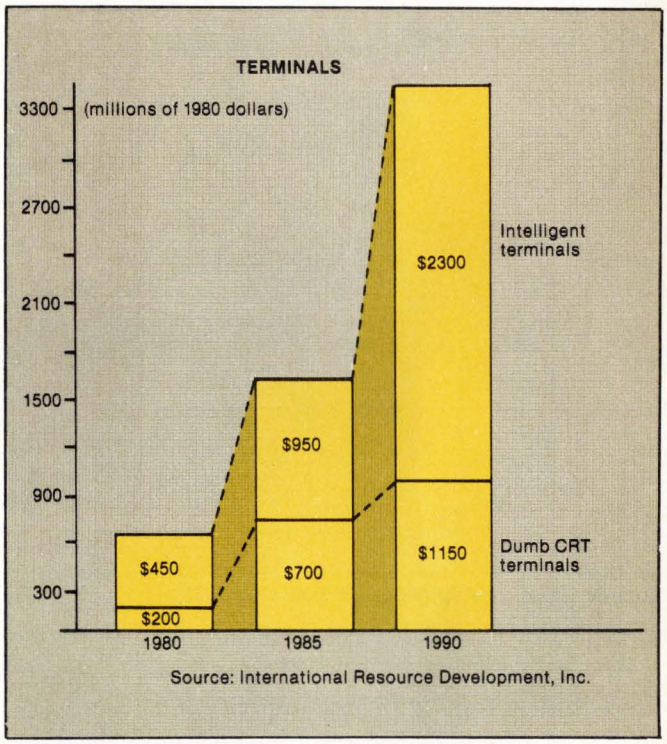
The pricing pressure that has hit the less-than-$1000 dot-matrix printer market may extend upward through the printer product lines. This is largely a result of increased competition from Japanese firms, said Jon A. Shirley, vice president of computer merchandising at Tandy Corp. Speaking at the Financial Analysts Federation conference, Shirley said, "Printers are an electromechanical product. Much of the same manufacturing technology that applies to video recorders can apply to a printer. Japanese producers typically are both vertically integrated and automated. They produce their own motors, PC boards, plastics and even some semiconductors." He predicted that, "Having reached a dominant share of the under-$1000 market, the Japanese will next achieve dominance in the $1000 to $2000 market for dot-matrix printers, which is the price range for most small-business printers. The Japanese also produce the only letter-quality daisy-wheel printers sold to end users for less than $2000. ... Despite the fact that the American suppliers to this market are larger companies than the dot-matrix suppliers, the Japanese will be very successful with daisy-wheel printers in America."

Winchesters lead the way in disk-drive industry

Disk drives will continue to set the pace for OEM peripherals sales over the next three years, say a number of industry analysts, with Winchester hardware in the less-than-30M-byte category leading in terms of units shipped, and Winchesters in the 30M-byte-and-higher range leading in terms of dollar volume.

Domestic U.S. sales of Winchester hardware in the less-than-30M-byte range totaled $42.4 million in 1980, representing more than 27,000 drives, says Jim Porter, Mountain View, Calif., industry analyst and publisher of *Disk/Trend Report*. These figures jumped to more than $110 million, representing more than 101,000 drives last year and are projected to hit $197.9 million by year-end, as nearly 198,000 drives will be sold. Projections for 1984 call for sales of more than 330,000 drives, representing a dollar volume approaching $300 million.

Top-selling units in this category will be 5¼-in. Winchester-disk drives, says Newark, Calif., industry analyst Andrew Roman. Roman says the worldwide market for 5¼-in. hardware accounted for 57,000 drives valued at $44 million last year, with the overwhelming majority delivered by Scotts Valley, Calif., Seagate Technology. This market will grow at a compound annual growth rate of 105 percent, Roman adds, and will hit more than 2 million units worth close to $2.9 billion by 1986.



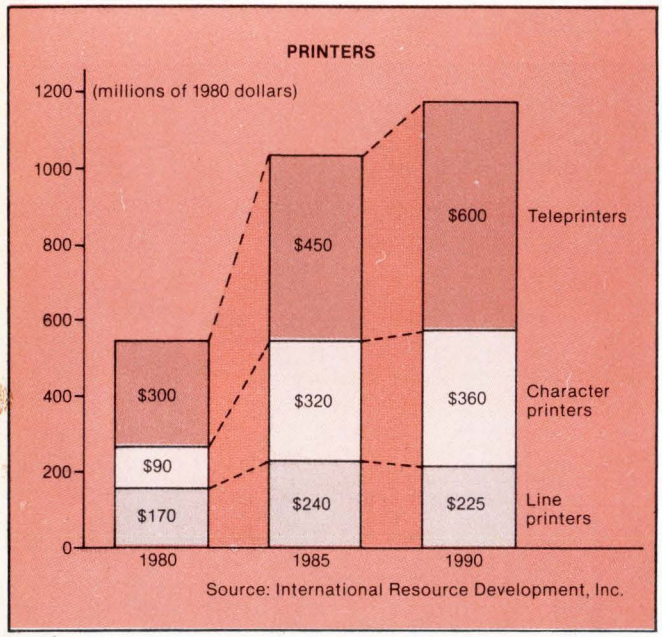
Intelligent terminal shipments *will show greater growth through 1990.*

Finis Conner, executive vice president and co-founder of Seagate believes these numbers to be slightly conservative, however. "We should ship 75,000 next year," he says. "The last half of 1982 will be very strong, with 1983 even stronger." Porter anticipates that 146,000 5¼-in. Winchesters will move next year, a number Jerry Lembas, senior vice president of Tandon Corp., Chatsworth, Calif., feels is a reasonable estimate of the size of the 1982 market. "It's anyone's guess though," he says. "If the big guys—Tandy, Commodore, Apple, DEC—really turn on, it could be a doable number."

Domestic sales of Winchester hardware in the 30M- to 200M-byte category will also continue to grow faster than other segments of the rigid-disk-drive industry, Porter notes, albeit at a slower unit pace than that projected for lower capacity drives. OEM shipments in this category totaled 7200 drives worth $25.3 million in 1980, Porter says, jumping to more than 29,000 drives worth $90.1 million last year. Porter estimates that shipments of Winchesters in this category will reach

close to 52,000 units worth more than $176 million by year-end, and will top 143,000 drives worth more than $415 million by the end of 1984.

Fueling the market for this hardware—principally



Growth of printer shipments *will slow after 1985.*

14-in. Winchesters with high-capacity 8-in. hardware coming on strong in 1983—will be a heavy demand for additional storage capacity in supermini-based systems and shared-logic word-processing systems. "System designers have a tendency to use Winchesters for these systems," Porter says, "rather than removable-media drives." The reasons: lower prices and high reliability.

Winchester shipments in the 200M-byte-and-higher category are also expected to increase over the next several years, although at a diminished rate. Last year, fewer than 3000 units worth $33 million were shipped into the OEM market. Porter estimates that this figure will almost triple by the end of 1982, with sales hitting $76.7 million. By the end of 1984, he projects, 14,300 units representing $138.7 million will be sold in the U.S.

Meanwhile, OEM sales of floppy-disk drives also continue to grow. Total U.S. sales for all types of hardware hit approximately $230 million in 1980, and are expected to reach more than $327 million by the time 1981 is closed out. Sales of close to $400 million are anticipated by year-end, with sales of more than $500 million forecast for the end of 1984. Double-sided, 5¼- and 8-in. drives are the fastest growing categories, according to Porter's figures, with 5¼-in., single-sided hardware growing at a slower pace, and 8-in., single-sided drives beginning a decline this year, from an estimated 346,000 drives worth $104.4 million to 337,000 drives worth $96.4 million by the end of this year. Domestic U.S. sales of 8-in., single-sided floppy-disk drives may sink as low as 183,500 drives worth $49.5 million by the end of 1984, Porter says.

In contrast, 5¼-in., double-sided drives will show a strong growth pattern during the same period, he says, with almost two-thirds of the drives in this category destined for use in small-business computer systems by the end of 1984. OEM shipments of 5¼-in., double-sided hardware totaled more than $27 million in 1980, rising to an estimated $58.1 million last year. This represents unit shipments of 119,400 and 244,100 drives, respectively. Sales for 1982 may reach more than $95 million, representing more than 440,000 drives, Porter says, but Tandon's Lembas thinks that figure may be too low. "We should do 500,000 drives ourselves next year," he says. "We're shipping at the rate of 55,000 5¼-in. drives per month, 80 percent of which are double-sided hardware." Porter projects that worldwide OEM sales of 5¼-in. units will total 558,900 units by year-end and 994,800 by the end of 1984. U.S. OEM sales will total 746,100 units in 1984, he says.

Datacomm segment shows LAN growth

As information-processing equipment has become more ubiquitous and users have outgrown the capacity of their local systems, use of data-communications equipment and services has boomed. Overall, the diverse segments of data communications, including equipment and transmissions, are growing at 22 to 24 percent each year, says John Malone, president of the Eastern Management Group, Morris Plains, N.J.

Some market sectors have experienced much higher growth than the composite rate, but these segments are new and still small; thus, they don't exert a major influence on the overall growth rate, Malone says. Roger Evans, executive vice president at Micom Systems, Inc., for example, says the market for the company's port-selector sales has grown 75 percent over the past year. Malone says that growth is linked to the growth of the small, local-area network market. "If you figure there are about 100 local nets in existence today, and that next year, there will possibly be 500, you've got massive growth," he says, "but you're working with awfully small numbers."

During the past year, the LAN market was a hot topic, as it moved from experiment and theory into more widespread commercial practice. Impressive growth potential in LANs has drawn scores of companies—both industry giants and tiny start-ups—into the LAN fray. Xerox Corp., with its single-channel, baseband Ethernet, remained the focus of much activity, and also emerged as the primary target for LAN

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companies promoting alternative technologies. Partly because of these assaults from broadband vendors and others, and partly because of internal production and delivery problems with its Star work station, Xerox installed only about 45 Ethernets by year-end, 1981—a figure far below the company's projections. Yet Xerox still has a jump on broadband LAN vendors, which are only now gearing up for major market penetration.

In a recently released study by Venture Development Corp. entitled "Local Area Networks, 1981 to 1990: A Strategic Analysis," the LAN market is predicted to attain shipments worth $264 million by 1985 and more than $1 billion by 1990. Even in a worst-case scenario, the study predicts, 1990 shipments will reach $622 million. Eastern Management Group market projections for nonproprietary LANs indicate that 3000 LANs will be installed during 1985, and as many as 10,000 will be installed during 1990.

The U.S. recession has slowed the purchase of high-ticket items and complete systems, says Micom's Evans, but low-priced equipment such as the kind that Micom sells has not suffered noticeably. Projections from IRD indicate that most data-communications equipment has a healthy future (see table). Even some high-cost systems have done well during the past year, however. Malone says 1981 was a surprisingly strong year for private branch exchanges. AT&T's migration strategy of raising prices on its aging PBX equipment, combined with customer realization that interest rates would probably remain high, prompted a flurry of purchases midway through the year. As a result, many PBX companies experienced growth rates of 35 to 100 percent this year, Malone says. ■

Mini-Micro Systems editors contributing to this report were Eric Lundquist, Dwight B. Davis, John Trifari and Kevin Strehlo.

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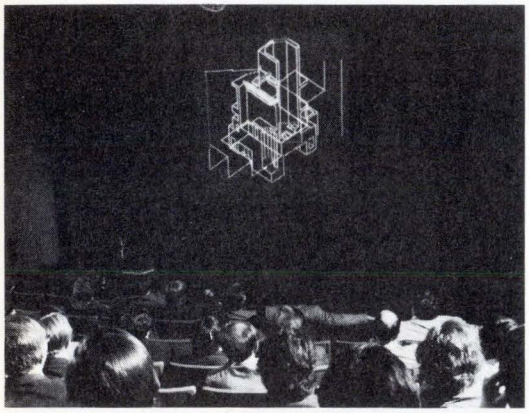

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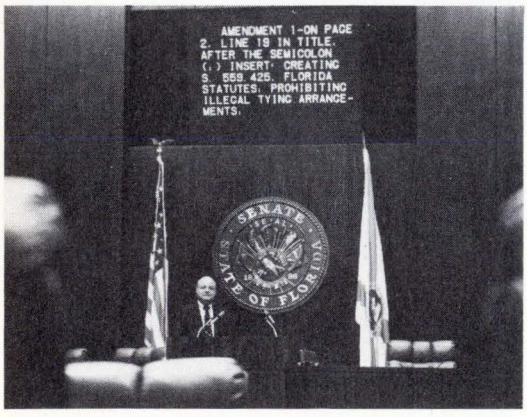

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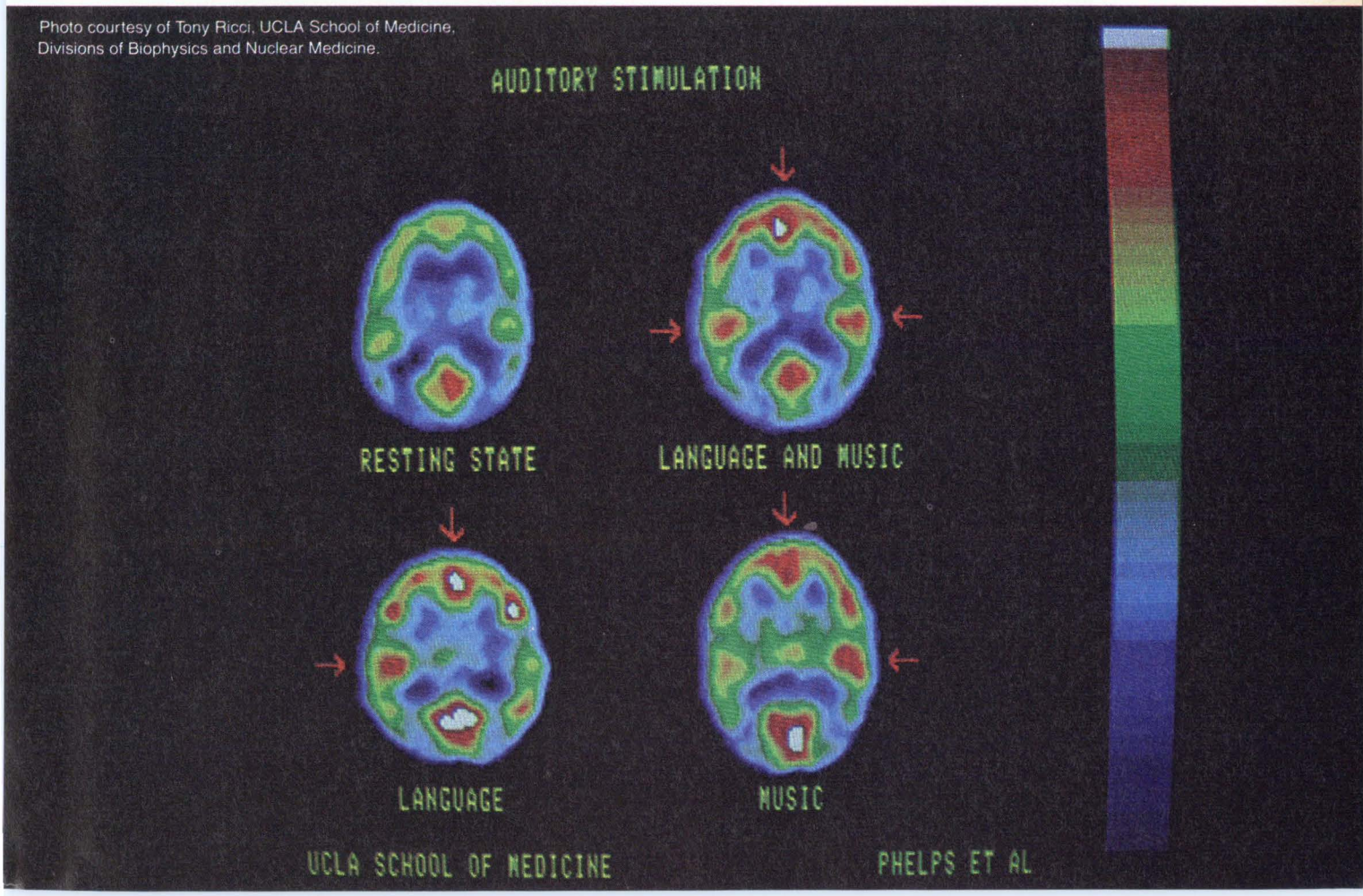

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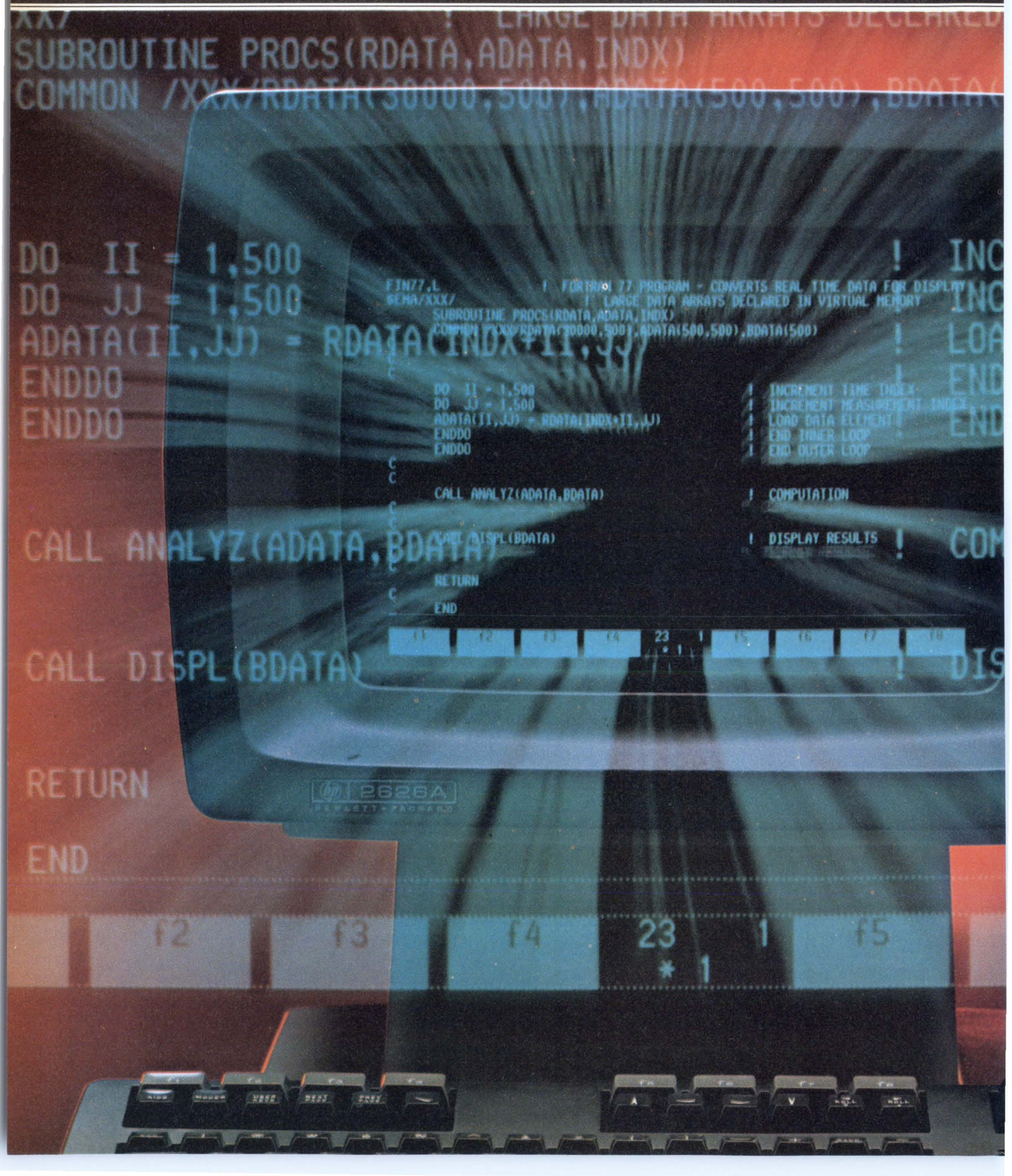
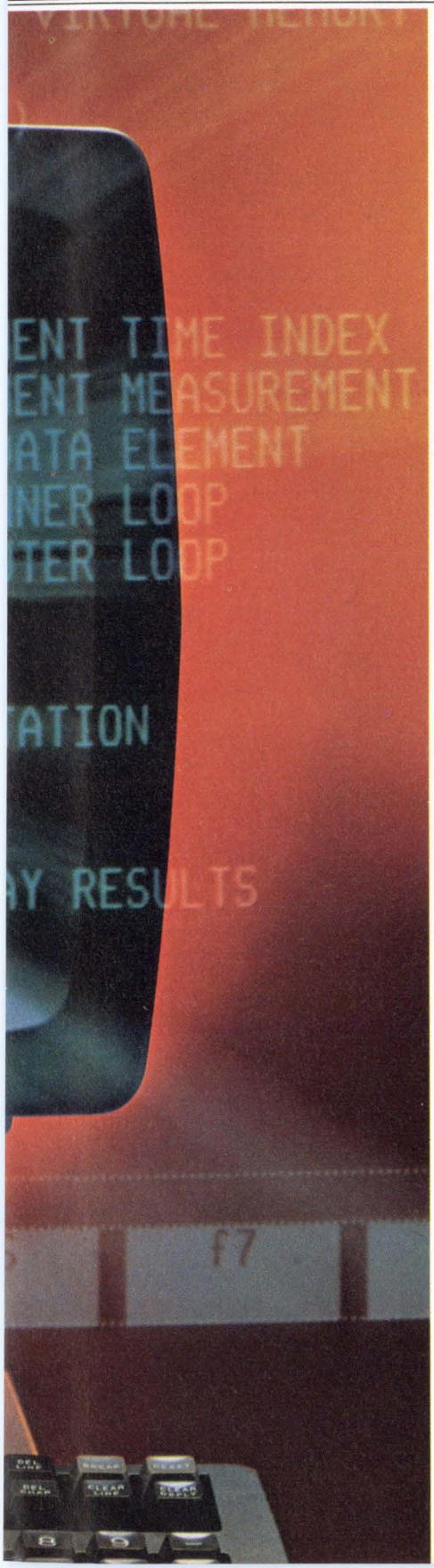


1000 Model 65: sitting at a mainframe.



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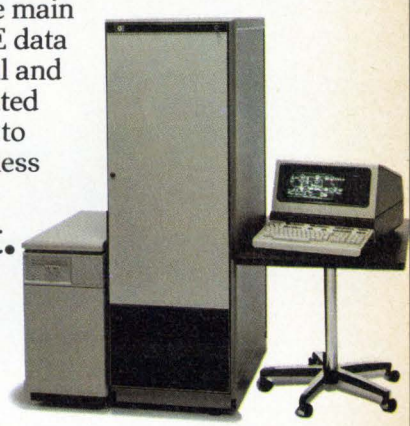

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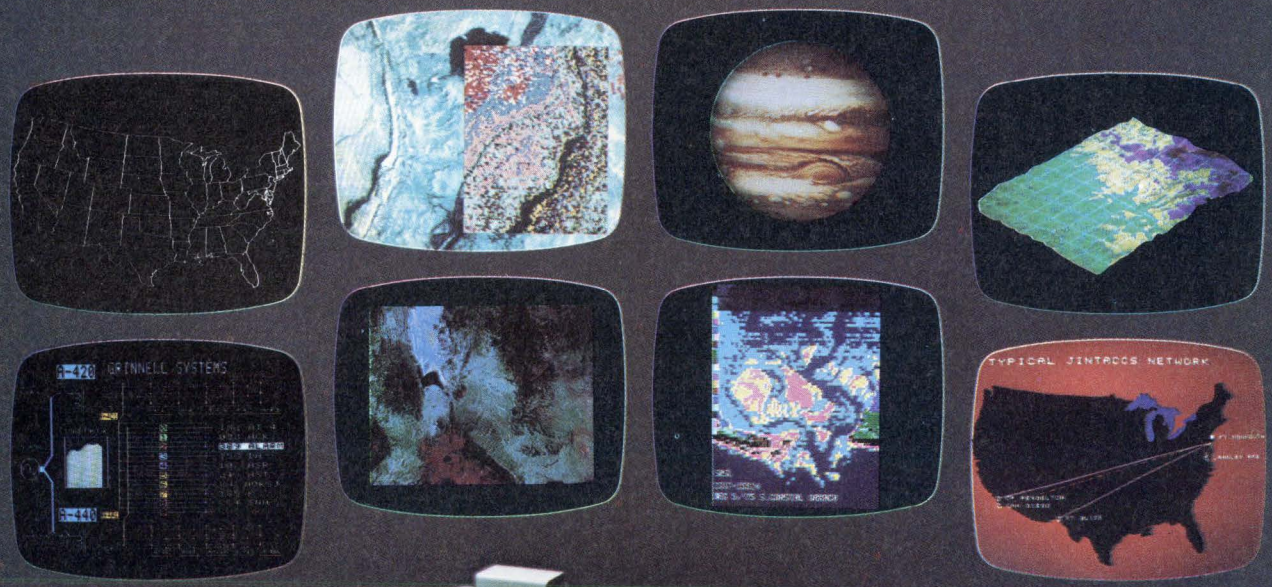

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Congress ponders the AT&T settlement

By Arthur Hill
Washington Correspondent

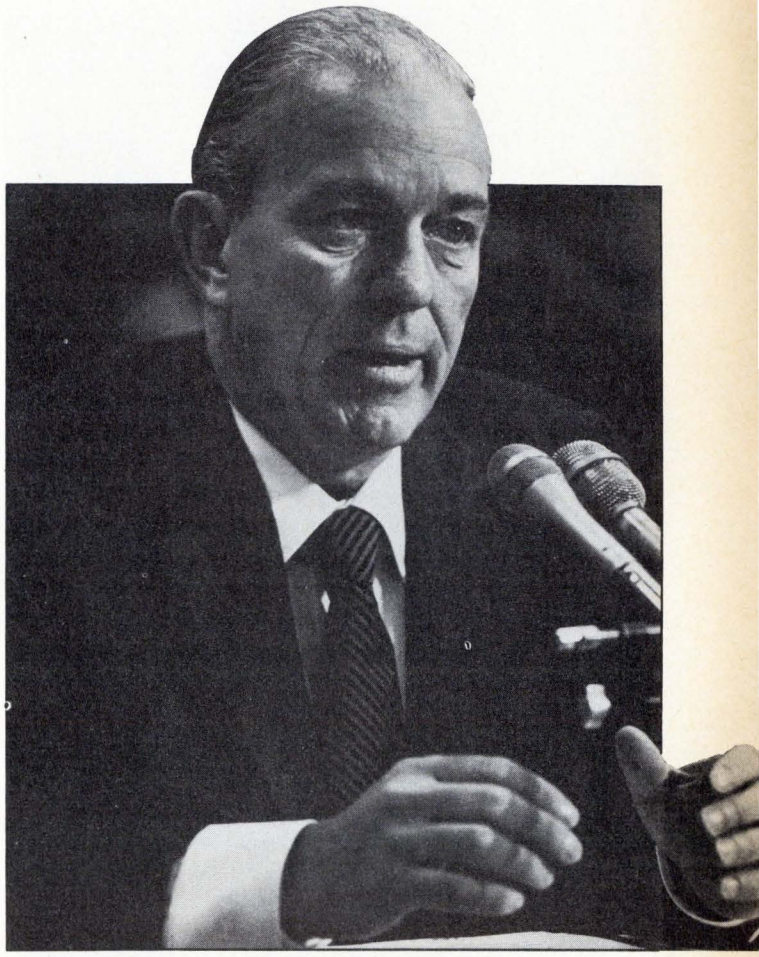
Members of Congress returned to Washington last month to face a full plate of legislative issues. Among them was what—if anything—should be done with legislation amending the Federal Communications Act in the wake of the historic settlement between AT&T and the Department of Justice.

Predictably, the decision to end years of litigation by separating AT&T from its local operating companies found supporters and detractors in the House and Senate. Among those supporting the decision was Senator Barry Goldwater (R., Ariz.), who announced the settlement was "the wisest reached during my life." Goldwater added that he hoped the attention the consent decree was receiving on Capitol Hill would not encourage legislation. "We don't know just where legislation is needed," the chairman of the Communications Subcommittee said. "We need to understand what it means and pray that we will not be deluged with legislation prompted by local politics."

What Goldwater had in mind was the impact on local telephone rates the decision would have. Since the settlement was announced in early January, Bell spokesmen, as well as several executives of local operating companies, have said that rates could climb by as much as two or three times present levels.

But in his appearances before Congressional committees, AT & T chairman Charles Brown, who approached the Justice Department to seek a resolution of the antitrust suit, said that local rates would not be affected by the settlement. "Upward pressure on rates is a result of today's competitive environment and inflation," he said, adding that he expects the average local rates to rise at a 10-percent clip over the next few years.

Not all the concern about the settlement was over local rates. Some congressmen fear that AT&T, with its massive revenue base from regulated long-distance revenues, could subsidize their Western Electric manufacturing subsidiary at the expense of almost all computer manufacturers. "We must make certain that fields in which the new, restructured AT&T competes do not become less competitive as a result of the entry of this telephone giant," said Representative Edward Markey (D., Mass.). "While we may have divested the giant gorilla of 200 or even 300 lbs., it may still sit wherever it wants."



AT&T chairman Charles Brown: *"Upward pressure on rates is a result of today's competitive environment and inflation."*

Markey is one of only a few legislators who raised the possibility that AT&T might use rate-regulated revenues to subsidize its giant manufacturing arm. "The regulators will watch closely if the price of our services and equipment change," Brown said. "The market will also stop subsidies, because it would mean that long-distance prices would be higher."

Congressional communications experts also seem anxious about how the 22 local-exchange companies (LECs) would fare once spun off by AT&T. The 22 LECs control about 80 percent of the "local loop" throughout the country. Inter-city computer networking would likely pass through this gateway, and, as a result, local telecommunications services were initially concerned.

Ohio Democrat Ronald Mottl said, "When AT&T calculates its balance sheet, it should include the Justice Department as one of its biggest assets." Mottl and others insist that the LECs got an unfair deal in the settlement. They maintain that because the LECs cannot own or sell terminal equipment, realize any

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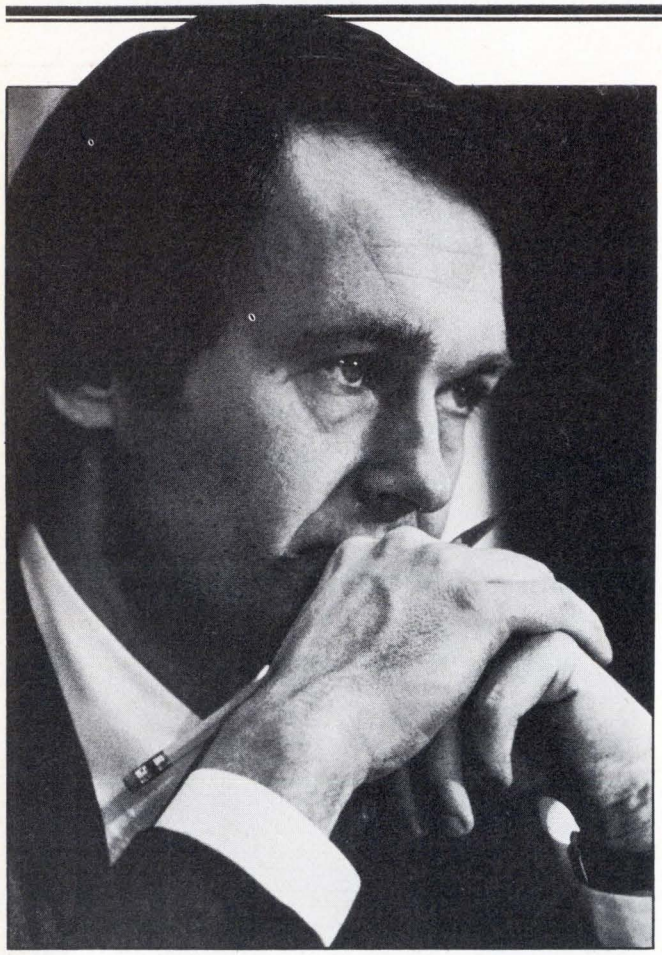
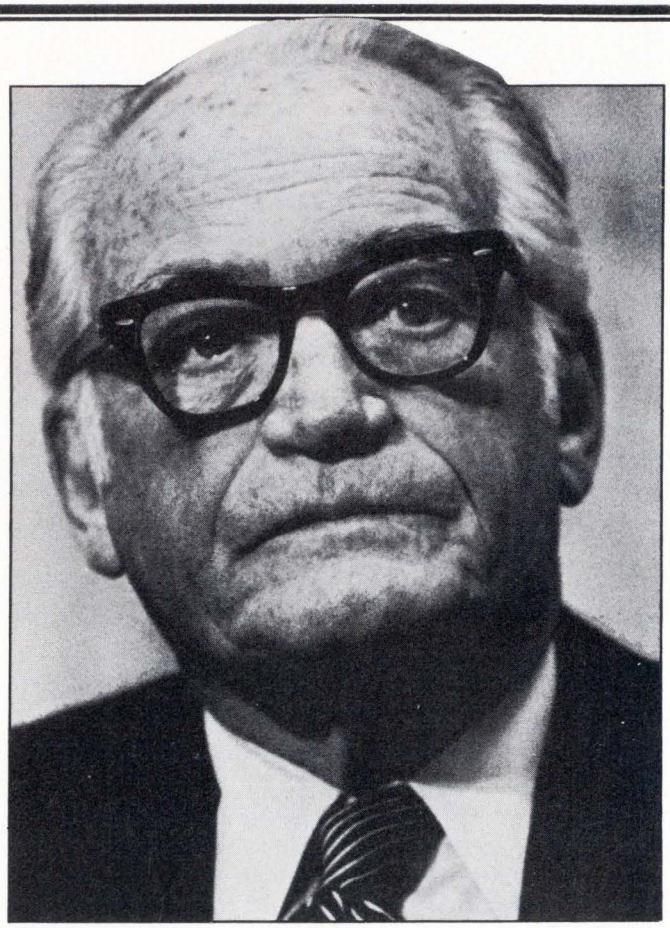


Representative Edward Markey: *"While we may have divested the giant gorilla of 200 or even 300 lbs., it may still sit wherever it wants."*



Senator Barry Goldwater, *chairman of the Communications Subcommittee: "We need to understand what it means and pray that we will not be deluged with legislation prompted by local politics."*

revenues from the Yellow Pages or share in the revenues generated by long-distance calling, the companies face bleak prospects in the years ahead.

Brown denies that AT&T will spin off its local exchange assets to become what some have called the railroads of the 1980s. He says that "no responsible manager would spin off two-thirds of his assets and maltreat those two-thirds." He also says that the new companies would be launched with "good balance-sheet conditions," adding that their position as a monopoly in nearly all markets, the fact that they provide a vital communications service, their growth potential and their status as the "gateway to the information age" position them well for the future.

"The establishment of LECs barred from providing inter-exchange or information service eliminates any incentive or potential to use local exchange facilities as a bottleneck," Brown says. "To the contrary, the incentive of the LECs will be to connect any and all users to local-exchange facilities, thereby enhancing the LECs' local-access revenue stream—a revenue stream that will be important to their financial viability."

But some observers still maintain that the new consent decree, once it goes into effect, will be too restrictive for the LECs. "The loss in revenues, plus inflation and the cost of labor, is going to put them in a tremendous bind," says Harry Shooshan, a principal in a telecommunications consulting firm, and until last year, the majority counsel for the House Telecommunications Subcommittee.

Another who believes the state regulators must address their rigid regulation of local telephone companies is Phil Verveer, formerly chief of the FCC's Common Carrier Bureau and once a leading attorney in the government's antitrust action against Bell. "The restrictions are so rigid they will not hold," Verveer says. "Rather than regulatory creep, the decree will begin to give way."

Computer interests that for years have battled AT&T's entry into unregulated telecommunications markets will not be pleased with such predictions. If the predictions come true, those interests must fight the same battle in state legislatures or regulatory agencies they have been fighting in Washington for years. It is unlikely they will stand by while the LECs, with their monopoly control of the country's information pipelines, seek a commanding interest in information sources as well. ■

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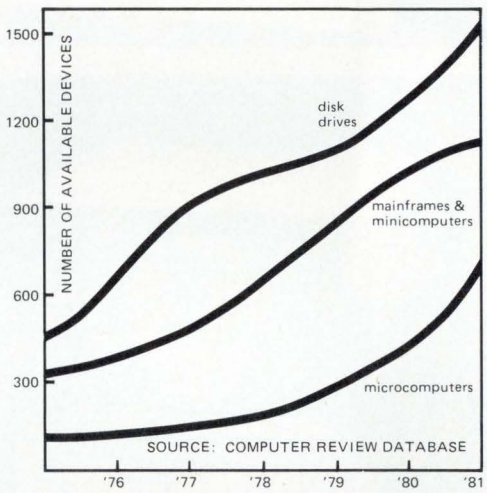

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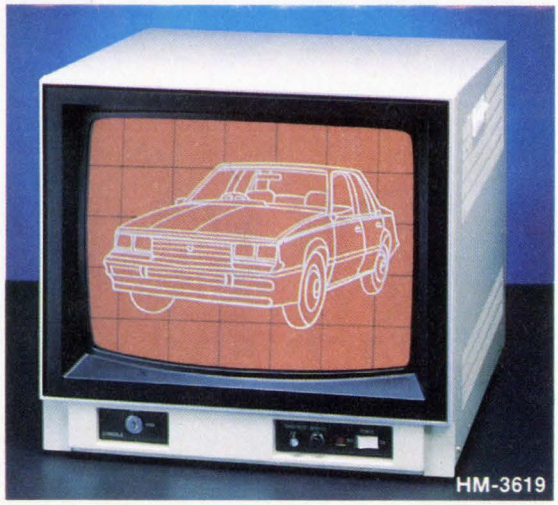

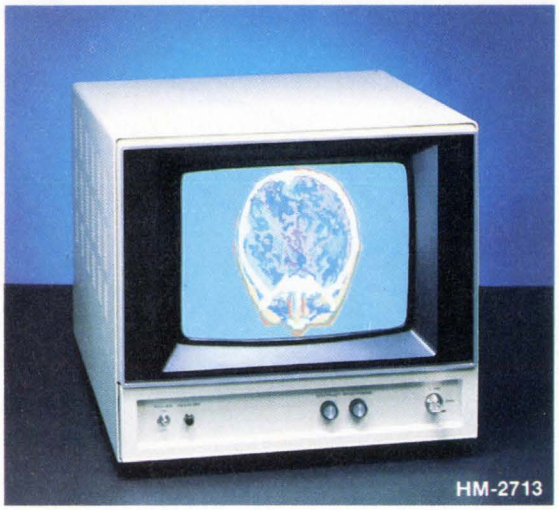

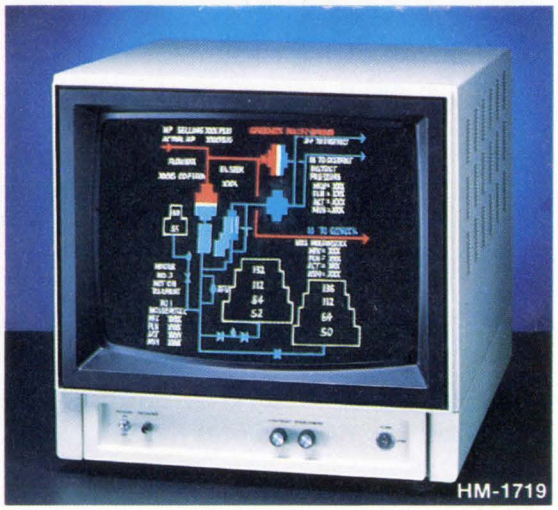

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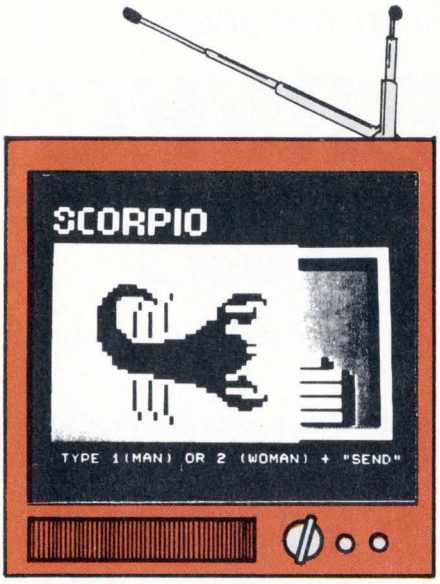
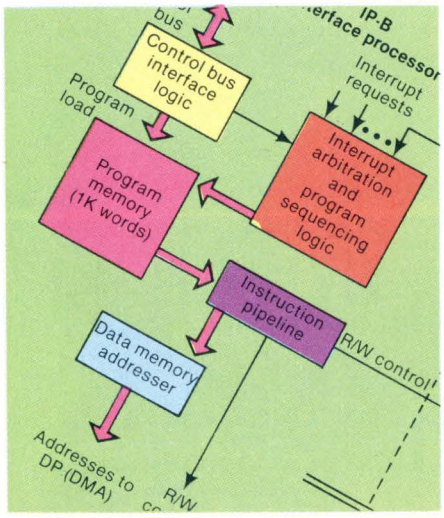


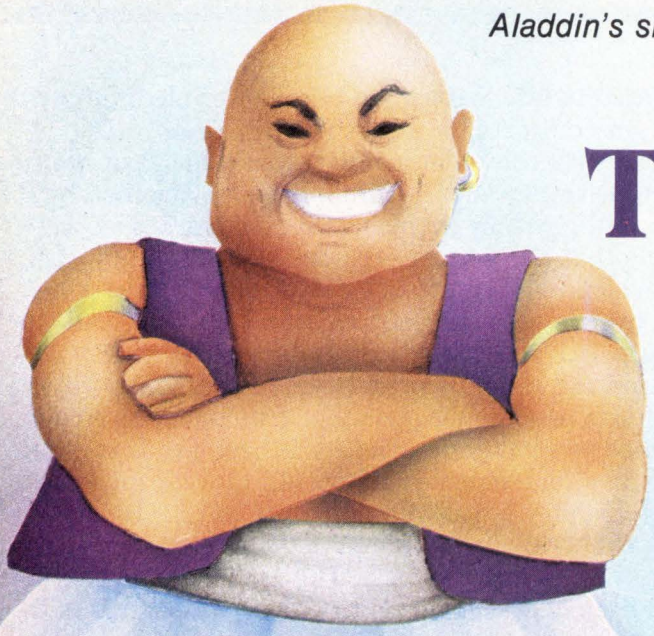
DATA COMMUNICATIONS: Just when users of minicomputers and μcs began to get comfortable with the equipment and concepts associated with their electronic helpers, data communications came along with new and unfamiliar terms. Ironically, it is the widespread proliferation of these inexpensive computers and their terminals that has engendered the need for, and stimulated the development of, effective data-communications networks. For an overview of the datacomm market, see the article starting on p. 121 . . . For minicomputer and μc users, voice-grade modems and the public telephone system are what make distributed data processing possible. The inclusion of μps into voice-grade modems has revolutionized these products and has added several new features that a potential buyer must consider. A comprehensive survey begins on p. 127 . . . In the second of a three-part series on local-area networks, contributing editor Walter A. Levy and his associate, Harriet F. Mehl, discuss matrix-switched local networks that use star architectures and twisted-pair wiring. Their article starts on p. 147 .

VOICE TECHNOLOGY: The VoiceWare development system from Centigram Corp. is a μc-based "digital voice studio" with all the hardware and software needed to create real-time, high-quality voice capabilities for virtually any application. A user can create voice messages in real time and record and update digital speech files as easily as using a word processor. The speech files can then be transmitted to a host computer and debugged using special test-support features. The cover story on VoiceWare begins on p. 183 . . . System integrators and computer and peripheral manufactuers stand to gain from the settlement of the antitrust suit against AT&T. That's one of the conclusions of Robert Bigelow, an attorney who specializes in the legal problems of the computer industry. At the same time, however, the AT&T reorganization will leave the communications giant unregulated, except for the Long Lines department. Bell will then be a major competitor, and there will be no holds barred. For an in-depth analysis of the settlement and its effect on the computer industry, see p. 195.



MICROCOMPUTERS: When Mostek Corp. found that its STD bus-compatible Matrix μcs occupied too many card slots, the company designed the Z80-based MDX-CPU3 board. The board has eight 64K RAMs that accommodate the addressing range of the Z80 CPU along with serial and parallel I/O—functions that previously needed as many as five cards. This, combined with the STD bus and a CP/M-compatible operating system, provides a flexible system that can be configured for various applications. For a description, see p. 203 . . . Over the last 10 years, array processors have typically been used in large, general-purpose computer systems. But, now that most recent array processors sell for much less than $20,000, the processors are beginning to appear in many μc-based systems. The ability to modify programs and parameters makes the arithmetic peripheral attractive to many system integrators. An explanation starts on p. 209.

Aladdin's slave was pretty good . . . but ours is even better.



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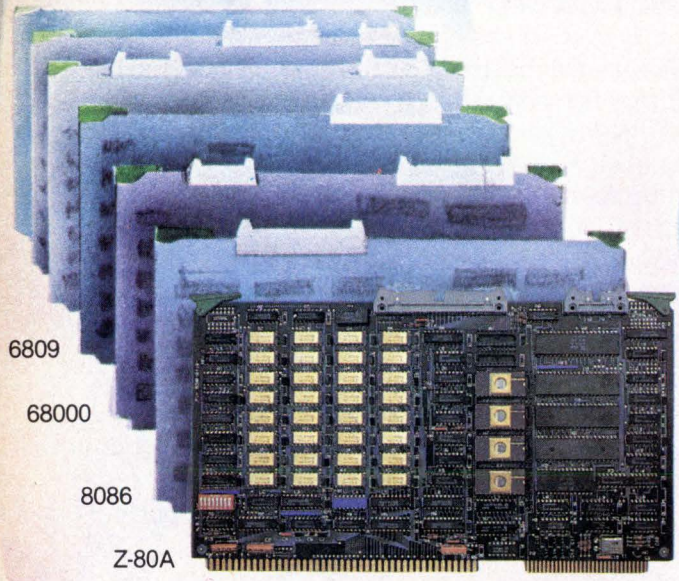

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CIRCLE NO. 60 ON INQUIRY CARD

Datacomm's presence grows in small-computer markets

DWIGHT B. DAVIS, Associate Editor

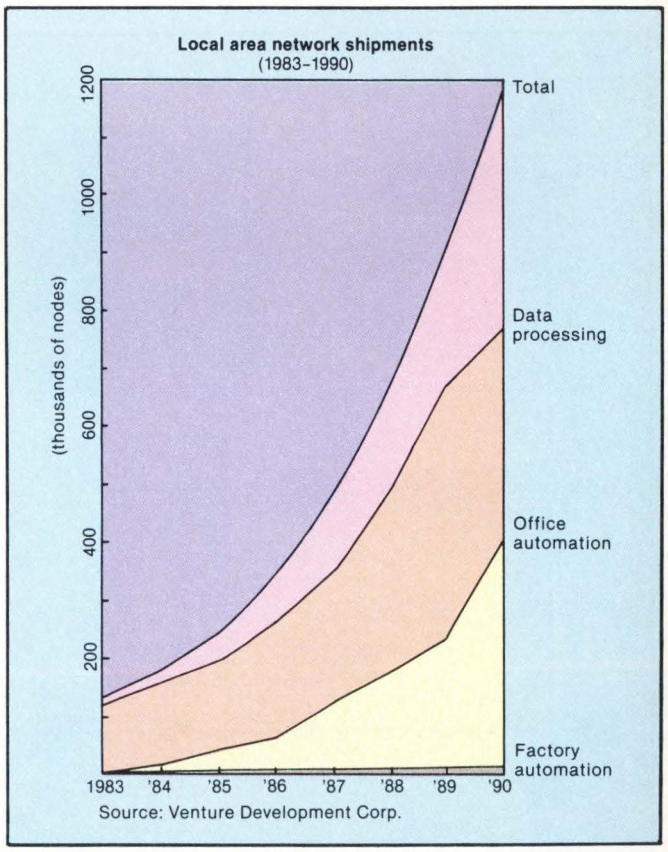
The proliferation of inexpensive computers is stimulating the development of effective datacomm networks

Just when users of minicomputers and μcs began to get comfortable with the equipment and concepts associated with their electronic helpers, data communications came sneaking out of the woodwork. Once again, eyes glazed as new and unfamiliar terms—baud rates, multiplexing, local-area networks, encryption and electronic mail—entered the small-computer vocabulary. Ironically, it is the widespread proliferation of these inexpensive computers and their terminals that has engendered the need for, and stimulated the development of, effective data-communications networks.

Several years ago, the term "distributed data processing" came into vogue when users realized that the traditional, centralized mainframe computer could often be beneficially replaced by two or more linked minicomputers. It wasn't until the mushrooming of μcs and intelligent terminals, however, that distributed data processing really took off. Powerful and inexpensive μps, combined with low-cost storage, have allowed placing as much computing power as possible near the people requiring the power.

Local networks emerge

Over the past year, a subset of distributed data processing has captured the attention of users and vendors alike—local-area networks. Proprietary LANs have existed for several years: Datapoint Corp., for example, introduced its Attached Resource Computer (ARC) network in 1977 and now has more than 2000 ARCs installed. But it was the idea of attaching unlike



Local-area network shipments will soar, *posting a 36-percent average annual growth rate over the last seven years of the decade. Annual sales volume will increase from $156 million to $1.065 billion over the same period. On the graph above, a node represents a cluster of eight terminals or similar devices.*

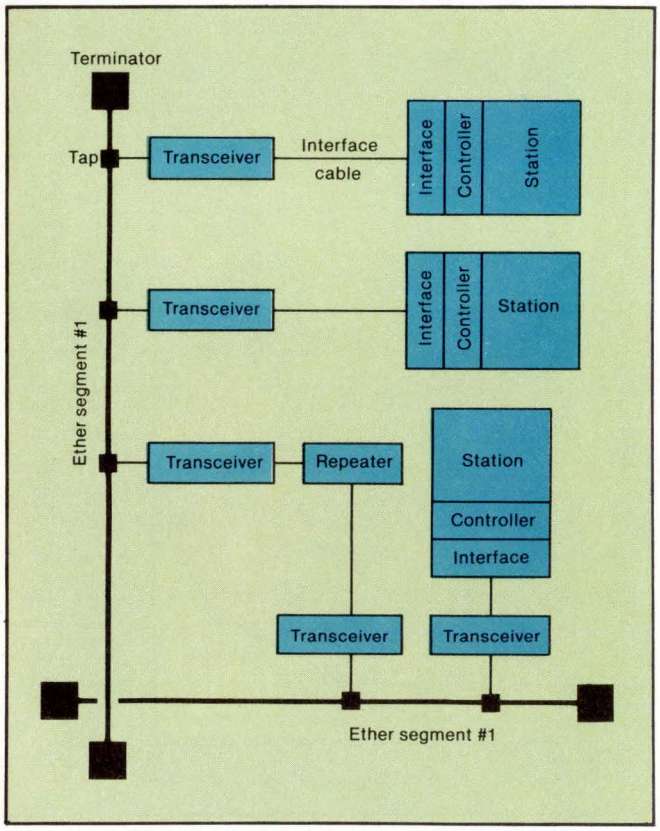
The idea of attaching unlike computers and terminals through general-purpose LANs caused a flurry of vendor R&D activity and user anticipation.

computers and terminals through general-purpose LANs that caused a flurry of vendor R&D activity and user anticipation.

The flagship of the general-purpose LAN approach has been the Ethernet network developed by Xerox Corp. and backed by Intel Corp. and Digital Equipment Corp. By the beginning of this year, nearly 50 Ethernets had been installed, and several vendors were gearing up to offer Ethernet-compatible equipment. But Xerox failed in its attempt to have Ethernet established as the industry standard for baseband LANs, a failure that has encouraged competitive networks.

In the single-channel baseband arena, the IEEE 802 Local Network Standards Committee proposed two fundamental approaches for accessing LANs: carrier sense multiple access with collision detection (CSMA/CD) and token passing. While each approach has its proponents, there seem to be various applications for which one or the other method is best suited. Unfortunately for Ethernet's supporters, the proposed CSMA/CD standard is slightly different from Ethernet's CSMA/CD implementation.

The highly visible Ethernet has also become the target of vendors who have selected the multi-channel broadband LAN approach. Among other broadband vendors are Wang Laboratories, Inc., with its Wang-Net, and Sytek, Inc., which has shipped more than 35 of its LocalNet systems. Keying heavily upon broadband's potential to carry video and interactive voice traffic along with data transmissions, the broadband camp has attacked baseband LAN limitations in this area. But here, as in the CSMA/CD-versus-token-passing debate, there seem to be legitimate needs for both approaches.



Stations connect to the Ethernet network *bit-serially through an interface cable to a transceiver, which in turn taps into the coaxial cable. Here, a two-segment Ethernet incorporates a repeater for signal regeneration between segments.*

OSI model guides development

One result of all the LAN activity has been the blossoming of the International Standards Organization's seven-layer reference model for networking architecture. Essentially a guideline for network design, this Open Systems Interconnection model has been accepted by most designers as a worthy foundation upon which to build, although adherence to the model by no means results in the production of compatible networks. Incompatible networks that incorporate the seven-layer architecture, however, are more readily adaptable for inter-network communications.

Local-area networks, such as Ethernet, specify interfaces and protocols only for the lower two or three levels of the seven OSI layers. While such standardization allows the connection of unlike devices within the network, standard protocols at the higher layers are required for true inter-device operations. Late last year, Xerox moved to make Ethernet live up to its claim of being a general-purpose LAN by publishing the protocols used by Xerox devices at layers three through six.

A technology related to LANs—and competitive with them in some instances—is that of digital private branch exchanges (PBXs). The list of vendors offering PBXs that carry data-communications traffic along with their primary voice transmissions includes Rolm Corp., Northern Telecom, Inc., Intecom, Inc., and Anderson-Jacobson, Inc. Data-transmission rates of the digital PBXs typically fall well below the rates provided by baseband and broadband LANs, relegating the PBXs, in some eyes, to terminal-to-terminal communications rather than computer-to-computer transmissions. Still, while many observers believe the best configuration for such PBXs will be in parallel operations with some sort of LAN, others promote the concept of the PBX as a supercontroller, handling all of a company's voice and data-communications requirements.

One networking application that has received considerable attention is electronic mail. Initially available from vendors as an off-premise subscription service, electronic mail is evolving into software packages for use on companies' internal word- and data-processing systems. International Business Machines Corp., DEC,

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The NURAM system from National is an entirely new on-line memory resource for DEC UNIBUS systems. It's up to 32MB of auxiliary data storage. And it's all self-contained in a 12.5" high rack-mountable chassis, including the indicator panel, power supply, and cooling.

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Better performance, higher integrity. NURAM consists of a memory controller and up to 16 two-megabyte memory boards, each containing more than 64KB of spare storage space. It's interfaced to the UNIBUS via National's powerful HEX-3000™ multi-device controller.

But as far as the operating system is concerned, NURAM looks exactly like an RS04 FHD subsystem, only faster. And in many respects, NURAM behaves much like a disk. For example, whenever a NURAM read or write operation detects a hard error, the entire data "sector" is transparently located to one of the card's spare RAMs and NURAM's map index is updated.

Finds errors and corrects them, too. But that's where the similarity ends, especially when it comes to system reliability and integrity of the stored data.

Since all writes into NURAM include a read/compare and three automatic re-tries should the first compare fail, data integrity is greatly improved.

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CIRCLE NO. 61 ON INQUIRY CARD

The highly visible Ethernet has become the target of vendors who have selected the multi-channel broadband LAN approach.

Wang, Datapoint Corp. and Prime Computer, among others, market electronic-mail packages.

International standards activity

Advances have also been made on the remote-transmission scene. X.25, the internationally accepted packet-switching standard, gained domestic support from both IBM and AT&T. In IBM's case, the X.25 interface gives that company's Series/1 computers access to packet-switched networks, even if the computers simultaneously operate within the Systems Network Architecture (SNA) environment. Slight variations in X.25 implementation exist from country to country, but the growing base of X.25 users makes this packet-switching protocol one of the more secure standards in the data-communications world.

A technology beginning to reach our shores after establishing itself in Europe is videotex (commonly called viewdata in England and the U.S.), a two-way information-dissemination-and-retrieval technology that can serve both residential and business users. Videotex functions as a central database accessible over telecommunications lines. Several videotex techniques have evolved, differing primarily in their methods of transmitting and reconstructing graphic displays. Britain's Prestel system, which has the only substantial user base, constructs images with a block-type alpha-mosaic technique. Canada's Telidon approach and AT&T's Presentation Layer Protocol method, on the other hand, use an alpha-geometric technique that produces more sharply defined graphics. As in all areas of data communications, work is under way to make the various approaches compatible enough to allow information exchange.

Open Systems Interconnection (OSI) reference model

Number	Layer name	Layer function
7	Application	Information exchange
6	Presentation	Syntax transformation; source encryption
5	Session	Source addressing; dialog structuring
4	Transport	End-to-end transfer assurance; system encryption
3	Network	System addressing; routing
2	Data Link	Single-link data transfer; link encryption
1	Physical	Physical circuit activation; bit transfer

The International Standards Organization's OSI model *serves as a conceptual guideline for groups developing communications standards and for companies designing networks. Most local-area networks address just the Physical and Data Link layers. Xerox has published the protocols its equipment uses at layers three through six. Source: Xerox Corp.*

Alpha-mosiac graphics generation, *as in this sample from Videodial, Inc., appears stair-stepped and not as smooth as the other major videotex method, alpha-geometrics.*

Modems/multiplexers get smarter

As all these new communications technologies come tumbling onto the market, some familiar products have been undergoing changes. By incorporating more and more powerful LSI chips, new modems and multiplexers are remaining price competitive with older products while offering new features. Many of the added features involve self-test and communication-line diagnostics. Users can more easily spot developing problems and, when breakdowns occur, can more readily isolate a defective component or line. Supported data rates are also jumping—several manufacturers have announced or plan modems in the 14.4K-bps range.

With the benefits of increased data communications come certain dangers. Users formerly secure in the knowledge that their sensitive data remained tightly under control now must face the possibility of unauthorized network access. Manufacturers such as Linkabit Corp., American Satellite Corp., Codex Corp., Fairchild Space & Electronics Co. and Motorola, Inc., offer digital encryption units to users needing to protect transmitted information. While varying in their coding methods, most recently announced domestic encryption devices incorporate chips that implement the Data Encryption Standard (DES) adopted by the National Bureau of Standards.

Behind all the products targeted at data-communications needs are companies ranging from five-person start-up firms to industry giants. The big corporate story in the communications field is the movement of AT&T from regulated telecommunications markets to deregulated status in the general information-processing and -transmission arena. Now accelerating in its approach to these fertile new markets—thanks to its recent antitrust settlement—AT&T with its innovative Bell Laboratories could become the most important player in the computer-based data-communications game. ■

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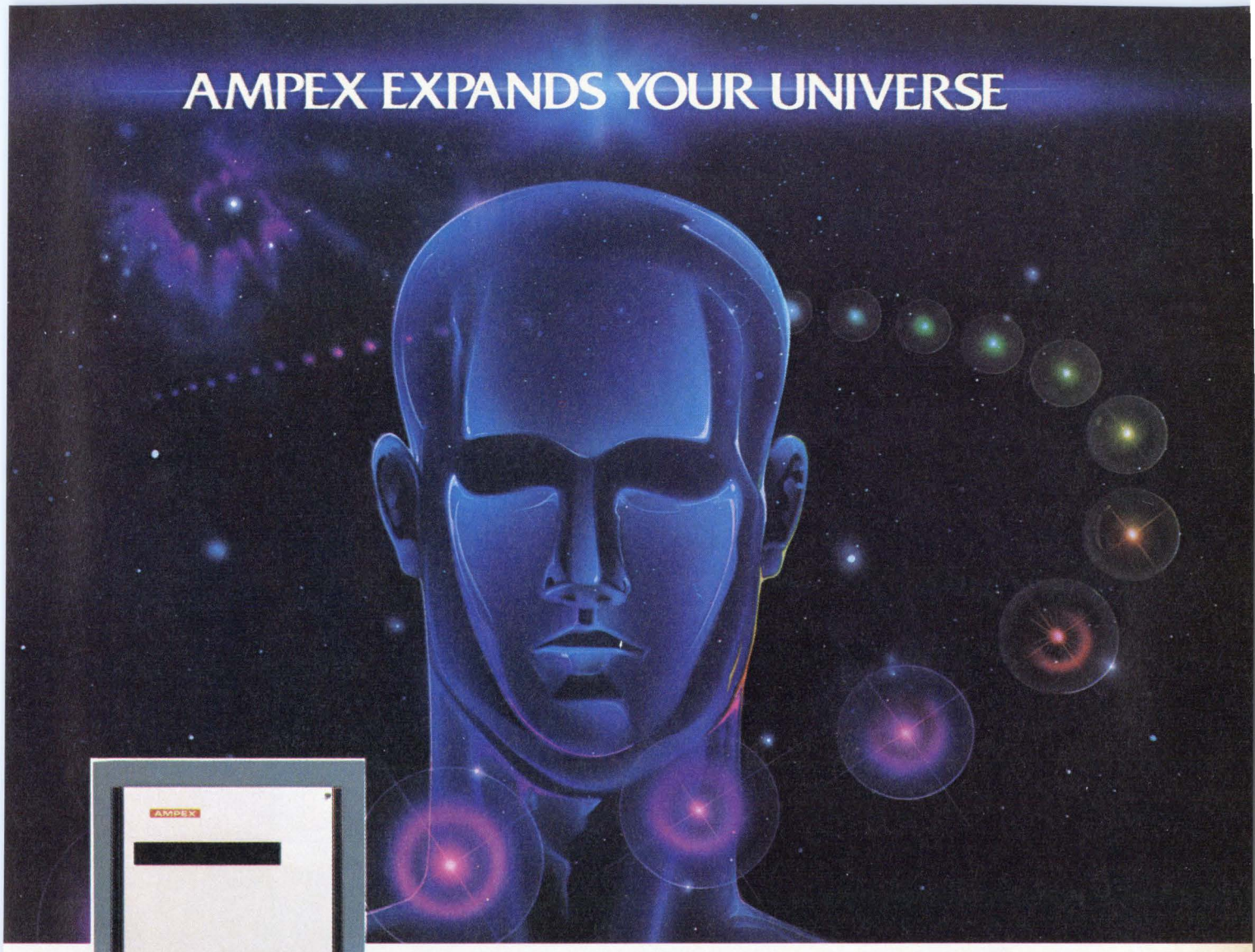

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T108	✓				✓	300
T212A		✓	✓	✓	✓	300/1200
T202S/T202T	✓	✓	✓		✓	1200/1800
TA201C	✓	✓	✓	✓		2400
T208A/B	✓	✓	✓	✓		4800
T209A	✓			✓		9600
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CIRCLE NO. 63 ON INQUIRY CARD

PRODUCT PROFILE: MODEMS

Data rates rise slowly, but features multiply

PATRICK KENEALY, Associate Editor

The inclusion of μps into voice-grade modems adds several new features that potential buyers must consider

Public telephone lines are the most popular carriers for connecting geographically dispersed data-processing systems. Private, twisted-pair wire, coaxial cable, radio, infrared, laser and satellite networks all connect data-processing centers, but especially for the minicomputer and μc user, voice-grade modems and the public telephone system are what make distributed data-processing possible. Public telephone lines are "voice-grade" lines that have a bandwidth of 3000 Hz (from 300 to 3300 Hz). This is adequate for voice transmission, but is a potential barrier for high-speed data transmission. This survey and the accompanying product table ignore high-speed, private-wire DC line drivers, wideband modems and short-haul modems in favor of the voice-grade modems that transmit over normal dial-up and leased telephone lines. The inclusion of μps into voice-grade modems has revolutionized these products since *Mini-Micro Systems* last surveyed them in March, 1980. The μp has added several new features to the list of standard characteristics that a potential buyer must consider.

"Modem" is an acronym for "modulator/demodulator." A modem connects to a digital device, such as a computer terminal, and, by modulating a carrier signal, converts its output to analog form for transmission to a remote computer or terminal. The modem also accepts incoming analog signals from the transmission line and demodulates them into digital form for the attached digital device. Amplitude modulation, FSK modulation, PSK modulation and a number of combination methods including DPSK and QAM are used (see "Basic modulation techniques," p. 129). While data modulation and demodulation are the modem's basic functions, the modulation method is user-transparent and should not be considered directly in modem evaluation. A modem buyer should instead consider the following easily understood modem specifications:

- **Data rate** is the transmission speed of the modem in bits per sec. Because "baud" means transmission line state changes per sec., not bps, and because some modulation techniques represent more than 1 bit with one state change, bps does not always equal baud.

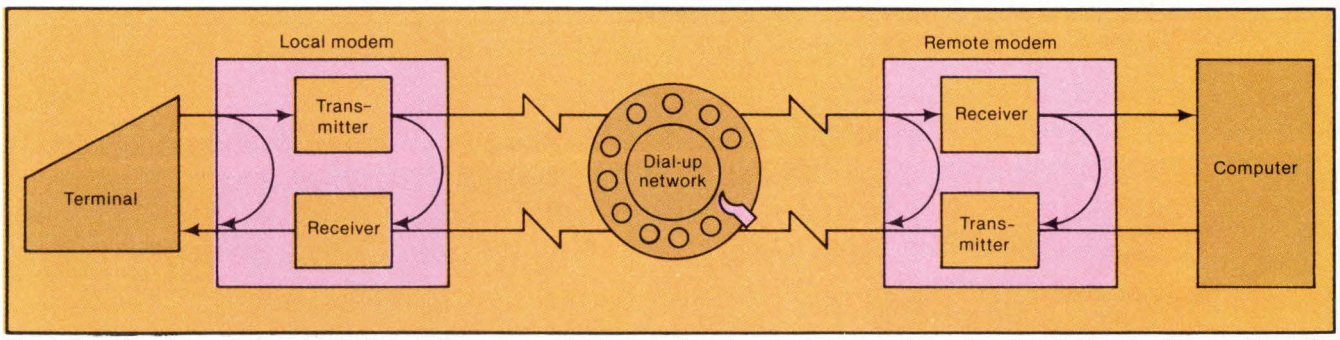


Fig. 1. Local and remote loopback diagnostics *are a major feature of modern μp-based modems. Local digital loopback (green) tests the digital interface connections of the local terminal and modem. Local analog loopback (red) tests add local A/D and D/A and transmit and receive functions to the test circuit. Remote and log loopback (blue) adds the transmission lines to the test circuit. Finally, remote digital loopback (yellow) adds all remote-modem functions to the test circuit. Signals for loopback testing can come from the terminal, computer or, most recently, from a self-test pattern generator in the modem.*

A modem connects to a digital device, and, by modulating a carrier signal, converts its output to analog form for transmission to a remote computer or terminal.

- **Synchronization** describes how data are grouped for digital transmission. Asynchronous transmission sends characters in bursts with every character preceded by a start bit and followed by 1 or 2 stop bits. Synchronous transmission sends blocks of many characters with special characters to mark the beginning and end of each block.
- **Transmission mode** indicates in what directions the modem can communicate. *Simplex* modems can send or receive data, *half-duplex* modems can send and receive data but not at the same time and *full-duplex* modems can send and receive data simultaneously. While most full-duplex modems require four-wire lines, "reverse channel" modems use filters to provide full duplex on two-wire lines.
- **Calling mode** describes a modem's ability to place and receive transmissions. *Originate* modems contain tone generators or dial circuits to gain access to the telephone system and initiate transmissions. *Answer* modems can receive and respond to calls but can't initiate calls. *Originate/answer* modems can do both.
- **Terminal interface** describes the modem's digital interface. Most modems are compatible with the EIA RS232C interface or with one of its international CCITT V series supersets.
- **Line interface** simply tells whether the modem connects to a two- or four-wire line. Most full-duplex modems use four-wire lines.
- **FCC certification** is required before modems can be connected directly to the telephone network. FCC-certified modems include circuitry to protect the telephone network. Noncertified modems require separate data-access arrangements (DAAs)—FCC-certified protectors that are available for roughly $150 from several manufacturers.

By understanding these basic modem characteristics, a buyer can match applications. A slow remote read-only serial printer might require a 300-bps, simplex, answer-only, two-wire modem compatible with its serial, asychronous RS232C interface. A buffered, intelligent CRT terminal for electronic-mail applications might require a 9600-bps, full-duplex, originate/answer modem.

Modern modem features

μPs have made modems more functional and more flexible. Modems now offer dynamic equalization circuits that adjust filters, attenuators and amplifiers to compensate for line inconsistencies, allowing faster, more accurate transmission. They perform complex local and remote diagnostic functions (Fig. 1) as well as comprehensive self-test routines. Some modems automatically retransmit data if an error is detected. Thanks to μp equalization and complex modulation, voice-grade modems have broken the 9600-bps barrier. Paradyne's Corp.'s MP-16.0 and General DataComm Industries' 16000 reach 16K bps. Paradyne's MP-14.4, Codex Corp.'s SP 14.4 and Racal-Milgo Inc.'s MPS-14.4K operate at 14.4K bps.

LSI and μps have reduced modem parts counts and power requirements. Modem reliability figures are in the 20,000- to 60,000- hour MTBF range, and many

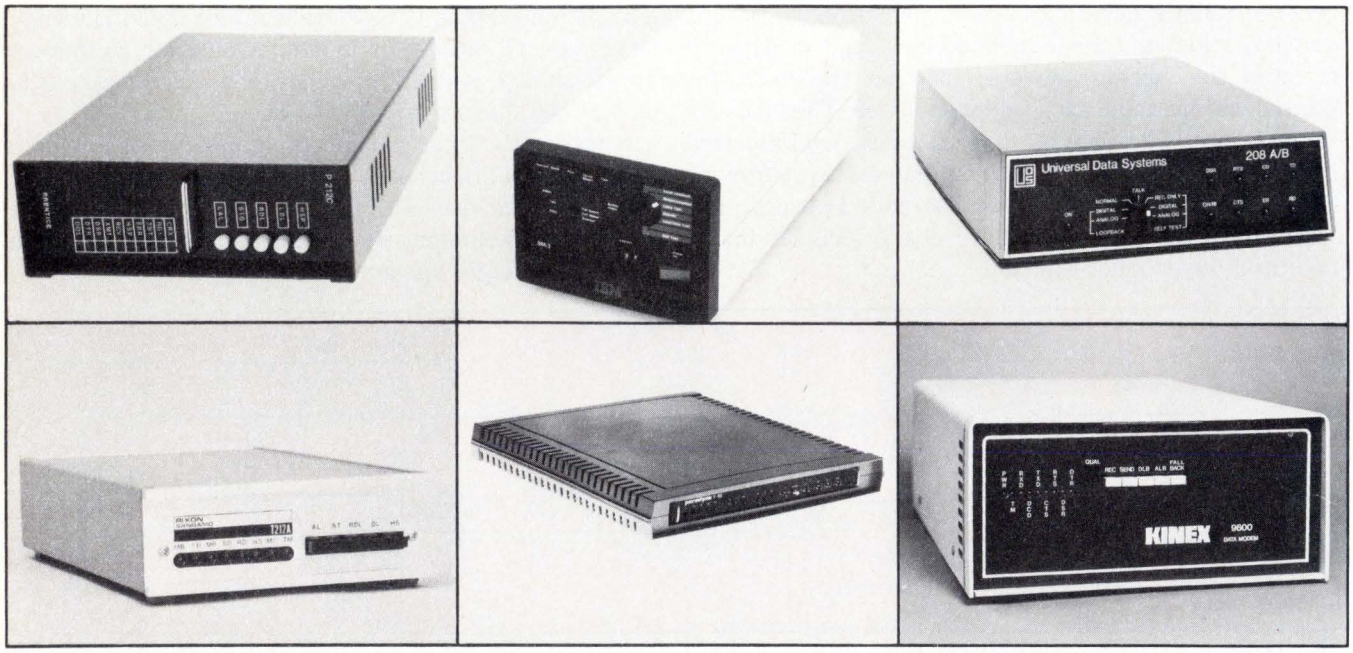
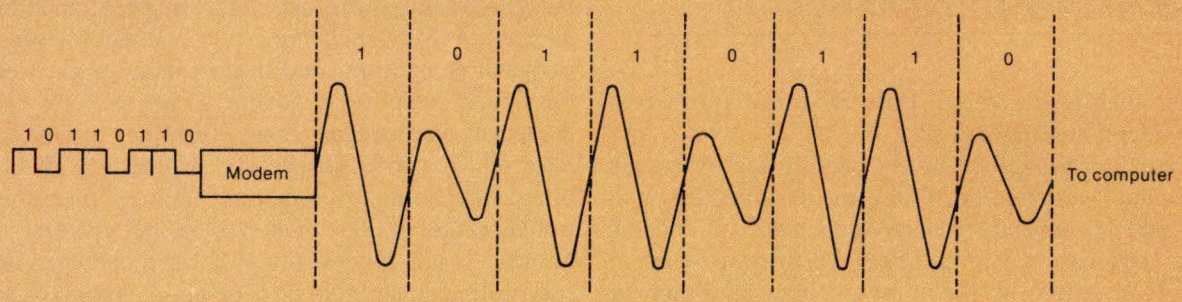
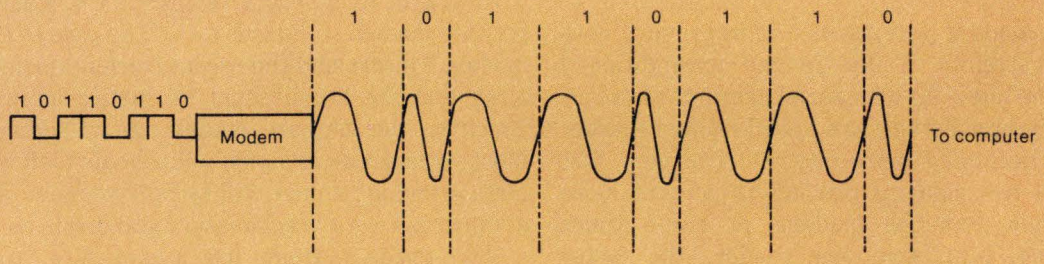


Fig. 2. Modern modems are available in a wide variety of shapes and sizes, *but, while some fit neatly under telephones and others fit into multi-modem racks, almost all offer informative displays and a mix of voice/data, diagnostic, speed-selection and on/off controls. Clockwise from top left, the modems include Prentice Corp.'s P212C, International Business Machine Corp.'s 3863, Universal Data Systems Inc.'s 208A/B, Kinex Corp.'s 9600/29, Paradyne Corp.'s T-96, and Rixon, Inc.'s T1212A.*

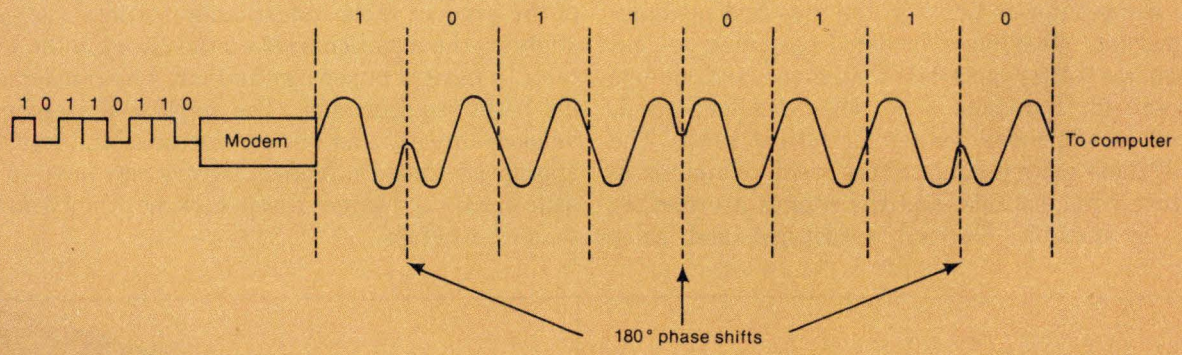
Basic modulation techniques



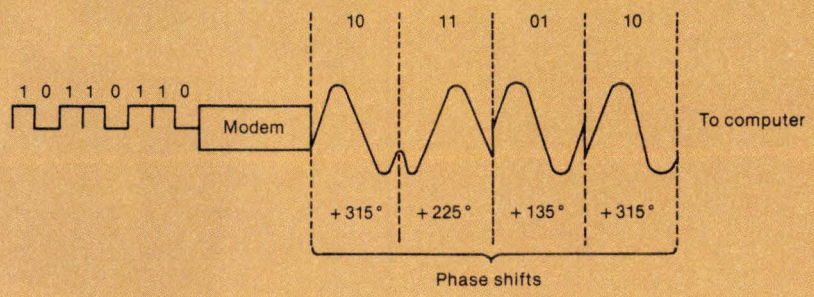
Amplitude modulator (AM) *converts digital data to analog signals using a single frequency carrier signal. A high amplitude wave denotes a mark (binary 1), and a low amplitude wave denotes a space (binary 0). Amplitude modulation is seldom used alone for modems because the signals it produces are susceptible to noise and because of the length of time it takes to sample the amplitude of the signal.*



Frequency-shift keying (FSK) *uses a constant amplitude carrier signal and two frequencies to distinguish between a mark and a space. One of the simpler modulation schemes, FSK is normally used in 1200-bps and slower modems.*



Phase-shift keying (PSK) *uses a phase shift at transition points in the carrier frequency to represent separate marks and spaces. In the example, a 180° phase shift indicates a space. High-speed modems use as many as eight phase shifts.*



Differential phase-shift keying (DPSK) *uses different phase shifts to represent the four possible combinations of 0 and 1 bits: In the example, a 45° represents "00," 135° stands for "01," 225° for "11" and 315° for "10." The pairs are called di-bits. By sending di-bits instead of single bits over the same carrier, DPSK modems achieve high transfer rates. Still other modems use combination encoding techniques such as quadrature amplitude modulation (QAM) that send three (tri-bit) or more bits per cycle to reach even higher rates.*

New modem flexibility can be seen in features such as voice/data alternation, integral multiplexers, auto-dial and auto-answer.

modems, such as Universal Data Systems, Inc.'s 103, run off telephone-line power.

New modem flexibility can be seen in features such as voice/data alternation, integral multiplexers and switch- and dynamically selectable transmit and receive speeds. Originate modems often feature auto-dialers that store multiple phone numbers, and auto-answer modems often adjust to incoming data rates. To keep users informed of diverse activities, most modems offer their own LEDs or similar displays (Fig. 2).

Salient trends

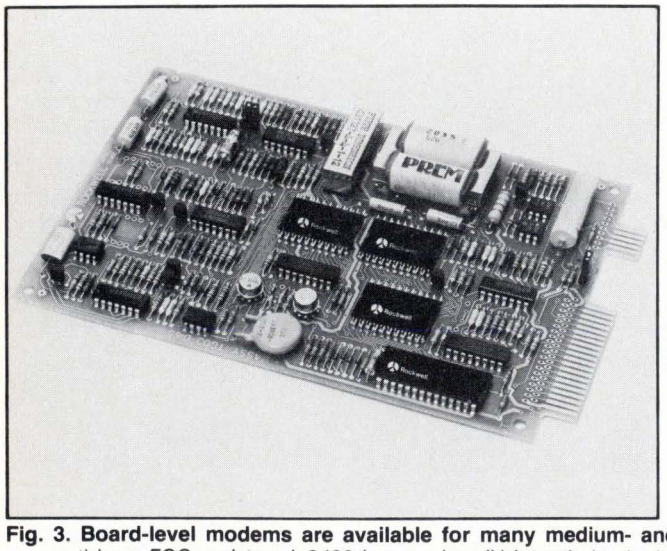
Voice-grade modem performance is improving with bandwidth constraints of dial-up and unconditioned leased telephone lines. As with serial printers, there's a speed for every application, and speed-related market segments are becoming more distinct. The very fast 14.4K- and 16K-bps modems provide 70 percent more throughput than 9600-bps modems at three times 9600-bps prices, but, says one vendor, the faster modems can save a user more than $1500 a month in phone bills for a normally used New York-to-Los Angeles channel.

Price competition is fierce in the low- and medium-speed market. Most basic modems operating at less than 1800 bps sell for much less than $1000, and 300-bps models sell for less than $400. Most medium-speed, 2400- and 4800-bps modems sell for $800 to $3500. The widths of these price ranges are the result of innumerable feature combinations, and the ranges are further blurred by flexible discount structures and sales incentives, such as free lifetime modem maintenance.

Board-level modems for integration into other data-processing equipment are gaining popularity because they eliminate expensive enclosures and redundant switches and power supplies. Integral modems are available off-the-shelf for a few popular terminals and personal computers, and in customer production runs for lower volume products (Fig. 3). Competitive pressure discourages most terminal manufacturers from diluting their design and production efforts with integral-modem development. Modem manufacturers would rather build modems to match EIA RS232C interfaces than diverse internal-terminal architectures. Integral modems could be much less expensive to build than stand-alones but would be more expensive to develop. For the foreseeable future, most modems will be stand-alone units connecting to standard terminal interfaces.

American Telephone & Telegraph Co. will continue to set U.S. modem standards (see "The case of the missing modem," p.131), and the recent consent decree between AT&T and the Department of Justice leaves Western Electric, the biggest modem manufacturer, intact. Most voice-grade modems will remain Bell compatible, but a growing number will be built to meet international CCITT network transmission standards as well.

Voice-grade modems are inexpensive, reliable and plentiful. The independent modem manufacturers compete with Bell by offering faster, more flexible and more feature-packed modems at lower prices. The size of the product table is testimony to their success. By studying the major characteristics listed in the product table, a modem buyer can find out what modems meet his basic requirements. The next step is to contact vendors directly and review the bells and whistles of appropriate models. Modem buyers may have to look a little harder and longer these days, but they'll do better than ever before. ■



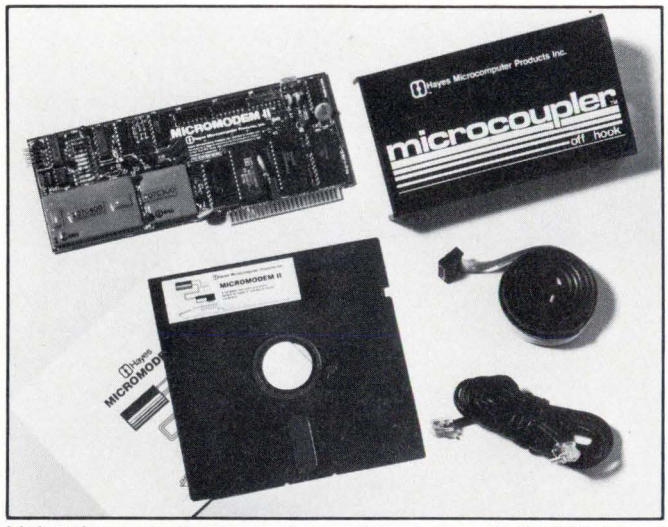


Fig. 3. Board-level modems are available for many medium- and high-volume applications. *Rockwell International's R24DC (direct connect) is an FCC-registered, 2400-bps modem (l.) intended to be integrated into μp-based equipment. The R24DC measures 5 × 7.85 in. and is priced at $450 in small quantities. The Micromodem II (r.) from Hayes Microcomputer Products, Inc., is a 110- or 300-bps, FCC-approved, Bell 103-compatible modem that plugs into an Apple II μc chassis. Also included in the Micromodem II's price is the Microcoupler, a device that substitutes an RJ11C connector for an acoustic coupler.*

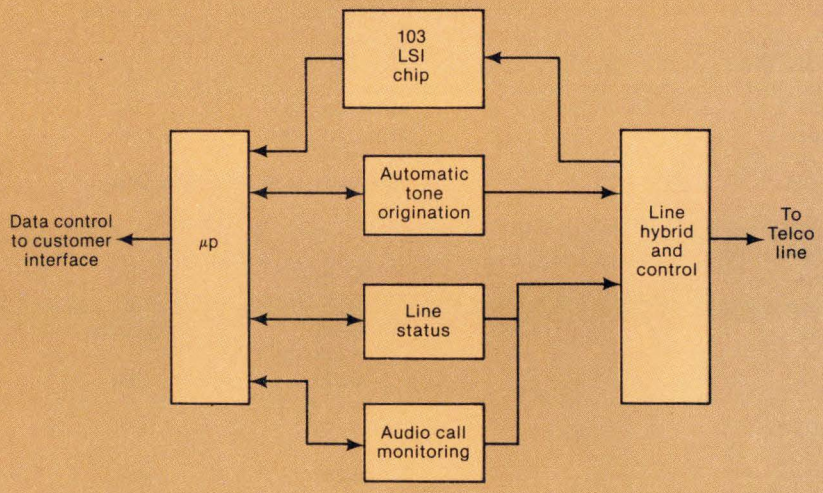
THE CASE OF THE MISSING MODEM

Since the Carterfone decision in 1968, companies have been striving to build smaller and more cost-effective equivalents to Bell's series of modems. This effort has paid off handsomely for independent modem manufacturers that have been supplying more modems than Bell for several years. It has also paid off for their customers, who have enjoyed the benefits of a more compact product at a lower price.

The 9600-bps modem is an example. In 1975, it required 575 MSI/SSI packages and sold for $10,000. Today, it can be implemented in about a dozen LSI/MSI packages for less than $3000—and with more features and improved performance.

Racal-Vadic, Inc.'s Type 103 modem is an even better example. In 1975, that modem required approximately 50 MSI/SSI packages and sold for $430. Today, it's made with two LSI and two MSI packages and sells for less than $100.

Racal-Vadic accomplished this by packing all of the modem's major analog operating elements on a single chip. Earlier LSI designs for modems centered around only some of these elements: receive and transmit filters, modulator or demodulator. Chip sets of this type—developed by such companies as Motorola, Inc., Rockwell International and Cermetek Microelectronics, Inc., and even license from Western Electric—offered reduced size and cost and allowed additional features. But Racal-Vadic's new 18-pin package integrates modulator/demodulator, transmit/receive filters, carrier detector, AGC and answer-tone generator and detector. The result of all this integration is a chip that, combined with a μp for control, can be quickly developed into a board-level product that significantly expands on the basic Bell 103. Racal-Vadic promises to design and deliver a full-featured custom modem having automatic call origination including tone dialing, number and log-on procedure storage) on a PC card no larger than 20 sq. in. in just 90 days, and selling for approximately $100, depending on quantity.



Racal-Vadic's "modem-on-a-chip" *is shown here with some of the discrete components it replaces. Inset diagram shows the modem's major functional elements. The 103 LSI chip uses switched-capacitor-filter techniques and is manufactured to Racal-Vadic's specifications by Texas Instruments Inc.*

Bell model	Data rate (bps)	Modulation	Synchronization	Transmission mode Half duplex	Transmission mode Full duplex	Calling mode	Line interface*	Monthly rental price
103JR	0-300	FSK	async	N	Y	originate, auto-answer	2-wire	$25-$35
113AR	0-300	FSK	async	N	Y	originate	2-wire	$15-$20
113DR	0-300	FSK	async	N	Y	auto-answer	2-wire	$20-$25
202SR	1200-1800	FSK	async	Y		auto-answer	2-, 4-wire	$20-$40
202T	1200-1800	FSK	async	Y	Y	originate, answer	2-, 4-wire	$20-$40
201C	2400	PSK	sync	Y	Y	originate, answer	2-, 4-wire	$60-$70
201CR	2400	PSK	sync	Y	Y	originate, answer	2-, 4-wire	$60-$70
208BR	4800	8-level PM	sync	Y	N		2-, 4-wire	$125-$150
212AR	1200	PSK	sync/async	N	Y		2-, 4-wire	$40-$45
108F	0-300	FSK	async	N	Y	originate	2-, 4-wire	$15-$20
108G	0-300	FSK	async	N	Y	answer	2-, 4-wire	$15-$20
Dataphone II 2024A	2400	PSK	sync	N	Y	originate, answer	4-wire	$95
2048A, C	4800	PSK	sync	N	Y	originate, answer	4-wire	$135-$145
2096A	9600	QAM	sync	N	Y	originate, answer	4-wire	$210

*All terminal interfaces are EIA RS232C-compatible

Bell compatibility. *AT&T is by far the largest supplier of modems, and its models have set standards in the same way as IBMs models have set standards in the disk-drive industry. Most modem manufacturers produce equipment that is AT&T (Bell System)-compatible. This means that their modems use the same carrier frequencies, timing and modulation techniques as modems manufactured by Western Electric for AT&T. The characteristics of the most popular Bell modems are summarized below and the compatibility of independent modems are listed in the product table.*

VOICE-GRADE MODEMS

This table is provided as a guide to modem vendors and their products. The staff of *Mini-Micro Systems* prepared the table from its own sources. Some suppliers may not be included, either because they did not respond to the survey or responded too late to be included.

Manufacturer Model	Data rates (bps)	Modulation	Synchronization Sync	Synchronization Async	Transmission mode Half duplex	Transmission mode Full duplex
Astrocom Corp.						
1100	0-300	FSK	Y	N	Y	Y
1300	0-300	FSK	Y	N	Y	Y
212	300, 1200	FSK, DPSK	Y	Y	Y	Y
Avanti Communications Corp.						
96	4800, 7200, 9600	QAM	Y	N	N	Y
3002	1800, 2400, 4800	QPSK	Y	N	Y	Y
3012	1800, 2400, 4800	QPSK	Y	Y	Y	Y
Backus Data Systems, Inc.						
Merlin	300, 1200	FSK	Y	N	Y	Y
Bizcomp Corp.						
1012	0-300, 1200	FSK, PSK	Y	Y	N	Y
1022	0-300	FSK	N	Y	Y	Y
1030, 1031	0-300	FSK	N	Y	N	Y
1080	0-300	FSK	Y	N	N	Y
1084	0-300	FSK	Y	N	N	Y
Datapoint Corp.						
9478	1200 transmit, 150 receive	FSK	N	Y	N	Y
9479	1200 receive, 150 transmit	FSK	N	Y	N	Y
Digilog, Inc.						
4800FP	4800	DPSK	Y	N		
4800/27	4800	DPSK	Y	N		
4800/208AB	4800	DPSK	Y	N		
Gandalf Data						
LDM404/3403	4800	QAM	Y	N	N	Y
LDM414/3414	4800	QAM	N	Y	N	Y
SuperModem II	9600	multiple carrier QAM	Y	N	N	Y
General Datacomm						
103J-L	300	FSK	Y	N	N	Y
103J-M	300	FSK	Y	N	N	Y
Datacomm 103J	300	FSK	Y	N	N	Y
Datacomm 113C	300	FSK	Y	N	N	Y
Datacomm 113D	300	FSK	N	Y	N	Y
201C	2400	DPSK	Y	N	Y	Y
201-7	2400	PSK	Y	N	Y	Y
Datacomm 202 S/T	1200, 1800	FSK	Y	N	Y	Y
Datacomm 202T	1200, 1800	FSK	Y	N	Y	Y
Datacomm 212A	300, 1200	PSK, FSK	Y	Y	N	Y
Datacomm 212M	300, 1200	PSK, FSK	Y	Y	N	Y

Calling mode	Line interface	Compatible Bell System mode	Price	Notes	Circle no.
					405
originate, answer	acoustic	103, 113			
originate, answer	2-, 4-wire	103, 113		diagnostic, analog/digital loopback standard	
originate, answer	2-wire	103, 113, 212		diagnostics, analog/digital loopback optional	
					406
	4-wire		$2950	leased-line modem	
	4-wire		$1395	medium-distance modem; 100-mi. radius, dual channel (2-2400 bps) standard	
	4-wire		$1690	medium-distance modem; dual channel (2-2400 bps) standard	
					407
originate	dial up	103, 212A	$1450	auto-dial standard	
					408
auto-dial, auto-answer	2-wire	212A	$895	keyboard dialing, remote diagnostics standard; FCC registered	
auto-dial, auto-answer	2-wire	103	$595	keyboard dialing standard; fully programmable; FCC registered	
auto-dial, auto-answer	2-wire	103	$395, $495	keyboard dialing standard; FCC registered	
originate	2-wire	103	$119	MODCON interface connects directly onto many personal computers; FCC registered	
auto-originate, auto-answer	2-wire	103	$299	keyboard dialing standard; FCC registered	
					409
answer	2-wire	103, 113	$995		
originate	2-wire	103, 113	$995		
					410
	2-, 4-wire				
	2-, 4-wire				
	2-, 4-wire	208A, B			
					411
answer	4-wire		$1200	2400/2400-bps split-channel operation optional; rack-mount version: $995	
answer	4-wire		$1300	2400/2400-bps split-channel operation optional; rack-mount version: $1095	
answer	4-wire		$3300-$3740	high noise tolerance design; 4800-bps fallback rate standard	
					412
originate, answer	2-wire	103, 113, 212A	$200		
originate, auto-answer	2-wire	103, 113, 212A	$250		
originate, answer	2-wire	103, 113C, 113D	$545		
originate	2-wire	103, 113C, 113D			
answer	2-wire	103, 113C, 113D			
originate, answer	2-, 4-wire	201B, C	$935		
originate, answer	4-wire	201B, C			
originate, answer	2-, 4-wire	202	$535		
originate, answer	4-wire	202T	$485		
originate, answer	2-wire	212A	$880		
originate, answer	2-wire	212A	$810		

Manufacturer Model	Data rates (bps)	Modulation	Synchronization Sync	 Async	Transmission mode Half duplex	 Full duplex
208B/A	4800	DPSK	Y	N	Y	Y
2400 ASM	2400	PSK	Y	Y	N	Y
2748	4800	DPSK	Y	N	Y	Y
4800	4800	DPSK	Y	N	Y	Y
9600	9600	QAM	Y	N	N	Y
9600MD	9600	QAM	Y	N	N	Y
9604	9600		Y	N	N	Y
16000	16000		Y	N	N	Y
Hayes Microcomputer Products, Inc.						
Micromodem II	110, 300	FSK	Y	N	Y	Y
Micromodem 100	45-300	FSK	N	Y	Y	Y
Hayes Stack Smartmodem	0-300	FSK	N	Y	Y	Y
IBM Corp.						
3863/1	2400	DPSK	Y	N	N	Y
3863/2	2400	DPSK	Y	N	Y	N
3864/1	4800	QAM	Y	N	N	Y
3864/2	4800	QAM	Y	N	Y	N
3865/1	9600	QAM	Y	N	N	Y
3865/2	9600	QAM	Y	N	N	Y
Infotron Systems Corp.						
DL96/V.29	4800, 7200, 9600	QAM	Y	N	N	Y
DL113B	0-300	FSK	N	Y	N	Y
DL201C	2400	QAM	Y	N	N	Y
DL212B	300, 1200	FSK, PSK	Y N	N Y	N	Y
DL4800	4800	QAM	Y	N	N	Y
Kinex Corp.						
2400/26	1200, 2400	4-phase DPSK	Y	N	Y	Y
4800/FP	2400, 4800	8-phase DPSK	Y	N	Y	Y
4800/27	2400, 4800	8-phase DPSK	Y	N	Y	Y
4800/M	2400, 4800	8-phase DPSK	Y	N	Y	Y
4800, 208AB	4800	8-phase DPSK	Y	N	Y	Y
9600/29	4800, 7200, 9600	QAM	Y	N	Y	Y
Lexicon Corp.						
LEX-11	300	FSK	N	Y	Y	Y
LEX-12	300	FSK	N	Y	Y	Y
Micom Systems, Inc.						
4024 Asynch	2400	DPSK	N	Y	N	Y
4024 Synch	2400	DPSK	Y	N	N	Y
M4048	4800	DPSK	Y	N	N	Y
M4748 multi-port modem	4800	DPSK	Y	N	N	Y

Calling mode	Line interface	Compatible Bell System mode	Price	Notes	Circle no.
originate, answer	2-, 4-wire	208			
originate, answer	4-wire	201B/C	$825		
originate, answer	4-wire				
originate, answer	4-wire	208A			
originate, answer	4-wire		$3200		
originate, answer	4-wire		$3500		
originate, answer	4-wire		$4200 $14,900	10,667-bps fallback rate; 7-channel multiplexer optional	
					413
originate, answer	2-wire	103	$379	direct connect, auto-answer, auto-dial standard; 2-yr. limited warranty; FCC registered	
originate, answer	2-wire	103	$399	direct connect, auto-answer, auto-dial standard; 2-yr. limited warranty; FCC registered	
originate, answer	4-wire	103	$279	a programmable modem; direct connect, auto-answer, auto-dial standard; 2-yr. limited warranty	
					414
auto-answer	4-wire		$2585	fan out and extended diagnostics standard	
auto-answer	2-wire		$2825	fan out and extended diagnostics standard	
auto-answer	4-wire		$4245	fan out and extended maintenance standard	
auto-answer	2-wire		$4485	fan out and extended maintenance standard	
auto-answer for SNBU	4-wire non-switched		$6435	point-to-point; multiplexing and extended diagnostics standard	
auto-answer	4-wire		$6435	multi-point; extended diagnostics standard	
					415
	4-wire		$4500	CCITT V.29 compatible	
answer	2-wire	103, 113 series	$265		
	4-wire	201C	$975		
answer	2-wire	100, 113, 212	$750	built-in test and diagnostics standard	
	4-wire	208	$3600	CCITT V.27 compatible	
					416
	2-, 4-wire		$795		
	2-, 4-wire		$2550	built-in tester, dial-up/leased-line switch, fast poll mode, 2400-bps fallback rate standard	
	2-, 4-wire		$2750	built-in tester, dial-up/leased-line switch, fast poll mode, 2400-bps fallback rate standard	
	2-, 4-wire		$3100	built-in tester, 2-channel multiplexer, 2400-bps fallback rate standard	
	2-, 4-wire	208A/B	$2750	built-in tester, dial-up/leased-line switch standard	
	4-wire		$2950	built-in tester standard	
					417
originate, answer		103	$175	acoustic coupler standard	
originate, answer	acoustic, 2-wire	103	$195	direct-connect or acoustic-coupler version available	
					418
leased line	4-wire	201B	$825	1200-bps fallback rate standard; rack-mount version optional	
leased line	4-wire	201B	$795	1200-bps fallback rate standard; rack-mount version optional	
leased line	4-wire	208A	$3200	rack-mount version optional	
leased line	4-wire	208A	$3850	rack-mount version, dynamic channel allocation, auto-reconfiguration optional	

Manufacturer Model	Data rates (bps)	Modulation	Synchronization Sync	 Async	Transmission mode Half duplex	 Full duplex
M4796 Multiport Modem	9600	QAM	Y	N	N	Y
M5596/24 Intelligent Modem	2400	DPSK	Y	N	N	Y
M5596/48 Intelligent Modem	4800	DPSK	Y	N	N	Y
MM5596/96 Intelligent Modem	9600	QAM	Y	N	N	Y
M8000/24 Concentrator Modem	2400	DPSK	Y	N	N	Y
M8000/48 Concentrator Modem	4800	DPSK	Y	N	N	Y
M8000/96 Concentrator Modem	9600	QAM	Y	N	N	Y
Multi-Tech Systems, Inc.						
FM30	0-300	FSK	N	Y	Y	Y
FM31	0-300	FSK	N	Y	Y	Y
MT103J	0-300	FSK	N	Y	Y	Y
MT113C	0-300	FSK	N	Y	Y	Y
MT113D	0-300	FSK	N	Y	Y	Y
MT202T	0-1200	FSK	N	Y	Y	Y
MT212A	0-300, 1200	FSK & PM	Y	Y	N	Y
MT212D	1200	PM	Y	Y	N	Y
MT201B	2400	PM	Y	N	Y	Y
Novation, Inc.						
Apple-Cat II	to 1200	FSK	N	Y	Y	Y
Auto-Cat	to 300	FSK	N	Y	Y	Y
212 Apple-Cat II	to 1200	FSK, PSK	N	Y	Y	Y
212 Auto-Cat	to 1200	FSK, PSK	Y	Y	Y	Y
Cat acoustic	to 300	FSK	N	Y	Y	Y
CCITT Cat	up to 300	FSK	N	Y	Y	Y
40202B	1200	FSK	N	Y	Y	Y
4202T	1200	FSK		Y	Y	Y
Ominitec Data						
9143AD	300	FSK	N	Y	N	Y
9113BOD	300	FSK	N	Y	N	Y
9123ADO	300	FSK	N	Y	N	Y
9202BOD	1200	FSK	N	Y	Y	N
9212AOD	300, 1200	FSK, PM	Y	Y	N	Y
Paradyne Corp.						
LSI 24A	1200, 2400	DPSK	N	Y	Y	Y
M-48	4800	4-level PAM VSB	Y	N	Y	Y
RP96	4800, 7200, 9600	QAM	Y	N	Y	Y
B1SYNC 48	4800	4-level PAM VSB	Y	N	Y	Y
M-96	4800, 7200, 9600	QAM	Y	N	Y	Y
T96	4800, 7200, 9600	QAM	Y	N	N	Y

Calling mode	Line interface	Compatible Bell System mode	Price	Notes	Circle no.
leased line	4-wire		$5250	rack-mount version, dynamic channel allocation, auto-reconfiguration optional	
leased line	4-wire	201B	$1500	async/sync conversion, auto-retransmission standard; rack-mount version optional	
leased line	4-wire	208A	$4000	async/sync conversion, auto-retransmission standard; rack-mount version optional	
leased line	4-wire		$5500	async/sync conversion, auto-retransmission standard; rack-mount version optional	
leased line	4-wire	201B	$2050-$5200	multiplexes 2 to 16 channels	
leased line	4-wire	208A	$3450-$6500	multiplexes 2 to 16 channels	
leased line	4-wire		$4450-$7500	multiplexes 2 to 16 channels	
					419
originate	2-wire	103, 113	$225	acoustic coupler standard	
originate, answer	2-wire	103, 113	$265	acoustic coupler standard	
originate, auto-answer	2-wire	103, 113	$295	for dial-up or leased-line use	
originate	2-wire	103, 113	$235	for dial-up or leased-line use	
auto-answer	2-wire	103, 113	$275	for dial-up or leased-line use	
originate, answer	2-, 4-wire	202	$345	for 2- and 4-wire leased lines only	
originate, auto-answer	2-wire	212A	$850	auto-dialing optional	
originate, auto-answer	2-wire	212A	$695	for dial-up or leased-line use	
originate, answer	2-, 4-wire	201B/C	$685	for leased lines only	
					420
originate, answer	2-wire	103, 113, 202	$389	auto-answer, voice data capability standard; a single-card modem	
originate, answer	2-wire	103, 113	$249	a complete modem measuring 10 x 4.7 x 1.2 in.	
originate, answer	2-wire	103, 113, 202, 212A	$725	adds Bell 212A compatibility to other Apple-Cat II features	
originate, answer	2-wire	103, 113, 212A	$695	a complete modem measuring 10 x 4.7 x 1.2 in.	
originate, answer	2-wire	103	$189	includes acoustic coupler	
originate, answer	2-wire		$299	adjustable acoustic cups fit all European handsets	
		202	$569	auto-answer, analog/digital loopback, built-in audio monitor standard	
	4-wire (leased line)	202T	$375	auto-answer, analog/digital loopback, built-in audio monitor standard	
					421
originate, answer	2-wire	103	$195	OEM modem for teletype model 43	
originate, answer	2-wire	103	$249.50	integral outpulse dialer with radial capability standard	
originate, answer	2-wire	103	$199	auto-answer, auto voice-to-data transfer standard	
originate, answer	2-, 4-wire	202	$671	integral outpulse dialer with radial capability standard	
originate	2-wire	212	$785	integral outpulse dialer with radial capability standard	
					422
	4-wire		$1300		
originate, answer	2-, 4-wire		$2000		
	4-wire		$6800	CCITT V.29 compatible	
originate, answer	2-, 4-wire				
originate, answer	4-wire		$2500		
	4-wire	208A	$2740	CCITT V.29 compatible	

Manufacturer Model	Data rates (bps)	Modulation	Synchronization Sync	Synchronization Async	Transmission mode Half duplex	Transmission mode Full duplex
MP 14.4	9600, 12200, 14400	propri-etary	Y	N	Y	Y
LSD 192	19200	optional	Y	N	Y	Y
LSD 576	48000, 56000, 57600	optional	Y	N	Y	Y
MP208B	2400, 4800	DPSK 8-phase	Y	N	Y	Y
MP16	16000	proprietary	Y	N	Y	Y
LSD 384	24000, 28800, 38400	optional	Y	N	Y	Y
LSI 24C	1200, 2400	DPSK	Y	N	Y	Y
LSI 48	4800	VSB 2-level PAM	Y	N	N	Y
LSI 96	4800, 7200, 9600	4-level PAM VSB	Y	N	N	Y
MP96	4800, 7200, 9600	QAM	Y	N	N	Y
LSI 24	1200, 2400	DPSK, PM, 4-phase	Y	N	Y	Y
LSI 24 (loop)	1200, 2400	DPSK	Y	N	Y	Y
LSI 72	4800, 7200	3-level PAM VSB	Y	N	N	Y
MP48B	2400, 4800	DPSK 8-phase	Y	N	Y	Y
Penril Data Communication Div.						
300/1200	300, 1200	FSK, PSK	Y	Y	N	Y
1800 DED	0-1800	FSK	N	Y	Y	Y
2400 DCM	2400, 1200	PSK	Y	N	N	Y
4800 DCM	2400, 4800	PSK	Y	N	Y	Y
8201	2400, 1200	PSK	Y	N	Y	Y
8208A/B	4800	PSK	Y	N	Y	Y
9629	4800, 7200, 9600	V.27 PSK, V.29 AM/PM	Y	N	N	Y
Prentice Corp.						
P-V.27 4800	2400, 4800	DPSK	Y	N	Y	Y
P-201C	2400	PSK	Y	N	Y	Y
ALD	0-9600	Polar NRZ-I	N	Y	Y	Y
FDM	300, 1200	FSK	N	Y	Y	Y
P-103-J	0-300	FSK	N	Y	Y	Y
P-113C	0-300	FSK	N	Y	Y	Y

Calling mode	Line interface	Compatible Bell System mode	Price	Notes	Circle no.
	4-wire		$14,400	six-port multiplexer optional	
	4-wire			combines two 9600-bps voice lines into 19,200 bps; CCITT V.35 interface optional	
	multiple 4-wire v.g.	303 opt.	$31,600	combines six 9600-bps lines into 57,600 bps	
originate, answer	2-, 4-wire	208B	$3400	CCITT V.27 compatible	
	4-wire		$16,000		
	multiple 4-wire		$25,000	combines four 9600-bps lines into 38,400 bps; CCITT V.35 interface optional	
	2-, 4-wire	201C	$1400	CCITT V.26 compatible	
originate, answer	4-wire		$3000		
originate, answer	4-wire		$4500		
	4-wire		$6500	CCITT V.29 compatible; four-part multiplexer optional	
	4-wire	201B, 201C, 2024	$1200	for leased lines; CCITT V.26 compatible	
	4-wire		$1400		
originate, answer	4-wire		$4000		
originate, answer	2-, 4-wire	208A	$3000	CCITT V.27 compatible; two-channel multiplexer optional	
					423
originate, answer	2-wire	103J, 212A	$850	FCC registered; diagnostics, auto-answer, auto-dial standard	
originate, answer	2-, 4-wire private	202D, 202R	$375		
	4-wire private	201C	$1400-$1600	diagnostics standard	
originate, answer	2-, 4-wire private		$2400-$3100	diagnostics standard	
	2-, 4-wire (dial/private)	201		diagnostics standard	
	2-, 8-wire (dial/private)	208A/B		FCC registered; diagnostics, auto-answer, auto-equalize standard	
originate, answer	4-wire		$4950-$6050	diagnostics standard	
					424
	2-, 4-wire		$2950	diagnostics standard; multiplexer option: $600	
originate, answer	2-wire 4-wire	201B, 201C	$950	diagnostics, voice/data switch standard	
			$280	diagnostics standard; rack-mount version: $190; extra range option: $20; lighting-protection option: $15	
	2-, 4-wire		$500	6-channel multiplexing, diagnostics standard; rack-mount version: $410	
originate, answer	2-wire	103J, 113C, 113D, 212A	$470	FCC certified; rack-mount version: $350; diagnostics standard	
originate	2-wire	103J, 113D, 212A	$385	FCC certified; rack-mount version: $250; diagnostics standard	

Manufacturer Model	Data rates (bps)	Modulation	Synchronization Sync	 Async	Transmission mode Half duplex	 Full duplex
P-113D	0-300	FSK	N	Y	Y	Y
P-202S	0-1200	FSK	N	Y	Y	N
P-202T	0-1800	FSK	N	Y	Y	Y
P-212A	0-300, 1200	FSK; PSK	N Y	Y Y	N	Y
P-212C	0-300, 1200		N Y	Y Y	N	Y
P-V22	0-300, 600, 1200	DPSK	Y N	Y Y	N	Y
P-V 29/9600	4800, 7200, 9600	QAM	Y	N	Y	Y
STAR	0-300	FSK	N	N	Y	Y
TriModem	0-300, 1200	FSK, PSK	Y	Y	N	Y
Qytel						
MA 96	4800, 7200, 9600	QAM	Y	N	N	Y
202C	1200, 2400	DPSK	Y	N	Y	Y
202D/T	1200, 1800	FSK	N	Y	Y	Y
208A/B	4800	DPSK	Y	N	Y	Y
212A-XT	0-300, 1200	FSK, PSK	Y	Y	N	Y
2150	0-300, 1200	FSK, DPSK	Y	Y	N	Y
Racal-Milgo, Inc.						
MPS 48	4800	FSK, QAM	Y	N	Y	Y
CMS48	4800	FSK, QAM	Y	N	Y	Y
MPS14.4K	14400	FSK, QAM	Y	N	Y	Y
CMS24	2400	FSK	Y	N	Y	Y
CMS	1200	FSK	N	Y	Y	Y
CMS7201	7200	FSK, QAM	Y	N	Y	Y
CMS9601	9600	FSK, QAM	Y	N	Y	Y
1200 MK II	1200	FSK	N	Y	Y	Y
24LSI MK II	2400	FSK	N	Y	Y	Y
Racal-Vadic, Inc.						
V11200LL	1200	FSK	Y	Y	Y	Y
VA103	300	FSK	N	Y	N	Y
VA315	0-300	FSK	N	Y	N	Y
VA317	0-300	FSK	N	Y	N	Y
VA355	300	FSK	N	Y	N	Y
VA1230	0-1200	FSK	Y	Y	Y	Y
VA2430	2400		Y	N	Y	N
VA2440	1200	Primary channel DPSK, secondary channel FSK	N	N	Y	N

Calling mode	Line interface	Compatible Bell System mode	Price	Notes	Circle no.
auto-answer	2-wire	103J, 113C, 212A	$395	FCC certified; rack-mount version: $260; diagnostics standard	
originate, auto-answer	2-wire	202 C, E, R, S	$455	FCC certified; voice/data switch, diagnostics standard; rack-mount version: $340	
	4-wire	202T	$440	diagnostics standard; rack-mount version: $325	
originate, auto-answer	2-wire	103, 113, 212A	$795	FCC certified; rack-mount version: $710; auto-speed selection, diagnostics standard	
originate, auto-answer	2-wire	103, 113, 212A	$810	FCC certified; rack-mount version: $725; auto-speed selection, diagnostics standard	
originate, answer, auto-answer	2-wire		$1034	FCC certified; rack-mount version: $949; voice/data switch, diagnostics standard	
	2-, 4-wire		$4950	LSI transmitter, diagnostics standard; multiplexer option: $600	
originate, answer	acoustic	103, 113	$199	diagnostics standard; CCITT V.21/V.24 version: $249	
answer, auto-answer	2-wire	103, 212	$1000	FCC certified; rack-mounted version: $850; auto-speed selection, self-test standard	
					425
	4-wire		$2595	local and remote loopback standard; 4-part time division multiplexer optional	
originate, answer	2-, 4-wire			diagnostics, local analog/digital loopback standard	
originate, answer	4-wire	202D/T		local analog/loopback standard	
originate, answer	2-, 4-wire	208A/B	$1995	diagnostics, local analog/digital loopback standard	
originate, answer	2-wire	103, 212A	$685	diagnostics, local analog/digital loopback standard	
originate, answer	2-wire	212A, 103, 113	$795	Vadic-compatible; local analog/digital loopback standard	
					426
	4-wire			2-port multiplexer, diagnostic secondary channel optional; bisync	
	4-wire			modem sharing, 2-port multiplexer optional; bisync	
	4-wire			6-port multiplexer diagnostics, secondary channel optional; bisync	
	4-wire		$2200	analog parameter serial number reporting standard	
	4-wire		$1900	synchronous transmission optional; analog parameter serial number reporting standard	
	4-wire		$6500	modem sharing, 3-port multiplexer optional; bisync	
	4-wire		$7500	bisync	
	4-wire		$1150	synchronous transmission optional	
	2-, 4-wire		$1450	secondary channel, diagnostics standard	
					427
	2-, 4-wire			CCITT interface standard	
originate, answer	2-wire	103, 113		FCC registered	
originate, answer	2-wire	103, 113		FCC registered	
answer	2-wire	113B/C		FCC registered	
originate, answer	2-wire	202C/S		FCC registered	
	2-, 4-wire	202		FCC registered	
	2-, 4-wire	201B/C			
	2-wire	201B/C		FCC registered; bisync	

Manufacturer Model	Data rates (bps)	Modulation	Synchronization Sync	Synchronization Async	Transmission mode Half duplex	Transmission mode Full duplex
VA1205/30	0-1800	FSK	N	Y	Y	N
VA3400	0-1200		Y	Y	N	Y
VA3413/12	0-1200	FSK	Y	Y	N	Y
VA3450	0-1200	QAM, 4-level PSK, binary phase coherent FSK	Y	Y	N	Y
VA3455	1200	QAM	N	N	N	Y
VA3467	0-1200	QAM, binary phase coherent FSK	Y	Y	N	Y
VA3480	1200	QAM, binary phase coherent FSK	Y	Y	N	Y
VS300P	0-300		N	Y	N	Y
VS1200P	1200	FSK	N	Y	Y	N
VA1250/55	0-1200	FSK	N	Y	Y	N
VA1251/52	0-1200	FSK	N	Y	Y	N
V13021	0-300	FSK	N	Y	N	Y
V13412	1200	QAM	N	N	N	Y
RFL Industries						
6385	0-1200	FSK	N	Y	Y	Y
6850	0-600	FSK	N	Y	Y	Y
6860	1200	FSK	N	Y	Y	Y
Rockwell International						
R24DC	1200, 2400	DPSK	Y	N	Y	Y
R24 Modular set	1200, 2400	DPSK	Y	N	Y	Y
V27P/I, 4800	2400, 4800	QAM	Y	N	Y	Y
V96P/1 9600	2400, 4800, 7200, 9600	QAM	Y	N	Y	Y
Telenokia OY						
DS2840	2400, 4800	DPSK	Y	N	Y	Y
DS2829	600, 1200	FSK	Y	Y	Y	Y
DS2810	300	FSK	N	Y	N	Y
DS2890	600, 1200	DPSK	Y	Y	N	Y
D2839	1200, 2400	DPSK	Y	N	Y	Y
Universal Data Systems						
12.12	0-300, 1200	PSK	Y	Y	N	Y
103J	0-300	FSK	N	Y	N	Y
103JLP	0-300	FSK	N	Y	N	Y
103LP	0-300	FSK	N	Y	N	Y
113D	0-300	FSK	N	Y	N	Y

Calling mode	Line interface	Compatible Bell System mode	Price	Notes	Circle no.
	2-, 4-wire	202		FCC registered	
	2-wire				
	2-wire	113			
originate, answer	2-wire	212, 103		FCC registered	
originate, answer	2-wire			FCC registered; bisync	
	2-wire	212, 113 VA3400		FCC registered	
originate, answer	2-wire	103, 113, 212		FCC registered	
originate, answer	2-wire	103, 113		FCC registered	
	2-wire	202C/S		FCC registered	
	2-wire	202C/S		FCC registered	
	2-, 4-wire	202C/R/T			
	2-wire			CCITT interface standard	
originate	2-wire			bisync	
					428
	2014	202	$350		
	2-, 4-wire	103			
	2-, 4-wire		$3500	simultaneous speech and 1200-bps E & M signalling	
					429
originate, auto-answer	2-, 4-wire	201B/C	$450	an FCC registered, board-level OEM product	
originate, auto-answer	2-, 4-wire	201B/C	$395	a board-level OEM product	
originate, answer	2-, 4-wire	CCITT V.27 ter V.27 bis		a single-board OEM product	
originate, auto-answer	2-, 4-wire	CCITT V.29, V.27 ter V.27 bis		a single-board OEM product	
					430
originate, answer	2-, 4-wire			auto-answer, auto-disconnect, analog/digital loopback, tester, reverse channel standard	
originate, answer	2-, 4-wire			auto-answer, auto-disconnect, analog/digital loopback standard; reverse channel optional	
originate, answer	2-wire			auto-answer, auto-disconnect, analog/digital loopback standard	
originate, answer	2-, 4-wire			all five V.22 operating modes, analog/digital loopback, auto-answer, auto-disconnect standard	
originate, answer	2-, 4-wire			auto-answer, auto-disconnect, analog/digital loopback, built-in tester standard; reverse channel, 2-channel multiplexer standard	
					431
originate, answer	2-wire		$600	auto-answer, integral test pattern standard	
originate, answer	2-wire	103	$450	voice/data switch, auto-answer standard	
originate, answer	2-wire	103	$245	voice/data switch standard	
originate, answer	2-wire	103	$195	voice/data switch standard	
answer	2-wire	113	$375	voice/data switch, auto-answer standard	

Manufacturer Model	Data rates (bps)	Modulation	Synchronization Sync	 Async	Transmission mode Half duplex	 Full duplex
201B	2400	PSK	Y	N	Y	Y
201C	2400	PSK	Y	N	Y	Y
202D	0-1800	FSK	N	Y	Y	Y
202LP	0-1200	FSK	N	Y	Y	N
202S	0-1200	FSK	N	Y	Y	N
202 SLP	0-1200	FSK	N	Y	Y	N
202T	0-1800	FSK	N	Y	Y	Y
208A/B	4800	8-phase PSK	Y	N	Y	Y
212A	0-300, 1200	FSK, PSK	Y	Y	N	Y
Ven-Tel Inc.						
AC103-1	0-300	FSK	N	Y	Y	Y
AC103-2	0-300	FSK	N	Y	Y	Y
AC103-4	0-300	FSK	N	Y	Y	Y
MD103J-1	0-300	FSK	N	Y	Y	Y
AC103-3	0-300	FSK	N	Y	Y	Y
MD103-1	0-300	FSK	N	Y	Y	Y
MD103-2	0-300	FSK	N	Y	Y	Y
MD103J-3	0-300	FSK	N	Y	Y	Y
MD113-13	0-300	FSK	N	Y	Y	Y
MD113-33	0-300	FSK	N	Y	Y	Y
MD113-43	0-300	FSK	N	Y	Y	Y
MD201-1	2400	PSK	Y	Y	Y	Y
MD201-2	2400	PSK	Y	Y	Y	Y
MD201-3	2400	PSK	Y	N	Y	Y
MD201-4	2400	PSK	Y	N	Y	Y
MD202-1	0-1200	FSK	N	Y	Y	Y
MD202-2	0-1200	FSK	N	Y	Y	Y
MD202-5	0-1800	FSK	N	Y	Y	Y
MD212-1	300, 1200	PSK				Y
MD212-2	300, 1200	PSK				Y
MD212-3	300, 1200	PSK				Y
MD212-4	300, 1200	PSK				Y
MD212-5	300, 1200	PSK				Y
Wang Laboratories						
WA3451 103J Mode	1200	FSK		Y		
WA3451 212A Mode	1200	QAM	Y	Y		

Calling mode	Line interface	Compatible Bell System mode	Price	Notes	Circle no.
	2-, 4-wire	201B	$845		
	2-, 4-wire	201C	$915		
	2-, 4-wire	202	$425	diagnostics standard	
	2-wire	202	$245	voice/data switch standard	
	2-, 4-wire	202S	$620	voice/data switch, auto-answer standard	
	2-wire	202	$295	voice/data switch standard	
	2-, 4-wire	202T	$445	voice/data switch, auto-answer standard	
	2-, 4-wire	208	$2450	voice/data switch, integral test pattern standard	
originate, answer	2-wire	212, 103	$900	voice/data switch, auto-answer, integral test pattern standard	
					432
originate	2-wire	all 103, 113 series, 212A, low-speed	$245	custom case, acoustic coupler standard	
originate, answer	2-wire	all 103, 113 series		low-profile case, acoustic coupler standard	
originate, answer	2-wire DDD	103, 113, 212A, low-speed		acoustic coupler, low-profile case standard	
originate, answer, auto-answer	2-wire	all 100, 113 series	$554, $505		
originate	2-wire	all 103, 113 series		custom case, acoustic coupler standard	
	3002 uncond., 2-wire, leased line	108	$210	a single-card rack-mount modem	
	3002 uncond., 2-wire, leased line	108	$280		
originate, answer, auto-answer	2-wire	all 100, 113 series	$554, $505	auto-dialing standard	
auto-answer	2-wire	all 103, 113 series	$280	a rack-mount modem card	
auto-answer	2-wire	all 113, 103 series	$300		
originate	2-wire DDD	all 103, 113 series	$230		
originate, answer, auto-answer	2-, 4-wire	all 201 series	$730, $685	a rack-mount modem card	
originate, answer, auto-answer	2-, 4-wire	all 201 series	$800, $750		
	2-, 4-wire	201B, C	$605	a single-card, sync/bisync, rack-mount, leased-line modem	
	2-, 4-wire			sync/bisync modem	
originate, answer, auto-answer	2-, 4-wire	202A, C, S	$310, $290	a rack-mount modem card	
originate, answer, auto-answer	2-, 4-wire	202A, C, S	$380, $345		
	3002 uncond. leased line	202B, D, T	$280	a single-card, rack-mount modem	
originate, answer	2-wire	all 212A, 103, 113 series	$850		
originate, answer	2-wire	all 212A, 103, 113 series	$780	a single-card, rack-mount modem	
originate, answer	2-wire	all 212A, 103, 113 series	$995	auto-dialing standard	
originate, answer	2-wire	all 212A, 103, 113 series	$925		
originate, answer	2-wire	all 212A, 103, 113 series	$995, $930	auto-dialing standard	
					433
	2-wire	103	$1050		
	2-wire	212A	$1050		

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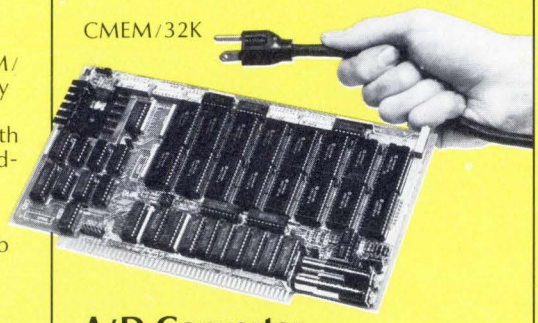

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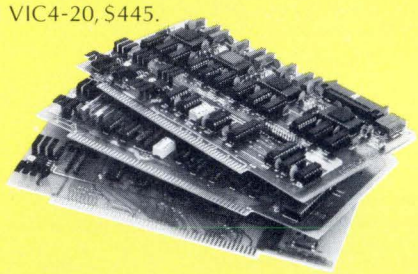

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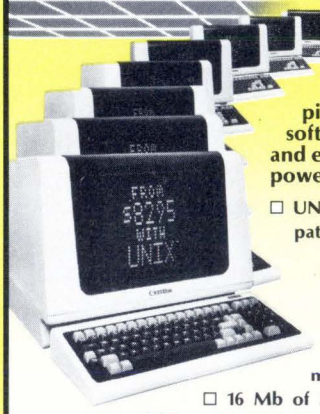

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LOCAL-AREA NETWORKS

Taking a new look at matrix-switched systems

WALTER A. LEVY and HARRIET MEHL, Edgewood Computer Associates, Inc.

Some old standbys find local-area-network applications: second in a three-part series

Local communications systems used matrix-switching methods long before coaxial cable was invented. Mechanical and then electronic matrix switching, using star architectures, were used in military and civilian telephone systems years before bus and ring architectures found practical communications applications. Two important groups of products that use matrix methods are available for local-area communication: integrated voice/data switches (PABXs) and port-contention systems. Both groups include established, well developed products with broad installation bases. In the recent furor over cable-based systems, both matrix-switching systems have been largely ignored, but their proven technologies, low cost and ease of installation make them worth studying.

Characteristics of matrix-switched systems

All matrix-switched systems use the basic star network architecture (Fig. 1). User equipment gains access to the network through a network-access device that in turn communicates with the system's central switching matrix and control through dedicated lines. All connections between users pass through the central facility. The design is conceptually simple, but raises important capacity and vulnerability questions.

The switching matrix through which all user data passes has a finite capacity. If the applied traffic load exceeds this capacity, service degradation results, usually in the form of service denial (busy signals) to latecomers. Switching systems that have reached the capacity limits of their single matrix switch can be

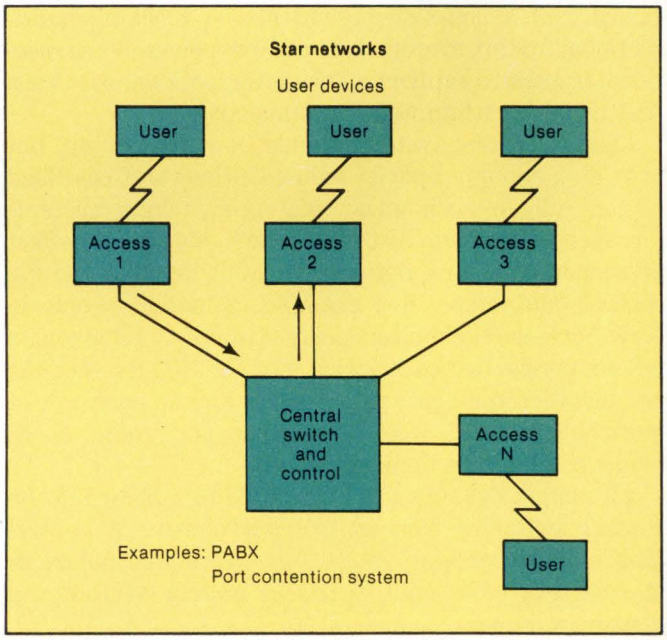


Fig. 1. The star network is the oldest and most common form of communications architecture. *Alternate network forms, such as ring networks, are often constructed of sections that are individually stars. In star networks, all users communicate directly with a central facility that connects users to each other and controls the entire network. Users gain access to the network through an access device that can be simple, such as a telephone, or complex such as a minicomputer. The access device is a user's first point of contact with the network and performs a significant validation function on the user's call request before permitting signals to reach the central switch. The star network is thus highly secure from user-device malfunction.*

(Editor's note: This is the second in a three-part series of profile articles on local-area communications. The first article (MMS, February, p. 227), discussed cable-based general-purpose local networks using bus and ring architectures. This article will discuss matrix-switched local networks that use star architectures and twisted-pair wiring. Next month's article will cover single-purpose (work-station) and host-computer networks.)

Any modern PABX system can, in principle, directly switch digital computer data if a supplier wishes to furnish the required equipment and features, but questions of practicality and economics must be answered.

expanded by sectionalizing, that is, employing multiple switches, each dedicated to a subset of the user population and connected to the other sections by trunk lines. This approach is the classical telephone exchange architecture and is referred to as a multi-sectional matrix system.

Matrix-switching system capacity is normally calculated by counting the number of ports that can be switched, measuring their transmission capacities and finding whether the system's matrix switch is "blocking" or "non-blocking." A non-blocking matrix switch permits all ports to be active at once and grants all possible data-call requests as long as the called party is free. A blocking matrix cannot grant all possible connection requests at the same time.

A blocking single-matrix system cannot always support as many simultaneous data calls as the connected devices can make. A blocking 1000-port matrix, for example, might not be able to support 500 simultaneous data calls, and be able to handle only, say, 200. Such a system would have 40 percent of the capacity of a non-blocking matrix. A blocking multi-sectional matrix system does not have enough intersectional trunks to support all the intersectional data calls that could be attempted simultaneously.

Ideally, matrix systems should be non-blocking, but providing enough capacity to handle the worst-case load is generally uneconomical. Matrix-switching systems for voice traffic have historically been blocking to effect an economic balance between variable demand and the cost of equipment. For example, 2 million people in New York could simultaneously attempt to telephone 2 million people in Los Angeles, but the Bell System has not installed enough equipment to handle such a load because the cost would be great and there is no evidence of such a demand.

All matrix systems are vulnerable to a failure in the central switching and control mechanism. A central failure can disable an entire system. Switch failure in one section of a multi-sectional matrix system can disable all users connected to the section. Matrix-system designers have minimized the probability of a critical central failure by incorporating extensive diagnostic and redundant central equipment with fail-safe monitoring and fast switch-over devices into their systems. Care is taken in design and manufacturing to assure the highest attainable reliability. Vendors provide post-installation service and are keen to identify and correct reliability problems to minimize maintenance costs and retain customer goodwill. As a practical matter, star networks have a track record of excellent reliability, and arguments to the contrary by proponents of bus networks are not based on experience.

Star networks are better than bus or ring networks at protecting themselves against a malfunctioning user-access device. Each user-access device communicates directly with a port on the central switch that contains a set of control features dedicated to the user-access device and designed to assure that the central switch's common facilities will be protected from misuse by a user-access-device malfunction. The common control features of matrix-switching systems are designed to validate user requests for service before execution. Bus or ring systems, on the other hand, are highly vulnerable to a user-device malfunction. In bus systems, all user-access devices are permanently connected to the bus and can transmit or receive at the same time. If a user device malfunctions

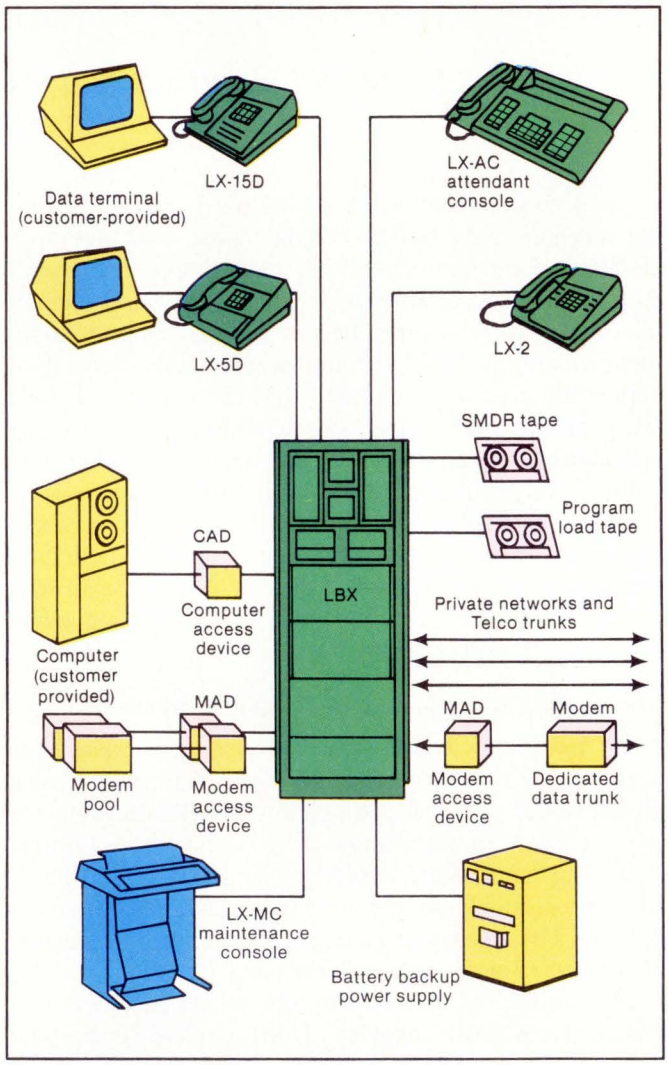
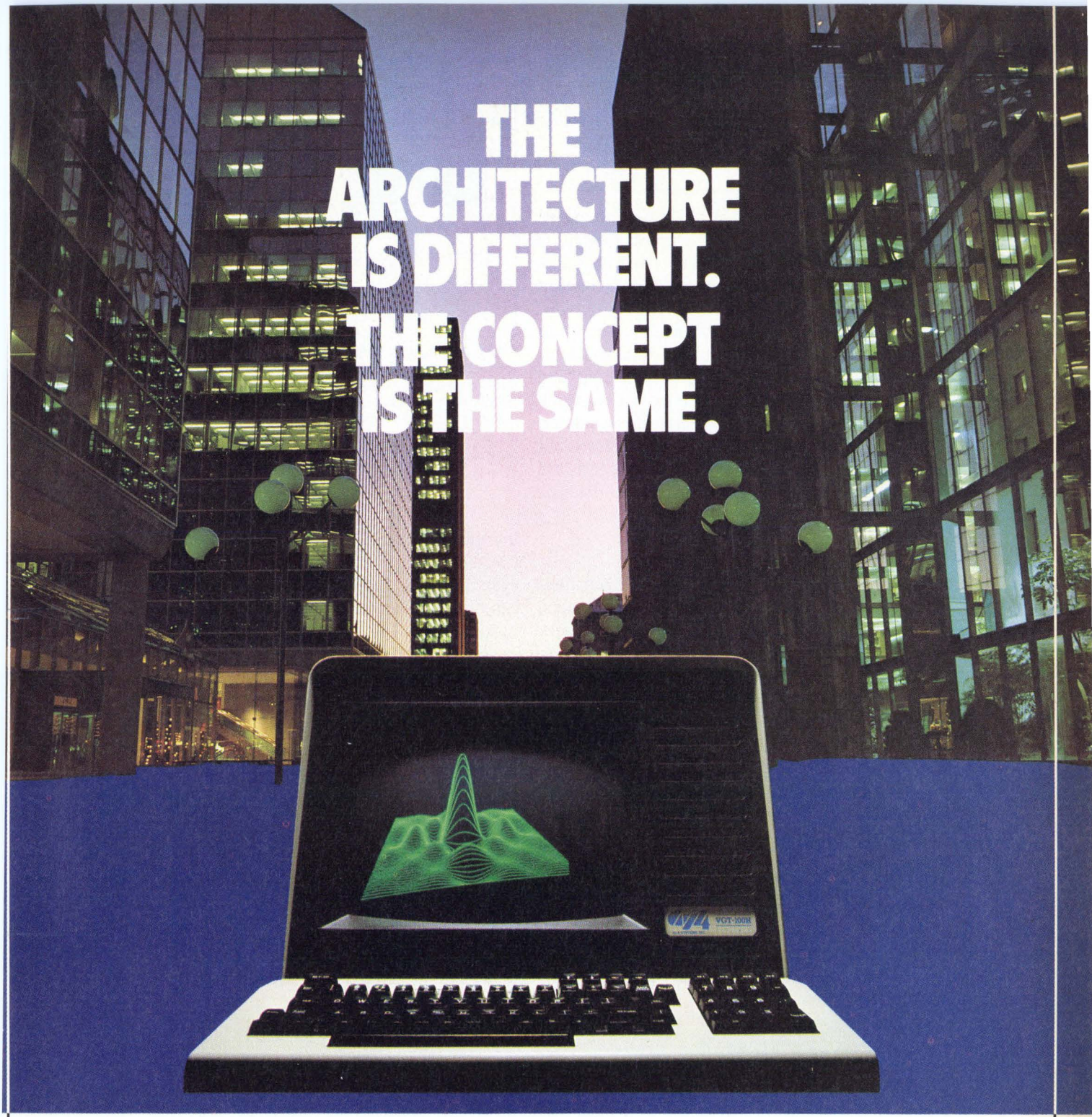


Fig. 2. The Lexar LBX integrated voice/data switch *includes the LBX mainframe, telephone sets and other access devices. This system offers three types of telephone instruments plus an attendant console, all requiring only a single wire pair for voice communications. For data communications, each telephone instrument can be augmented to permit attachment of an RS232C cable from a computer device. Additional modules are provided to permit computer and modem direct attachment without a telephone.*



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A blocking single-matrix system cannot always support as many simultaneous data calls as the connected devices can make.

and transmits unwanted signals on the bus, the entire system will be disabled until the errant device is identified and removed from service. Ring systems have the same kind of problems because all information must pass through each user-access device.

The matrix-switching systems for local-area communications provide transparent data channels and support data-transmission speeds as high as 56K bps. The data channels are transparent because matrix systems provide the equivalent of a direct electrical connection between the pair of user-access devices associated in a "data call," switching data bit-by-bit. The speed and capacity of matrix systems is a function of their designs and historical applications.

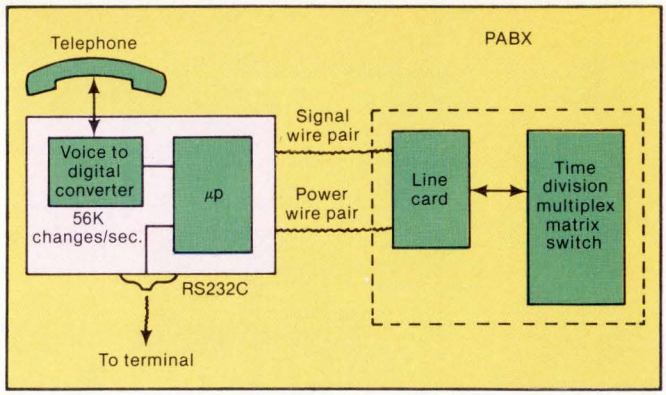

Fig. 3. Analog-to-digital voice-signal conversions are done in the telephone sets of modern voice/data PABXs. *The digitized voice data is then combined with normal digital computer data and telephone control signals into a multipurpose digital data packet that is then exchanged with the PABX mainframe. Packets are exchanged in both directions at a rate of 8000 per sec. on a single wire pair, providing the equivalent of full-duplex transmission of voice and data simultaneously.*

Integrated voice/data PABXs

PABX systems have been widely used in business voice-communication applications for several years. Like all other communication switching systems, PABX systems were built using metal-contact switching mechanisms and evolved to the use of nonmechanical solid-state techniques during the 1960s and 1970s. Digital circuitry still survives. This modernization process was completely justified by the competitive needs of the voice-PABX industry, but the industry quickly recognized that digital PABXs could also switch computer data in its normal form, bypassing the digital-to-analog process typically performed by modems. PABX systems are still primarily voice systems, even if 100-percent digital, and they are marketed accordingly. No one has yet bought a digital PABX strictly for digital switching.

While a PABX switching digital data and voice data integrates the two kinds of traffic, the benefits of this integration have not been demonstrated to end users. Consequently, the technology of integrated voice/data systems is the technology of "how digital PABX systems can directly switch digital computer data."

All modern PABX systems use TDM digital switching as the principal matrix functional element. The capacity of a TDM matrix is a function of its overall speed, measured in bits per sec., and the bps demand of the systems for each voice-circuit pair. Capacity can be extended by using higher speed electronics, bit parallel matrixes or multiple (and therefore blocking) matrix sections with selector switching between them.

Analog voice signals are converted to digital form for PABX switching in the line-interface card in the PABX or in the telephone set. The first approach is more common, and permits the digital PABX to support existing old-fashioned single-line and key telephones. The second approach uses a special telephone set containing a μc and provides advantages over the older systems (Fig. 2).

INTEGRATED VOICE/DATA SWITCHES

The systems described here are voice systems to which data-switching features have been added. All the PABX systems provide a comprehensive set of voice-switching features. The table lists only those system features that relate to the data-switching services. The systems listed are grouped into two classes: the new systems offering integrated voice/data transmission from the telephone set inward (left), and the older systems offering data switching by add-on modules and separate wiring (right).

Manufacturer Model number	Anderson Jacobsen IOXX	InteCom IBX	Lexar LBX	Mitel SX-2000	Datapoint ISX	GTE 1000/4600	Northern Telecom SL-1	Rolm CEX
Max. number of ports	1024	4096	1024	10,000	20,000	1024/12,000	5000	800 to 4000*
Wire pairs required for voice-only switching	2	2	2*	2	1	1	2**	1
Wire pairs added for switching	0	0	0	0	2	2	0	2
Voice digitized in telephone set?	yes	yes	yes	yes	optional	no	yes	no
Max. async data rate (Kbps)	64	19.2	56	19.2	9.6	19.2	9.6	19.2
Max. sync data rate (Kbps)	56	57.6	no	56	56	56	no	no
Blocking/non-blocking?	NB	NB	NB	NB	B	B	B	B
Common voice/data PABX port?	yes	yes	yes	yes	no	no	no	no
Incremental cost per data port ($)	235	—	350	—	—	1800	—	—
Max. distance from teleset to PABX (ft.)	3000	8500	2400	5000	***	***	4500	5000
Notes			*one pair for power		***distance comparable to others		**add pair power	*several models offer increasing max. size

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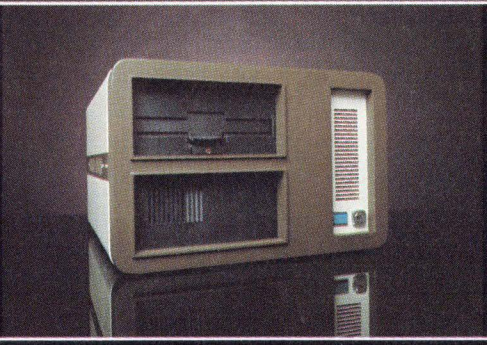

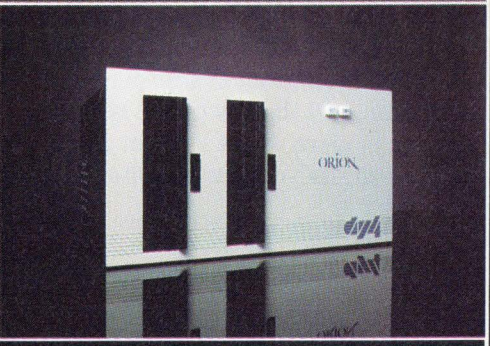

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Port-contention systems were developed by data-communications system suppliers to solve a problem arising from the growth of computer time sharing.

In the telephone set, μp control can support telephone features and services not possible or affordable with older PABXs. The μp telephone set is more expensive than the older instrument, but less expensive to install and move because it requires no more than one or two pairs of wires to reach the PABX.

The presence of a μp in the telephone set enables local analog-to-digital conversion of voice signals. Digitized voice data can then be combined with telephone signaling data (which is in digital form) in the telephone set and then transmitted to the central switching matrix. Local voice digitization does not provide operational benefits to the telephone user, but it does lead to economies in the overall design of the PABX system, assuming that μp control in the telephone is justified by the other convenience features it provides.

Introduction of μp-based telephone sets marks an important shift in PABX-system design. The PABX was previously concerned largely with recognition and generation of the various analog signals that govern telephone operation: voice, dial tone, on-off hook, dial pulses or DTMF tones, ringing and busy—regardless of what form of internal switching was used. The new trend is toward the PABX's becoming a generalized high-speed digital system, with all analog functions performed in the telephone set.

Any modern PABX system can, in principle, directly switch digital computer data if a supplier wishes to furnish the required equipment and features, but questions of practicality and economics must be answered. Most suppliers of larger PABX systems have announced data-switching features. The Bell System's Dimension system is the most noteworthy exception. The announced products fall into two classes:

- **Add-on-data PABX systems** are older voice-only systems that have been reengineered to support digital data switching by adding equipment. Terminal equipment, terminal-to-PABX wiring, line-interface cards and TDM matrix channels are typically required for data switching.
- **Integrated voice/data PABX systems** are not yet in wide use. They employ μp-based telephone sets incorporating A/D conversion. They offer options permitting computer data to be entered at the telephone set and consolidated with the digitized voice and the (normally) digital telephone control signals into a single consolidated digital data stream transmitted over a single wire pair to the PABX.

The older add-on systems were not engineered for direct digital data service. While the add-on features enable them to provide the service, practical and economic considerations limit their application. PABX matrix-switching capacity is 56K to 64K bps for each voice circuit. Some PABX suppliers, therefore, offer digital data-switch service at speeds as high as 56K bps. Add-on digital data service uses a complete set of facilities, otherwise available for voice service, for each data port, without any economies of sharing. Allocation of such capacity to support digital data circuits is wasteful because there are virtually no current digital data devices that transmit data faster than 9600 bps. Other suppliers offer more practical lower speed channels and attempt to get better use from their system matrixes by using add-on matrix subdivision equipment.

PORT CONTENTION SYSTEMS

The port contention systems listed here vary in their overall line capacity and flexibility of switching services, but they all support asynchronous traffic to 9.6K bps and provide terminal-to-computer port switching. Some systems have a full switching matrix and can also support terminal-to-terminal switching, making them potentially useful in an office automation environment. Port contention systems are generally designed to be non-blocking with respect to computer ports; they support as many simultaneous connections as there are computer ports.

Manufacturer Model	Develcon	DCA Sys 355	Infotron TL450	Gandalf PACX	Micom Micro 6000	Micom Micro 650
Maximum number of lines/computer ports	2000	124	254/124	1022/510	922	126
Max. number of connections	1000 @ 2.4K bps		124	510	496	
Asynchronous ports						
Data rates (Kbps)	19.2	9.6	9.6	9.6	9.6	sync only
In-terminal dialing?	yes	yes	yes	yes	yes	
Synchronous ports						
data rates	19.2	9.6	9.6	19.2	async only	19.2
manual call setup	yes	no	no	no		yes
automatic call setup	yes	yes	yes	yes		yes
Max. distance from terminal to switch	4000 ft.	2000 ft.	50 ft.	5.5 miles	50 ft.	50 ft.
Full switching matrix?	no	yes	no	yes**	yes	
Representative system size	300 lines*	124 lines*	32 lines/ 16 ports	100 lines/ 60 ports	180 lines*	30 lines*
Representative system price	$50	$40	$10,000	$30,000	$35,000	$16,000
Incremental cost per port	$100	$150	$300/line $240/port	$100	$100	$300
Number of installed systems	100	110	450	more than 1000	400	none

* terminals or ports ** terminal to terminal via "looparound" port

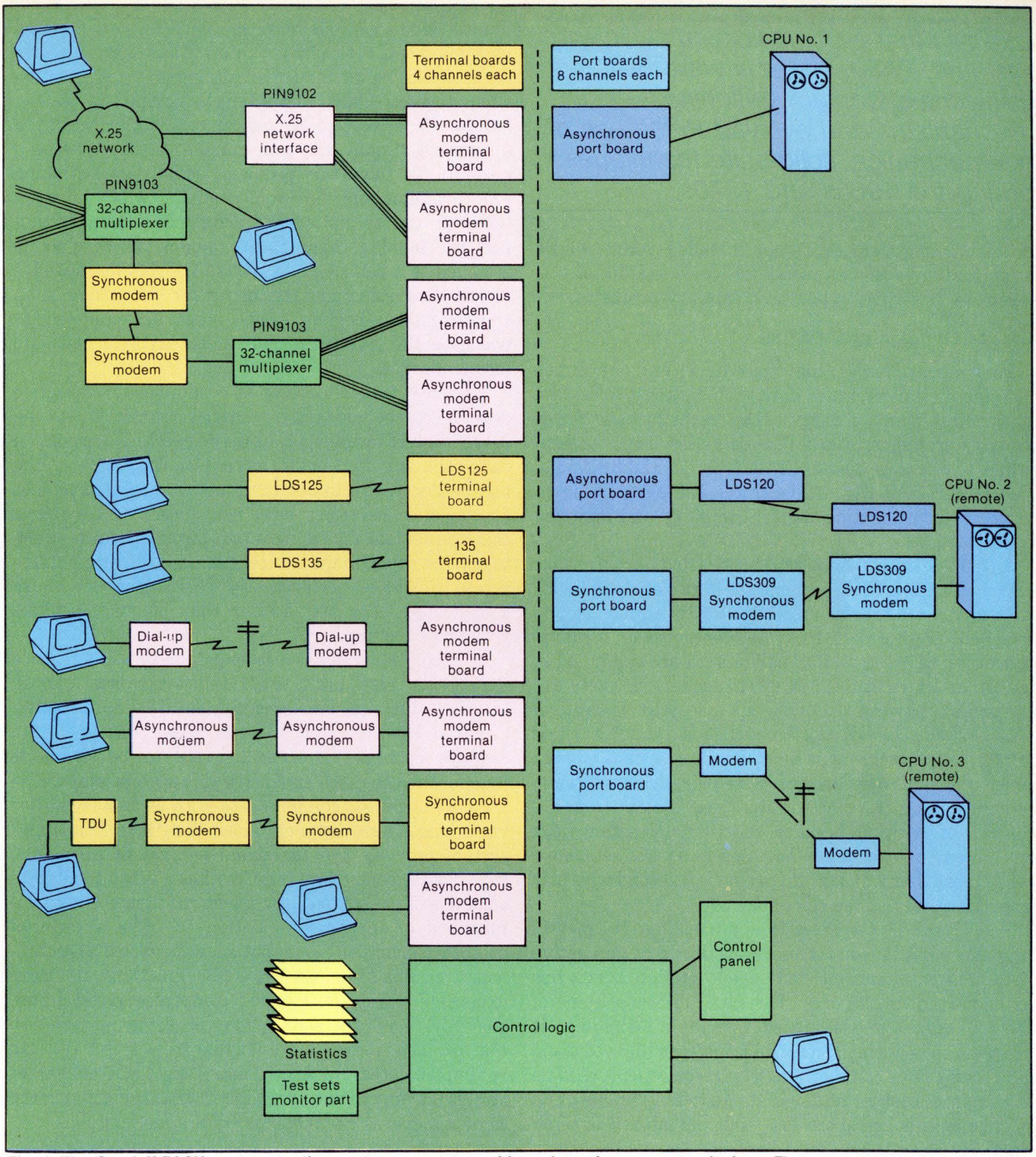

Fig. 4. The Gandalf PACX port-contention system supports a wide variety of user-access devices. *The common control section of the PACX contains the basic time-division multiplexer switching matrix and its controls. Terminal boards and modems are added to the system as required by the number and types of lines.*

Add-on systems are also vulnerable to capacity overload. Voice traffic in an office is usually characterized by many short calls, averaging perhaps 5 percent to 10 percent of use per instrument. A PABX with enough switching capacity for such use might be overloaded by data traffic. Someone placing a data call typically connects a terminal to a computer. The call often lasts hours, even days, so a small number of data calls could easily preempt enough PABX switching matrix capacity to cause severe degradation in voice service.

Capacity overload is a basic problem for any voice-oriented PABX attempting to support data traffic. It is much more of a problem for the old systems than for new ones because the older systems rely more heavily on the economics of blocking techniques. Adding

Like all other communication switching systems, PABX systems were built using metal-contact switching mechanisms and evolved to the use of nonmechanical solid-state techniques during the 1960s and 1970s.

data-switching service to an installed PABX whose configuration was optimized for voice traffic only is especially sensitive to potential capacity problems.

Integrated voice/data PABXs

The newer integrated voice/data PABX systems combine digital computer data with digitized voice data at the first point of entry. They seem to have fewer capacity problems. Fig. 2 illustrates the basic configuration of one new system, LBX from United Technologies Lexar, and Fig. 3 illustrates the system's technique for consolidating digital computer and digitized voice data.

A μp in each telephone set encodes and decodes voice data at 56K bps. The telephone set is also equipped with an RS232C port to which a computer or terminal can be attached. Digital data from the computer or terminal and digitized voice and signaling data are combined in the μp and formatted into 10-bit packets. Packets are exchanged between telephone set and PABX at a rate of 8000 per sec. This system supports voice at 56K bps and full-duplex asynchronous digital data at speeds as high as 9600 bps, all over a single wire pair. (The additional 1600 bps of digital computer data are "stolen" from the control-bit position because control information does not have to be exchanged between PABX and telephone set at more than a dozen bits per sec.) A second wire pair provides power to the telephone set.

The Lexar LBX system is non-blocking. Its matrix supports simultaneous connections between 1024 active ports and data-transmission speeds as high as 56K bps by dedicated PABX ports. The LBX illustrates some of the advantages of integrated voice/data switching. It provides an economical method for supporting voice and data traffic over common single wire-pair facilities. The incremental cost for adding data switching to one of its telephone sets is rather low, and portability is high. Further, it enables any telephone set to become a computer-access port.

PABX systems are designed to set up voice calls between two parties (occasionally more, counting conference calls) and to handle the problems of voice traffic in a general business office: ingoing, outgoing and inter-office calls; transfers; alternate extensions; and call-placement restrictions. These features can be applied in principle to data calls as well as to voice calls.

In an effort to gain wider acceptance for the use of PABX systems in data switching, manufacturers have developed data-call-switching features that can be added to PABX systems. For example, data switching PABX systems can eliminate the need for conventional modems when both parties to a data call are directly connected to a PABX. Such an arrangement is effective when terminals are connected to computers at one location. However, a terminal can be used for both local (modem-less) data calls and outside calls (requiring a modem). To solve this problem, some data-switching PABX systems offer "modem pooling," which allows a terminal user to dial up and acquire a modem from a pool for outside calls. Each modem in the pool is attached to a pair of PABX ports, one for the modem's digital data side, and the other for its analog side. Digital modem-pooling ports must be equipped to translate the PABX internal digital data format into RS232C format.

Whether modem pooling is economically attractive depends on the needs of a terminal population. As the percentage of terminals that may need to place outside data calls simultaneously increases, the value of the feature decreases. In contrast, modem pooling becomes an economic necessity with new data PABX systems that consolidate digital data and digitized voice at the telephone set. Otherwise, terminals requiring outside access would need permanently wired modems and use a dedicated voice port rather than sharing facilities with voice traffic.

Protocol conversion is a second data-handling feature finding its way into integrated voice/data PABXs. InteCom, Inc., has implemented features that permit a group of low-cost asynchronous "glass Teletype" CRT displays connected to PABX ports to perform the functions of the more expensive IBM 3270 displays. The low-cost terminals communicate with an IBM computer via a single 3270 bisynchronous data link. The PABX system provides the functional equivalent of an IBM 3270-cluster controller. InteCom has elected to allocate a portion of the computing capacity of their PABX to the functions of terminal emulation to offer a form of protocol conversion—one that allows low-cost asynchronous terminals to perform the functions of more expensive terminals. Several companies make stand-alone systems that accomplish the same purpose, so that protocol conversion available from this PABX can be implemented by an outboard protocol converter attached to any data-switching PABX and selected in the same manner as are modems from a modem pool.

Port-contention systems

Port-contention systems were developed by data-communications system suppliers to solve a problem arising from the growth of computer time sharing. Time-sharing computers are usually equipped to permit any of a population of terminals to obtain access to any computer port by dial-up methods on a first-come, first-served basis. But these computers cannot recognize demand that is turned away because all ports are occupied. They generally cannot qualify a user's requests for access to a port on the basis of priority or grade of service. Further, computers at a multi-

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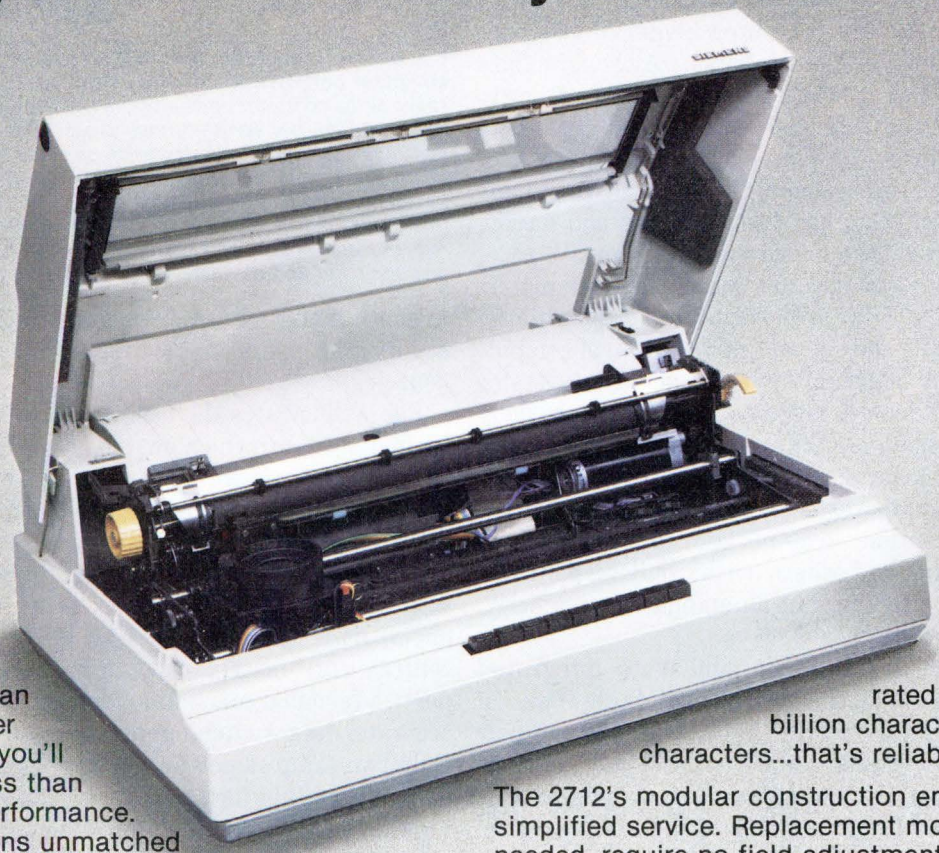

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The newer integrated voice/data PABX systems combine digital computer data with digitized voice data at the first point of entry.

computer site typically cannot recognize the existence of other computers and share loads. These problems were not important when time-sharing systems were small. But as time-sharing systems grew and became multi-computer neworks, an additional traffic manager was required between the terminal population and the computers. Thus, the port-contention system was born.

There are roughly 2000 port-contention systems installed (according to vendor statistics), mostly at university and research computer centers. They are relatively inexpensive and reliable. Although their suppliers have yet to call them local-area networks or to promote them in competition with other local-area communications products, port-contention systems perform a legitimate local switching function, solving many problems that the other products address and having the latent ability to take on further functions.

Port-contention systems are simple digital matrix switches normally positioned between a population of computer terminals and a smaller population of computer ports in a time-sharing environment. The systems are designed to handle a large population of relatively low-speed (9600-bps), asynchronous devices. They also recognize that a user at a terminal typically does not need to select a computer port, only one from a group. Some port-contention systems permit terminal-to-terminal switching, and others permit only terminal-to-computer-port switching, but all emphasize simplicity, reliability and low cost.

Port-contention systems are similar to integrated voice/data switches to the extent that both types of products use digital matrix switching, twisted-pair wiring and voice-grade transmission speeds. Port-contention systems are much less expensive because of their simplicity and dedication to digital data service. Their purchase can be justified solely to support a computer center and its terminal population.

Port-contention systems are normally priced as configurations including a mainframe, line-interface adapters and limited-distance modems at the terminals. Prices typically range from $300 to $500 per line.

In the Gandalf port-contention system (Fig. 4), terminals gain access directly through low-cost limited-distance modems and indirectly through dialed systems and conventional modems. Several options are available for user service requests, including an attention key that causes the system to connect a user to a predefined port group, assuming a port is available; a port-selection device incorporated into the limited-distance modem; and port selection from the terminal keyboard. The system responds to selection requests if ports are available and the requester is authorized, places users

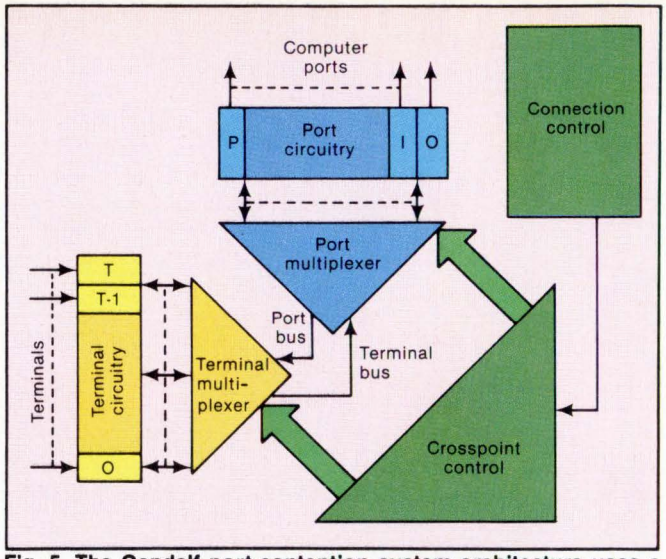

Fig. 5. The Gandalf port-contention system architecture uses a computer port-oriented time-division multiplexer. *The multiplexer scans all the computer ports at a rate fast enough to permit each bit at 9600 bps to be sampled four times. This system is typically configured to support roughly twice as many terminals as computer ports. The system responds to a connection request from a terminal by scanning to find an available port of the proper class or group (user specified). If the port is available, the system will make the required connection, and thereafter switch data between terminal and computer port at whatever rate is required to system maximum.*

in queue if all ports are busy and provides historical and status information for a system operator at a central console.

Fig. 5 illustrates the basic matrix architecture of the Gandalf system, which switches terminals to computer ports. The central time-division multiplexer (TDM) matrix switch is computer port-oriented and designed for a population of 126 ports at asynchronous and synchronous speeds as high as 19.2K bps. The basic scan cycle of the TDM matrix is 26.04 μsec., exactly one-quarter the length of 1 bit at 9600 bps. Thus, the central TDM matrix can sample each asynchronous port-to-terminal connection four times per bit, assuring accurate data switching of an asynchronous stream. Only two samples per bit are required for synchronous data, accounting for the higher rating of the switch.

Other port-contention switching techniques result in different configuration limitations, features and prices. The Gandalf approach minimizes the amount of active electronics between the two data paths being switched. Other products use more complex electronics at the interface between the matrix switch and the data path to the terminal or computer (bit- and byte-sized registers, for example, which can permit higher capacity switching). The functions of a port-contention system can also be provided by statistical multiplexers that interface user devices at a packet level, and perform the switching function at the packet level in semiconductor memory. ■

Walter A. Levy is president, and **Harriet F. Mehl** is on the research staff, of Edgewood Computer Associates, Inc., Hillsdale, N.J.

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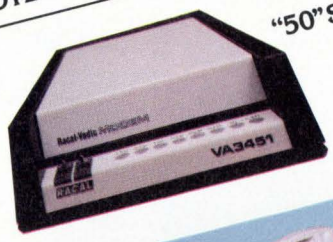

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Interfacing minis and μcs to IBM networks

STEPHEN J. RANDESI, Communications Solutions, Inc.

A software emulator provides system designers the protocol support of popular IBM products

A modular software-emulation package called Access/SNA allows system integrators to interface minicomputer and μc systems with user networks based on International Business Machines Corp.'s Systems Network Architecture (SNA). It provides the level of SNA protocol support used by most of IBM's intelligent-terminal, distributed processing and office-automation products, including the 3274/3276 controllers and 8100 Information System. To understand where and how Access/SNA can lower user cost and increase flexibility entails understanding the nature of linking into SNA networks and the structure of the software package itself.

SNA usage will increase

The rapid growth of SNA and SNA terminal usage is forcing non-IBM terminal and computer manufacturers to provide SNA compatibility in their products. An example is the growth of SNA 3270 terminal usage. The 3270 is IBM's most widely used terminal system and a de facto industry standard for interactive communications. Most installed 3270 systems use BSC (binary synchronous communications) for communicating with IBM host mainframes. But BSC 3270s are rapidly being replaced by SNA 3270s (Fig. 1). There will be an increasing demand for minicomputer and μc systems that offer BSC 3270 emulation to upgrade this support to SNA/SDLC (synchronous data-link control).

SNA will greatly impact systems that provide or intend to provide IBM-compatible communication interfaces. IBM is pushing its users to SNA partially in an attempt to recapture a large share of the terminal base they lost to emulators of IBM products such as the BSC 3270. To derive the full benefits of SNA, users must switch to SNA terminals.

Independent vendors must provide the SNA interface. SNA development typically is more complex, takes longer and requires greater support than BSC development. One reason is that SNA addresses a much wider range of communications issues than does BSC. BSC is a protocol for controlling transmission of data over a single data link, while SNA defines a wide range of functions and protocols, some of which control logical conversations between end users as well as data-link protocols.

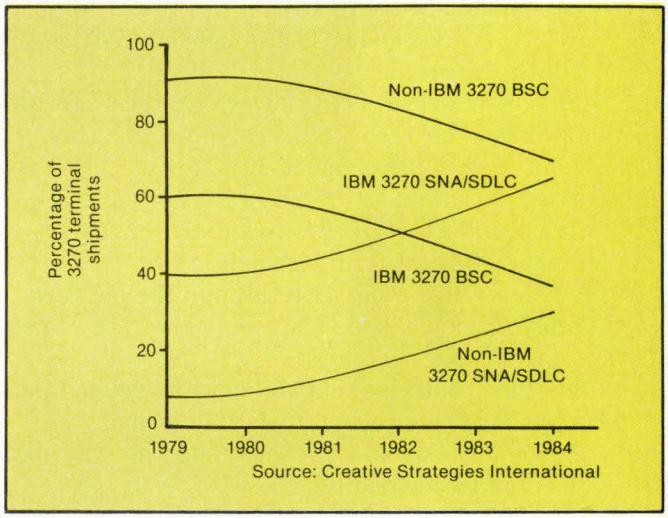

Fig. 1. BSC versus SNA sales. *Systems Network Architecture is gradually replacing binary synchronous communications, and minicomputer users are increasingly seeking SNA compatibility.*

Comparing BSC with SNA

There are differences between BSC and SNA compatibility requirements in minicomputer/μc systems. For BSC 3270 emulation supporting one CRT terminal, there are three major functional requirements: the system must support the BSC data-link protocol to communicate with the IBM mainframe; it must control the 3270-format data streams between the display-station

The rapid growth of SNA and terminal SNA usage is forcing non-IBM terminal and computer manufacturers to provide SNA compatibility in their products.

and the mainframe; and it must have a device handler interface to drive the attached display station. The software necessary to support these functions is not extremely complex, and many non-IBM systems offer such emulation software.

While the compatibility requirements for SNA 3270 emulation are greater because of the need to support the higher level of processing used by SNA systems such as the 3274, SNA 3270 emulator functions are similar to those described for BSC emulation. A data-link protocol handler is needed to communicate with the mainframe, but in this case to provide support for IBM's SDLC protocol. The data streams between the display station and the mainframe are in the same 3270 format as they were in the BSC environment, so SNA emulation requires similar 3270 data-stream processing support software. A device handler is also needed to drive the attached display station.

The major difference is in the SNA protocol-processing software required for SNA 3270 emulation (Fig. 2). The support includes implementing subsets of the functions and protocols performed at the upper layers of the SNA architecture. These upper layers and some of the functions they perform include:

- Path control: routing data through the network,
- Transmission control: controlling the rate of data flow,
- Data-flow control: grouping logically related data and controlling the direction of data flow and
- Function management: controlling the way data are presented to end users.

Not only are the protocols at these layers more complex, but the way they are used affects the entire structure of the software emulating the SNA device.

The SNA network link

SNA networks comprise several types of components with different SNA protocol-handling abilities. Host nodes in an SNA network are typically IBM-compatible mainframe computers running SNA access-method software such as VTAM or TCAM. The host nodes are the central control points of the SNA network. Communications controller nodes are typically IBM 3705 front-end processors running the network-control program software. These nodes manage data links and handle end-to-end data routing. Cluster controller nodes are products such as IBM's 3274 or 3276 controllers and 3770 or 8100 systems. These nodes support multiple end users (application programs or devices) and are the end users' interface to the SNA network. Terminal nodes are implemented in IBM products such as the 3767 terminal. They support a single end user at a time.

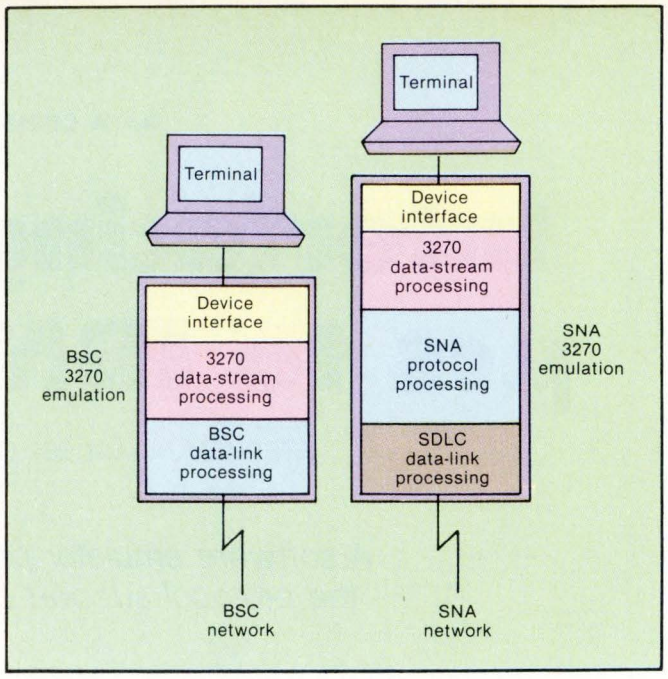

Fig. 2. Major functional requirements *of BSC and SNA differ for software compatibility in minicomputer/μc systems emulating an IBM 3270 interface. In addition to BSC requirements, an SNA interface needs processing software to support the higher level SNA protocols used by SNA cluster controller products such as IBM's 3274.*

A simple SNA network (Fig. 3) includes the host node represented by the S/370 mainframe running VTAM and one communications controller node represented by the 3705 running NCP. Cluster controller nodes include the 3274, the 3770 and the Series/1. One terminal node represented by the 3767 terminal is shown. A non-IBM minicomputer or μp system runs with the Access/SNA software, which provides the SNA capabilities similar to those used by the SNA cluster controller and terminal nodes. A cluster controller node is also referred to as a Type 2 physical unit, and a terminal node is also referred to as a Type 1 PU. Access/SNA can be integrated into a minicomputer/μc system to provide the SNA compatibility necessary to emulate Type 1 and 2 PUs.

The products described above use SNA/SDLC protocols as the basis for their communications. SDLC, a bit-oriented data-link protocol, transmits data over a single data link for systems that are remotely attached to the communications controller node. SDLC is one implementation of the lowest layer defined by SNA—the data-link layer. In addition to the SDLC protocol, SNA products use other higher level SNA protocols to facilitate logical communication between end users. These higher level protocols are defined by the upper layers of the SNA architecture. They are transparent to, and independent of, the physical communications occurring over a data link supported by SDLC protocols.

SNA elements

SNA cluster controller and terminal products contain a physical unit and one or more logical units (Fig. 4). PU

QUME

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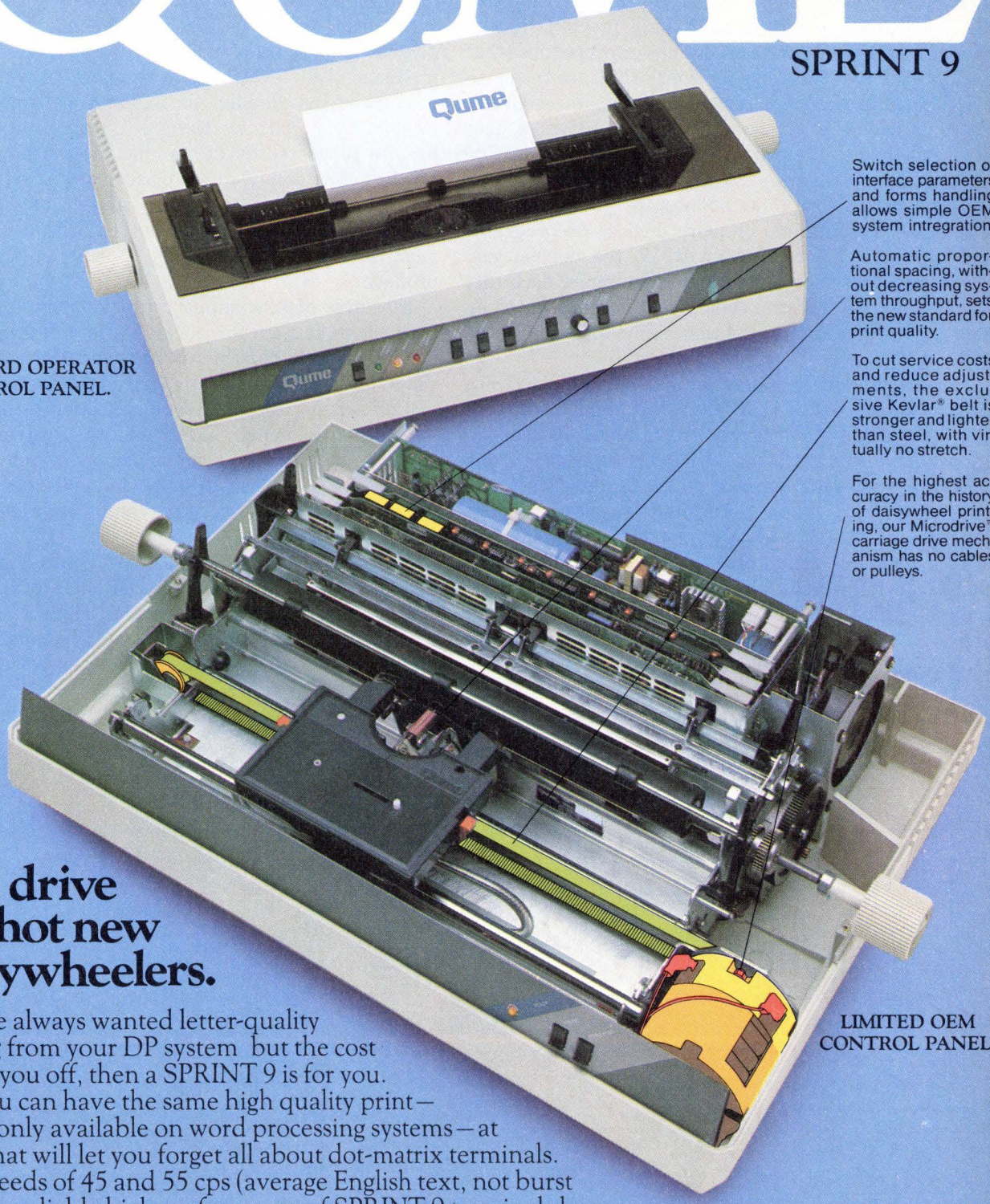

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SNA networks comprise several types of components with different protocol-handling abilities.

and LU are SNA architectural terms that refer to the basic components of an SNA network. The architectural definitions of PU and LU describe the SNA functions and protocols for which these logical entities are responsible. PUs and LUs are usually implemented in SNA products as sets of software routines or procedures that perform the SNA functions for which they are responsible. The PU procedures control a product's resources. For example, the PU activates and deactivates data links attached to the product. The LU routines provide an interface between the SNA network and the devices and application programs supported by the product. The LU represents one or more devices or programs and is a logical port through which the devices and programs access the network. For example, each CRT device attached to a 3274 control unit is represented by an LU (set of SNA software) that is implemented in the 3274.

No SNA product supports the full range of functions and protocols defined by the SNA architecture. To identify the subsets of functions and protocols that are supported within a product, IBM defines various PU and LU types, assigning numbers to the types so they can be referred to when describing a product's SNA capabilities. The PU and LU types define combinations of SNA functions and protocols that are performed at each layer of the SNA architecture. For example, the PU type identifies those SNA functions and protocols that are supported by the product at the lower SNA layers—the data-link control and path-control layers. The LU types identify those SNA functions and protocols that are supported by the product at the higher SNA layers—the transmission control, data-flow control and function-management layers. The LU type specifies a combination of various subsets of SNA functions and protocols at each of these higher layers. These subsets are called profiles, and as with the PU and LU types, IBM has assigned numbers to them. A unique type of LU consists of a combination of three profiles corresponding to the higher SNA layers supported by an LU.

IBM has defined a device-independent means of describing the SNA functional capabilities of their products. The level of SNA support provided by a product is not defined to the SNA network by the product type, but by the PU types, LU types and profiles supported by the product. Because each layer of the SNA architecture performs its set of SNA functions and protocols, which subsets of these functions and protocols are supported within a product must be specified with the PU and LU types and profiles.

The level of SNA support provided by Access/SNA allows it to be used for a wide variety of SNA product emulations including the IBM 3274 and 3276 controllers, the 3770 data-communication terminal, the 8100 information system, the 3767 communication terminal, the 8775 display terminal, the Series/1, the System/32/34/38 and the 3600 finance-communication system. Future Access/SNA packages will support a wider range of SNA protocols so that the software can be upgraded as new SNA products become popular.

The Access/SNA software is structured along the lines of an SNA cluster controller node (Type 2 PU). Access/SNA contains one data-link control (DLC) element (Fig. 5). The DLC processing is common for the entire node (the system in which Access/SNA is

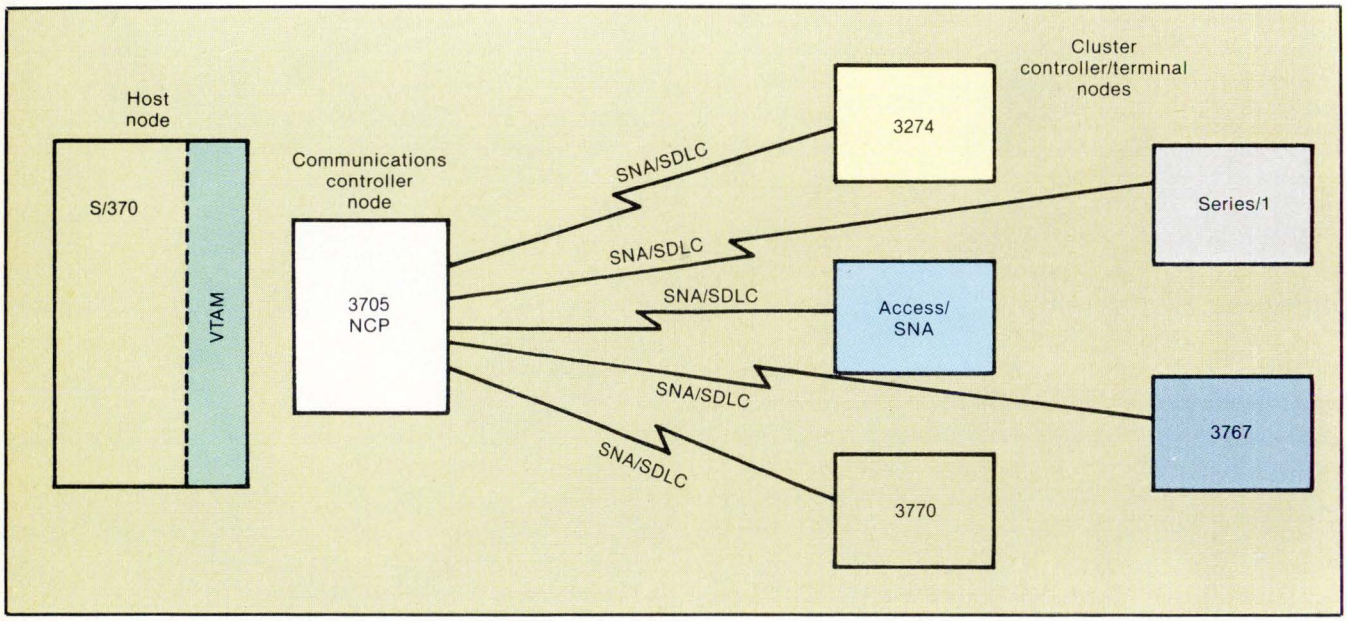

Fig. 3. Simple single-host SNA network *with remotely attached SNA cluster controller and terminal systems. A non-IBM minicomputer/μc system running Access/SNA interfaces to the SNA network in the same manner as the IBM cluster controller products. These types of products use a common subset of SNA/SDLC protocols supported by Access/SNA software.*

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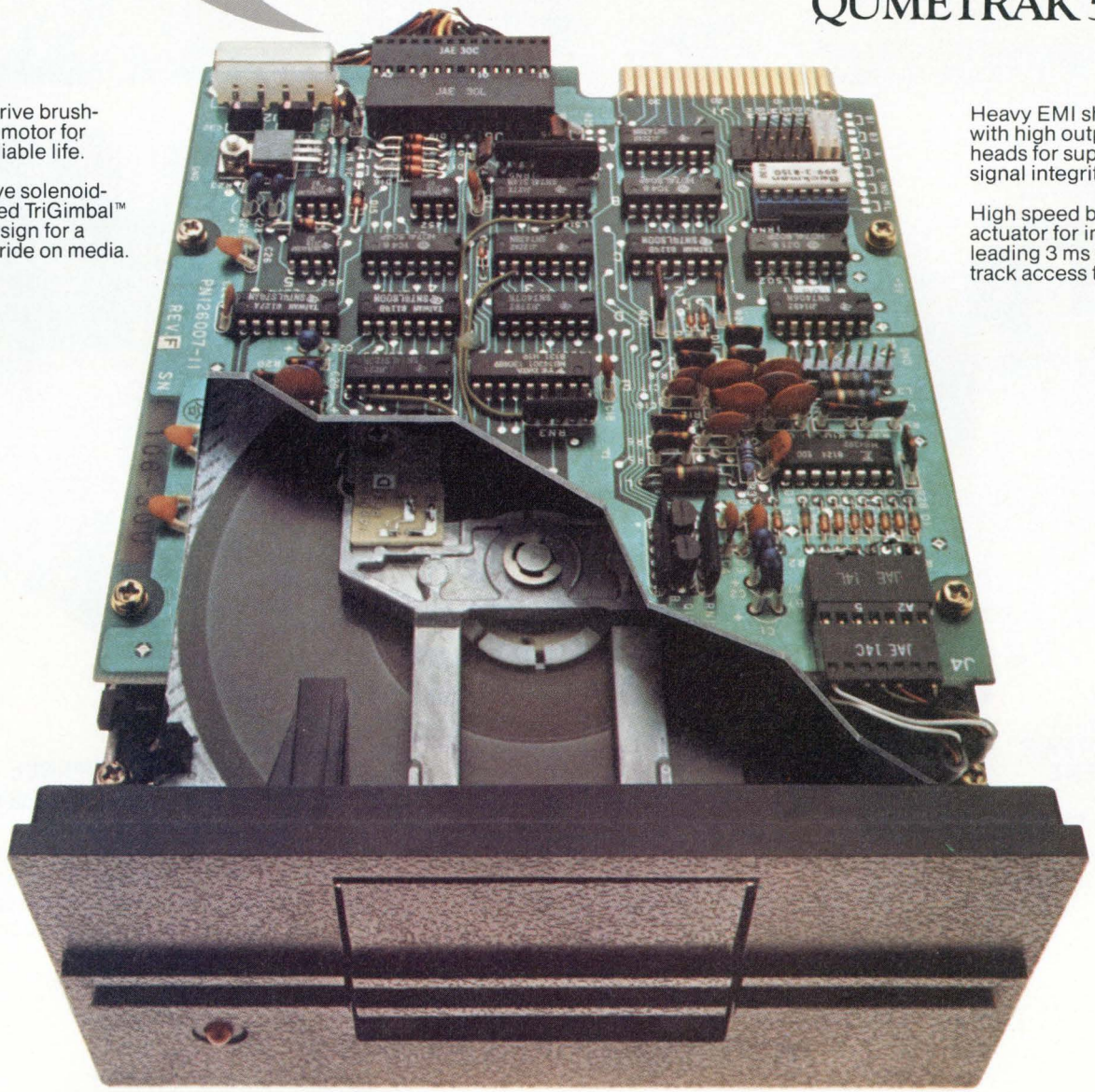

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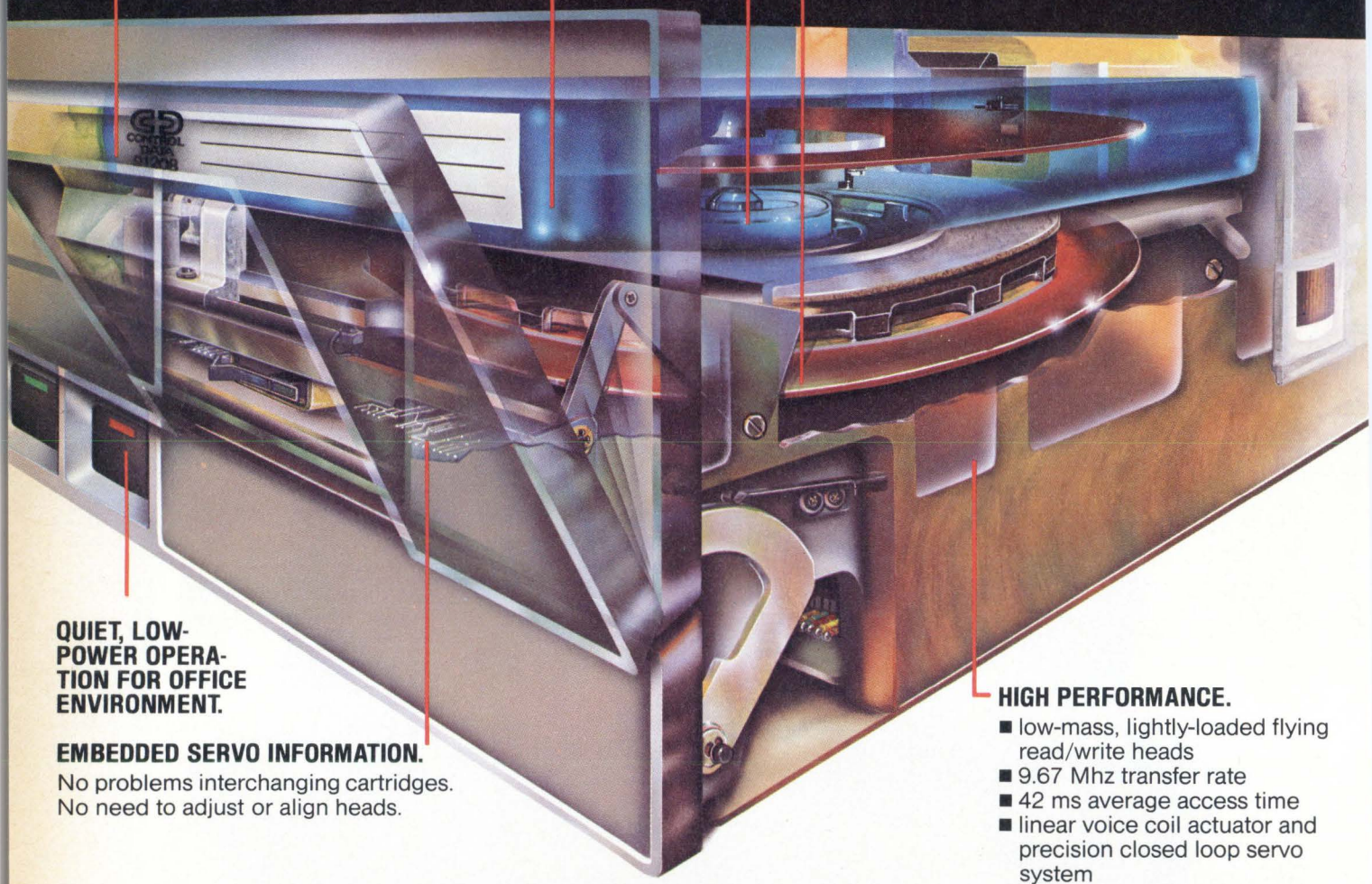

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integrated). The DLC implemented in Access/SNA is SDLC, which is the communications protocol for SNA and SNA-compatible products that are attached remotely (via common-carrier or customer-owned communications facilities) to an SNA mainframe computer.

Access/SNA also contains a single path-control (PC) element. The PC is common to the entire node and, like the DLC, is shared by all the applications running with Access/SNA. The PC provides the local routing of data to and from the applications using Access/SNA and the host mainframe computer to which the product is connected.

The functions and protocols of the higher layers of SNA (TC, DFC, FM) are not common to the entire node (Fig. 5). Instead, each supports one active end user (device), so there may be many occurrences of these functions. These sets of logic represent the SNA "half-sessions" used for communications with host mainframe application programs.

Access/SNA supports the multitasking requirements to control these concurrent half-sessions. The maximum number of concurrently active devices (half-sessions) that can be supported by Access/SNA is a function of the amount of memory available to Access/SNA.

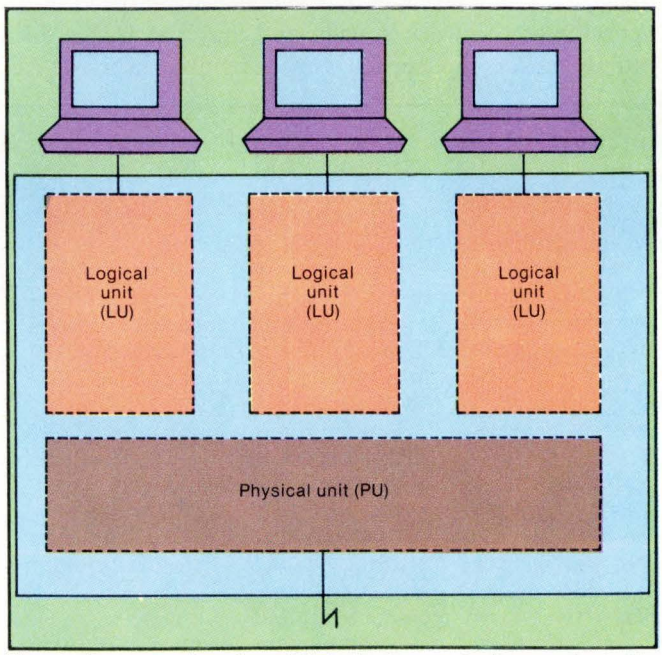


Fig. 4. An example of an SNA cluster controller product. *The cluster controller contains one PU and one LU for each CRT terminal attached. The PU type identifies the SNA data-link control and path-control processing supported. The LU type(s) identifies the transmission control, data-flow control and function-management protocols supported. An LU type is a combination of profiles that describe a particular subset of the SNA protocols supported at these layers.*

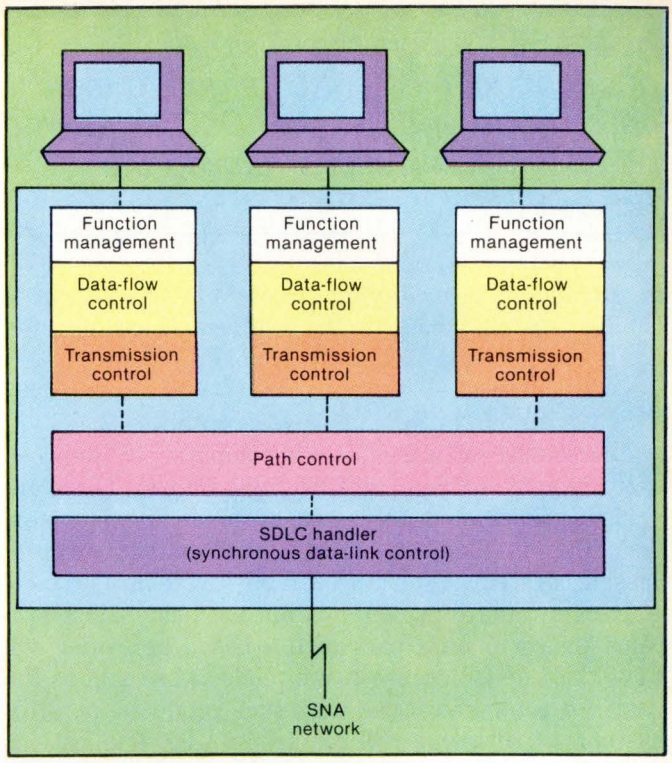


Fig. 5. Access/SNA software *provides SNA cluster control and terminal compatibility. Running in a mini or μc system, Access/SNA can be used in a multi-tasked environment to support multiple concurrent device operation.*

Two program interfaces to the Access/SNA software are provided, one of which is at the DLC—the lowest level of interface. This interface consists of a set of subroutines that control the SDLC processing performed by Access/SNA. In most cases, users do not have to worry about this interface because it is governed automatically by the path control (PC) component of Access/SNA. The user-application software does not have to be concerned with the SDLC processing being performed. However, an interface at this level allows the DLC code to be moved into a separate board that can be dedicated to data-link communications processing. It also allows users the use of the SDLC code without the higher level SNA code implemented in Access/SNA.

The other user interface is at the data-flow control (DFC) level of Access/SNA. At this level, the user gains some control over the SNA processing done by Access/SNA. This level of control is needed to emulate an IBM SNA product, such as the 3274 control unit and the 3278 display stations. At this interface level, a user has control over SNA protocols such as chaining and bracketing.

Access/SNA software is written in C for portability and is modular for each configuration. It contains its own tasking scheme so it does not depend on any one operating system. It can also be easily modified to support additional SNA protocols as users migrate to other SNA product emulations. The modularity is also

Access/SNA contains a single path-control element common to the entire node and, like the DLC, is shared by all the applications running the Access/SNA.

an advantage in modifying Access/SNA to conform to changes IBM may make to the SNA protocols supported by its cluster controller and terminal products.

Applications

Access/SNA software lets minicomputer- or μc-based systems communicate with IBM mainframes. There are various products with this type of communication need, including intelligent terminals, distributed data-processing systems, word-processing systems, protocol converters and office-automation products. Most systems that will be a part of IBM-based networks will have this need. Because IBM intends to use SNA as the basis for communications with such products, non-IBM systems of this type will require SNA communications capability. Access/SNA allows non-IBM vendors to emulate IBM SNA cluster controller and terminal products.

The way that the Access/SNA software fits into minicomputer and μc systems is shown in Fig. 6, which illustrates how Access/SNA can implement a multifunction work station. The work station supports word processing/electronic-mail operations and an IBM 3270-compatible inquiry/response function for data processing. The Access/SNA software coexists with the operating system and application programs running on the system.

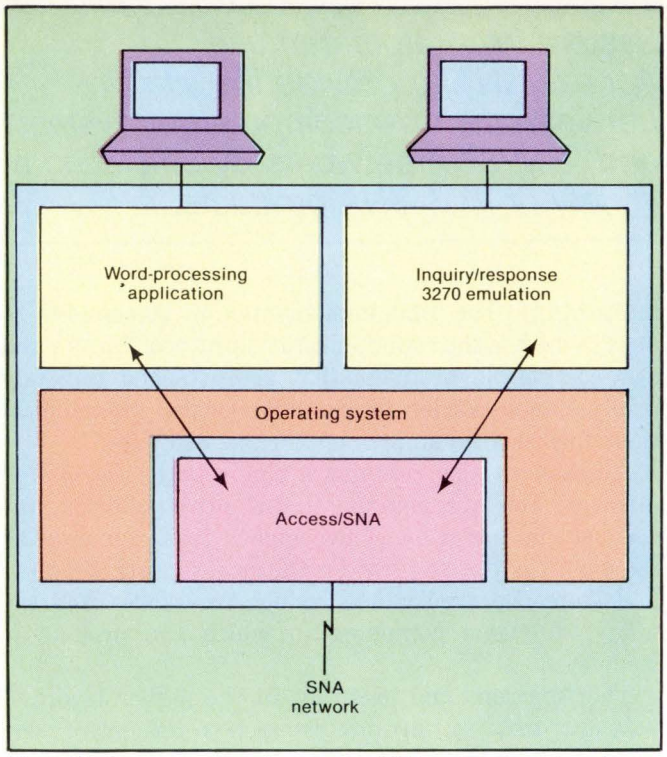


Fig. 6. Mini/ μc system *using Access/SNA software to interface to an SNA network. The software package can be integrated with the operating system to provide a communications-access method level of interface.*

Each application program using Access/SNA to communicate with an IBM SNA mainframe may be performing a different function and may be emulating a different SNA device. For example, the word-processing application may be collecting information entered by an operator at the work station and may batch this data into the host computer for storage or processing. It can

GLOSSARY

Access/SNA—a software package providing an SNA cluster controller and terminal compatibility.

Binary synchronous communications (BSC)—a byte-oriented, half-duplex IBM data-communications protocol.

Cluster controller—an SNA node (such as 3274/3276, 3776, 8100) that supports multiple end users.

Communications controller—an SNA node (such as 370X) that performs network control and routing functions.

Data-flow control (DFC)—an SNA layer that controls the direction and logical grouping of data.

Data-link control (DLC)—an SNA layer that transmits data across a physical connection.

Function management (FM)—an SNA layer responsible for presentation and network services.

Function-management profile—defines a subset of SNA data-flow control protocols and options.

Host—an SNA node having a control point for an SNA network (270 or 4300).

Logical unit (LU)—a port through which end users access an SNA network.

Network control program (NCP)—SNA software that runs in a 3705 communications controller.

Node—a grouping of SNA components characterized by the type of physical unit it contains.

Path control (PC)—an SNA layer that routes data through a network.

Physical unit (PU)—SNA function and protocol subset that controls the resources of an SNA node.

Presentation services (PS)—protocols for presenting data to end users in a form required by them.

Profile—defines a subset of optional SNA functions and protocols.

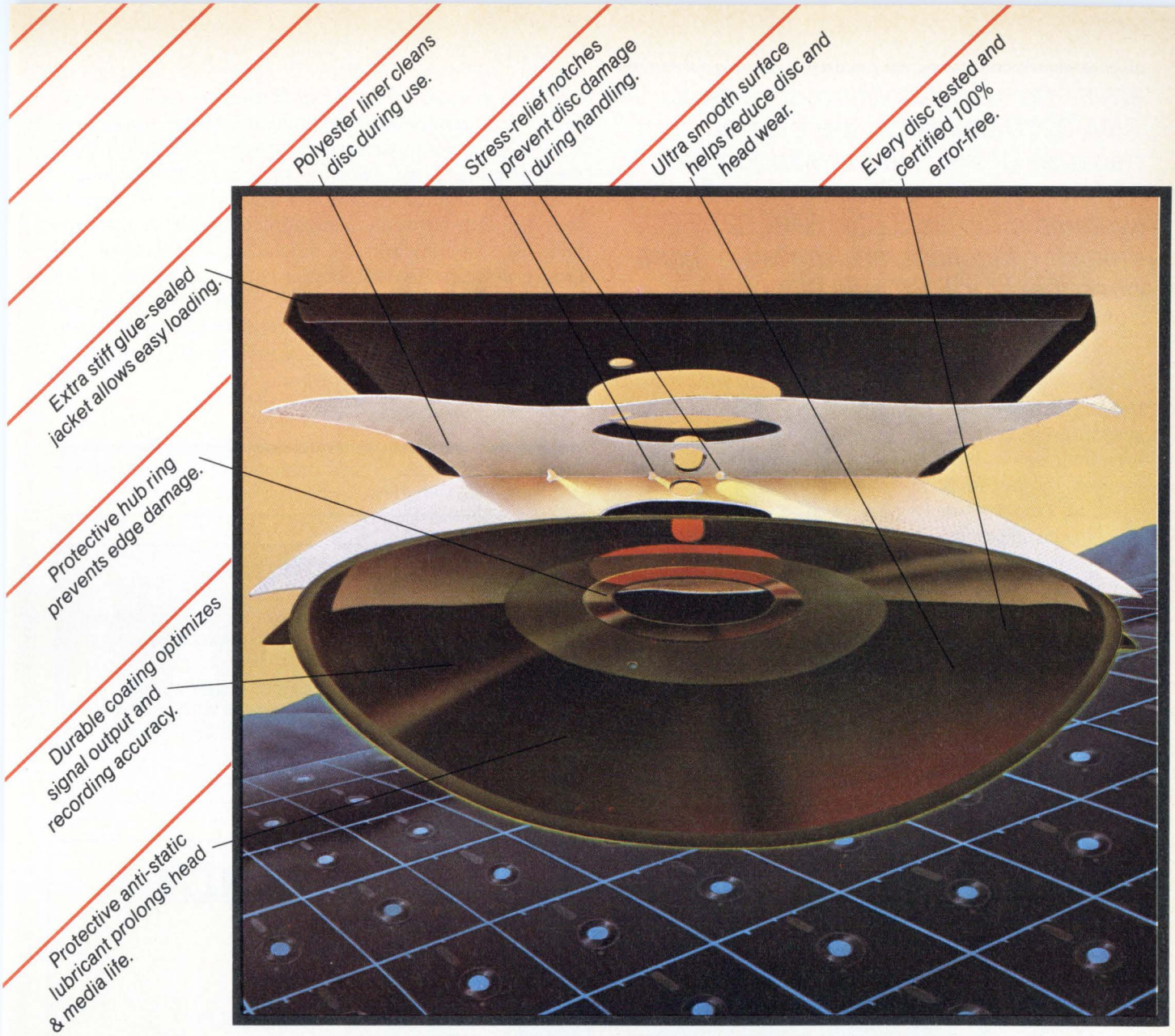
Synchronous data-link control (SDLC)—a bit-oriented protocol used for remote connections in SNA networks.

Systems network architecture (SNA)—IBM's formal definition of its data-communications networking philosophy.

Telecommunications access method (TCAM)—an IBM-queued access method supporting pre-SNA products.

Transmission control (TC)—an SNA layer that controls the rate of data flow.

Virtual telecommunications access method (VTAM)—IBM's primary SNA access method.



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CIRCLE NO. 73 ON INQUIRY CARD

While the compatibility requirements for SNA 3270 emulation are greater because of the need to support the higher level of processing used by SNA systems such as 3274, SNA 3270 emulator functions are similar to those described for BSC emulation.

do this using the Access/SNA interface by emulating an IBM 3770 terminal. At the same time, the inquiry/response application may be emulating an IBM SNA 3270 terminal, again using the appropriate SNA logic implemented by Access/SNA. Thus, a single system can be used to emulate many SNA products. This lowers a user's equipment costs and increases the flexibility of the system.

Because it contains its own tasking structure, Access/SNA software can also run stand alone in a minicomputer or μp system. And used in a configuration in which communications processing is done in a separate card or board plugged into the system, Access/SNA provides the front-end communications processing.

Minicomputer and μp systems use Access/SNA software in much the same way they use other access method software. A user interface to Access/SNA consists of a set of function/subroutine calling statements and parameters. By invoking these statements with appropriate parameters, users can tailor their application-level software to emulate an SNA product.

System integrators can use Access/SNA to provide the vital link between their minicomputer/μc systems and IBM SNA networks by emulating a variety of IBM SNA products. As IBM begins to bring more of its products under the SNA umbrella, user demand for SNA compatibility will grow. Access/SNA is designed to help system integrators and independent terminal/computer manufacturers meet this demand. ■

Stephen J. Randesi is vice president of Communications Solutions, Inc., Cupertino, Calif.

NEXT MONTH IN MMS

Two minicomputer profiles will hold the spotlight in the April feature section of Mini-Micro Systems.

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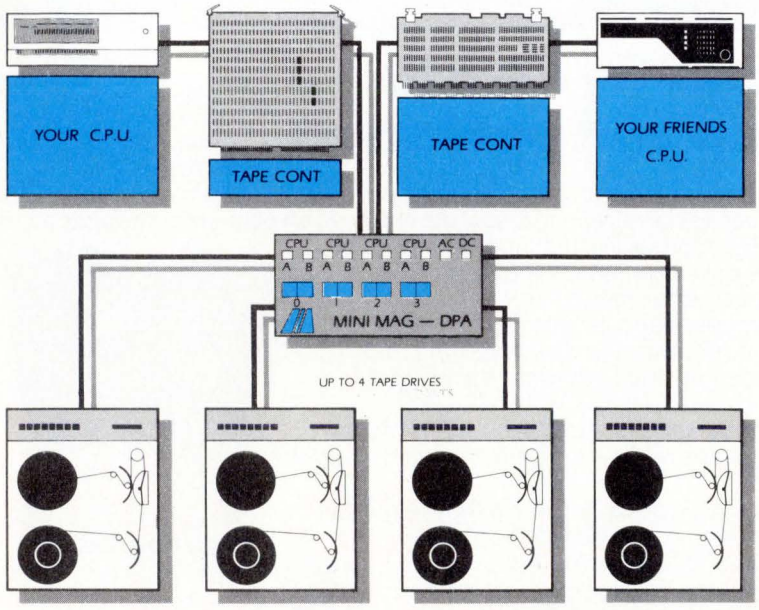

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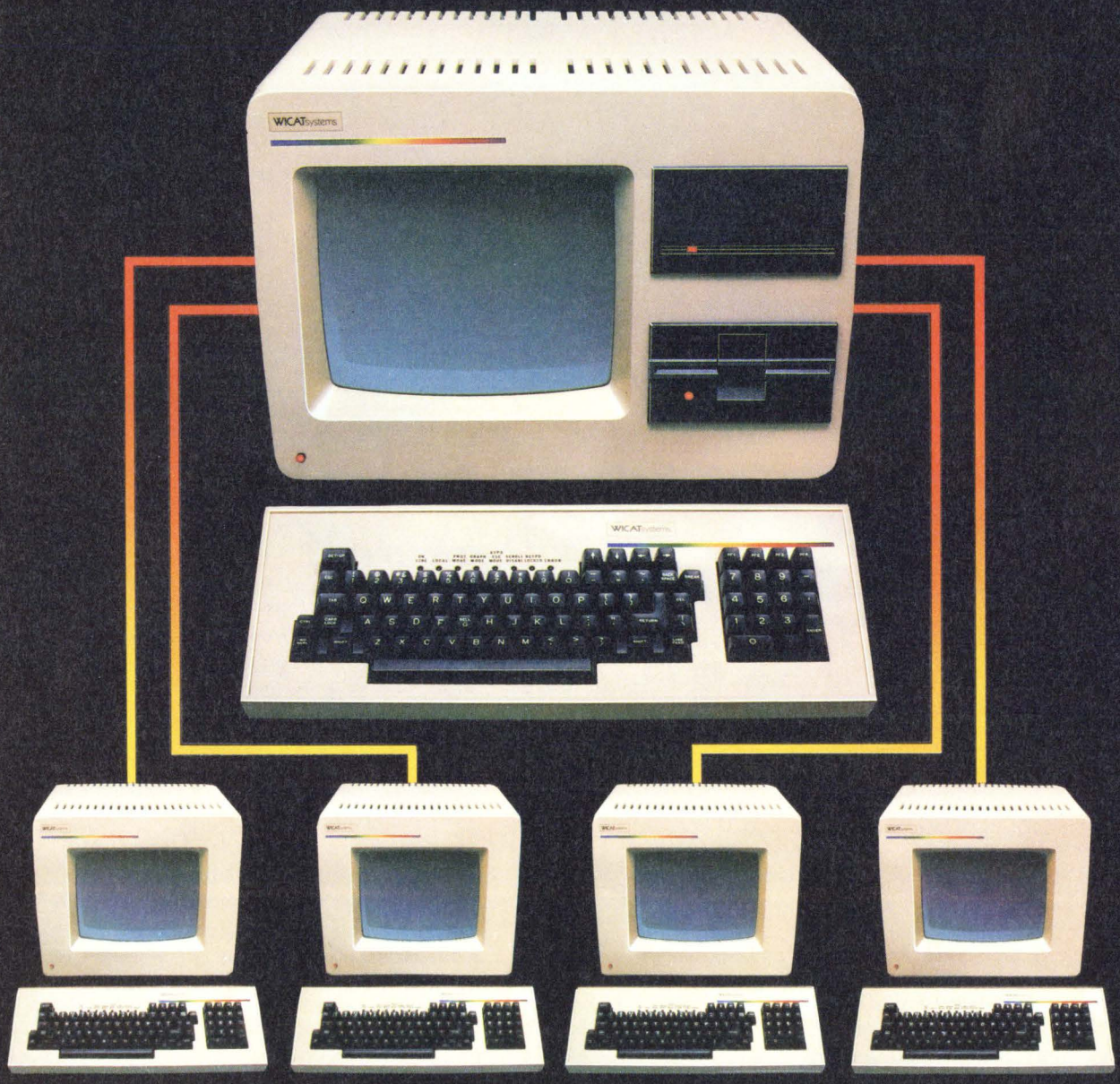

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CIRCLE NO. 75 ON INQUIRY CARD

Token-access controller minimizes network complexity

MARK STIEGLITZ, Western Digital Corp.

Users can benefit from the increased speed this transmission method provides

In a data-communications network, contention among stations trying to get through to the central computer is inevitable. One of the more effective procedures to eliminate this contention is a form of distributed polling known as token passing. Despite its effectiveness, however, token passing has not been very popular with system integrators. Most network architects have been intimidated by the complexity of the algorithms required to set up the station linkages and to recover from network exception conditions, and have settled for less complex control methods. A new LSI token-access controller (TAC) residing in each station of the network minimizes this complexity for network designers.

A token is a message granting a polled station the temporary but exclusive right to transmit on the medium, a right the station must then relinquish to the next designated station. This method has been historically used on sequential media on which access sequence is implied by the physical interconnection, but tokens can also be used on broadcast media such as baseband coaxial or CATV systems by assigning unique addresses to each station or node (MA: "my address") and passing transmission rights between them (Fig. 1).

The simplicity and non-reliance on quirks of a medium make token methods superior for use on a wide array of applications. Relatively simple (from the data-movement viewpoint) applications such as file transfer to the complex time-critical applications of factory automation are supported with the same access

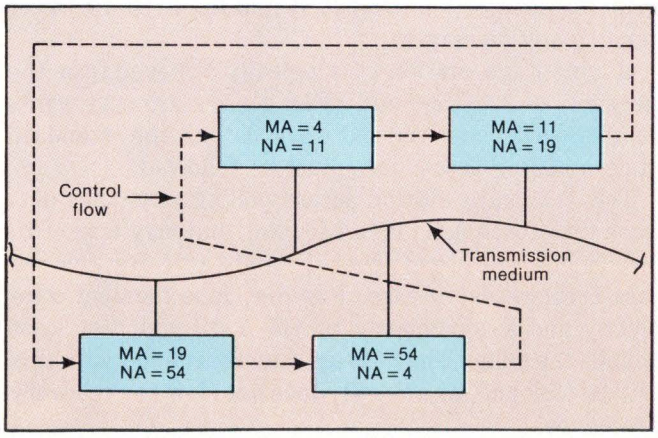


Fig. 1. Access control flow. *When a station (MA: "my address") has transmitted its data, it sends the transmission rights—the token—to the station identified in the next address (NA) register. Station numbers are in ascending order but need not be sequential for network efficiency.*

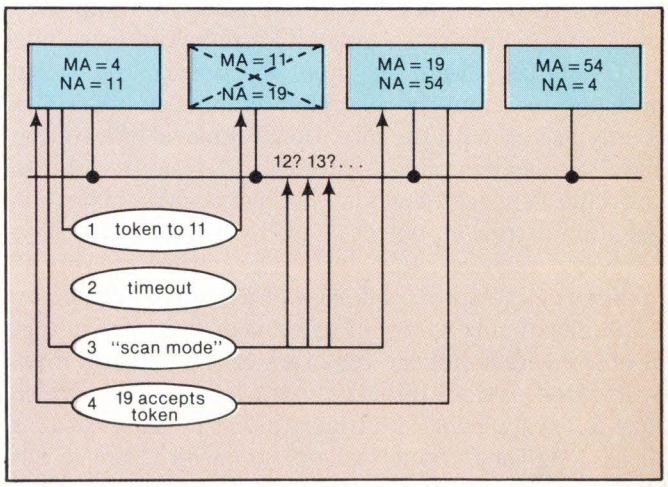


Fig. 2. Station dropout. *Station 4 attempts to pass the token to 11, which has dropped out of the network. Station 4 then "times out" and scans for another station to which it can pass the token, finding 19.*

TAC must handle three main exception conditions: network initialization and recovery from failed nodes, addition of stations to the access ring while the network is in use and recovery from an error situation in which two or more tokens have been generated on the network.

protocol. Also, data rates optimized for the application, not mandated by the network implementation, are possible with the same LSI network controllers.

TAC's tasks

TAC must handle three main exception conditions: network initialization and recovery from failed nodes, addition of stations to the access ring while the network is in use and recovery from an error situation in which two or more tokens have been generated on the network.

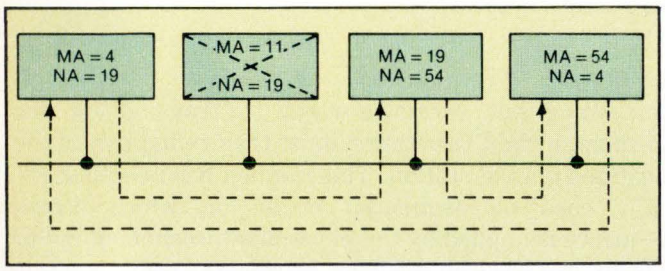


Fig. 3. Station patched out. *Station 11 is logically removed from the network when station 4 changes its next address (NA) register to 19. Thus, station 11 no longer consumes network time.*

Initialization and recovery

Initialization is setting up the network's token linkages and determining the correct values for registers in all TACs wanting to be part of the access ring (desiring INRING status). Failed-node recovery refers to the network restart when a token is lost or damaged.

Token loss results from exception or expected conditions. Error cases may be a product of noise hits on the transmission medium corrupting the token message, or simply a controller failure. A token loss usually occurs with the intentional removal of a station from the access ring. The ratio of noise hits to controller failures depends on a network's application and administration, but both are recovered identically. Recovery requires the detecting station to set its linkage register to the address of an active station.

Initialization is a form of failed-node recovery in that all of the access linkage registers of the network must be updated. Before initialization it is not known which node follows which. Two timers assist in these cases: a fairly long-time value called TD, which times out network inactivity and a shorter timer called TA, which is the maximum turnaround time required for a response (token or data) to be sent by the receiving station of a previous message. These timers are user settable and depend greatly on a network-transmission rate, and to a lesser extent, on an application. The timers work together and are the key to solving the initialization and failed-node challenges.

Two manifestations of a failed node can occur. One happens when a token holder tries to pass the token to the next station in the ring. If the next station does not respond to the token, the token-passing station soon knows because it knows how long it should take for a node to pass the token or to send a data message (time TA). In this case, the node that tries to pass the token has primary responsibility to recover. It does so by entering a scan mode from an access level, and polling the network for another successor.

Assume that station 11 (Fig. 2) is removed from the network and station 4 is attempting to pass the token to it. Station 4 will time out because 11 does not respond to the token within time TA and will attempt recovery by passing the token to station 12. Station 12 will not respond because it also is not present, which will cause

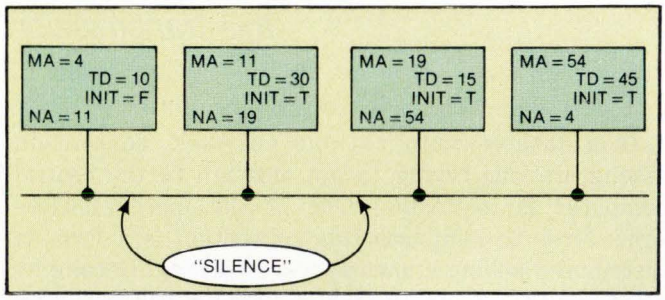


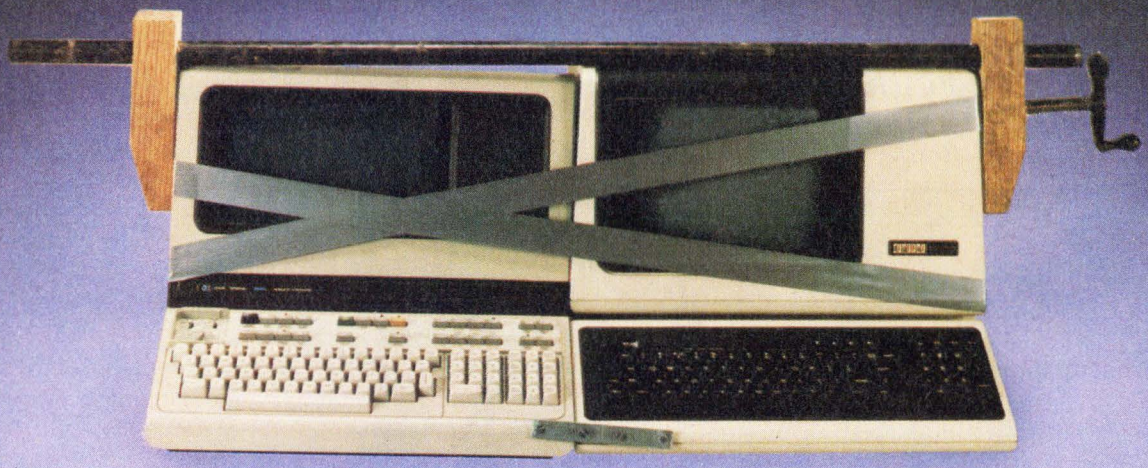
Fig. 4. With no token, there is no transmission. *All stations detect this and start internal timers. When one expires and has the proper control bit enabled, it restarts the network. TD is the station-inactivity timer. INIT is a switch that, when false (F), tells TAC not to attempt recovery regardless of TD. When INIT is true (T), TAC attempts to initialize the network after there has been no activity for duration of TD.*

station 4 to try 13. This "polling" continues by station 4 until it finally gets to 19. Station 19 will respond, causing station 4 to update its next address register (NA) to 19, bypassing station 11. The next time station 4 gets the token, it immediately passes it to 19 (after sending any messages).

At this stage, station 11 is logically removed from the network, or "patched out" (Fig. 3). If station 11 wants to get back into the network later, the standard station-adding procedures must be followed.

This station-by-station access polling consumes network time (each poll takes TA time), and may appear to be an inefficient use of network bandwidth. But this is a rare error-recovery case. Further, it is handled completely and autonomously by the TAC, which at least bounds the delay. The host μp is not burdened with this critical task and, as a result, does not slow the recovery procedure.

The second failed-node manifestation occurs when a station holding the token itself fails before it has a chance to pass the token to another. If station 4 has the token (Fig. 4) and dies before passing it, no activity



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CIRCLE NO. 76 ON INQUIRY CARD

Additional stations can be added to an operating token network at any time. The distributed method does not rely on a specific station. Thus, there are no problems or efforts spent selecting the administrator.

occurs on the network and no station has the short timer (TA) running. All stations, however, have the timer TD, or network dead timer, running. The station whose TD timer expires first takes recovery responsibility.

To simplify network administration, not all stations must be able to reinitialize the network. The first station whose network timer TD times out tests the control bit "INIT," saying, in effect, "when timer TD expires, should I claim the token?" If INIT is false, the station waits, as does every other station, for a station's TD to expire that has INIT true.

One station on the network's timer TD that has the ability to initialize will eventually expire. That station will claim the token and send its messages, or send the token to its successor station as directed by its NA register. Thus, if station 19 happens to have the shorter timer TD and has its initialize enable bit set (Fig. 3), station 19 assumes the token, sends whatever messages it had queued and sends the token to station 54.

On receiving the token, station 54 (Fig. 4) sends its messages and tries to pass the token to station 4. If station 4 has recovered from its problem (its failure caused this recovery condition), it receives the token and transmits with it.

If station 4 still does not transmit, station 54 has primary recovery responsibility (54 has started its timer TA) and will enter the scan method. The scan starts at station 5 and searches until it finds the next available on-line station (11 in this example).

The power-up initialization case behaves in the same manner. As stations come up, they wait for a message or for their timer TD to expire.

Host software is responsible for setting up the next address register before enabling the transmitter in the TAC. This is set to the station address plus one (which will in effect cause a polling by that station) or, if it has some prior knowledge of what the network configuration looks like, it sets NA to reflect the correct address of the successor. Host software is also responsible for setting the time-out values in the recovery timers (TA and TD). The value for TA should be consistent among all stations of a network, but TD is not critical, and thus may vary greatly because it is used only in exception situations.

For example, there can be half a dozen stations on the network that are intended to recover from catastrophic conditions such as loss of token. These stations can all have substantially different time values TD so that if a couple of them are not on-line at a time, one will come up and reinitialize the network.

Additional stations can be added to an operating token network at any time. If a supervisory communication path can be assumed, a candidate station requests of the administrator that it be admitted to the access ring. This approach is not unlike the method pay-TV companies use to enable new subscribers' decoder boxes. When installed, a service representative of the cable-TV company telephones (the supervisory communications method) the central site, which then sends the properly addressed enabling signal over the network. While this method is efficient from the network viewpoint (the infrequent control messages are handled "out of band"), such duplicate communications schemes do not usually exist.

A more acceptable solution is to allow the control communications to share the data bandwidth. To avoid data collisions and retain the prized asset of a token system—determinism—new stations are added on a controlled-polling basis. To accomplish this, the TAC requires the host to initiate the test for a new station. Although, in this case, host interaction is required to expand the network, that interaction doesn't set back the goal of autonomous TAC network control in that adding stations is not a real-time requirement. The time to add a new station is not critical to the performance of the rest of the network.

There are three primary methods by which a station can be added to a network. The first is a distributed method, in which each station in the network can poll for new stations in the gap between its address and the next address (between MA and NA). Second is a centralized method, in which an individual station designated by the network architect can interrogate the entire address space seeking a new station desiring INRING. The third—central seam—is a simpler (from the host point of view), centralized method in which a station can send a global frame causing all the on-line TACs to reset their next address register. This causes each TAC to poll its address space at its next token-pass attempt. Each method has advantages and disadvantages.

The distributed method does not rely on a specific station. Thus, there are no problems or efforts spent selecting the administrator, nor is there any concern about backup administrators. In the distributive method, each station has the same responsibility to allow new access members as other stations. This method is the most host intensive and requires each station to maintain a timer (that can be configuration set as to its value) as to how often it should poll its gap for new stations.

For example, assume the timer in each station is 5 sec. and that station 4's timer has expired (Fig. 5). The host attached to station 4 notes that the next address register (NA in the TAC) is set to 11, which indicates that a new station might be added to the network as station number 5, 6, 7, 8, 9 or 10.

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A token is a message granting a polled station the temporary but exclusive right to transmit on the medium, a right the station must then relinquish to the next designated station.

The host queues a frame into the TAC transmit chain, polling station 5. This frame will be sent by 4 with an acknowledgement requested from 5. If 5 is present it responds; otherwise, the TAC aborts its attempt after time TA. The TAC marks the result on the frame in the host memory space and proceeds with other tasks.

After this exchange, the host, at its leisure, checks

IMPLEMENTING TAC

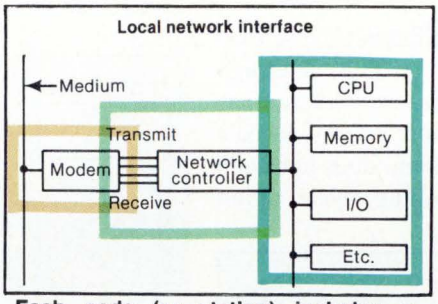
The TAC is a single-chip NMOS LSI device that performs all real-time communication tasks in a μp-based system. The assumed existence of a μp allows some less critical, non-network performance-affecting tasks to be performed outside the TAC, such as flow control and adding new stations.

Removing these functions from the device results in:

- Less processing power, which, in turn, makes the chip smaller and less expensive;
- No processing burdens, enabling the TAC to respond faster to network conditions, thus improving efficiency;
- Saved firmware space and processing power, which can be used for internal diagnostics and a more sophisticated host interface—a chained frame buffer scheme, which is a trade-off in favor of system efficiency.

To meet the network requirements and to include the other features expected in LSI, such as internal validation, a three-processor design was used consisting of a primary microcontroller, a receiver and a transmitter.

The primary microcontroller performs all token-algorithm support such as network initialization and error recovery, manages host interrupts and coordinates internal and system diagnostics. It also evaluates the host commands and arms and supervises the receiver and transmitter microcontrollers.



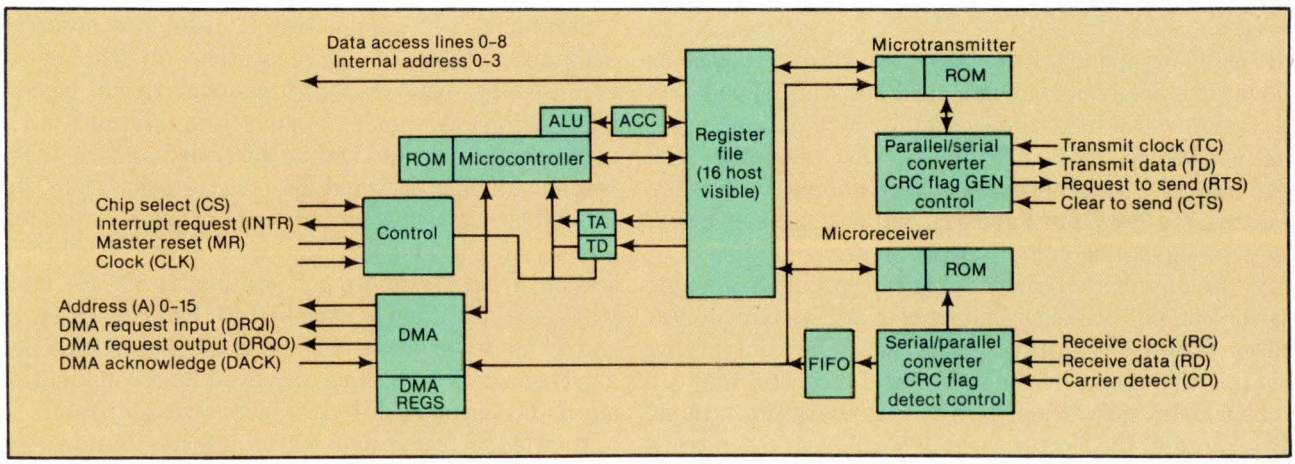
Each node (or station) includes a modem, *a network controller (TAC: token access controller) and appropriate hardware as required by the application ("host").*

The receiver does minor frame (group of bytes) filtering and frame validation and, independently of and simultaneously with the primary controller, performs DMA operations storing incoming data. The transmitter sends data via its DMA interface when allowed by the main controller, that is, when a token is received.

The register file is used by the host to set memory pointers, network address registers, long-term parameters such as frame transmit limits (allowing users to select exhaustive or non-exhaustive transmission) and the conventional command, status and interrupt indications. The TAC's primary interface to the host is its DMA system. Data to and from the network and options selectable on a frame-by-frame basis are read in this manner.

The half-duplex network interface has standard RTS/CTS handshakes. Another feature of the receiver is a signal-quality input that allows errors that are easily detected by the modem (such as a missing clock detected in a Manchester decoder or low carrier in a broadband system) to be signaled to the TAC. The use of these low-level checks further enhances the basic frame integrity beyond that of the CRC.

Messages are sent between stations on the network in frames. The frame structures are similar to the industry standard HDLC; delimiters are unique flag patterns with zero insertion used for data transparency. In addition to adding the required control fields to support the token protocol, the TAC recognizes three basic frame types: a short token pass frame, a short frame conveying only acknowledgement and control information and variable-length frames holding user information and optional network control information.



TAC includes three processors implemented in a single LSI device *that interfaces with the host through a register file and a DMA subsystem.*

In the centralized station addition method, a single station can poll the entire address space, seeking a new station that desires INRING.

the transmit status of the frame. The host sees that the frame acknowledgement timed out, meaning that station 5 has not been added to the network, or that station 5 is on the network and whether the request INRING is set in the network code field. In either case, the host takes appropriate action. If the desired INRING bit is set, station 4 changes its NA register to 5, allowing its next token to be passed to 5. This action puts station 5 in the ring.

Depending on an application's sophistication, a control message can be sent to station 5. That message says, "Your successor is X." In this case, X = 11, so that 5 is not forced to poll for its successor. In any case, 4 updates its next address register to 5 and does not need to go through this distributive polling cycle again

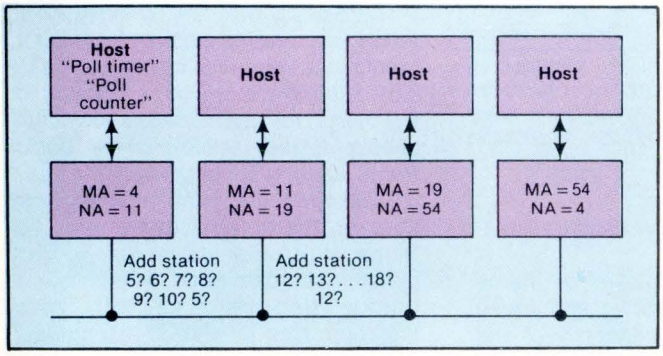


Fig. 5. Distributed polling. *Each host polls the gap in its address space for the possible addition of new stations. The host internal poll timer and poll counter set the polling rate and range as desired.*

because there is no gap between 5's address and the next address; there is no possibility that a new station can be inserted between addresses and 5. If 5 didn't respond to 4's poll, station 4 updates its poll counter so that the next time that the poll timer times out, station 6 will be tried.

If node 6 responds, its desired INRING bit is tested as above. If 6 does not respond, the host will queue a poll to station 7 the next time its poll timer expires. This continues until the host completes 10, when the cycle goes back to 5 and repeats. In this example, with a gap of 6 stations (between 4 and 11), and with a 5-sec. clock, a new node can be added within 30 sec.

In the centralized station-addition method, a single station can poll the entire address space, seeking a new station that desires INRING. One reason for centralizing this function might be the more careful control that can be placed in a network. There can also be optimizations. For example, the central polling station can keep track of the stations that already exist and, therefore, bypass some address ranges. A polling station may know the network will never have more than, say, 75 stations. In the example of Fig. 6, when station 4 starts polling, it polls only to address 75 before resetting to zero. This works like the distributed method except that a single station does all the work.

When the polling station determines that a station has been added, it must place the new station in the access ring. For example, station 4 is the centralized station doing all the polling (Fig. 6), and it discovers that station 27 has recently been added. Station 4 knows this because station 27 now responds to a first-time poll, and because its status bit is set, indicating that it wants to be added to the ring. (Some stations may be receive only, never desiring the right to initiate transmissions.) Station 4 sends a high-level message to the software in station 19, telling it to change its next address register to 27. This message

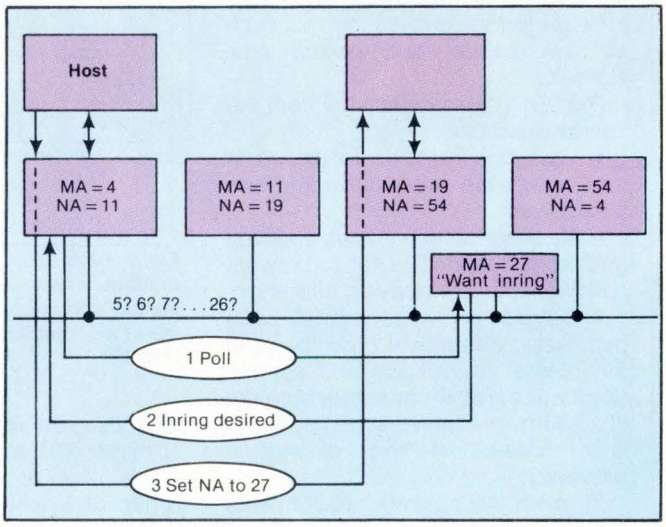


Fig. 6. Central polling. *A single station—in this case, station 4—dubbed "the administrator," can be charged with all polling tasks. This simplifies the software in the other stations and centralizes network control.*

can also prompt station 19 to tell 27 its next address register should be 54. This gets confusing, but it is all done with high-level software. These tasks are not real time and are quite efficient from the network point of view.

Station 4, the administrator, need not create and maintain a table of active stations on the network because the poll response returns three pieces of information. As node 4 polls the stations on the network, it finds out (a) that the polled station does not respond at all, as it would if it polled station 12 in Fig. 6; (b) that the station is already part of the network and is already in the ring or is receive only, as it would if station 4 happened to poll station 11 or 19; and (c) whether the station is attached to the network, is alive and wants to be in the ring, as is the case with a poll to 27. These indications are conveyed by a combination of status bits sent back by the acknowledge frame. This acknowledge frame and status information are transferred at a TAC device level, so a host is not concerned with whether its station wants to be in the ring. The host simply sets up the proper bits in the control

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To simplify network administration, not all stations must be able to reinitialize the network.

registers; the bits are relayed automatically by the TAC. Thus, with a simple algorithm, an administrative station can poll the entire network address range and know the network's exact membership and status.

Central scan

Central scan is the simplest method of adding stations to a network. It involves sending a global frame to all stations on the network, which forces each to update its own next address register to its station address plus one (NA = MA + 1). Assume station 4 is the centralized station and sends the scan command frame (Fig. 7). Station 11, upon receiving it, automatically sets its next address register to 12 (the TAC does this; the host is not involved but is notified of the situation). Also, station 19 sets its next address register to 20, and station 54 sets its NA register to 55.

The result of this is a round of polling at the TAC level. Station 11, on completing its use of the token, tries to send it to 12. The token to station 12 times out because 12 is not present. Station 11 reclaims the token trying to send it to 13 and so on, causing 11 to poll for station addition. The drawback of this is the huge time disruption incurred by the simultaneous polling.

It is not required that station 4 send this scan control frame to all stations at the same time. If it is known that station 11 exists in the network and that a station may be trying to add into the network after station 11 in the address space, a command can be sent to 11 telling it to set its next address register to 11 + 1. Now 11 will go through scanning station 12, 13, 14 ... again without intervention from station 11's host software. This directed scanning has the effect of smoothing the polling disturbance over a greater time.

The trade-off of all these methods is the software complexity distribution. If a TAC user assumes more responsibility, providing more intelligence distributed in the software, the system can be more sophisticated in handling new stations. If a user wants the TAC to handle this task itself, saving host software development, he pays only slightly in inefficiency. TAC gives the user an option.

Recovery from multiple tokens

Multiple tokens are not allowed on a token bus because their presence causes a breakdown of the orderly nature of the protocol. Their presence can only be the result of a combination of exception and hardware failure conditions but, once present, must be handled immediately.

The primary defense against multiple tokens is prevention. The control algorithms and the frame formats have been designed to minimize multiple tokens. For example, the TAC can refuse to allow a

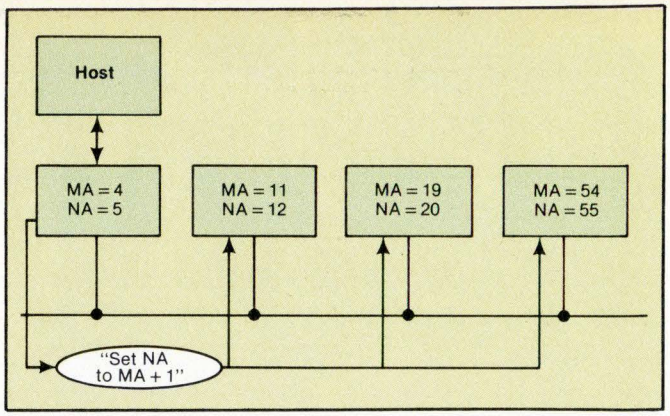

Fig. 7. Central scan request. *A special command can be sent by any station causing all attached TACs to set their NA register to the address of the next possible node. This causes each TAC to poll without the help of the host.*

piggyback token (a single frame containing both the token and a user-information field) with the data-acknowledge option. If this were allowed, conditions could result in which the data was negative acknowledged by its receiver and retransmitted, but the token arrived successfully at its destination—in this case, twice—creating two tokens.

Duplicate tokens, or at least network confusion, can result from more than one station having the same network address. Unless the stations are receive only, their simultaneous responses to data frames and tokens will probably result in their response not being accepted. While conceptually simple to prevent, address duplication can be the result of hardware failure (a bad DIP switch), operator error or configuration error (if a device is moved from one network to another).

Because the access controller must monitor the network for messages addressed to itself anyway, it is simple to check for messages sent by a station with its address (most frames contain both a source and a destination address). Part of a host's attachment algorithm would normally check this counter in the TAC before allowing it to transmit anything, thereby catching most of these duplicate station faults before they have a chance to affect the network.

A token access controller can also detect duplicate tokens by knowing that, when it has the token, no other station can transmit. This ability is supported in the TAC by incorporating separate receive, transmit and control sub-controllers. This allows the receiver to monitor the medium while the primary controller is, for example, searching the host's memory for a frame to be sent. If another token exists or is suspected, the TAC drops its token, allowing the other to circulate. If there is no other token, the network is left in a no token state and is easily restarted with the aid of recovery timer TD. ■

Mark Stieglitz is manager, local networks, Western Digital Corp., Newport Beach, Calif., and chairman of the IEEE committee working to set a token-passing protocol standard.

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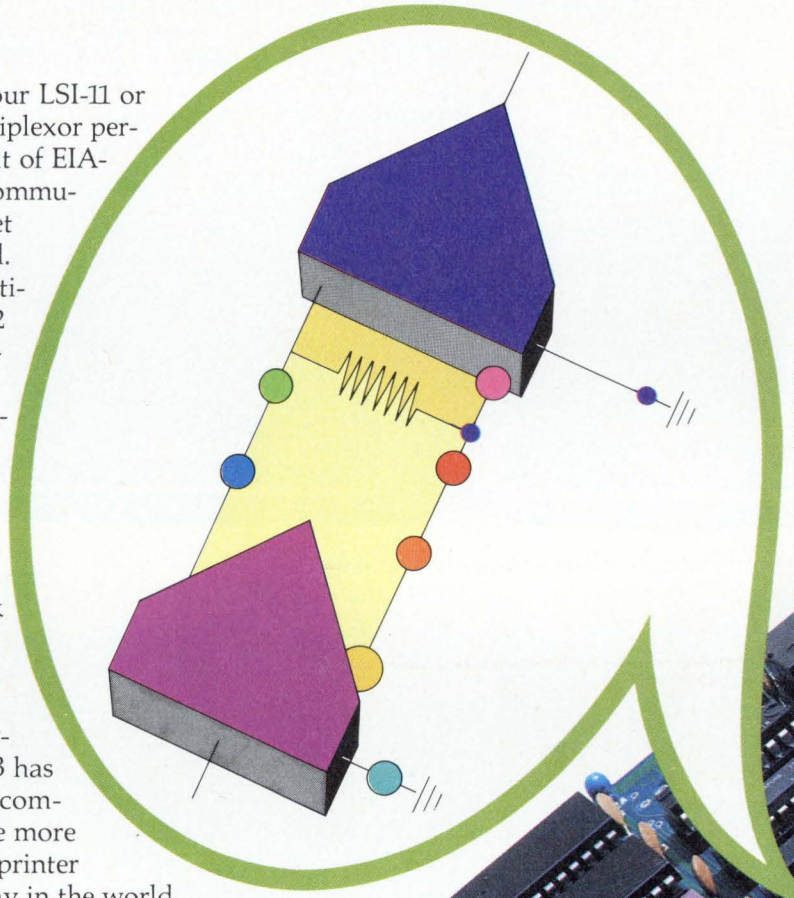

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VOICE TECHNOLOGY

VoiceWare does it differently

CARL L. BERNEY and CY HARSHMAN, Centigram Corp.

Centigram's VoiceWare 'digital voice studio' creates real-time, high-quality voice capabilities

The VoiceWare development system from Centigram Corp., Sunnyvale, Calif., is a μc-based "digital voice studio" with all the hardware and software facilities needed to create real-time, high-quality voice capabilities for virtually any application. A user can create voice messages in real time and record and update digital speech files as easily as using a word processor. The speech files can then be transmitted to a host computer and debugged using special test-support features.

VoiceWare system components

The basic system (Fig. 1) consists of a microphone or cassette recorder input to a voice digitizer that supplies a 4000-bps data stream to the μp-based CRT-terminal work station. The bit stream is stored on the 5M-byte hard disk and can be transferred to either the RAM buffer of the voice synthesizer for playback and editing, or the 600K-byte floppy-disk drive for off-line storage.

The software is written in C, executes under CP/M and includes:

- The speech-file record and edit package to create and update speech-message records.
- The Lisaload Package to create files to be loaded in correct format for the Lisa voice-output terminal.
- The host communications package to support on-line connection to a host for file transfers and on-line debugging aids such as stand-alone Lisa emulation,

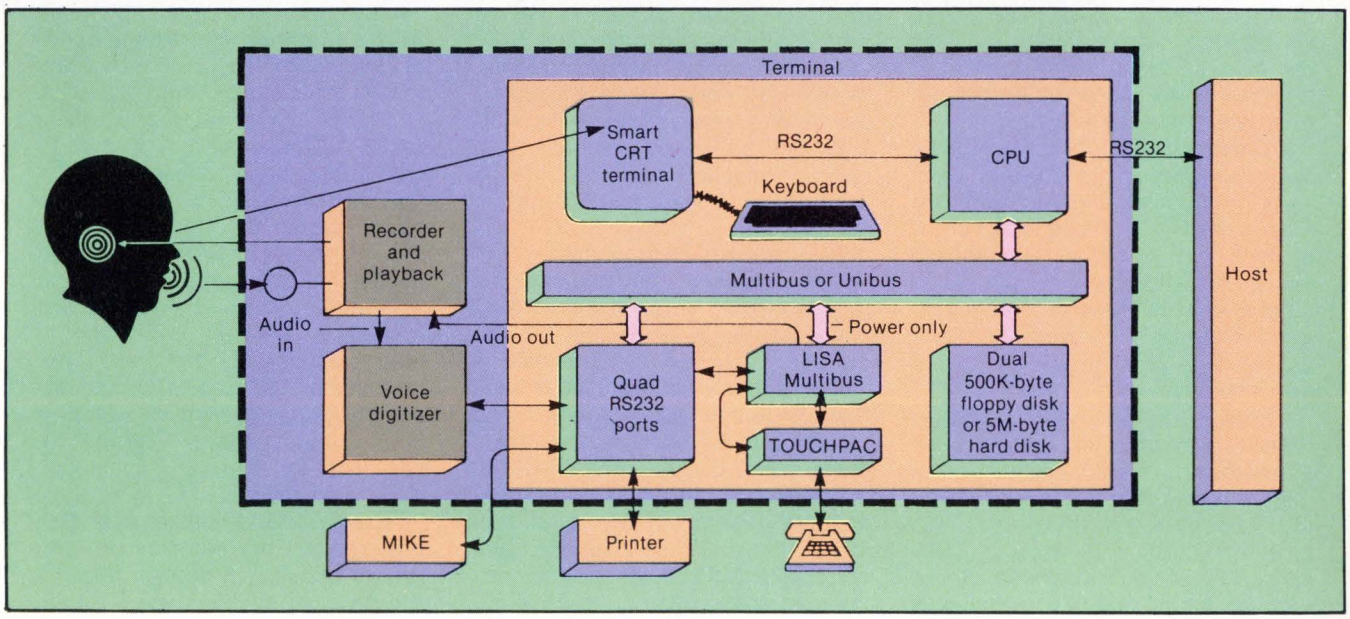


Fig. 1. VoiceWare development system. *A user creates a speech file by speaking into a microphone. The words are digitized and stored on the hard disk as a speech file. Once stored, the speech file can be edited on the video terminal and played back on the synthesizer for evaluation. Edited files can be transferred to floppy disks for off-line storage.*

The total message content could have been recorded on tape, the tape read into the system and then edited into message records via the cut-and-paste editing features.

with protocol trace and trap facilities.

A case history

Conceptually, the speech-file development process is fairly simple. The basic steps include:

- Designing scripts or dialogues,
- Creating and editing messages,
- Organizing messages into run-time loads.
- Testing with delivery hardware such as the host CPU,
- Iterating until satisfied.

The complications arise from the interactive cut-and-try nature of the prototyping process, in which the real-time voice-development and editing features of the VoiceWare system are useful. A case history of an in-house project helps illustrate the point.

The VoiceWare system was used to develop speech files for Tymshare, Inc., to be used in a telephone inquiry system. Tymshare is using the Lisa synthesizer to deliver voice-response message to multiple users from a large central database. Although the initial application comprised only a few minutes of speech, all the features of the VoiceWare system were used. It was also critical to provide convenient update and add-on capability for the speech files because Tymshare plans to add many more applications that require digital voice in the near future.

Create dialogues: In this case, the speech-file content was supplied by Centigram, which provided the output half of the customer dialogue. Input is from Touch-Tone phones. The dialogue was supplied as a list of messages, many with variable phrases, such as, "The amount is...dollars and...cents." The variables were supplied as a series of concatenated numeric phrases.

Build file structure: The messages were grouped under a speech-file name and individual reference tags, and the dialogue was typed as text in the descriptor field.

Record and edit voice messages: The first recordings were made by Centigram personnel directly from a microphone. After initial checking of texts for accuracy, length and content, this process was repeated with a professional announcer using a tape cassette as the transport and input medium. When emphasis or inflection was improper for the concatenated phrases, the phrases were simply rerecorded to achieve the desired continuity and balance.

The steps could have been performed in another order. For example, the total message content could have been recorded on tape, the tape read into the system and then edited into message records via the cut-and-paste editing features.

Build run-time loads: Because the application involved several inquiry modes, a subset of messages

VOICEWARE TERMINOLOGY

Waveform coding—Direct digital sampling of an analog waveform recording the absolute value of the waveform at each sample. Provides the most accurate reconstruction of the original waveform, but requires a data rate of at least 56K bps.

Continuously variable slope delta modulation (CVSD)—A form of waveform coding that encodes the difference in magnitude of adjacent samples. It is suited to speech waveforms because of the large amount of adjacent sample redundancy. Adequate reproduction is achieved at 32K bps with severe degradation lower than 16K bps.

Linear predictive coding (LPC)—A method that encodes the parameters of a mathematical model describing the shape of the vocal tract at fixed analysis intervals. This provides satisfactory reconstructed-speech quality at a moderate bit rate of 0.8K to 3K bps. LPC speech is characterized by an overriding buzzing sound and has difficulties with the voices of women and children.

Parametric waveform coding (PWC)—A parametric coding method proprietary to Centigram that uses variable-length analysis intervals. More robust performance is achieved over a wider range of voices than LPC and can be used effectively with carbon (telephone) microphones. It uses a higher bit rate than LPC at 1K to 5K bps.

Synthesis—Construction of speech waveforms by combining the fundamental speech sounds—phonemes and allophones. It produces aesthetically unpleasing "robot" speech, but has the lowest bit rate—80 to 200 bps. Synthesis is also the most flexible because any word in the language can be constructed. The waveform coding and parametric methods rely on an original spoken input that is then digitized and compressed. Only the original can then be reproduced.

Phoneme—The set of basic sounds that are used to produce the words in a language. There are 40 to 50 phonemes in English.

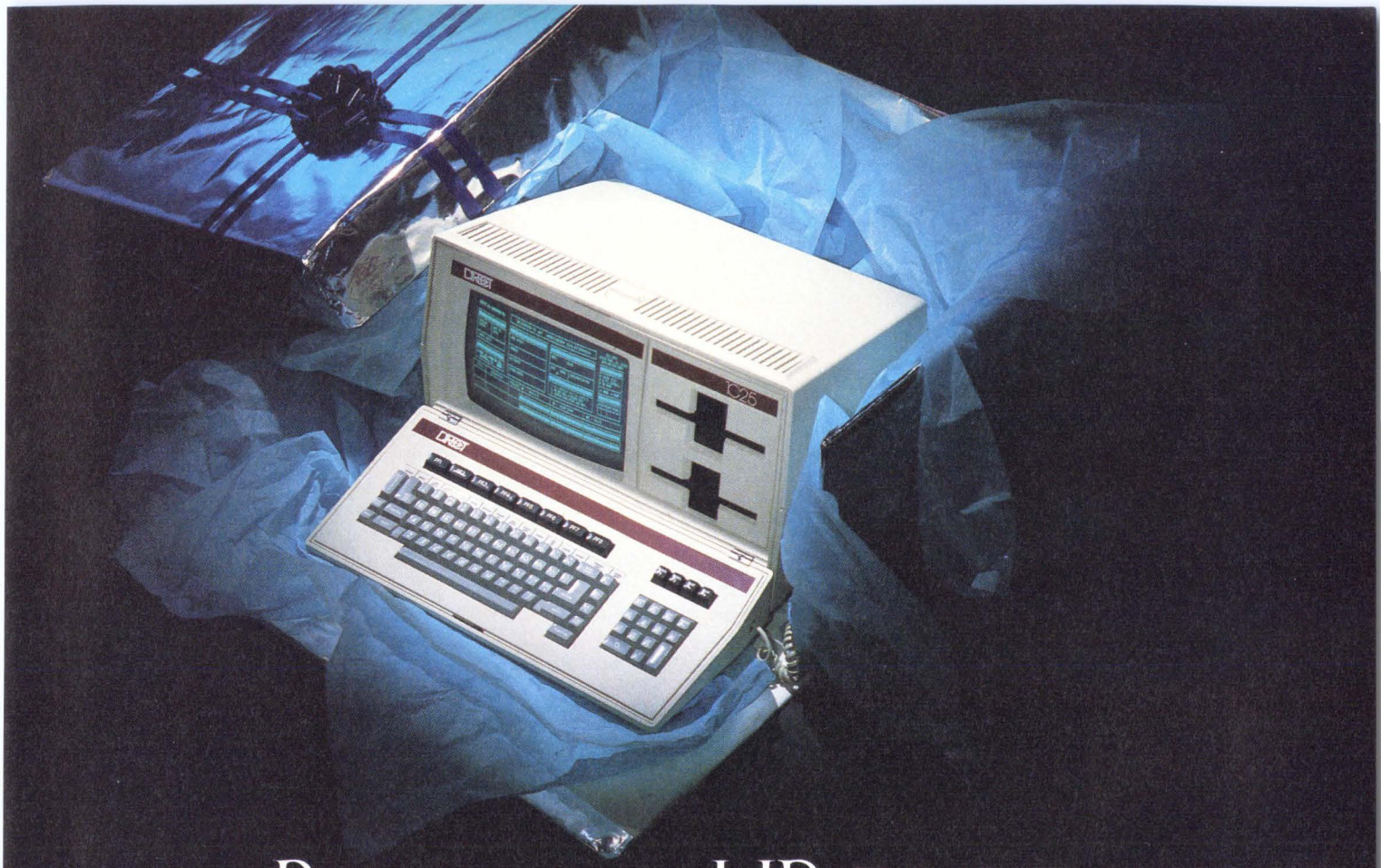
Allophone—A "super" phoneme used in synthesis that adds prosodic information to the basic phoneme such as pitch, emphasis, inflection, position within a word and others. Several allophones are usually derived from each phoneme.

Transparency—The measure of reproduced speech quality such that non-informed listeners would not detect that the speech had been digitized.

Speech file—A collection of speech messages that have been produced and are ready for output.

Vocabulary—A set of words or phrases that have been trained by an individual for use on a speech-recognition device.

Lisa—A voice-output terminal manufactured by Centigram that can store several minutes of speech encoded with PWC technique.



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From the earliest days of experimenting with digitized speech, the goal has been to encode the speech with the minimum number of bits to allow satisfactory reproduction.

for each mode was selected, and a load file was built (by the system) for each subset. Each load file was stored with its own name.

Test and revise: The run-time load files were transmitted to the host. The host program then exercised the Lisa with a test dialogue to ascertain that each message was properly recorded and loaded. At the conclusion of this debug cycle, the files were transferred to the host for down-loading to the Lisa units in the field to support customer dial-in inquiries.

Anyone who has experienced a process such as the one outlined will realize that revisions and refinements were necessary before the application was satisfactory. It was not necessary to manipulate data at the digital speech level. However, the VoiceWare system will eventually include such capabilities.

Evolution of Centigram's approach

The Centigram VoiceWare system reflects a late step in the evolution of digital speech technology in its use of

What the VoiceWare user sees. *VoiceWare is divided into several operating modes to support the development of a voice-output application. First, the messages must be defined using the speech-file text-edit mode (a). Then the messages are recorded, edited and stored in the speech file in the speech-edit mode (b). Messages from several speech files are combined in a load file (c), which groups the messages to be loaded to Lisa. The messages are tested with application programs in the host in the emulation mode, one of the host-communications mode options (d). In emulation, VoiceWare responds to the host as the synthesizer, but a trace of the data exchanged with the host is presented on the VoiceWare screen. When the messages have been satisfactorily tested, they are transferred to the host using the terminal on-line and host-file-transfer options of the host-communications mode.*

PWC attempts to produce natural-sounding speech by providing a greater degree of freedom to the excitation mode and implementing it in a variable frame-rate mode, with the frame rate determined by the voiced/unvoiced decisions in the original speech.

parametric waveform coding (PWC) rather than linear phase coding (LPC).

From the earliest days of experimenting with digitized speech, the goal has been to encode the speech with the minimum number of bits to allow satisfactory reproduction. In the '40s and '50s at Bell Laboratories, Drs. Shannon and Flannagan experimented with waveform coding techniques and probed the limits of pulse code and delta modulation. Some work in frequency-domain analysis disclosed the existence of the format or resonant frequencies in the vocal tract.

The '60s saw little progress because the memory and disk storage bits were too jealously hoarded to make way for the gluttonous requirements of waveform coding methods.

In the early '70s, Votrax produced the first commercial phoneme synthesizer, and voice output for computers was born. About the same time, Dr. F. Mozer discovered that the phase information in the waveform could be manipulated to eliminate almost 75 percent of a waveform after digitization and still reproduce the speech. The resultant waveform bears no resemblance to the original, however. This technique was first used by Telesensory Systems to produce a talking calculator and is now incorporated in the National Semiconductor Corp. Digitalker.

Dr. Atal and others point out that the mathematical technique of LPC could be used to describe a speech waveform because of the slowly changing and predictable behavior of the human vocal tract. LPC was attractive because it took far fewer bits to describe the changing parameters of the model for the vocal tract than it did to encode the speech waveform itself.

By the mid-'70s, IC technology had evolved to allow implementation of digital lattice filters and support circuitry of sufficient complexity to synthesize speech from a bit stream produced by LPC analysis. The "Speak and Spell" learning aid from Texas Instruments Inc. was the first commercial use of an LPC synthesizer. Variants of LPC, such as the formant coding used by General Instruments and the PARCOR techniques used by several Japanese synthesizers, can all be realized by a chip architecture similar to that required by LPC.

The tool was now at hand to produce speech at a bit rate not too demanding of storage. But where were the bits to come from? Customers want different voices and different words and sentences, and no convenient method existed to generate the bits demanded by the synthesizer chips to make speech. Most LPC-analysis programs require moderate to large computers and take 10 to 100 times real time to produce results. The resultant bit stream must then be massaged by a competent linguist to correct analysis errors and to refine power levels.

Great strides have been made in programs that analyze text to identify the phonemes and allophones to produce the corresponding speech, but the resultant speech is not satisfactory when intelligibility and speech quality are issues.

In the late '70s, Dr. Charles Davis at Centigram and others were working on a machine that would perform LPC analysis in real time. This device was used to generate low bit-rate speech for transmission over a data network, another medium that jealously guards its capacity. The descendant of that machine is the Centigram voice digitizer used in the VoiceWare development system, which generates a PWC-encoded bit stream for Lisa.

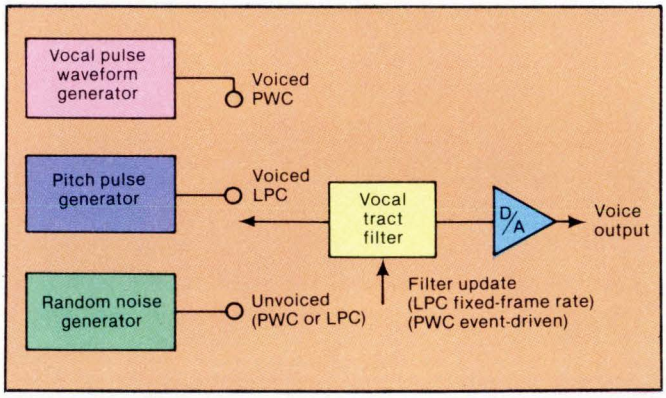

Fig. 2. The distinction between LPC and PWC hardware *is that PWC replaces fixed-pulse generator with vocal-chord pulse waveform generator, which is software-derived from the analysis system. Thus, the LPC filter is periodically updated; PWC filter is event driven.*

LPC versus PWC

Both LPC and PWC approximate natural speech sounds by exciting a filter via an impulse train or via white noise (Fig. 2). All LPC hardware implementations update the filter and the excitation decision at a fixed frame rate (typically around 50 times per sec., for a 20-msec. frame length). Speech, unfortunately, is a random event relative to an arbitrary frame structure, so that transitions between voiced and unvoiced sounds frequently occur within frames. Because five transitions per sec. are common, as much as 10 percent of the total frames may be incorrectly voted voice or unvoiced for at least part of their 20-msec. duration.

PWC attempts to produce natural-sounding speech by providing a greater degree of freedom to the excitation model and implementing it in a variable frame-rate mode, with the frame rate determined by the voiced/unvoiced decisions in the original speech. The objective of these two improvements is to make the synthesized waveform identical to the original, thus preserving the

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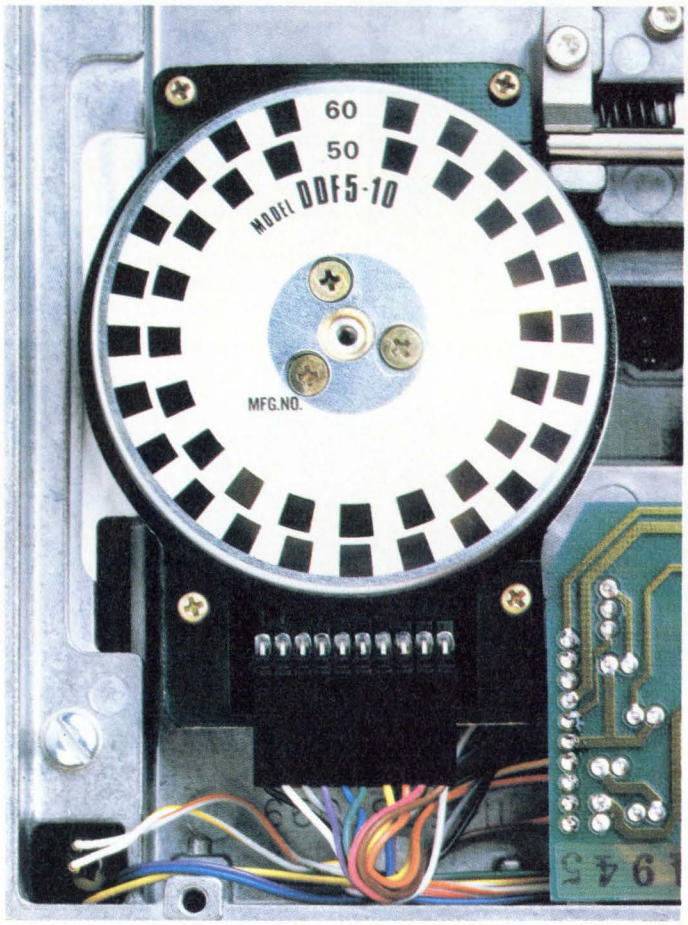
THE HIDDEN TRUTH ABOUT 5¼ INCH FLOPPYS

Belts and Brushes Murder on Life Span

The bad news for mini floppy disk drive buyers is that 5¼ inch drives are designed with belt and brush type AC motors . . . and they suffer the consequences. The good news according to high level authorities is that there is an exception. The Remex PICO™ 48/96 tpi, 5¼ inch flexible disk drive has no belts or brushes because it is the first mini-sized floppy with a direct drive DC motor. Direct drive means that improper belt seating is nonexistent so variations in speed and friction-producing side loading are eliminated. Motor life is also extended. A reliable industry source indicates that the MTBF of the PICO motor is 5 years—typically ten times that of most brush type motors. The President of the United States, in his comments, stated (continued on Page 5).

Trouble Maker Eliminated

"Tap-tap wear is a thing of the past" according to design engineers evaluating the Remex PICO 5¼ inch flexible disk drive. This major cause of media damage and wear on mini floppy drives, the loading and unloading of the head on the media, has been eliminated with the Remex PICO because the PICO has no head load solenoid.This design innovation also reduces magnetic leakage which may result in data errors. Rumors that PICO will receive an award from the Association for the Preservation of the Sanity of Systems Designers were not confirmed by Remex.



Direct drive DC motor saves life of 5¼ inch floppy.

Designers Spellbound by Interchange

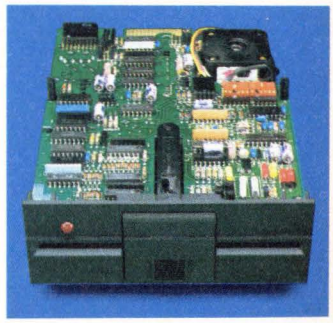
Reliable interchange of media between Remex PICO drives is enhanced by the precise speed control of the motor's closed loop servo. Speed is regulated to 1% on Remex PICO versus typically 2¼% on other small drives, therefore read/write errors caused by speed variation are not a major factor with PICO. The drive's speed control may also simplify controller design because phase lock loop requirements are less demanding. Vast crowds of cheering engineers stood outside the office of (continued on Page 11).

Drives Embezeled!

A choice of bezel sizes on the Remex PICO 48/96 tpi, 5¼ inch floppy makes this drive the appropriate choice for a wide variety of system configurations according to sources. Among the sizes available is a 2¼ inch low bezel which is ideal for space limited micro-systems. An "industry standard" bezel is optional.

Proud Parent Praises PICO

Remex is a Division of Ex-Cell-O Corporation, a Fortune 500 company with manufacturing and marketing arms in such industries as machine tool, aerospace and automotive as well as electronics. Ex-Cell-O Corporation through its Remex Division is committed to advanced technology development and quality manufacture of both 5¼ inch and 8 inch flexible disk drives.



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Equipment-procurement costs and cost per word are both important in developing a digital-speech system.

spectrum and the phase, and hence the identity of the sounds.

The first and most important task of PWC is to isolate the glottal events in time and to use these events as the starting point for the analysis windows. Using this event-driven analysis and synthesis, all frames are now correct over the whole frame length, that is, transitions from voiced to unvoiced excitation and vice versa automatically start a new frame (Fig. 3).

The second task of PWC is to reduce the resulting bit stream from 10K to 15K bits per sec. of speech to an acceptable 4800 bps of speech (Fig. 4). This is accomplished by a modified form of run-length coding.

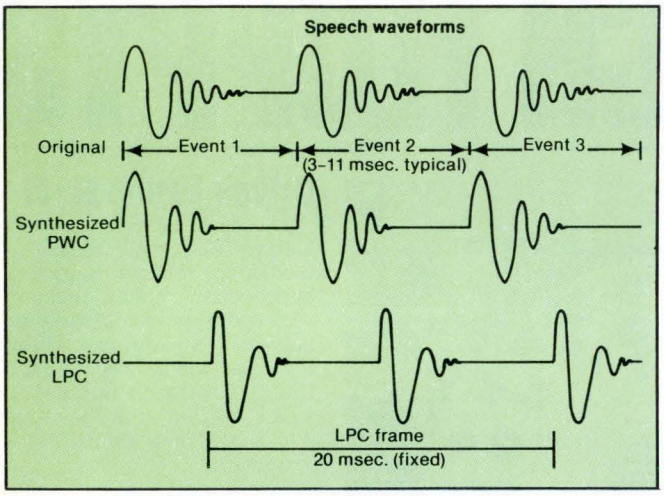

Fig. 3. The distinction between LPC and PWC waveforms is apparent by comparing phase correlations. *The original waveform consists of the excitation of the vocal chords and the impulse response of the vocal-tract filter. The key to parametric waveform coding is deconvolving (separating) the original waveform and a filter-resonse waveform by performing the filter analysis over an event window. This differs from the LPC approach, which determines the filter over a fixed time (20 msec.) frame length. Because time is a random event relative to the speech events, this results in a synthesized output waveform that has the same frequency content as the original, but no phase correlation.*

New applications

Until now, the costly and time-consuming process of developing digital speech systems has limited their applications. PROM-stored fixed speech files are typical of applications in which anticipated large-volume production justifies the engineering investment (talking appliances, elevators, etc.). The VoiceWare system cuts development time and costs in such applications and opens new ones. These applications include:

Computer-based inquiry systems, in which the computer can verbally supply rapidly changing information to ordinary Touch-Tone telephones as remote

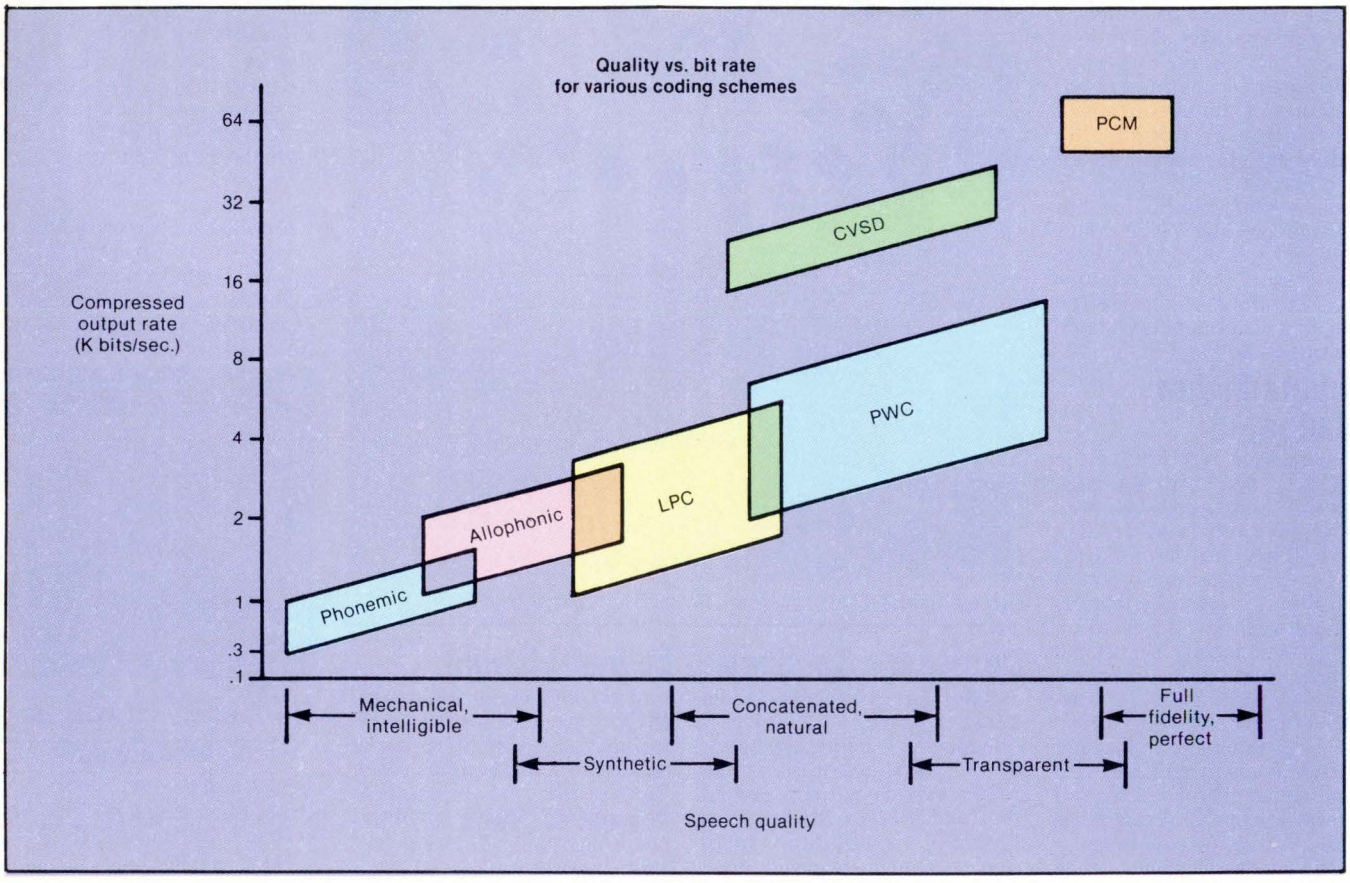

Fig. 4. A comparison of the output bit rates shows VoiceWare PWC about double that of LPC *implementations. "Perfectly transparent" (indistinguishable from live speaker) quality requires approximately 10K to 15K bps of speech.*

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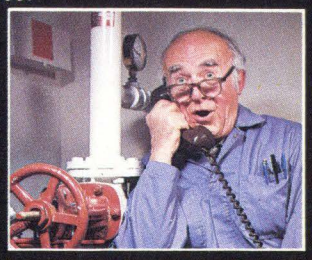

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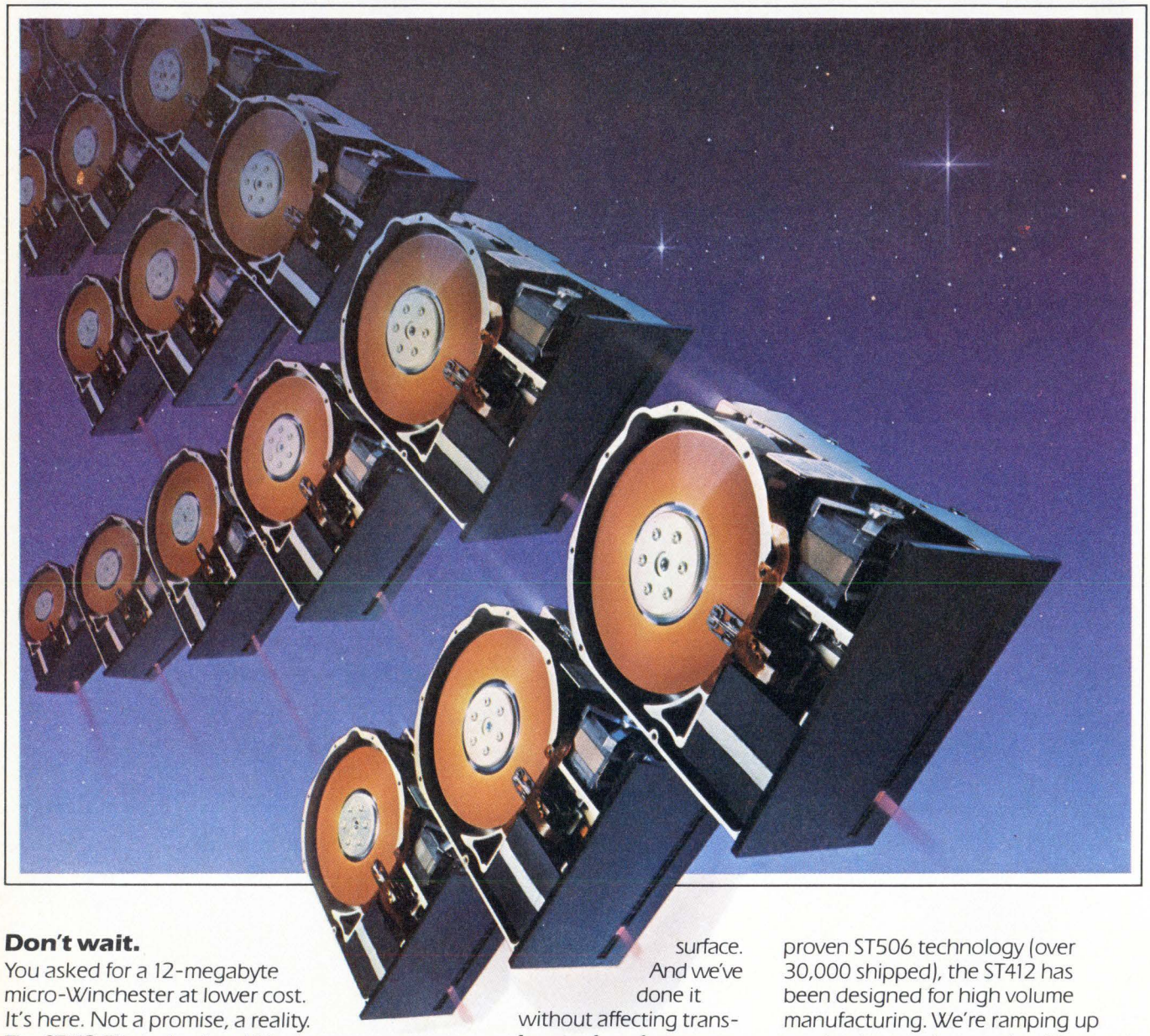

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By the mid-'70s, IC technology had evolved to allow implementation of digital lattice filters and support circuitry of sufficient complexity to synthesize speech from a bit stream produced by LPC analysis.

terminals. The VoiceWare System makes it possible to change the data frequently and permits a dialogue between a customer and a computer, although the input from the customer is in the form of Touch-Tone signals. Examples include phone inquiry to stocks, retail point of sale, airline reservations, cash consolidation and credit and check verifications.

Computer-aided instruction (CAI) or computer-based training (CBT) systems. In these systems, speech files can be quite lengthy and require frequent updating as student feedback is obtained and instructor changes and additions are made. CAI and CBT are useful in both academic (language labs, math drills) and industrial-training situations. The VoiceWare system provides the added ability of creating a dialogue between a student and a computer, prompting and correcting improper input. High-quality voice is essential in applications in which users must listen for more than a few seconds.

Proprietary systems. The VoiceWare system is particularly useful in applications that require in-house speech-file development such as process-control machine operator instructions or training that uses proprietary formulas or methods.

Cost considerations

Equipment-procurement costs and cost per word are both important in developing a digital-speech system. A simple 1000-word custom vocabulary (about 8 min. of continuous speech) would cost $80,000 at the $80-per-word rate charged by outside services. Such rates are prohibitive for many applications and out of the question for applications requiring lengthy continuous speech, such as CAT.

A basic VoiceWare system sells for $29,500. At service-bureau rates, it will have paid for itself after the development of 370 words. In addition to increasing productivity by providing speech-editing capabilities, the system eliminates the substantial costs associated with off-site speech-file development.

Future enhancements of the VoiceWare system include support of chip-based voice synthesizers from semiconductor manufacturers. In addition, facilities to develop voice mail applications will be incorporated. ■

Carl L. Berney is vice president, engineering, and **Cy Harshman** is director, system products development, for Centigram Corp., Sunnyvale, Calif.

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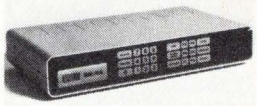

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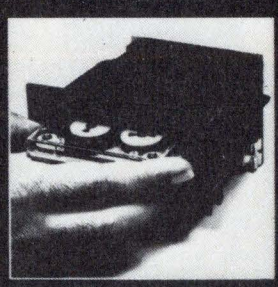

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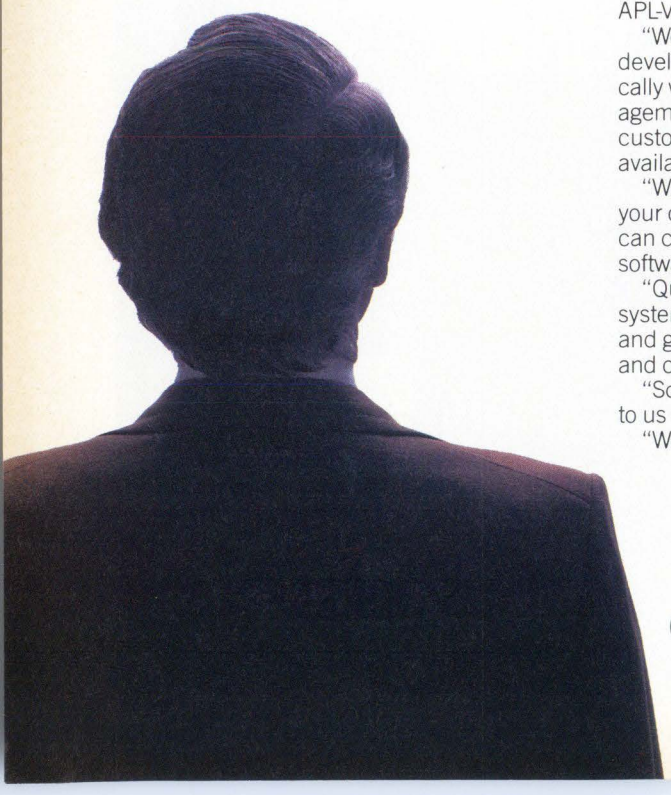

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A look at the AT&T settlement

ROBERT BIGELOW, Bigelow & Saltzberg

Some historical perspective on the AT&T settlement, and a look into what it means for system builders

One of the world's largest corporations, developed and expanded over the last century, will divide itself, cell-like, to survive against the attack of government and competitors. In January, American Telephone & Telegraph Co. chairman Charles L. Brown and Assistant Attorney General William Baxter announced the settlement of history's largest antitrust case, a lawsuit begun in November 1974 to split up the Bell System.

The government got much of what it wanted but not everything, and AT&T came up smelling like a rose. The communication giant avoided the possibility of being found guilty of violating the antitrust laws, and may have positioned itself for the rest of the century and beyond. Whether consumers benefited is a toss-up, however, and Bell's competitors may be losers. But system integrators and computer- and peripheral-hardware manufacturers stand to gain.

The agreement prohibits selected operating companies from favoring AT&T and its affiliates in the purchase of products to be linked to the operating companies' systems and to long-distance facilities of Bell's Long Lines department. The other side of that coin, however, is that the agreement allows AT&T to compete unregulated (except for the Long Lines department) with any other company to provide products that can be interconnected to an operating company's system.

AT&T has been a major stockholder of 24 operating telephone companies, plus Bell Laboratories, one of the world's most spectacular scientific laboratories, and

The new, smaller AT&T will still be one of the world's largest companies. *Its operating subsidiaries accounted for roughly half of its 1981 revenues, two-thirds of its assets, three-quarters of its long-term debt and four-fifths of its employees. Its remaining divisions are technically advanced, profitable and free from local regulation. AT&T's Long Lines division will continue to provide virtually all U.S. long-distance communications services. Western Electric will still be the world's largest builder of communications equipment and will serve new buyers. Bell Labs will expand its already-large computer hardware and software research.*

The communications giant avoided the possibility of being found guilty of violating the antitrust laws, and may have positioned itself for the rest of the century and beyond.

Western Electric Co., one of the largest manufacturing complexes in American industry. The agreement said that AT&T's 22 fully or almost fully owned Bell Operating Companies with their local telecommunications-transmission operations will be spun off within 18 months after the agreement is approved by the court. Representing more than two-thirds of AT&T's assets, these companies range from such giants as Pacific T&T, Southwestern Bell and New York Telephone to the Nevada Bell and Diamond State Telephone companies. Pulled from under the AT&T umbrella, they will become independent companies providing local telecommunications service and access to the long-distance network.

AT&T keeps Western Electric, whose consolidated assets at the end of 1980 were more than $8 billion; Bell Laboratories (owned half by Western Electric and half by AT&T); AT&T International, which is seeking global markets for the Bell System's products and systems; a minority interest in two operating telephone companies (Southern New England in Connecticut, and Cincinnati); and a new company, "Baby Bell," being formed to provide the "enhanced services" authorized by the Federal Communications Commission's (FCC) decision in the so-called Second Computer Inquiry (see "Bell since the first antitrust suit"). AT&T also keeps its Long Lines department, which for years has provided the long-distance pathways that link the nation.

On the legislative front

For several years, efforts have been under way to deregulate the communications industry through amendments to or revisions of the Communications Act of 1934. One major snag has been the AT&T question. The Senate passed a bill, S. 898, that would deregulate the company over time, but the House of Representatives did not receive this approach favorably. In testimony before the House last Nov. 4, Assistant Attorney General Baxter discussed the antitrust case, saying that passage of legislation with appropriate competitive safeguards would be an acceptable solution to the litigation. He also mentioned the problems with the Department of Defense and reported proposals made at a conference in April, 1981, between himself and representatives of the Antitrust Division and DOD.

At that time, Baxter told DOD of the Division's intention to recommend that Western Electric, Bell Labs and Long Lines be left intact as parts of the parent AT&T, with Long Lines expanded to include all of AT&T's inter-city services. Baxter said the Division would also recommend that consolidation of the divested Bell operating companies into one or a limited number of holding companies be permitted.

That is close to what happened. Baxter has been consistent over the months, and appears to have received DOD approval. As of February, the question of

BELL SINCE THE FIRST ANTITRUST SUIT

Western Electric's continuing exclusive right to supply hardware for the operating companies has been a thorn in the side of the regulators, and on Jan. 14, 1949, the Department of Justice filed the first antitrust case in Newark, N.J., primarily seeking to separate Western Electric from telephone operations.

The case puttered along in court until Department of Justice Antitrust Division attorneys and Bell lawyers devised a "Consent Decree" approved by Judge Thomas F. Meaney in Federal Court in Newark on Jan. 12, 1956. The January, 1982, settlement was presented as a modification of that 1956 decree, which barred Western Electric from the non-telephone hardware business and enjoined Bell from furnishing anything but common-carrier communications services (with certain exceptions). AT&T and Western Electric also had to open their patents to competitors.

One of AT&T's trump cards in securing this settlement was Defense Department support. AT&T had assumed management responsibility of the Sandia Base in Albuquerque, N.M., which designed and produced atomic bombs. In July, 1953, Secretary of Defense Charles Wilson told Attorney General Brownell, "The Department of Defense wishes to express its serious concern regarding the further prosecution of the antitrust case now pending against the Western Electric Co. and AT&T Co."

The Carterfone case

While AT&T ended its fight against interconnecting with subscribers of other telephone companies in 1913, it continued its vehement opposition to allowing anyone else to provide any hardware. In a series of cases beginning with the Hush-A-Phone, a cuplike device that mechanically fastened to the mouthpiece of the telephone handset to ensure privacy, the Federal Communications Commission and the courts during the '50s, '60s and '70s struck down these Bell System rules. But the best-known case, and the beginning of the end for AT&T's monopoly on telephone hardware, was Carterfone. The Carterfone was a device that connected a telephone to a two-way radio at a base station communicating with other mobile radios. AT&T told subscribers that the Carterfone's use would subject the user to possible termination of service. Carterfone sued AT&T under the antitrust laws and won. But after settling for about $500,000, the Bell System still tried to enforce its anti-interconnection policies, arguing that devices that it didn't make might be harmful to the telephone network. The Bell system was successful for a while in requiring the installation of Western Electric "network-control protective devices" on non-Bell equipment but an independent industry has since grown up selling telephones to customers. Not long ago, AT&T started selling telephones too, rather than just

whether he would get the necessary court approval was not so clear. But a settlement has been proposed that will knock out entirely Western Electric's monopoly of customer-premises equipment, and will end Long Lines' competitive advantage over other long-distance carriers.

Equality of opportunity

The theme of the settlement agreement as presented to the courts [as of February, it was approved by Judge Biunno in Newark, but was subject to approval by Judge Greene*] is equality:

- of access to AT&T for long-distance users as well a competitors such as MCI, Southern Pacific and Satellite Business Systems (partly owned by International Business Machines Corp.)
- of opportunity to telecommunications equipment suppliers for both users and operating companies.

For system integrators, the most important provision of the settlement is paragraph IIB, which reads:

> "No BOC (Bell Operating Company) shall discriminate between AT&T and its affiliates ['affiliate' includes Western Electric, Bell Labs and any other organizations of which AT&T owns 50 percent or more. This would include Teletype] and their products and services and other persons and their products and services in the: (1) procurement of products and services; (2) establishment and dissemination of technical information and procurement and interconnection standards; (3) interconnection and use of the BOC's telecommunications service and facilities or in the charges for each element of service; and (4) provision of new services and the planning for and implementation of the construction or modification of facilities used to provide exchange access and information access."

"Exchange access" refers to access to long-distance systems. "Information access" refers to the specialized services a BOC provides, such as automatic-calling number identification and network-control signaling.

Other provisions of the settlement that can have a major effect on integrators include a requirement that, when the reorganization of AT&T is complete (not more than 18 months after the settlement becomes effective, which will probably be in the spring, after Judge Greene has had an opportunity to consider public, Congressional, FCC and industry comments), no BOC can, directly or through any affiliated enterprise, manufacture or provide telecommunications products or customer-premises equipment. This means that the operating companies will be out of the telephone-instrument business, all of which will be kept by AT&T through Western Electric.

It appears that AT&T will also own all of the Bell equipment now installed at customer sites. It will be up to the customers to obtain what equipment they need

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** To get rid of the restrictions on AT&T's activities, the settlement agreement was filed with Judge Biunno as a modification of the 1956 consent decree. The big antitrust suit being tried before Judge Greene in Washington was to be dismissed; the New Jersey suit (originally brought in 1949 in New Jersey and resulting in the 1956 consent decree) was then transferred to Judge Greene for public hearing before the judge who knew most about AT&T's recent activities.*

leasing them.

The long-distance battle

As computing systems expanded exponentially during the '60s and '70s, some companies saw profit in supplying data-transmission services on heavily used routes if it wasn't necessary also to provide service through sparsely settled areas. A number of specialized common carriers went into competition with Long Lines and, over the screams of "cream skimming" by the Bell System, were allowed by the FCC to compete. The Bell operating companies did not take this lying down. They made it as difficult as possible for AT&T's long-distance competitors to access local telephones. Additional code numbers were required, and companies such as MCI and Southern Pacific found it difficult to get connections to the local network. MCI eventually brought an antitrust case against AT&T in Chicago for Bell's alleged anticompetitive practices between 1971 and 1974. The jury awarded MCI $600 million, which was tripled as required under the antitrust laws. AT&T has appealed that decision.

The computer inquiries

The 1956 consent decree prohibited AT&T from being in any business other than the communications common-carrier business. But by the early '60s, with the advent of remote data processing, AT&T was the source of the long-distance transmission facilities. How much could the Bell System do? Where was the line between data processing and communications? To answer these questions, the FCC kicked off an inquiry in 1966 that ended in 1973 after several opinions and a court challenge. The Commission defined data processing and message switching and said that all common carriers except Bell could do both, but that data processing could be done only through a separate corporate entity. Bell, because of the Consent Decree, could not participate in any data processing.

The first FCC distinction between data processing and message switching did not hold up as technology improved and computers and communications became more intertwined. In August, 1976, the FCC began its Second Computer Inquiry. In that inquiry, the FCC attempted to identify the uses of computers by common carriers that would require a separate subsidiary and stimulate economic activity in the regulated communications sectors by removing ambiguous definitions.

Through a series of public comments, tentative decisions, final decisions and reconsiderations, the Commission reached a conclusion in 1980 and 1981 that telecommunications common carriers could split their services into "basic" and "enhanced" types. Basic, which would be regulated, is essentially telephone service as we know it; everything else is enhanced. In addition to computer-processing applications, all telephone-user hardware was also unbundled (required to be available for sale). This includes customer-premises equipment, such as handsets and PBXs.

A settlement has been proposed that should knock out entirely Western Electric's monopoly of customer-premises equipment and will end Long Lines' competitive advantage over other long-distance carriers.

from Bell or from any of its competitors. As part of the reorganization, all the license contracts between AT&T and the operating companies, and the standard supply contract between Western Electric and the BOCs, are also being canceled.

A BOC is also restricted from providing any other product or service (except telecommunications) "that is natural monopoly service actually regulated by tariff." According to that provision, the telephone operating companies can no longer run the Yellow Pages, nor can they provide answering devices or answering services (although a call-forwarding service may be allowed).

One of the major complaints in the antitrust case was that the operating companies favored Western Electric equipment unfairly, vis-à-vis other suppliers. Now that the BOCs are a market and cannot discriminate in buying equipment, there will be more opportunity to sell communications-related hardware and software. These are huge markets. Diamond State, the smallest of the spun-off subsidiaries, had assets at the end of 1980 of $366.3 million and revenues of more than $144 million for the year. Most BOCs in 1980 had revenues in excess of $1.5 billion each.

The requirements that there be no discrimination of the BOCs' establishment and dissemination of technical-information procurement and interconnect standards probably means the end of the Bell System's attempts to preserve its telecommunications-monopoly approach by pushing protective connective arrangements (PCAs) to "assure" service quality. Termination of the license and supply contracts may also mean that integrators will get a better shot at Bell Labs' developments. However, Bell Labs and Western Electric are still owned by Bell, and it's possible that all of the Labs' expertise will be fed into making Western Electric a greater manufacturing giant than it already is, particularly because it will no longer have to license its patents, a requirement of the 1956 Consent Decree. Also, until 1987, the BOCs are entitled to priority help from Western Electric and Bell Labs for R&D, manufacturing and other services.

The settlement also prohibits BOCs from providing long-distance services or "information services" ("a capability for generating, acquiring, storing, transforming, processing, retrieving, utilizing or making available information that may be conveyed via tele-

CHRONOLOGY AND ISSUES OF THE SUIT

The antitrust case, settled with such fanfare in January, began in November, 1974, when the Federal Government filed a 15-page complaint in Federal Court in Washington alleging that AT&T had pursued monopolistic practices. The complaint requested that AT&T give up Western Electric, which in turn would have to divest itself of sufficient manufacturing assets to ensure competition in the manufacture and sale of telecommunications equipment. The Justice Department also asked that some or all of the operating companies be split from Long Lines, and asked for such relief against Bell Laboratories as the court considered appropriate.

Seven years later, the Justice Department's William Baxter, assistant attorney general, got a good deal of what his predecessor in the Nixon Administration had sought. Along the way came numerous lawyers' battles, a lengthy trial, which was scheduled to conclude only two weeks after settlement was announced, and millions of dollars in legal costs: $360 million for AT&T and $13.8 million for the Antitrust Division.

Among the specific 1974 allegations of AT&T's wrongdoing, according to Assistant Attorney General Thomas Kauper, were:

- "obstructing the interconnection with the Bell System of specialized common carriers—firms that transmit voice, data and other telecommunications on private lines, such as a regional telephone network to serve the various offices of a company;
- "obstructing the interconnection of domestic satellite carriers—the few firms that transmit voice, data and other communications on private lines via satellite;
- "obstructing the interconnection of customer-provided terminal equipment and refusing to sell terminal equipment, such as telephones, automatic answering devices or switchboards, to subscribers; and
- "directing a majority of Bell System telecommunications equipment purchases to Western Electric."

Among the issues considered in the seven-year litigation by the two federal judges who worked on the matter—Joseph C. Waddy from 1974 TO 1978 and Harold H. Greene, thereafter—were:

- Whether the court had the authority to hear the case because of a 1949 case, which was ended by a still-enforceable 1956 consent decree. In October, 1976, Judge Waddy finally decided that both the '49 and the '56 cases could be brought.
- Whether the FCC and state regulatory bodies rather than the court, should make the rules because of the requirements of the Communications Act of 1934 and other federal and state statutes. In November, 1976, Judge Waddy ruled that the antitrust laws did apply, despite regulation by federal and state authorities.
- Whether the Federal Government had to save all documents related to AT&T. In 1975, Judge Waddy ordered all Federal agencies to keep all documents and records that AT&T asked them to keep.
- A 628-page statement of contentions and proof filed by the Department of Justice in November, 1978.
- Efforts by AT&T, directed to Magistrate Lawrence S. Margolis, to subpoena files held by the U.S. Army's Independent Research and Development Operation containing a number of confidential and proprietary docu-

communications," with some exceptions). There may also be an opportunity for hardware developers and service organizations to provide such services. On-line database providers would be affected favorably by this provision, as would companies that provide the hardware and software to operate these systems efficiently.

Another advantage to the independent suppliers is the possibility that, as the operating companies become more independent, they will weed out personnel, including maintenance and installation employees. As a result, companies in the telecommunications-hardware and -software fields could find it easier to hire competent and experienced personnel.

On the other hand...

Not everything in the settlement agreement is great for system integrators and users. When reorganization is complete, AT&T will be unregulated, except for the Long Lines department. Bell will be a major competitor, and there will be no holds barred. Western Electric, with its more than $8 billion in assets, is the eighth-largest company in the U.S.

A 1956 consent decree, which has been supplanted by the 1982 settlement, prohibited Western Electric from building hardware other than that needed by the operating companies and AT&T. AT&T was generally prohibited from doing any business other than that incidental to furnishing communications services as a common carrier. These prohibitions have been lifted. Western Electric and AT&T are free to compete as hard as they want, not only in the telecommunications-hardware market but also in the computer market, for hardware, software and services.

One of the most successful developments of recent years has been UNIX, a computer operating system developed by Bell Laboratories using the C programming language. UNIX had been licensed (very profitably) to a number of companies that supply computers commercially. Nothing now prevents Western Electric itself from manufacturing computers for that market.

And, because AT&T can now provide information services, there is nothing to prevent it from entering the database business. The American Newspaper Publishers Association fought a battle with Bell on this issue last year and blocked the commencement of an experimental service by Southwestern Bell. Whether ANPA can do it again remains to be seen.

Another conclusion that can be drawn about the agreement, is that the BOCs won't be pushovers for suppliers. While they will be big buyers, the settlement agreement does not say that each of these 22 companies must remain separate. With $87 billion in assets, they can combine into several operating companies, or even one. The purchasing power of such an immense organization could overwhelm most suppliers, with the possible exception of IBM and Exxon.

ments including those of competitors. (This issue was settled by agreement.)

- A 2000-page filing in January, 1980, by the Antitrust Division of its final version of the charges, including specific examples of AT&T's alleged monopolistic activity.
- A 2850-page response filed by AT&T in March, 1980, arguing that the issues between the government and the Bell System had not been narrowed at all.
- Pre-trial memoranda of law and facts running to hundreds of pages submitted by both parties prior to the trial, which finally began on Jan. 15, 1981, before Judge Greene. He then recessed to give the Reagan Administration an opportunity to consider settlement proposals made by the Carter Administration in its last days of office. The Reagan team could not reach a decision, and Judge Greene was unwilling to hold off longer.

Testimony began Mar., 4, 1981, with the government taking four months to present its case. Bell then moved to dismiss the case and cited lack of proof. Judge Greene denied the request, saying, "The govenment has presented a respectable case that the defendants have violated the antitrust laws." AT&T followed up with a 550-page brief, again asking for dismissal. Justice replied with a 411-page memorandum. Judge Greene recessed the trial in late August so that he could read both documents.

In mid-September, Greene refused to dismiss the case entirely, but he did throw out some of the Justice Department's charges. Among his conclusions—based only on the government's case and not on AT&T's defense—were:

- While there were suggestions that the use of inferior equipment could harm the network, there was no proof that "harms associated with such interconnection were sufficiently substantial to render a practice so fraught with anticompetitive implications as the PCA (Protective Connecting Arrangements) tariffs reasonable under the antitrust laws."
- The government's evidence backed its claim that the operating companies were used "to foreclose competition in the terminal-equipment market by refusing unreasonably to interconnect equipment not provided by the Bell System, or by unreasonably impeding such interconnection."
- There was evidence tending "to show that general trade manufacturers encountered a considerable number of obstacles in trying to design equipment for, and sell this equipment to, the Bell operating companies and that these obstacles perpetuated a 'buy-Western' bias."
- Judge Greene found that even when Bell didn't have the equipment, "crash programs were initiated to develop competing Western products," rather than buy them outside.

Bell began its defense with a 34-page report prepared by the Department of Defense that said, in part, "DOD can unequivocally state that divestiture as currently proposed by Justice would cause substantial harm to national defense and security and emergency-preparedness telecommunications capability."

Judge Greene was not impressed, so AT&T began to present defense witnesses. A recess was called last Dec. 18. By then, there were more than 24,000 pages of testimony and voluminous exhibits. Trial was scheduled to begin again last Jan. 12 and conclude 10 days later, but on Jan. 8, the Justice Department and AT&T jointly announced the settlement.

The agreement allows AT&T to compete, unregulated (except for the Long Lines department), with any other company to provide products that can be interconnected to an operating company's system.

There are still a lot of questions to be answered. AT&T will be handling the telephone hardware—perhaps through Western Electric, perhaps directly. Presumably, it will pick up some maintenance personnel and perhaps some of the other installers. But additional installers will be needed to bring the wires into houses and places of business. There may be overlap and duplicate visits at a higher cost to the consumer.

A number of commentators have suggested that local phone rates will go up because the long-distance profits that subsidized them in the past will not be available. Public utility commissions, responsive to residential subscribers, are likely to widen the gap between business and residential rates for local service, increasing the cost to business users. Alternatively, rates for access to the long-distance network may be increased to replace the subsidies. Less than a week after the settlement was announced, AT&T asked the FCC to almost triple the rates it charges competitors to access the local network. The fairness of these charges, an FCC source says, promises to be a major FCC concern in the years ahead.

Nothing is final. Judge Greene, after hearing from the public, may not approve the settlement agreement. Those who were battling Bell in the Second Computer Inquiry, trying to get Judge Biunno's approval revised, won't necessarily quit. The Computer and Communications Industry Association, which was the first to appeal to the courts concerning the FCC's decision in the Second Computer Inquiry, has asked Judge Greene to let it intervene in the antitrust case to protect its interests. There's legislation pending in both the House and Senate. Will Congress buy the settlement? Or will it try to change it by statute? Some big battles remain to be fought. ■

THE AT&T DIVESTITURE: NEAR-TERM EFFECTS

The Yankee Group, a Cambridge, Mass., communications consulting and market-research firm, has identified several immediate effects of the AT&T breakup:

Local telephone-call rates will double over the next two years as the newly independent telephone operating companies lose AT&T subsidies taken from long-distance revenues and move toward cost-based pricing.

The ex-Bell operating companies will be out of the customer-premises equipment-supply business, leaving it to "Baby Bell," AT&T's new subsidiary.

The ex-Bell operating companies will be free to buy equipment from Rolm, GTE, Mitel, Northern Telecom, NEC and other Western Electric Co. competitors.

AT&T will retain control over its long-distance and inter-city facilities.

Independent inter-city carriers such as MCI, SBS and SPC will be better able to compete with AT&T for long-distance business because the ex-Bell operating companies will be required to provide equal local service access to the independents.

Long-distance calls will not get less expensive because local access charges will increase, compensating for lower inter-city rates.

Robert Bigelow is a partner in the law firm of Bigelow & Saltzberg, Woburn, Mass., which concentrates on legal problems of the computer industry such as drafting, negotiating and enforcing contracts, protection of proprietary rights and the conduct of related litigation. He is a founder and past president of the Computer Law Association; a member of the American, Massachusetts, Boston and Federal Communications Bar Associations; an associate member of the Canadian Bar Association; and a member of the Society for Computers and Law (U.K.). He is also a fellow of the British Computer Society, a senior member of the IEEE Computer Society and a member of ACM, the DPMA, the Canadian Information Processing Society and the Australian Computer Society.

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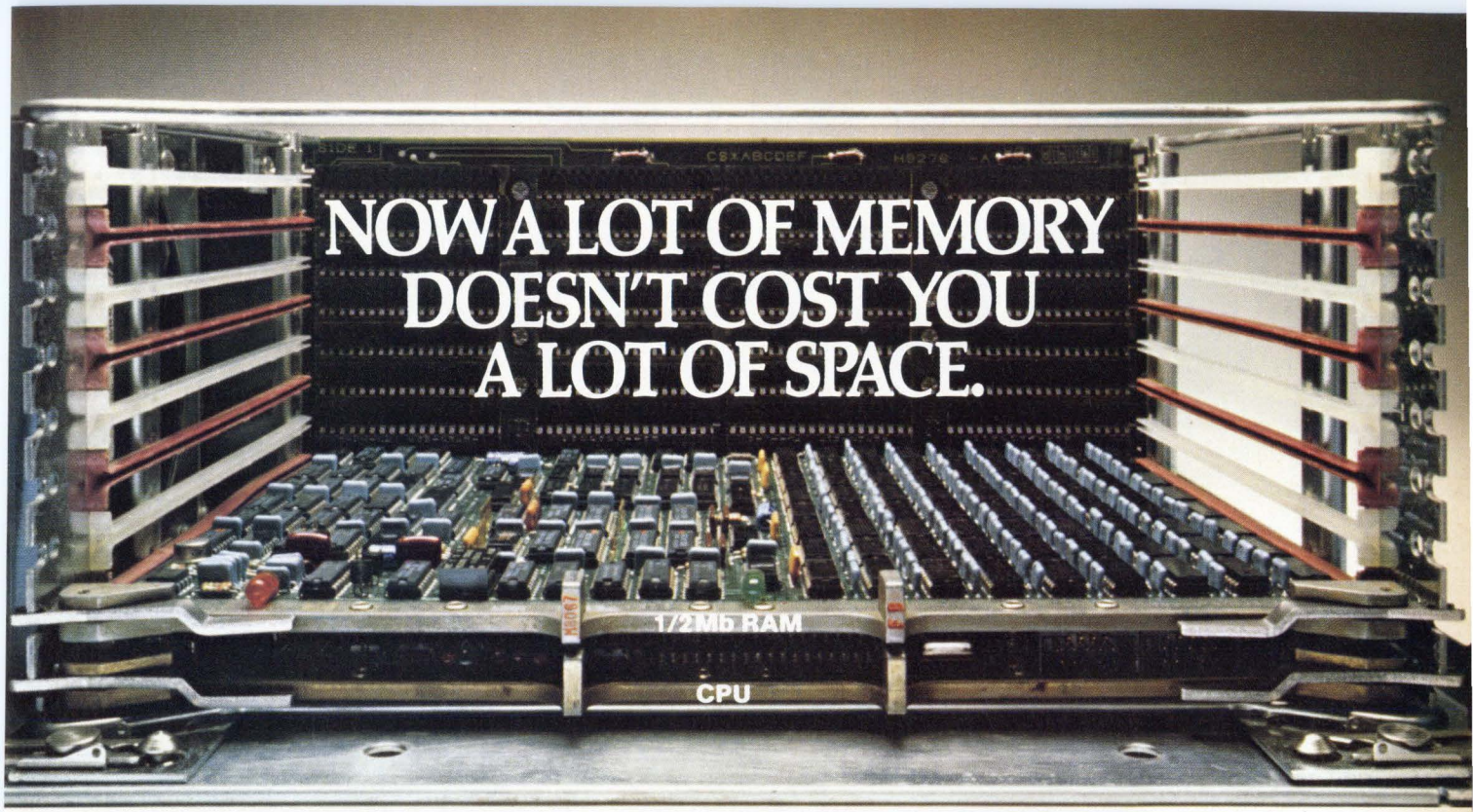

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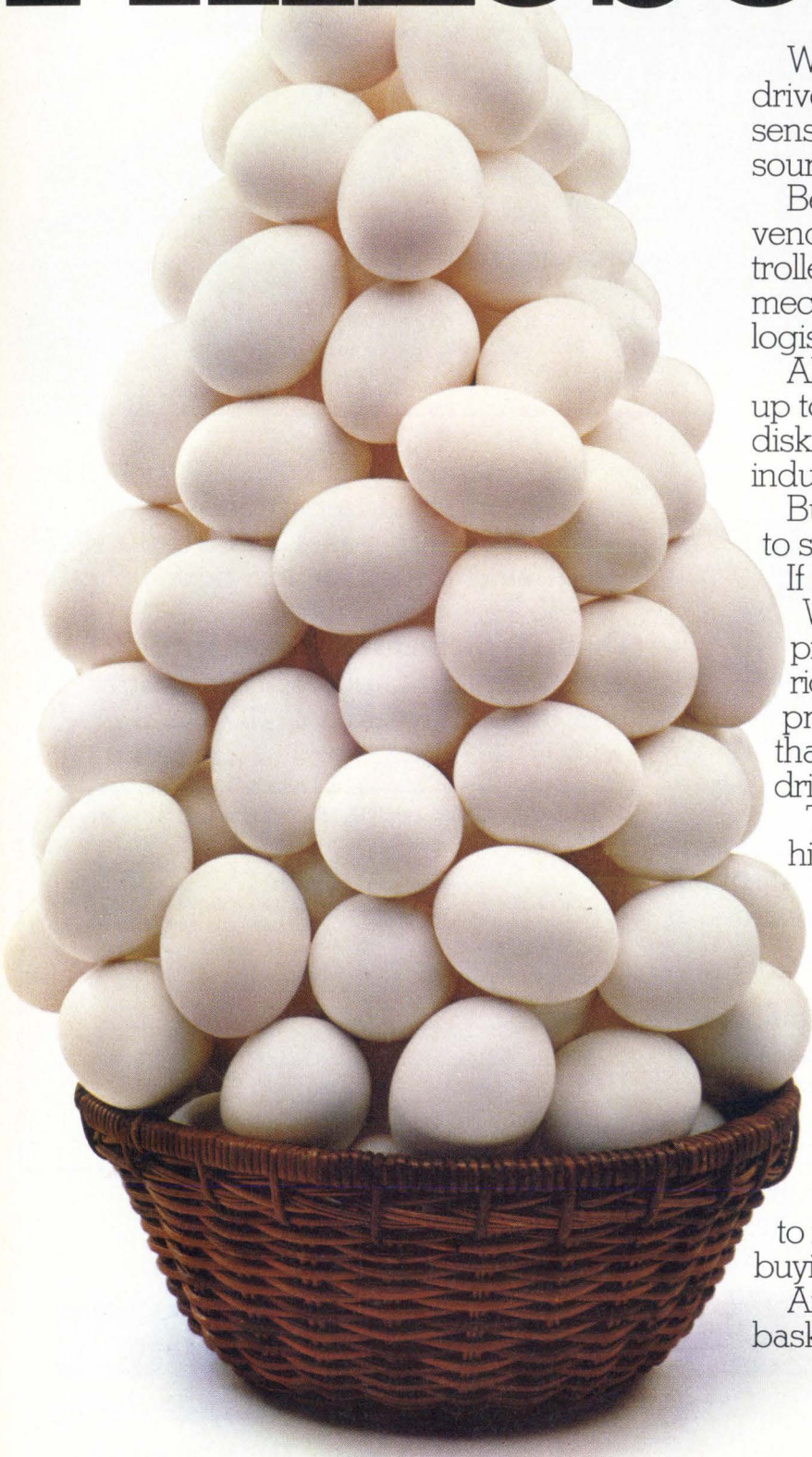

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CIRCLE NO. 96 ON INQUIRY CARD

Shrinking five boards to one...

RON BALDRIDGE, Mostek Corp.

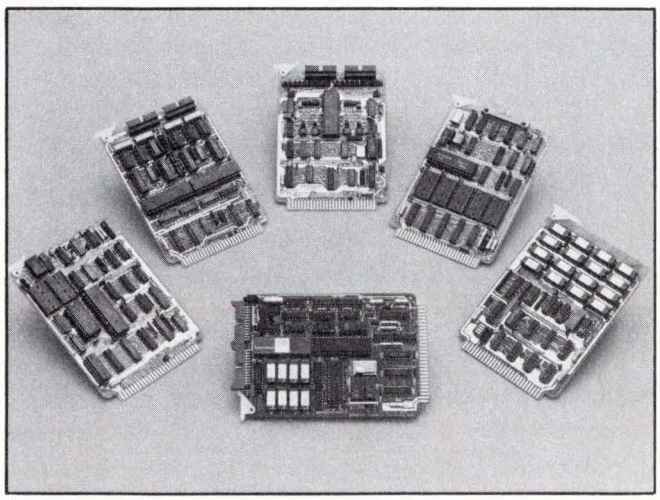
...and adding one more results in a complete floppy-disk system with two 4½- × 6½-in. PC cards

When Mostek Corp. found that its STD-bus-compatible Matrix μcs occupied too many card-cage slots, without allowing other functions to be added, the company designed the Z80-based MDX-CPU3 board. The MDX-CPU3 has eight 64K RAMs that accommodate the full addressing range of the Z80 CPU along with serial and parallel I/O—functions that previously needed as many as five cards. This, combined with the STD bus and a CP/M-compatible operating system, provides a flexible system that can be configured for various applications.

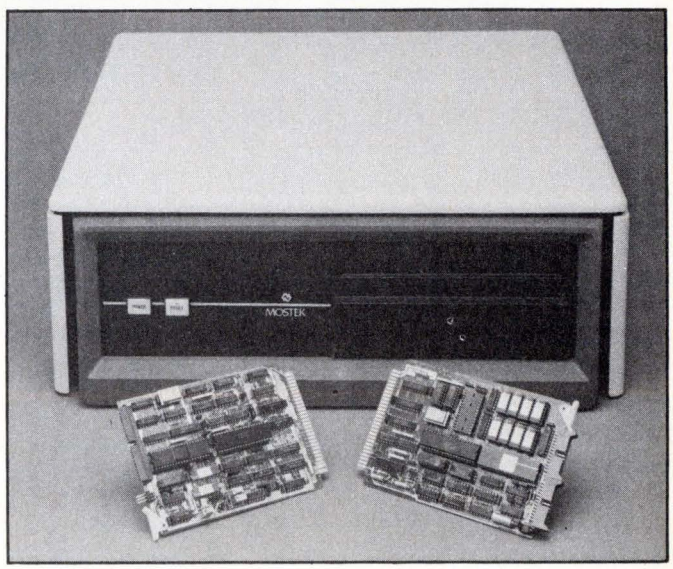
Five cards become one

The heart of the matrix system is the CPU-3 CPU card. In addition to a Z80 processor, this card contains 64K bytes of on-board dynamic RAM, a 2K to 32K Bytewyde EPROM/ROM socket, an RS232 channel, an 8-bit parallel output port and four software-programmable timers.

Previously, simultaneous support of a printer, a CRT terminal and 64K bytes of RAM required a CPU board (the CPU-1), two 32K-byte dynamic RAM boards (DRAM-32), a parallel I/O board (PIO) and a serial I/O board (SIO2 or an EPROM/UART combination). These boards combine more functionality than offered on the CPU-3. For example, the PIO card has four parallel 8-bit I/O ports that are programmable for input or output; CPU-3 has one 8-bit output-only port. The SIO card contains two serial I/O channels strappable for RS232 or 20-mA current loop; CPU-3 contains only one RS232 channel. Therefore, CPU-3 does not replace these



The MDX-CPU3 card (center) provides many of the same functions on a single board as the five other STD-bus-compatible cards *(background). The other cards are, from left, a CPU-1, serial input/output, parallel input/output, USART and dynamic memory.*



The MDX-FLP2 floppy-disk controller card and the MDX-CPU3 card are the only two boards needed to make a complete disk-driven computer, *such as the Mostek Matrix 100 shown here. A user can mix and match other STD-bus-compatible cards to expand the functions to fit requirements.*

Combining CPU-3 and FLP-2 with the Matrix series permits a high-performance, single-user, disk-based system to be configured with only two cards.

boards, but it does provide a combination of functions previously not integrated on a small card. The PIO or SIO cards can be used to expand the I/O functionality of CPU-3 even further.

And one more spells complete

Mostek has also developed a new floppy-disk controller card for disk-based systems. Called FLP-2, it controls as many as four 8-in. disk drives or as many as three 5¼-in. disk drives plus motor control. It enables the use of double- or single-sided drives and is compatible with standard IBM single- or double-density soft-sectored formats. It also supports high-speed DMA transfers, including single-sector, multiple-sector or full-track transfers.

Combining CPU-3 and FLP-2 with the Matrix series thus permits a high-performance, single-user, disk-based system to be configured with only two cards. This leaves as many as eight slots for the OEM or system integrator to implement special functions or I/O.

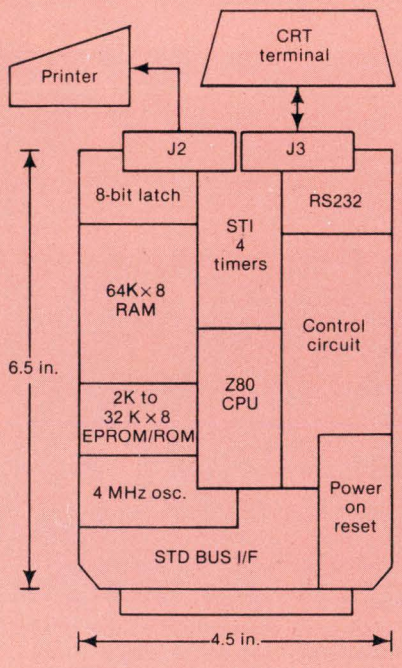
A third card contains a Shugart Associates system interface (SASI). It supports various peripherals, including 5¼- and 8-in. Winchester-disk drives and streaming tapes that use the SASI. A 128K-byte memory card that uses the 64K RAM technology supported by CPU-3 is also available. This card allows the system memory to be expanded in increments of 64K or 128K through the use of a multiple memory-bank selection technique.

Package is rack mountable

The Matrix's low-profile enclosures are constructed of rigid aluminum with a snap-on front structural-foam bezel, and can be mounted in standard 19-in. racks. The

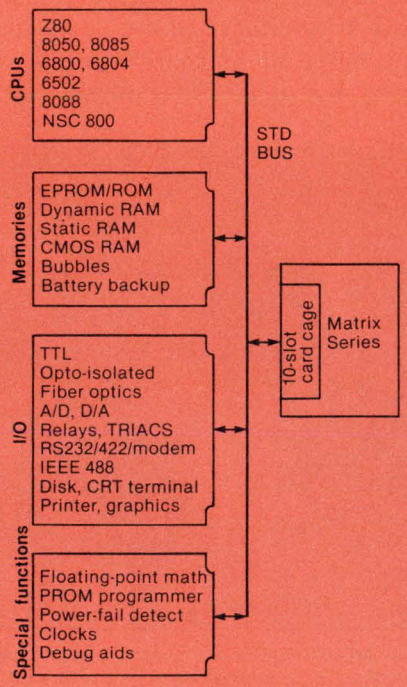
CPU-3: HOW IS IT DONE?

Combining the functions of five boards on one was accomplished through the use of new LSI technology. First, with the Mostek MK4564 64K RAM chip, the entire DMA space of the Z80 CPU is provided with just eight 16-pin IC packages—with the Z80 automatically performing the refresh function. Second, Mostek designed a new LSI peripheral chip called MK3801 or serial-timer-interrupt (STI). This IC is packaged in a 40-pin DIP. It combines a full-duplex USART with an 8-bit parallel port, which can be used as general I/O or as interrupt input, and four programmable timers-functions that previously occupied several IC packages. Third, the advent of high-density EPROMS and ROMS permits a 28-pin socket to contain as much as 32K bytes of ROM using the new Mostek MK38000 ROM or 8K bytes of EPROM using the industry-standard 2764 device. This socket contains a boot-up program, BASIC, an operating system kernel or all three, and can be switched in and out of the Z80 memory space, or phantom ROM, or loaded into RAM, so that the entire 64K-byte memory space can be used. With advanced LSI technology, CPU-3 thus provides a complete system computer on a 4½- × 6½-in. PC card.



STD BUS: MORE THAN 70 MANUFACTURERS

The STD bus was one of the first public-domain buses developed jointly by more than one manufacturer. There are no copyrights or known patents restricting the development and marketing of STD-bus-compatible products. The bus also has a highly modular form factor, and has attracted more than 70 manufacturers of a variety of products, making the STD bus one of the leading 8-bit buses. The Multibus and the S-100 bus are also popular, and are moving toward 16 and 32 bits with accompanying increased price and complexity. As a result, the STD bus may become the dominant 8-bit μc bus.



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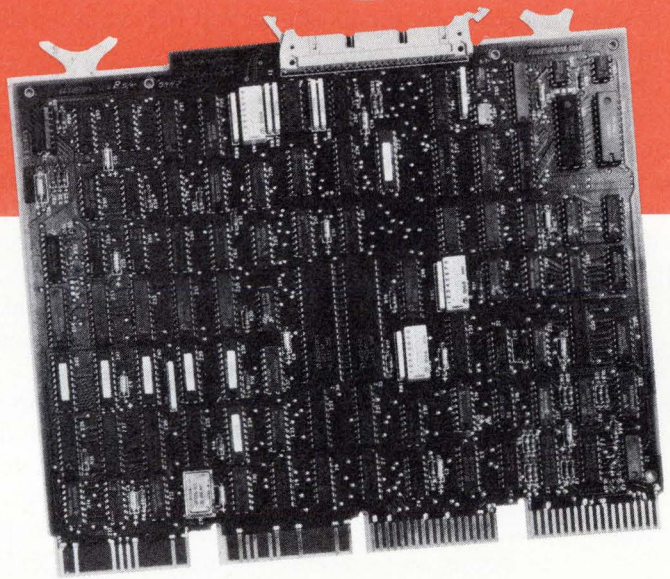

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C33	Cartridge disk controller	RK05
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T04/N	NRZI mag tape controller	TM11/TU10
T04/D	Dual density mag tape controller	TM11/TU10
T34/N	NRZI mag tape controller	TM11/TU10
T34/D	Dual density mag tape controller	TM11/TU10
T36	Dual density mag tape controller	TM11/TU10
S03/A	80 MB/300 MB SMD controller	RM02/RM05
S03/A1	80 MB/160 MB SMD controller	RM02
S03/B	80 MB/300 MB SMD controller	RK07
S03/C	200 MB/300 MB SMD controlle	RP06
S03/D	96 MB CMD controller	RK06
S33/A	80 MB/300 MB SMD controller	RM02/RM05
S33/A1	80 MB/160 MB SMD controller	RM02
S33/B	80 MB/300 MB SMD controller	RK07
S33/C	200 MB/300 MB SMD controller	RP06
S33/D	96 MB CMD controller	RK06

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CIRCLE NO. 97 ON INQUIRY CARD

Various utilities are available, including a designers' development tool, which is an interactive debugging program, file and disk dumps and transfers, print spooling and disk diagnostics.

Matrix-100 configuration, for example, contains a 10-slot STD-bus card cage, an 8-in., 512K-byte, single-sided, double-density floppy-disk drive, a built-in fan and an integrated switching power supply capable of 50- or 60-Hz operation with optional 115V or 230V power for the U.S. or European market. The Matrix-010 has the same configuration, but without a disk drive, allowing this space to be used by the OEM for other functions, such as instrumentation, relays or displays.

Optional tabletop versions are also available with structural-foam side skins and a snap-on top lid. All units also have a hinged door in the rear for access to the card cage and include adjustable strain relief for peripheral cabling and front-panel on/off and reset switches.

Future additions to the Matrix series will probably include a version with an integral 5¼-in. Winchester-disk drive.

M/OS-80 provides CP/M compatibility

The Matrix's M/OS-80 operating system is functionally compatible with industry-standard CP/M, thus providing a wide variety of pre-written μc software. Various additional utilities are available, including a designers' development tool, which is an interactive debugging program, file and disk dumps and transfers, print spooling and disk diagnostics.

An OEM can also configure M/OS-80 to match a set of hardware and memory requirements on the Matrix system. This is accomplished by a system-generation procedure called Mosgen that can be operated interactively from a terminal. A multitasking executive program and PROM-resident BASIC are also available to support real-time systems and industrial applications.

STD bus provides flexibility

The STD-bus interconnect concept, jointly developed by Mostek Corp. and Pro-Log Corp. in 1978, supports 8-bit μcs in industrial-control, data-acquisition and communications applications. More than 70 manufacturers make STD-bus-compatible cards, producing such functions as high-speed floating-point math, bubble memories, IEEE-488 interfaces, CRT-terminal controllers, fiber-optic controllers, triacs and analog I/O, functions that typically occupy one card.

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CIRCLE NO. 98 ON INQUIRY CARD

Ron Baldridge is corporate strategic marketing analyst for 8- and 16-bit board- and system-level products at Mostek Corp., Carrollton, Texas.

NEXT MONTH IN MMS

Two minicomputer profiles will hold the spotlight in the April feature section of Mini-Micro Systems. The surveys of 12- through 16-bit machines and of 32-bit superminis will compare offerings, review advances in hardware and software and examine architectural and packaging trends. The profiles will also probe the dynamics of the minicomputer industry and the state of the minicomputer peripheral environment, and discuss criteria for mini-and μc application decisions.

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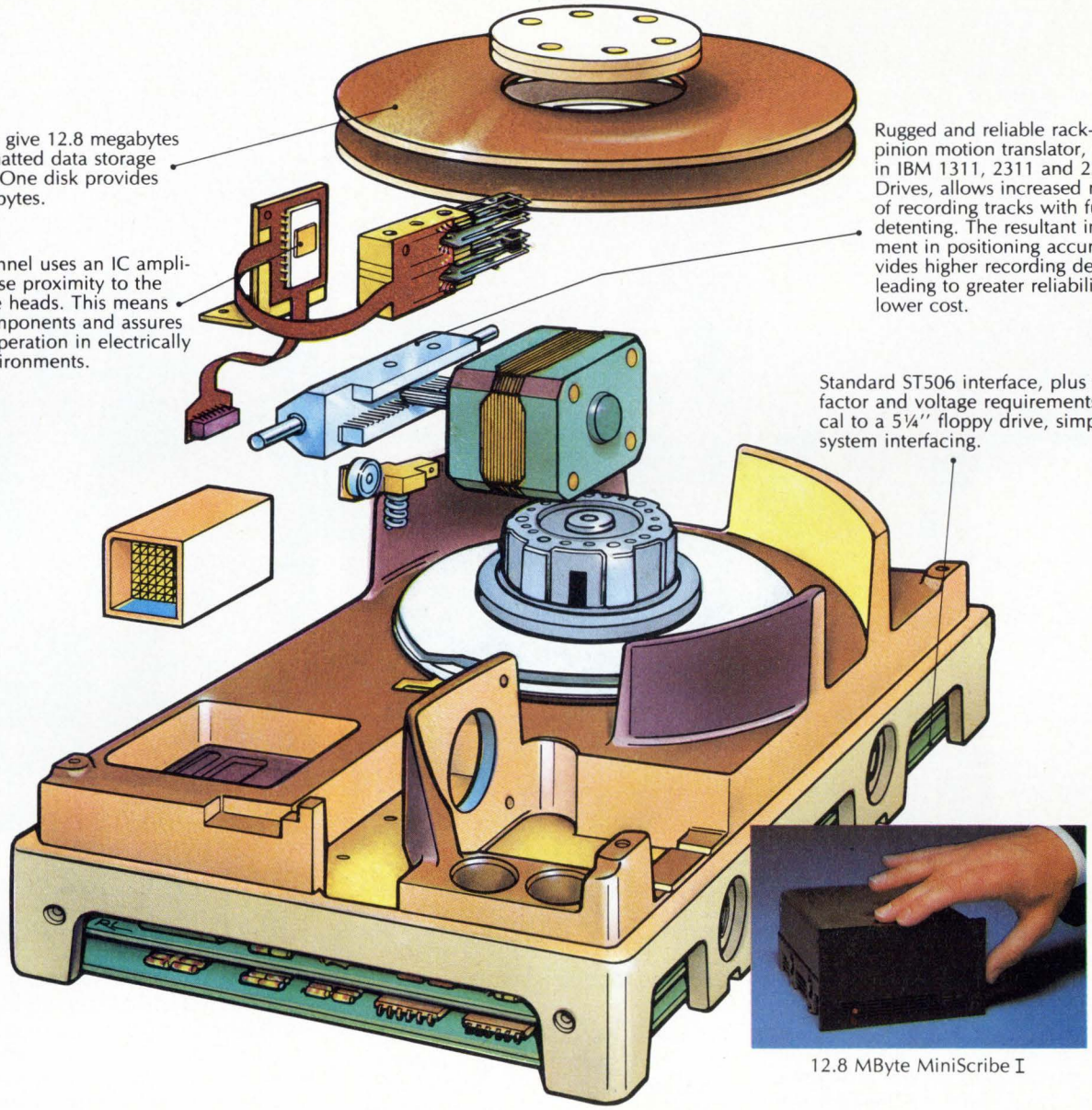

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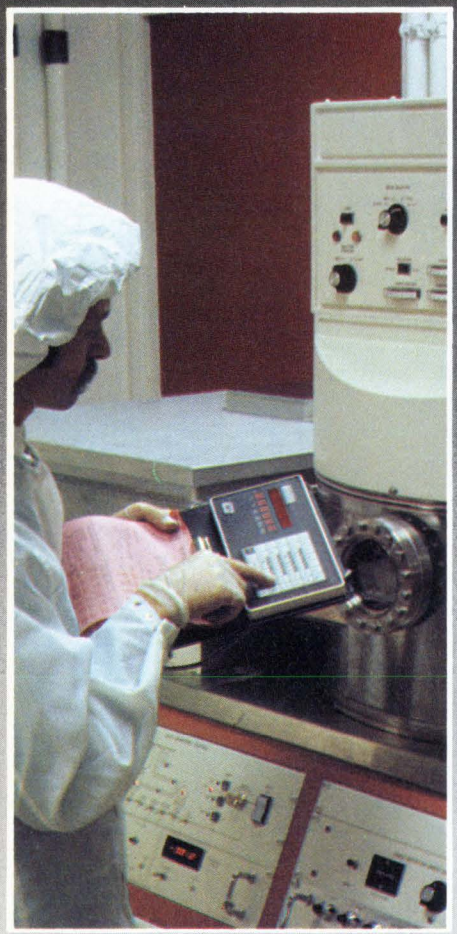

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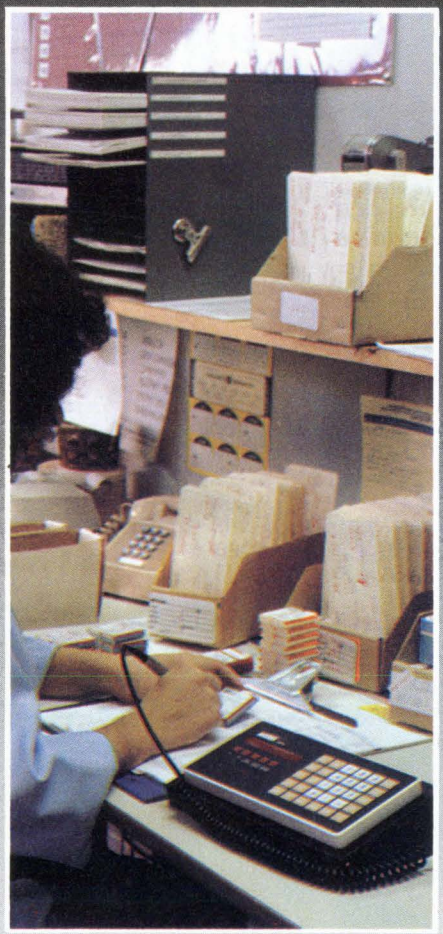

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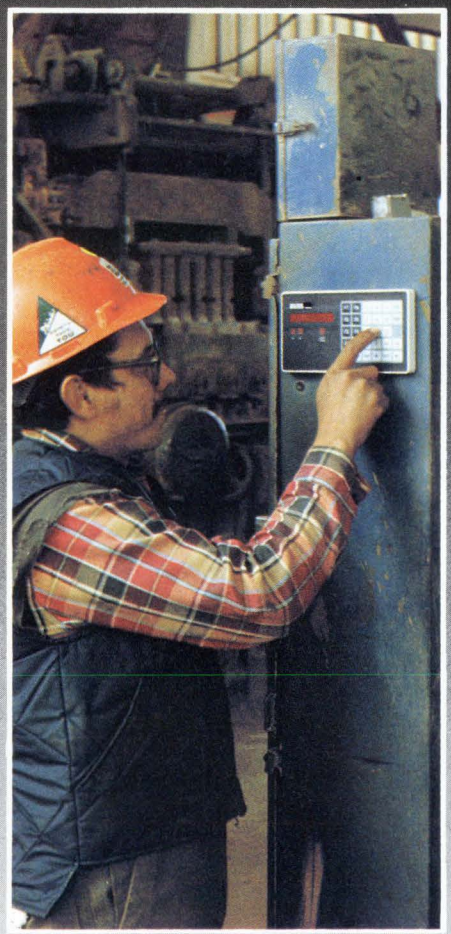

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Array processors adapt to the μc age

PETER ALEXANDER, CNR, Inc.

New designs optimize array-processor-to-μc communication and keep μc overhead low

Over the last 10 years, array processors have typically been used in large, general-purpose computer systems. But, now that most recent array processors sell for much less than $20,000, the processors are beginning to appear in many μc-based systems. The ability to modify programs and parameters makes the arithmetic peripheral attractive to many system integrators working in noise/vibration-analysis, on-line visual-inspection, nondestructive-testing, seismic-data-acquisition and digital-communications applications.

For typical data-oriented processing, such as arithmetic and table-lookup operations, the addition of an array processor to a μc system speeds execution by factors of 100 to 300. Because the essence of array processing is arithmetic speed, communication between the array processor and the host computer must be as efficient as possible.

Three classes of array-processor-to-host communication are available: single function, function list and image file loading. Each has advantages and disadvantages. System integrators who understand how the classes differ can choose a supplier whose product matches the integrator's circuitry requirements.

Control differences and considerations

A relatively inexpensive OEM-oriented array processor system differs from a larger, general-purpose system in several respects. The general-purpose system needs a disk drive and terminal, and its array processor uses RAM. In the lower cost OEM system, however, a host μc is configured with ROM storage for its own programs and parameters and, if needed, programs for the array processor (Fig. 1). OEM systems place minimal demand on the μc host; control is provided via a basic touch-pad alphanumeric keyboard, eliminating the need for a terminal and disk peripherals. The μc contains RAM for dynamic parameter modification and program module swapping, while the array processor is ROM-based, handling dynamic parameter manipulations (program and data related) through its own RAM data modules. Meanwhile, the μc earns its way as an inexpensive operator command interpreter and supervisor for slow, but logically complex, control and fault-conditioning monitoring.

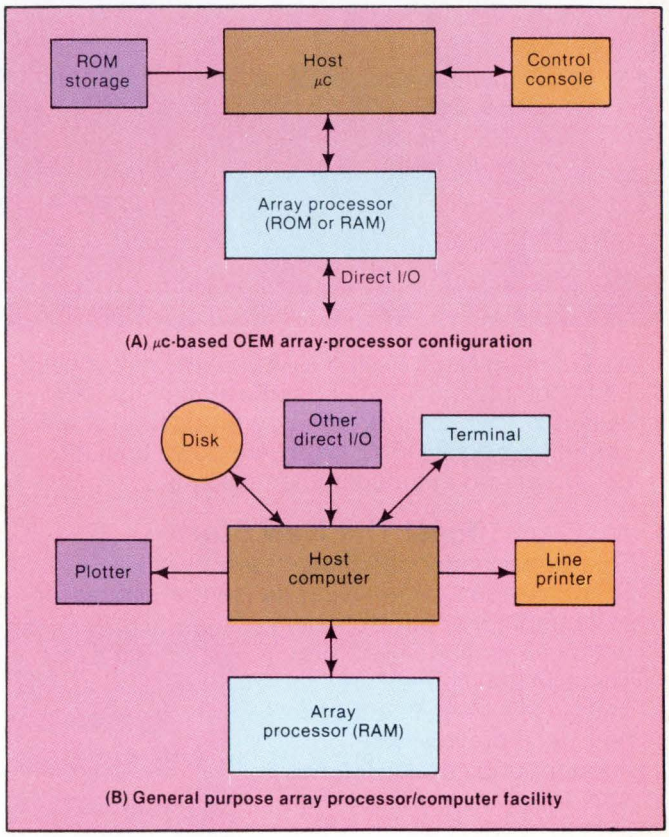
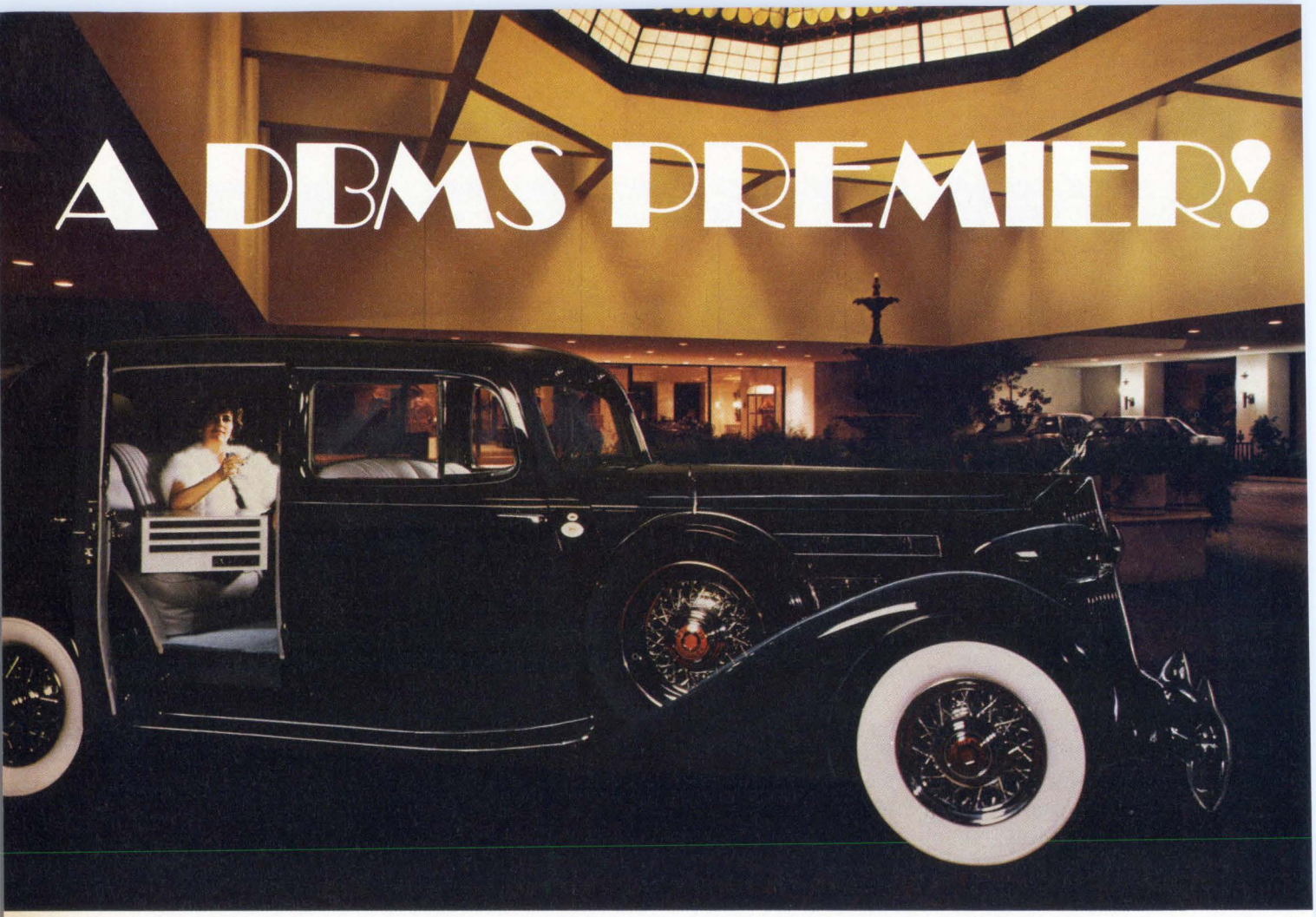


Fig. 1. In the low-cost OEM-oriented array processor system (A), *the host μc has ROM storage for its own programs. Control is via a basic keyboard, which eliminates the need for terminal and disk peripherals in larger array processor system (B). The array processor of the smaller system is ROM-based, handling dynamic manipulations through its own RAM.*

An array processor user views his arithmetic-peripheral processor through a host-resident program



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For typical data-oriented processing, the addition of an array processor to a μc system speeds execution by factors of 100 to 300.

and accesses the machine via array-function subroutine calls. Several array-processor access methods are available, but most are designed around two key considerations:

Function call overhead—the apparent increase in array processor execution time involved in program loading, starting, stopping or synchronizing processing elements,

Dilution of host-processing resources, that is, the burden of maintaining control of the array processor in terms of lost host CPU or memory cycles.

The first consideration pertains to overall array-processor throughput capability. The second is important even if the array-processor load can be met; the host can become fully devoted to array processor control, particularly with complex multitasking operating systems.

Types of communication

The three classes of array-processor-to-host communication—single function, function list and image file loading—are not definitive (Fig. 2). Hybrid designs exist, including the CNR, Inc., MARS-132 array processor. Others, such as Floating Point Systems' AB-120B, run in two modes and, thus, fall into two categories.

In **single-function** communication, ROM or RAM (microcode) is accessed under the control of a sequencer. For each host data-processing request, there is a corresponding transfer of control parameters to the array processor, including data attributes (starting address, block size) and the function microcode address. No further commands can be issued until the array processor returns with an idle flag. Similarly, a command can be triggered to initiate a transfer of data in either direction.

Single-function communication is easy to use and has cost advantages in ROM-based systems, in which program-loading hardware and software can be eliminated. When the processing throughput reaches a certain level, however, the one-at-a-time calling procedure limits performance. To what extent it limits performance depends both on the size of the data blocks being processed and on the speed of the arithmetic. A thresholding routine that operates on samples of a 128 × 128 array typically does the complete block of 16K samples in one sweep, resulting in a computation time much greater than any potential call overheads. A variable threshold function, however, might need 128 subroutine calls to process rows individually. With some host operating systems, I/O call times are as high as 5 msec.; these overheads dominate the arithmetic execution time in this situation.

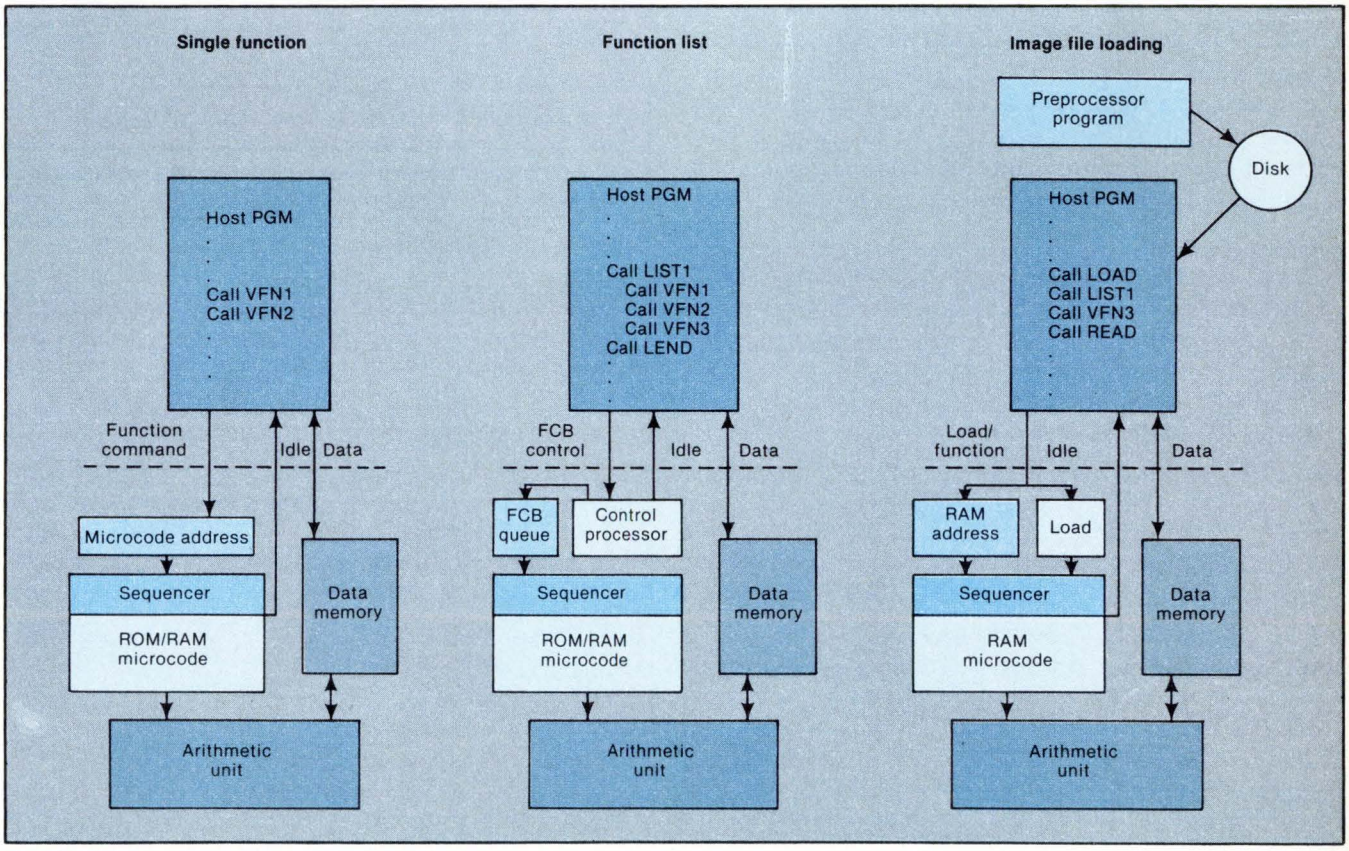

Fig. 2. Array-processor-to-host communication and loading mechanisms. *In a low-cost OEM market environment, single-function and function-list communication are preferred.*

Image file loading is the least restrictive of the control methods, but the most demanding of host resources and utility support.

To reduce single-function overhead, the concept of chained-function control blocks (FCBs) was introduced. This communication system—**function-list**—uses initialization subroutines to transfer a string, or list, of FCBs. Once loaded into a RAM or a FIFO memory, a subroutine call triggers execution of the list. Code modules are then executed in turn from microcode stores until the complete list has been exhausted. More complex FCB structures, including nested and conditional function-list execution, can also be used. One major deficiency of function-list communication is that all function-execution and control commands from the host must fit within a fixed format FCB, and construction of these control packets via subroutine call arguments is often restrictive.

When high performance and efficiency are required, **image file-loading** communication can be used. A preprocessor software utility package converts programs written in a higher level array-processing-oriented language, which allows a mixture of scalar operations, control functions such as function-list looping and calls to optimized subroutines. Thus, a linking operation is carried out using pre-assembled object modules in disk-based object libraries similar to minicomputer compilation and linking, and the disk file produced is down-loaded into the array-processor at run time. Host computer calls are then limited to start, stop and status requests and initiation of I/O transfers. Special provisions must be made for array processor-initiated I/O to ensure that the host computer can synchronize to data blocks transferred by DMA action.

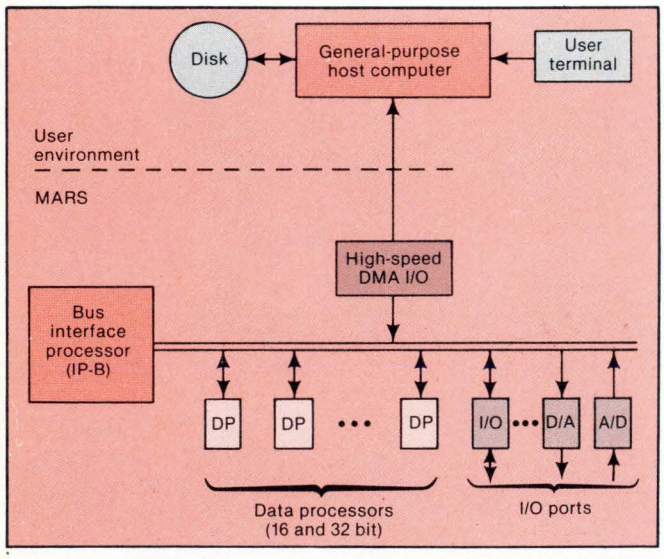

Fig. 3. MARS-232 modular array processor needs direct I/O from user equipment to keep it supplied with data. *This array processor system—one of CNR's most versatile—can process 300 million arithmetic operations per sec.*

Image file loading is the least restrictive of the control methods, but the most demanding of host resources and utility support. In a low-cost OEM-market environment, single-function and function-list communication are preferred.

A study of opposites

As the speed of array processors increases, host-to-array processor interaction becomes more critical. For instance, CNR's MARS-232—one of the company's most versatile array processors—has high arithmetic power and high I/O bandwidths. The processor architecture (Fig. 3) enables integrating multiple arithmetic-processing modules, data processors and a programmable interface processor. Because each data processor can perform 50 million arithmetic operations per sec., a total processing load exceeding 300 million operations per sec. can be reached.

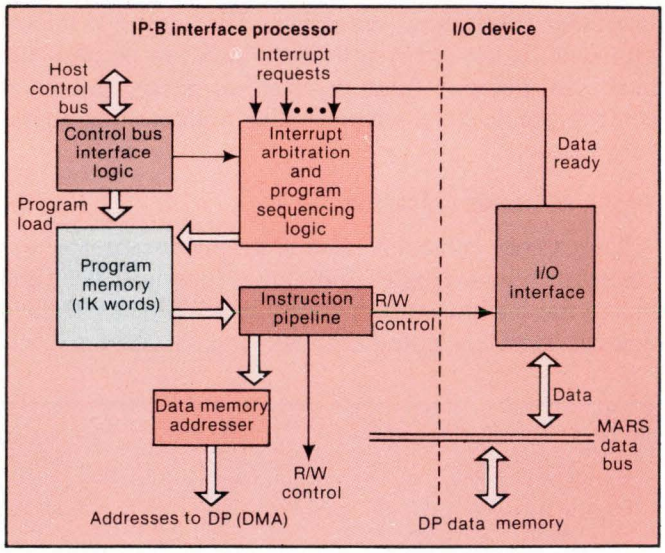

Fig. 4. A bit-slice interface processor manages the rapid data flow of the MARS-232 array processor system. *To reduce control overhead in a high-performance environment of this type, image-file-loading communication is preferred.*

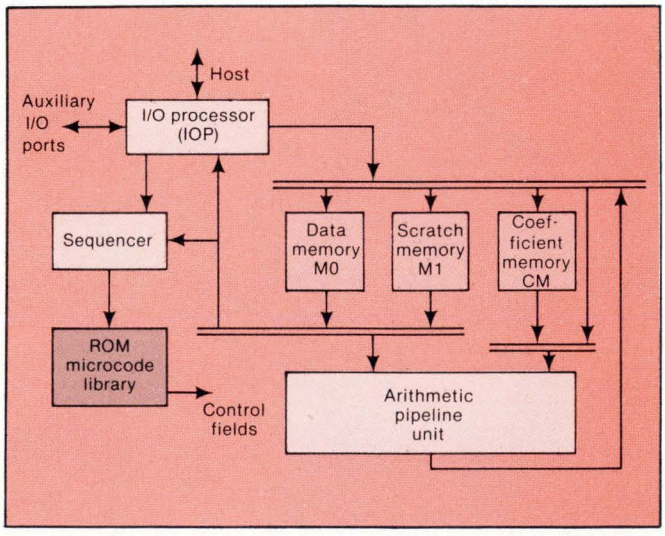

Fig. 5. Low-cost array processors such as the MARS-132 use ROM microcode to reduce costs, *unlike the more versatile array processors, which use image file loading.*

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The use of ROM takes a significant burden from the host because program loading or disk storage is not required.

Feeding such an appetite with data is not a trivial consideration, and is almost impossible to do through the host, so the emphasis is on direct I/O from user equipment. To manage the data flow, which in this system can be rated as high as 20M bytes per sec., the bit-slice interface processor (Fig. 4) is used. It is interrupt-driven and can support eight concurrent I/O channels. Because of replicated hardware, channel context switching overheads are negligible.

With the arithmetic throughput power of the MARS-232, control overheads must be low. Subroutine calls from the host should be avoided, particularly when more than one data processor is involved. An arithmetic-intensive function, such as the 1024-point complex-to-complex FFT, takes only 1.05 msec. in each data processor, whereas less substantial tasks typically consume just a few hundred μsec.

The solution in this case demands image-file-loading control. Each data processor is initialized with an image-file transfer into its own program memory. From within its own arithmetic and control resources, independent function-list program structures can be managed with negligible overhead. A key point is that each data processor and the interface processor must

ARRAY-PROCESSOR ARCHITECTURE

	Single function	Function list	Image filing loading
Advantages	• Standard FORTRAN subroutine calls • Rearrangement of calls in program is easy • User does not need to understand detailed AP behavior	• Can eliminate host function call overhead • AP and host can process independently for long periods • Integration of AP functions statements and host control statements makes program flow easy to follow	• Exceptional flexibility and performance • Multiple entry points are permitted, both function list and individual functions can be called
Disadvantages	• AP-initiated I/O cannot be implemented • ROM microcode restricts development of custom algorithms • Incurs host overhead for each function call (as much as 5 msec. for some operating systems) • Scalar and AP control functions not easily implemented • Lacks versatility for customized code	• Control processor function call overhead may be significant for problems • Programming is constrained by need to use FORTRAN call arguments to manipulate data and control the AP • Allowed control and branching within function lists may be too restrictive for demanding problems	• Requires substantial software utility support and usually disk-storage facilities • Program definition is outside the user's host FORTRAN routine • AP programming language is not familiar to user and varies with different APs
Critical performance issues	• Ease of programming and simple program constructs are important • Performance improvement of AP is always related to host processing alone, and must include overheads of host-AP data transfers	• Operator interaction is useful • Repeated function execution, very often stepping through successive rows of a 2-D image	• Low levels of communication with host computer • Internal AP control must be used extensively
Application characteristics	• Simplified host-AP protocols; host always controls the data flow; data usually originate in host or are derived from disk/tape files	• Quasi-real time 2-D or real time 1-D problems; e.g., overall performance may not be time-critical	• Real time, high I/O rates • AP often controls data flow
Application areas	• Mathematical modeling, general scientific (matrix) problems, non-real time simulation, seismic trace processing	• Seismic data acquisition, speech, robotics, automated visual inspection, noise and vibration testing; X-ray tomography, ultrasonic testing	• Radar, sonar, synthetic image generation, flight simulators, communications, fast convolution, real-time control

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	LA34 DECwriter IV Forms Ctrl.	1,095	105	58	40
	LA120 DECwriter III KSR	2,295	220	122	83
	LA120 DECwriter III RO	2,095	200	112	75
	VT100 CRT DECscope	1,695	162	90	61
	VT101 CRT DECscope	1,195	115	67	43
	VT125 CRT Graphics	3,295	315	185	119
	VT131 CRT DECscope	1,745	167	98	63
	VT132 CRT DECscope	1,995	190	106	72
	VT18XAC Personal Computer Option	2,395	230	128	86
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	TI765 Bubble Memory Terminal	2,595	249	138	93
	TI Insight 10 Terminal	695	67	37	25
	TI785 Portable KSR, 120 CPS	2,395	230	128	86
	TI787 Portable KSR, 120 CPS	2,845	273	152	102
	TI810 RO Printer	1,695	162	90	61
	TI820 KSR Printer	2,195	211	117	80
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	EXCEL 42 Smart Buffered CRT	995	96	54	36
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An array-processor user views his arithmetic-peripheral processor through a host-resident program and accesses the machine via array-function subroutine calls.

have its own program/data memories and sequencer logic. Overall coordination can be handled by the host using conventional subroutine calls to load, start and stop data processors, and to coordinate data flow in the system.

At the low end of CNR's spectrum is the MARS-132, an OEM-oriented low-priced array processor (Fig. 5) that retains the arithmetic speed of the MARS-232 data processor but sacrifices some performance in I/O and control. The MARS-132 design, based on software compatibility with the MARS-232, uses ROM microcode to reduce the price, relying on MARS-232 general-purpose development systems to provide code generation and test capabilities.

The use of ROM takes a significant burden from the host because program loading or disk storage is not required. The question of control, however, resurfaces, for now there is no opportunity to use the strategy implemented in the high-performance MARS-232. Either single-function or function-list communication is applicable, but the function-list FCB method was adopted because applications such as on-line inspection and image processing frequently require nested row-by-row function calls for 2D data arrays.

To simplify the design further, a portion of a general-purpose data memory is designated as the holding area for host-generated FCB strings. In effect, the FCBs are linked by embedded pointers, so that looped-FCB execution can be set up. Data paths from memory M1 allow the microcode function starting address to be passed to the sequencer, while standard host-to-array-processor data paths can be employed in the initial loading of an FCB string.

Finally, the I/O processor (Fig. 5) was developed as a microcoded interrupt-driven controller. It provides I/O services for two channels connecting data memories to the auxiliary and host I/O ports via DMA transfer mechanisms.

While hardware characteristics of array processors have moved toward arithmetic speed over the past few years, supporting software in the form of sophisticated operating systems has created a barrier to further gains using array processors in a conventional way. It is becoming increasingly necessary to give these arithmetic peripherals greater flexibility by building in intelligence and localized control mechanisms. ■

Dr. Peter Alexander, vice president of computer products, CNR, Inc., Needham, Mass., is responsible for development of array-processor products for signal-processing, communication, visual-inspection and robot applications.

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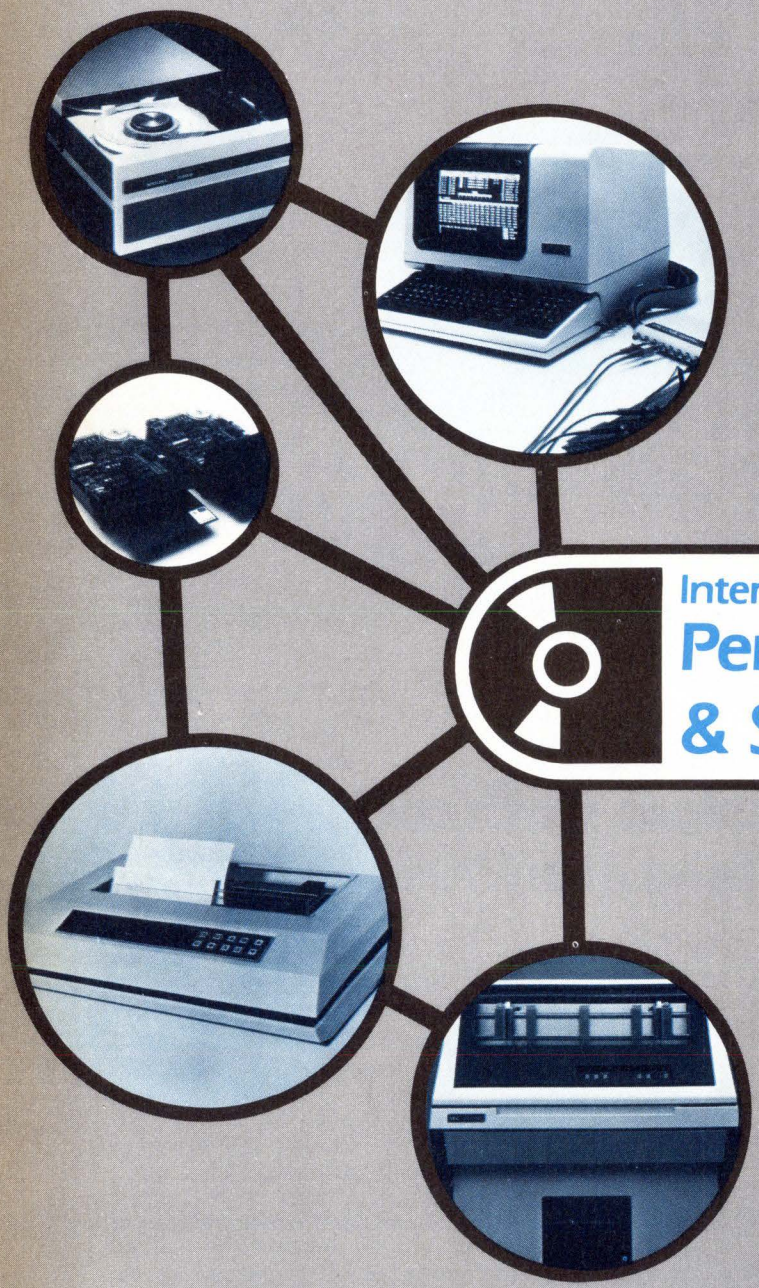

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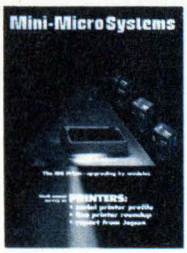

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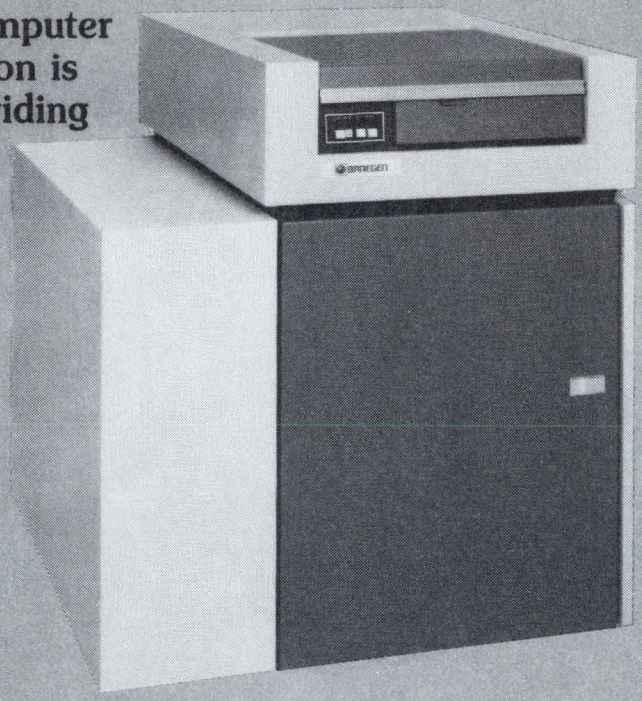

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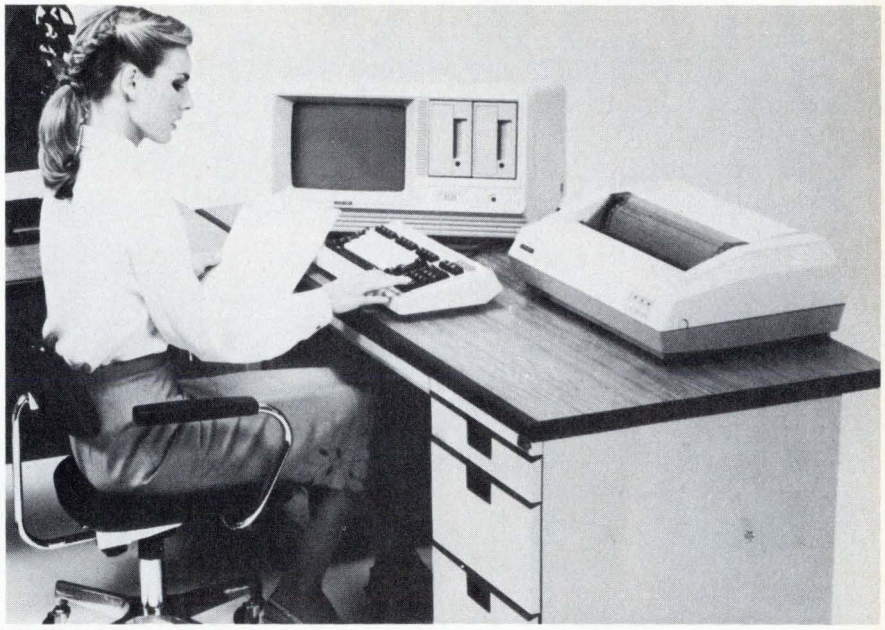
Toshiba announces tabletop systems

A four-model family of tabletop small-business systems and a four-model family of word-processing systems have been introduced by Toshiba America Inc.

The small-business systems include CPUs with 64K bytes of storage, 85-key keyboards with 10 user-programmable keys, a 12-in. CRT terminal and a 125-cps printer. Two models (T-200-3 and T-200-4) use 5¼-in. floppy-disk storage, and two (T-250-3 and T-250-4) use 8-in. floppy-disk storage. Storage capacity ranges from 280K bytes to 2M bytes.

Toshiba has signed agreements with Digital Research Inc. for CP/M operating systems, Microsoft Systems for M BASIC and Compiler Systems Group for business-application packages.



Toshiba America offers *a self-training audiovisual course as a teaching tool that acquaints users with the business systems' applications programs.*

The tabletop word-processing systems carry the EW-100 designation and have 296K- to 2M-byte storage capacities. The systems include a 45-cps letter-quality, daisy-wheel printer and a word-processing-oriented keyboard.

The system has a global search-and-replace capability that allows the text to be scanned for a word or phrase and makes corrections each time the word or phrase appears. With the search feature, the system stops each time a phrase is located and asks if replacement is required. A glossary feature enables 62 glossaries to be called out.

Prices for the small-business systems range from $4950 to $7000. The word-processing systems range from $7290 to $8995. The systems differ only in the amount of floppy-disk-storage capacity each one has. Both the small-business systems and word-processing systems are designed for tabletop use. **Toshiba America Inc.,** Information Processing Systems Division, 2441 Michelle Dr., Tustin, Calif. 92680.

Circle No 361

Scenic introduces 8-bit μcs for P-code

With the recent introduction of so many 16-bit μcs, some of the shine has faded from 8-bit products such as the Apple II. Yet Peter Martin, president of Edmonds, Wash., start-up Scenic Computer Systems Corp., thinks there's room for another Apple-like computer, provided it has increased throughput and greater hardware reliability. Martin hopes those qualities will carve a slice for the Scenic One and Two μcs in the clearly defined, if somewhat narrow, market of companies developing software for Softech Microsystems' UCSD p-System.

The Scenic One and Two systems are built around a 6512A μp, a more advanced but software-compatible version of the 6502 on which the Apple II is based. Martin says its 2-MHz clock speed and 500-nsec. CPU cycle time result in twice the throughput of the Apple II, the Xerox 820, the Radio Shack TRS-80 III and comparable personal computers. On-line storage capacity is higher on the Scenic One (2.28M bytes) and Two (14M bytes) than on typical target systems with 5¼-in. floppies. A further advantage is faster disk I/O, achieved via Scenic's double-density format, data buffering and DMA channel. This all translates to compilation of Pascal source code at 400 to 700 lpm.

Regarding reliability, Martin says, "Disk drives, being electromechanical, are the weakest link of most systems, especially when they're double-sided, double-density like ours." Scenic carefully evaluated the drives of several vendors before deciding on Control

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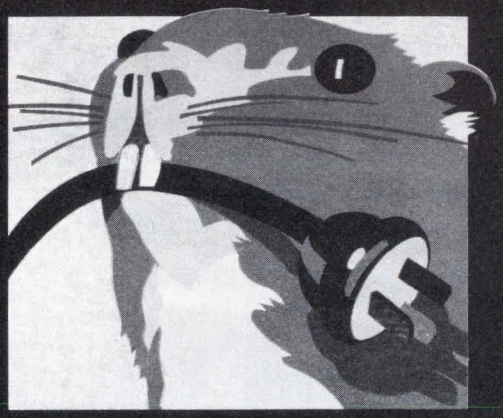

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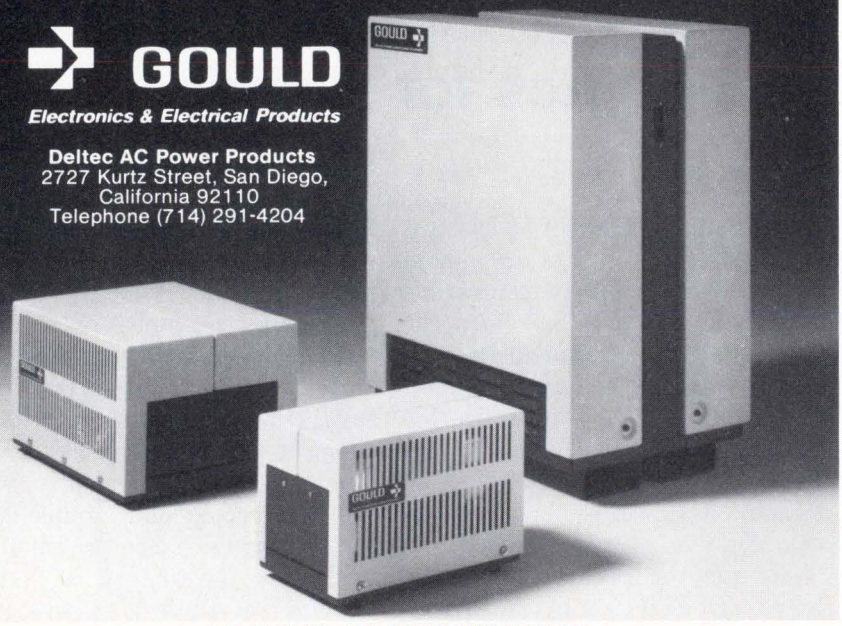


CIRCLE NO. 109 ON INQUIRY CARD

Data Corp. drives, Martin says.

One of Scenic's early customers is Volition Systems, San Diego, Calif. Volition's Carolyn Chase, who worked on a Scenic One, vouches for the Scenic's reliability. She says the system operated an average of 18 hours a day for months as part of the effort to write a compiler for the newest language from Pascal's creator, Nicklaus Wirth.

Martin hopes Scenic's strategy of selling to software houses will also lead to OEM business, "because once these people have developed their programs, they often want to market hardware as well as software." But Scenic's bread-and-butter product for the forseeable future is software-development support. To that end, the company offers an array of optional development tools besides UCSD Pascal Version IV.0, including Volition Systems' Modula II compiler for the Apple and Advanced Screen Editor (ASE), Volition's improved version of the UCSD Pascal screen editor with recursive editing and macro capabilities. Also available are FORTRAN 77 and TI BASIC compilers. Cross assemblers for the 6800, 6809, 8080, Z80, Z8, TI9900 and LSI-11 are also supported.

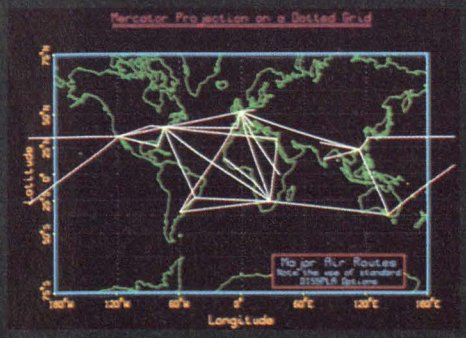
Price of a standard Scenic One, which includes a 64K RAM, dual 2.28M-byte, 8-in. disk drives, a resident monitor program and a system manual, is $5195, or $5695 with the UCSD Pascal operating system Version IV.0. The company offers OEM discounts of as much as 36 percent in 200-unit quantities.

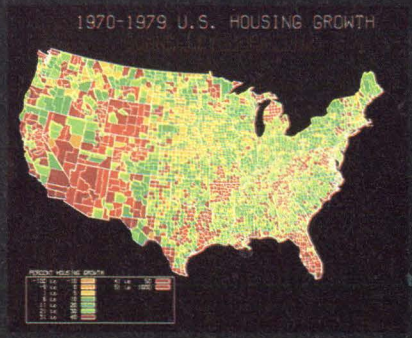
—Kevin Strehlo

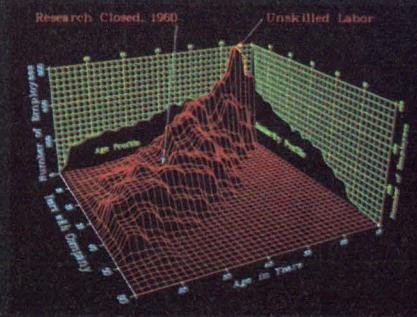
Scenic Computer Systems Corp., 12314 Scenic Dr., Edmonds, Wash. 98020. **Circle No 362**

MST system tests 8-, 5¼-in. floppy disks

The System 810 single- or multi-station system tests and certifies almost 40,000 single-sided 8-in. floppy disks and 63,000







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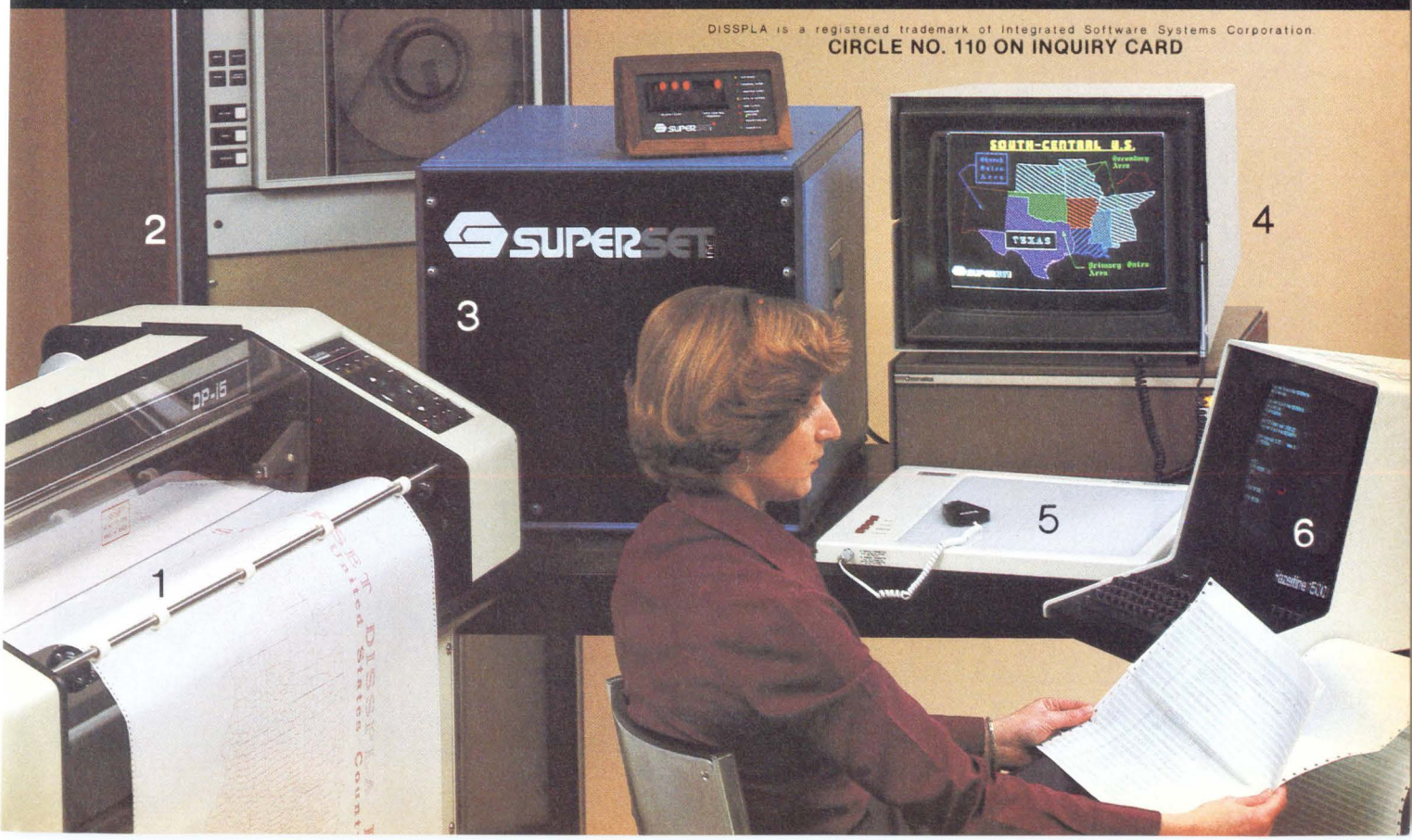

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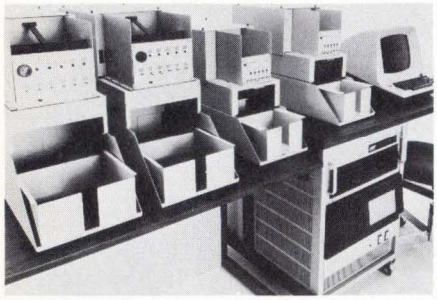


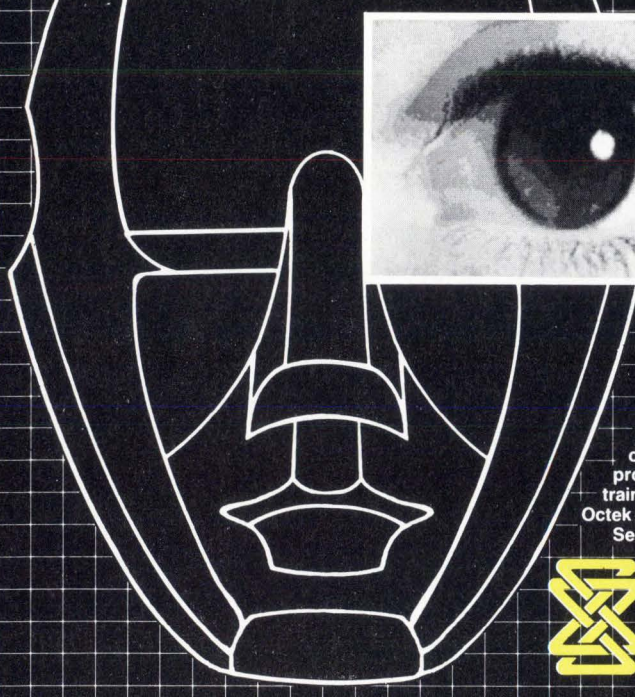
SYSTEM 810 *from Media Systems Technology provides diskette manufacturers with automatic testing and certifying capabilities for single and double-sided 5¼-in. and 8-in. diskettes.*

single-sided 5¼-in. floppy disks per month. The system comprises one to four certification stations, a system console, an operator terminal and a system software diskette. Three certification stations are available. Model 811 tests 8-in., 48-tpi disks, model 812 tests 5¼-in., 48-tpi disks, and model 813 tests 5¼-in., 96-tpi disks. Each model processes single- and double-sided disks. The system supports any combination of models 811, 812 and 813, with a maximum of four certification stations per system. Each 811/812/813 station contains a floppy-disk drive, a media sorter, a pre-amp driver, an analog certifier controller and a proprietary FDIC controller. The stations are controlled by software via the FDIC and the analog certifier. Price for a system with four certification stations is less than $100,000. Stations are also available separately. **Media Systems Technology, Inc.,** 17991 Fitch Ave., Irvine, Calif. 92714. **Circle No 363**

System supports five work stations

The 32M-byte 5032 Multishare Winchester-disk system supports as many as five work stations. It includes a 6-MHz Z80B processor, 128K bytes of RAM and the CP/M operating system. The system features a 630K-byte floppy-disk drive, the vendor's dual-mode disk controller and an optional four-track, 15M-byte cartridge-tape backup. Software includes Microsoft BASIC, SCOPE editor and ZSM assembler. The system, including power supply, sells for $13,995. Additional terminals sell for $1995 each, and the backup tape drive is $3695. **Vector Graphic, Inc.,** 500 N. Ventu Park Rd., Thousand Oaks, Calif. 91320. **Circle No 364**

Computer Eyes!



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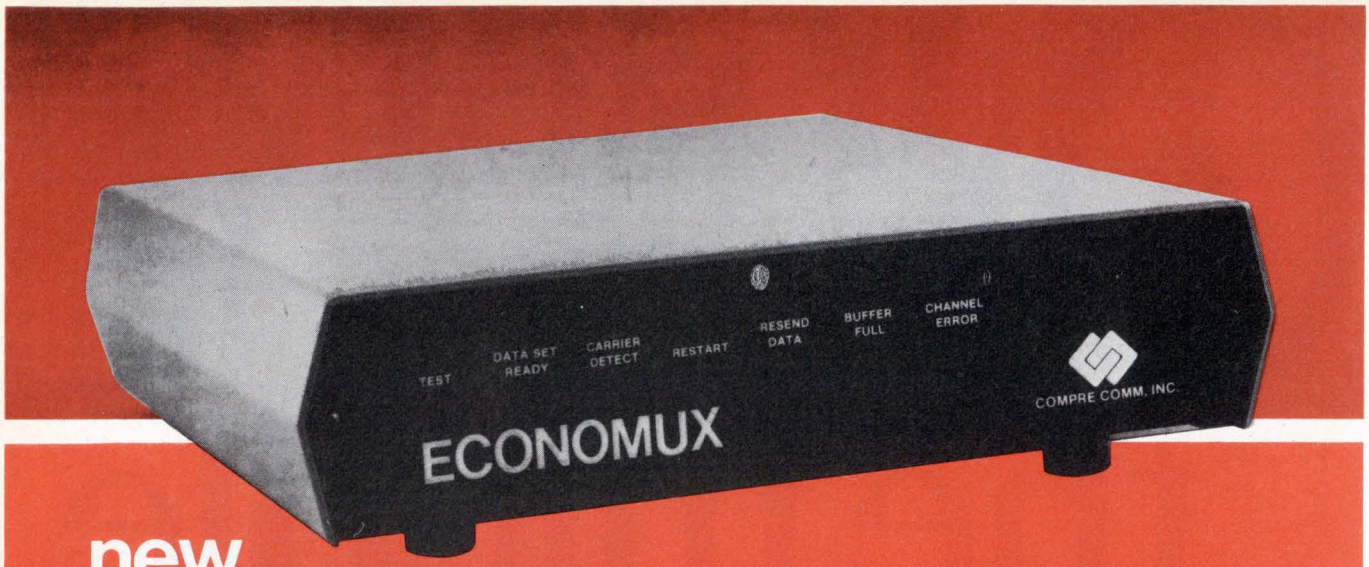

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82-23-19-2

CIRCLE NO. 113 ON INQUIRY CARD

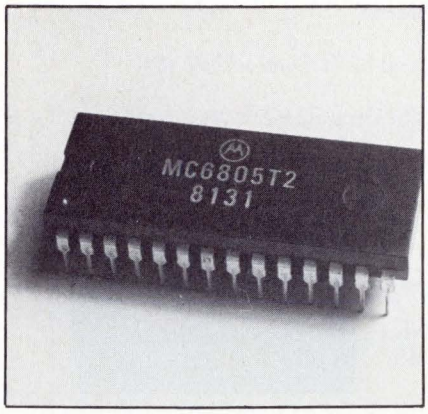
16-bit system offers three backup options

The 16-bit AM-1061 μp-based computer system offers 128K-bytes of main memory, optionally expandable to 1024K bytes, and a 60M-byte, 14-in. Winchester-disk drive. Other features include a parallel port, two RS232 I/O ports, floating-point hardware, eight interrupt and eight DMA levels and a real-time clock. Three backup options are available: an IBM-compatible 1.2M-byte dual-sided, double-density floppy-disk drive, a 20M-byte ¼-in. streaming-tape drive and a 100M-byte video-cassette tape drive. The system operates under the vendor's multi-user, multitasking, time-sharing software. Prices range from $50,000 to $100,000, depending on configuration. **Alpha Micro,** 17881 Sky Park N., Irvine, Calif. 92713.

Circle No 365

8-bit μc has 64 bytes of RAM

The MC6805T2 8-bit μc incorporates a CPU, 64 bytes of RAM, 2508 bytes of ROM, an on-chip timer and



phase-lock loop logic. Other features include 19 TTL/CMOS-compatible bidirectional I/O lines, eight of which are LED-compatible, a 14-bit binary variable divider, a 10-stage mask-programmable reference divider and a three-state phase and frequency comparator. Price is $5 in 1000-unit quantities. **Motorola, Inc.,** 3501 Ed Bluestein Blvd., Austin, Texas 78721.

Circle No 366

Vector's mini offers 32M bytes

The model 3032 minicomputer system includes a 32M-byte 8-in. Winchester-disk drive and a 630K-byte, 5¼-in. floppy-disk drive. The system features a 6-MHz, Z80B-based disk controller, an RS232C port and a work station, which includes a console with an 80- × 24-character screen and a keyboard with numeric keypad. The vendor's model 3500 or 7700 letter-quality printer is optional. All application and development software runs with the vendor's CP/M 2 operating

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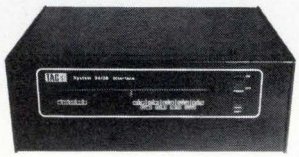

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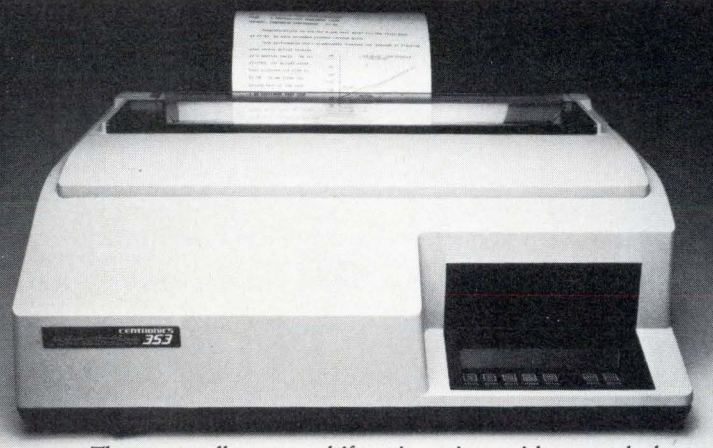

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CIRCLE NO. 116 ON INQUIRY CARD

Systems

system. The system sells for $12,795. The 3500 printer is $2695, and the 7700 printer sells for $3450. **Vector Graphic, Inc.,** 500 N. Ventu Park Rd., Thousand Oaks, Calif. 91320. **Circle No 367**

Systems Group unveils small-business computers

The System 2832/2834 hosts the vendor's Super CP/M operating system. The System 2842/2844 features an enhanced MP/M or OASIS operating system. Both systems feature a 20M- or 40M-byte, 8-in.

Winchester-disk drive with a 20M-byte, ¼-in. streaming-tape cartridge backup. Other features include tape data-transfer rates of 30K bytes per sec., 30-ips tape speed, four recording tracks with 8K-bpi recording density and 20M bytes of unformatted storage. The System 2832 sells for $11,400; the 2834, for $13,160; the 2842, for $12,200; and the 2844, for $13,960. All include a one-year warranty on parts and labor, and dealer and OEM quantity discounts are available. **Systems Group,** 1601 Orangewood Ave., Orange, Calif. 92668. **Circle No 368**

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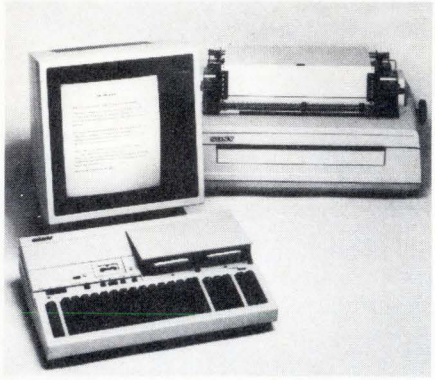
CIRCLE NO. 117 ON INQUIRY CARD

32-bit system includes 1G-byte disk storage

The Sequel business system includes a 32-bit CPU. The system includes four CRT terminals, a magnetic-tape drive and a 300-lpm printer. It stores as much as 2M bytes of main memory and 1G byte of disk storage and requires 208V and 30A of power. Software includes the vendor's DATA/BASIC and ENGLISH database-retrieval language. ALL application software is optional. The system sells for $155,500, and ALL has a one-time $22,700 licensing fee. **Microdata Corp.,** 17481 Red Hill Ave., Irvine, Calif. 92714. **Circle No 369**

Sony introduces word-processing system

The Series 35 word-processing system uses microcassettes for data entry and is compatible with the vendor's Typerecorder professional communication system. The system



includes a 15-in. black-and-white display, a letter-quality printer and two built-in 3½-in. floppy-disk drives. A high-speed printer, 55-cps office-quality printer and a 40-character LCD are optional. **Sony Corp. of America, Office Products Division,** 110 E. 59th St., New York, N.Y. 10022. **Circle No 370**

Teletek introduces 128K-byte μc

The model SBC-I μc contains a Z80A CPU, two parallel ports and 128K bytes of RAM, addressable in 4K-byte segments. The device can be used as a slave on the S-100 bus via a 1K- or 2K-byte FIFO or as a stand-alone computer in a network environment. As much as 8K bytes of EPROM for initialization routines is optional. The system also includes two RS232C ports that permit communications at rates as high as 19.2K bps. An RS422 interface and a synchronous modem interface are optional. **Teletek,** 9767F Business Park Dr., Sacramento, Calif. 95827. **Circle No 371**

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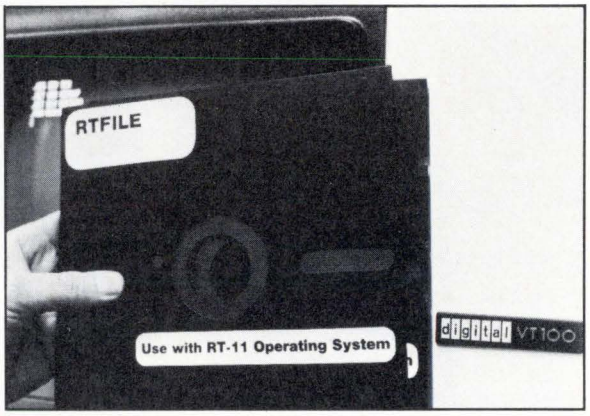

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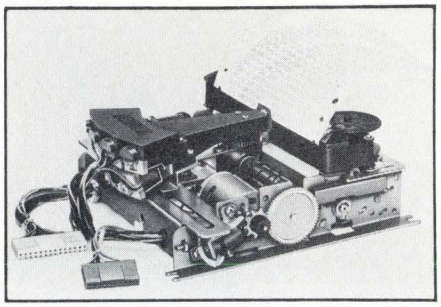
CIRCLE NO. 119 ON INQUIRY CARD

Star introduces miniature graphics printers

Star Micronics, Inc., is one of the recent entrants among low-end printer suppliers to take advantage of the growing need for graphics output from μcs.

The company has introduced five miniature printer mechanisms priced from $60 to $110 in 100-unit OEM quantities. The model DP-822G, which prints 21 columns in text mode at 2 lines per sec., is designed for use with 2¼-in.-wide adding-machine tape and 12V DC power. The 40-column models DP-824G-12 and DP-824G-24 print on 4½-in.-wide friction-fed tapes at 12V and 24V DC, respectively. The DP-824 GS-12 and DP-824GS-24, also 40-column mechanisms, are for use with sprocket-fed tapes, fan-fold forms and gummed or pressure-sensitive labels. Both the DP-824G and DP824GS series print 1 line per sec. All 7- × 6- × 3-in. units weigh less than 1½ lbs.



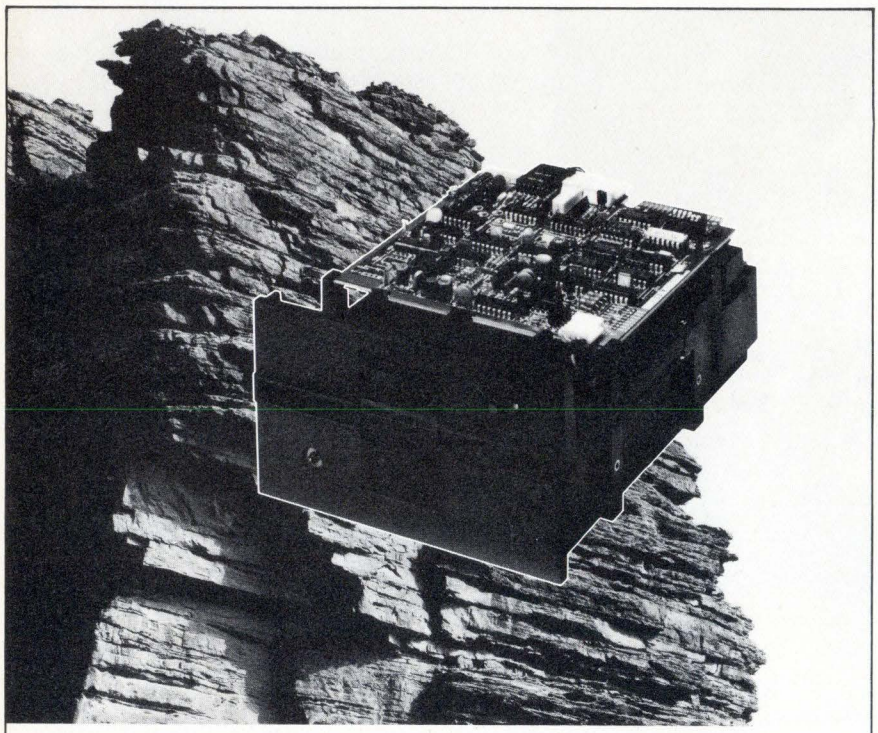
Star's miniature printers illustrate graphics *using a combination of interlaced needles in the print head and a 12-lpi line-spacing reduction by the paper-feed rachet*

Graphic information is printed by a combination of interlaced needles in the print head and a 12-lpi line-spacing reduction by the paper-feed rachet. Print mechanisms include a phototransistor position switch and a voltage-regulator circuit that enhances dot resolution through vertical and horizontal alignment.

In addition to graphics software supplied by the end user, Star offers a series of 8-bit parallel, 96-character ASCII control/drive cards with 64 graphics patterns and expanded or inverted fonts. **Star Micronics, Inc., division of Star Manufacturing Co., Ltd.,** Pan Am Building, Suite 2308, 200 Park Ave., New York, N.Y. 10017. **Circle No 380**

DEC CRT emulator offers low-cost graphics

For several years, Digital Equipment Corp. has been the acknowledged leader in the design and



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If you'd like more information on the growing family of Diablo printers, write to Diablo Systems, Inc., P. O. Box 5003, Hayward, California 94545, or contact the Diablo Systems sales office nearest you.

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CIRCLE NO. 121 ON INQUIRY CARD

manufacture of computer display terminals. Emulators of that company's equipment have found it difficult to overcome customer loyalty to DEC and respect for its experience. In the last few years, however, because of extended delivery dates for DEC terminals, buyers have begun to turn to other manufacturers of quality products that not only emulate DEC's equipment but also provide a variety of additional features. For instance, companies such as Data Media, Cobar, Plessey, and C. Itoh have been making terminals that emulate DEC's VT-100 series, and those companies' success in the market has forced the formerly complacent giant to sit up and take notice.

The CIT-101 terminal, manufactured by C. Itoh Electronics, Inc., Japan, and marketed by Acro Corp.

The CIT-101, which emulates Digital Equipment Corp.'s VT-100 display terminal, *adds graphics capability via a plug-in graphics board. The terminal is priced at $1995; the color board is $1595.*

is one such VT-100 emulator. The CIT-101, a multifunction display terminal with a detachable keyboard and display screen, can be interfaced with a variety of computer systems. Its price of $1995—$200 lower than that of the product it emulates—includes features that are extra-cost options for DEC's terminal or are not available on the VT-100. And the CIT-101 can be enhanced to provide graphics capability by simply plugging in a board.

Features include a non-glare monochromatic screen, non-glare key caps and a time-based screen dimmer. A green or amber phosphor screen is optional. If the terminal is left on without being used for 1 hour, the screen dims automatically to avoid monitor burnout.

Other features on the CIT-101 that are extra-cost options for the VT-100 include multi-mode and bidirectional auxiliary-port operation, true half-duplex communication and the ability to display 24 lines of 80 or 132 characters per line. The terminal also has an alternate character-set capability.

Despite these features, Acro

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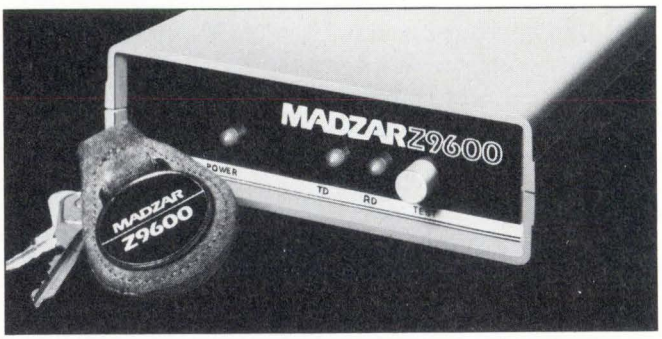

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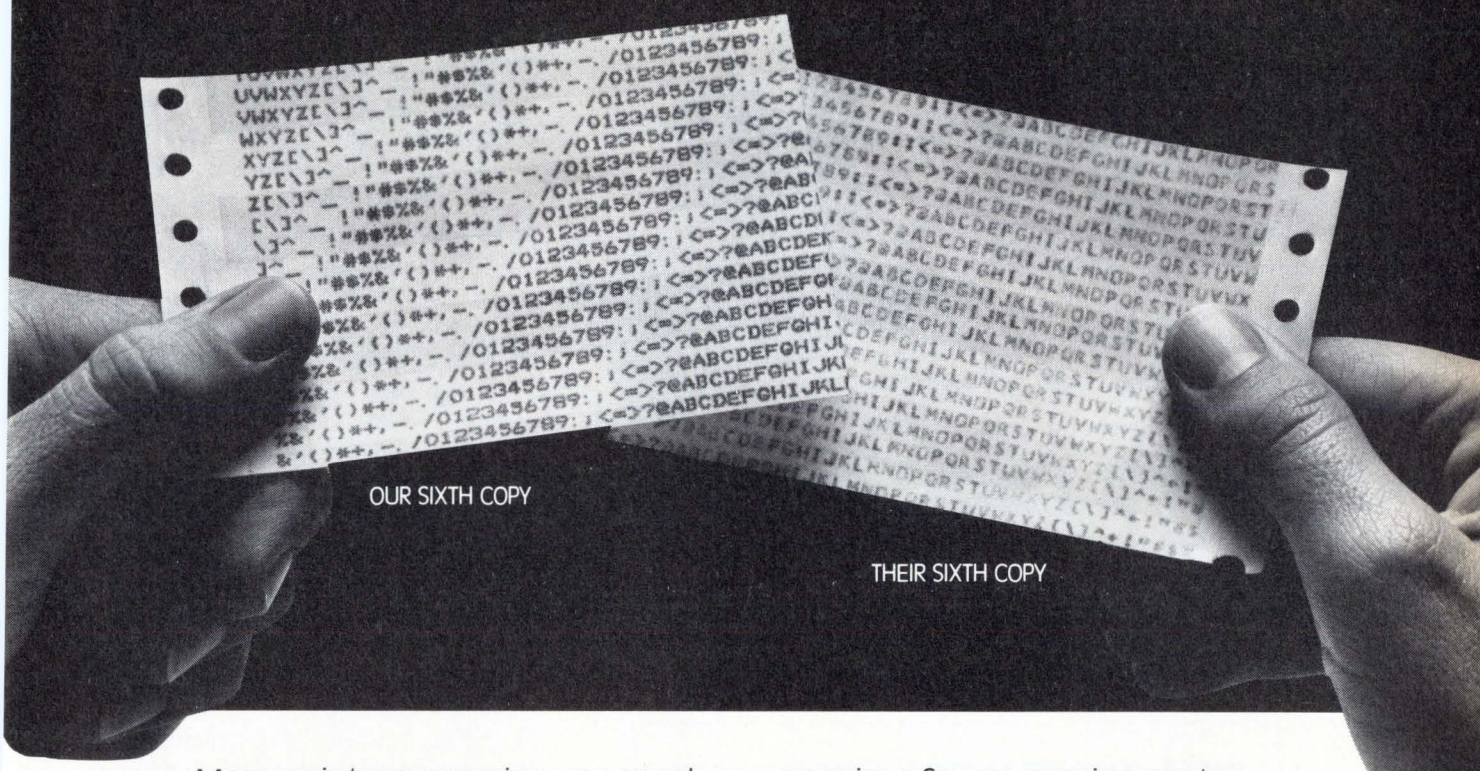

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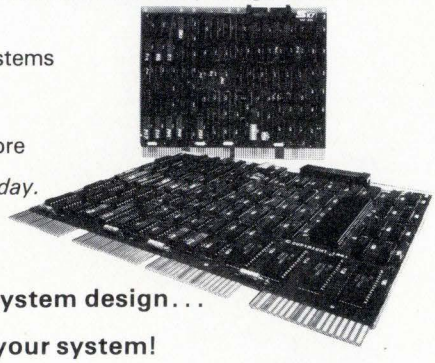

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Peripherals

realized that to compete with the VT-100, the CIT-101 would need graphics capabilities. The company decided to have Selanar Corp., Santa Clara, Calif.—one of the two major manufacturers of low-priced graphics boards for VT-100 terminals—design a graphics board for the CIT-101. Selanar produced the Graphics 101, which provides 1225- × 24-dot resolution on an 8- × 5-in. screen and has an addressable plot area of 65,536 × 65,536 dots. The board, which sells for $1595, plots vector and raster graphics and offers ASCII, APL, math and user-defined character sets.

Graphics 101 is also compatible with Tektronix, other standard software packages, DISSPLA from ISSCO and other time-sharing graphics packages. It has a native mode that requires no programming experience to use and a μc-based vector generator.

The system also includes an independent memory, allowing simultaneous display of alphanumeric and graphics memories in a biplanar environment.

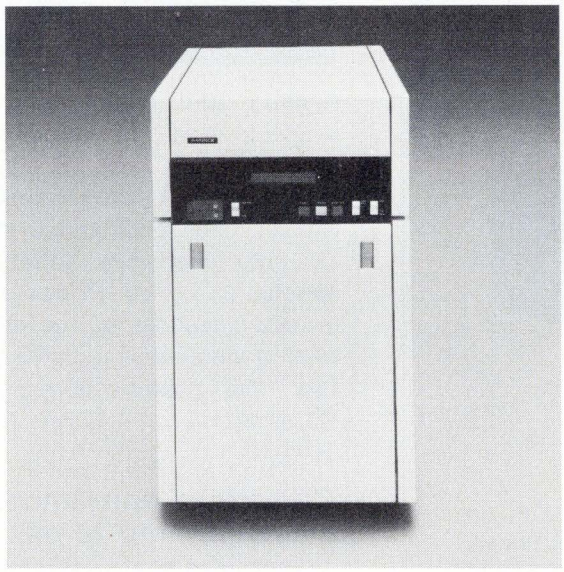
The board can be connected to low-cost graphics hard-copy devices, and can be field-installed by a user. A light pen and cursor are optional. 5301 **Acro Corp.,** 18003-L Sky Park S., Irvine, Calif. 92714.
Circle No 379

Selanar Corp., 437-A Aldo Ave., Santa Clara, Calif. 95050.
Circle No 378

Chrislin offers RAM for IBM personal computer

The CI-PCM memory module for IBM's personal computer uses 64K-bit NMOS dynamic RAM technology. It requires one I/O expansion slot for 256K bytes of memory. It generates and checks parity with interrupt and is addressable in 64K-byte increments through the computer's 1M-byte address field. The module

YOU SHOULDN'T HAVE TO WAIT FOR A DISK DRIVE.



You won't, with our CDC 9755 plug-compatible and media-interchangeable drive. It's available when you need it, with excellent delivery times that enable you to meet your own completion and installation deadlines.

Our 9300 AQ 300-megabyte disk drive is housed in a quietized foam-insulated enclosure that is perfect for office environments. Design permits data to be written and read by either Ampex or CDC drives. Standard features include SMD-compatible interface and single port daisy chain interface (dual port available as an option). Trouble-shooting is easy as possible: LED indicators, and easy access top, front and rear. We've also provided for easier pack installation with our front lid design.

We know nothing's more frustrating for a systems integrator than waiting for a drive. With Ampex, now the waiting's over.

For more information, contact Gary Owen, Ampex, Memory Products Division, 200 N. Nash St., El Segundo, California 90245. (213) 640-0150.

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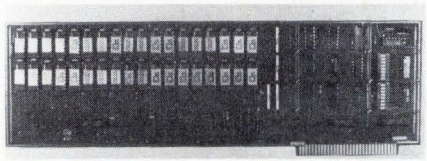
CIRCLE NO. 127 ON INQUIRY CARD

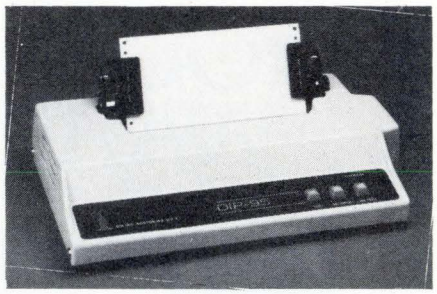
has a 225-nsec. access time and a 400-nsec. cycle time. Current requirement is less than 1A from a 5V power supply. The CI-PCM is available in 64K-, 128K-, 192K- and 256K-byte configurations. Single-quantity price is $1150 for 256K bytes. **Chrislin Industries, Inc., Computer Products Division,** 31352 Via Colinas, #102, Westlake Village, Calif. 01361.



Circle No 377

DIP unveils two-mode printer

The DIP-95 nine-wire impact printer has two switch-selectable printing modes. The data-processing mode uses a 9 × 9 matrix font, and the correspondence mode uses an 11 × 9 font. A user can specify six character sizes and one- or two-pass printing. The printer offers bidirectional printing, tractor and friction paper feed, continuous-loop ribbon cartridge, variable line density and continuous forms-length control. It also features a baud rate as high as 9600 bps, parallel and RS232C transmission control, X-on/X-off and a standard 1K FIFO character buffer or an optional 2K buffer. Prices are $625, in OEM quantites of 100 units and $929 in single-unit quantities. **DIP, Inc.,** 745 Atlantic Ave., Boston, Mass. 02111. **Circle No 376**



Carterfone announces message-prep terminal

The model 7860 message-preparation terminal for use on communication networks using X-ON, X-OFF protocol operates on non-conversational dial-up networks with originate/answer modems. The 7860 responds with a programmable answerback of as many as 20 characters. The unit enables transmission of messages in single or batch mode at telegraph speeds as high as 1200 bps. Other features

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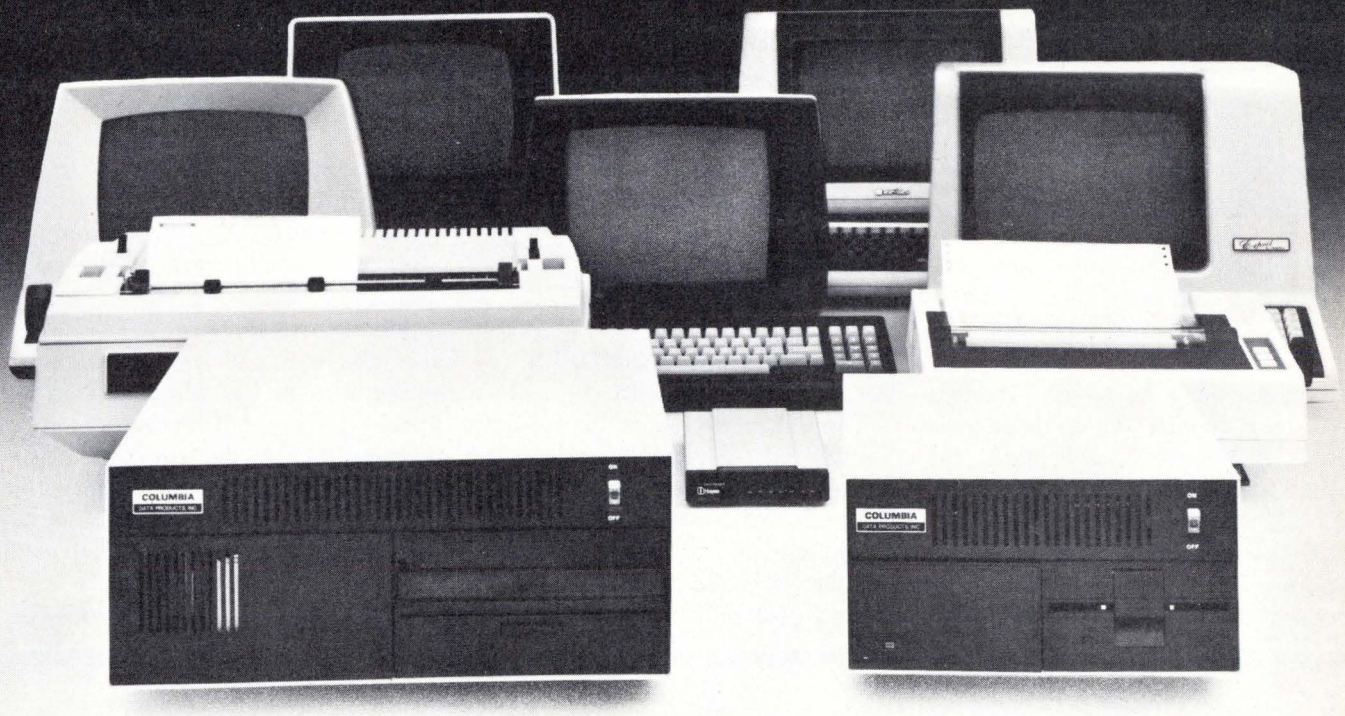

Now you can utilize the storage capacity, access speed and reliability of Winchester disk technology . . . and the economy and portability of floppy disk systems with the Columbia Data Products' single and multi-user, multi-tasking 1500/1800 microcomputer series.

The 1500/1800 product line provides a complete selection of 5¼ and 8 inch floppy and Winchester disks, Z-80A microprocessor architecture, up to 256K RAM and DMA disk controllers. Two parallel ports allow for interface of high-speed peripherals such as printers and expansion storage, and six RS-232 ports give you up to five user stations in a true CP/M® and MP/M® operating system environment. The sixth RS-232 port is available for modems, serial printers or an additional CRT station.

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CIRCLE NO. 129 ON INQUIRY CARD

include a detachable four-row keyboard, seven LED indicators, self diagnostics and print tests. Price is $3780 in single-unit quantities. An installment/sale agreement is $183 per month on a two-year plan and $131 per month on a three-year plan. A service agreement for either a sale or installment/sale is $23 per month. **Carterfone Communications Corp.,** 1111 W. Mockingbird Ln., Suite 1400, Dallas, Texas 75247. **Circle No 375**

Cynthia announces evaluation unit

The new Easy Box disk-drive evaluation unit enables OEMs to test the vendor's D140 20M-byte cartridge disk drives. The device incorporates a cartridge disk drive with built-in disk-to-disk backup, a disk controller, a power supply, a cartridge and cables. Price is $3600. **Cynthia Peripheral Corp.,** 3606 W. Bayshore Rd., Palo Alto, Calif. 94303. **Circle No 374**

Xebec unveils controller for Seagate drives

The S1410 controller for Seagate Technology-compatible 5¼-in. drives incorporates a μp-based controller with on-board data separator logic and Shugart Associates' SA 1400 series host interface. It can control two drives simultaneously. Commands are issued to the controller over an 8-bit bidirectional bus connected through an adapter to the host computer. The data separator logic serializes bytes and converts to MFM data and deserializes MFM data into 8-bit bytes. The device includes the 32-bit polynomial error-correction fire code, which allows 22-bit burst error detection and 11-bit burst error correction. Other features include automatic seek and verify, automatic fault detection, fast step mode, multisector transfers, selectable sector size (256 or 512 bytes), an on-board sector buffer, the Shugart Associates' System Interconnect bus, programmable sector interleave and a software protocol. Single-unit price is $295, with volume discounts available. **Xebec, an MSC Co.** 432 Lakeside Dr., Sunnyvale, Calif. 94086. **Circle No 373**

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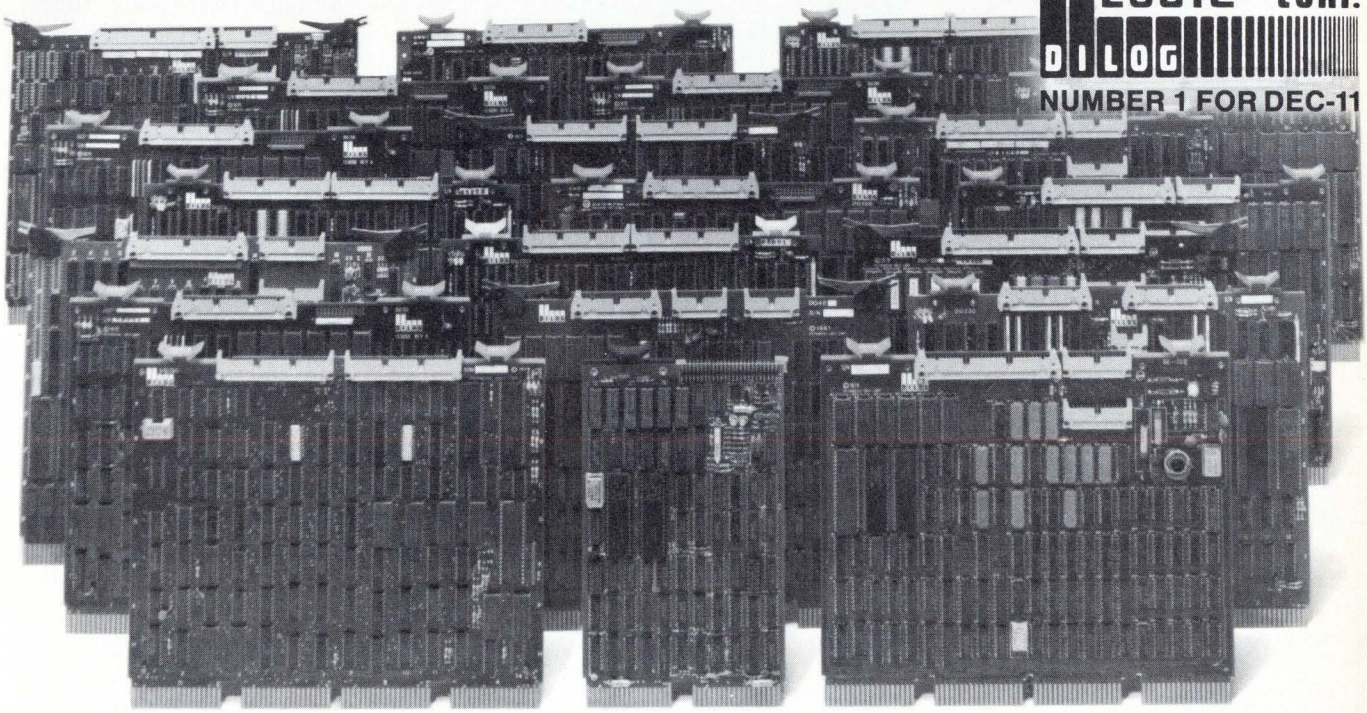

*Trademark Digital Equipment Corp.

CIRCLE NO. 131 ON INQUIRY CARD

Converter opens SNA nets to ASCII terminals

IBM has established its Systems Network Architecture (SNA) as a de facto networking standard, but the company's 3270 series of compatible terminals are relatively expensive and limited in variety. Companies working in SNA/SDLC environments can now substitute ASCII terminals for the 3270 line, however, by using a protocol converter from Protocol Computers, Inc., Woodland Hills, Calif.

Replacing IBM's 3276 controller, the PCI 1076 unit supports as many as seven ASCII devices, including CRT terminals, printers and autoanswer modems for remote communications. The CRTs appear to the host as full-screen 3278s, and the printers appear as 3287s. Operators can also use the ASCII terminals as if they were IBM counterparts, thereby eliminating the need to retrain IBM-oriented staffs.

An optional 1076 feature, called PaperCRT, gives ASCII hard-copy keyboard terminals the same full-screen editing capabilities offered by 3278 CRTs. With this option, remote users with portable ASCII terminals can perform paper-based editing and access the host's library for such tasks as order entry, programming and systems analysis.

Diagnostics within the PCI 1076 let users at any terminal determine the availability of the asynchronous ASCII communications link and the SDLC communications status. The 1076 displays both the address and control of the SDLC line, and each terminal displays its SNA frames.

The PCI 1076 is available in several versions, with one, three, five or seven terminal ports. Maximum transmission speed is 9600 bps for each port, and the SNA/SDLC link also operates as high as 9600 bps. The unit provides standard RS232C interfaces for the ASCII terminal connections and an RS232C or a direct link to the SNA/SDLC communications controller (DTE or DCE).

In quantities of one to five units, the PCI 1076 ranges in price from $3100 for the one-port model to $7000 for the seven-port model. In like quantities, the PaperCRT option sells for $450. In quantities of more than 100 units, the 1076 models range from $2480 to $5250, and the PaperCRT option sells for $250.

Protocol Computers, Inc., 6430 Variel Ave., Woodland Hills, Calif. 91367. **Circle No 381**

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WTI offers a choice of RS232 Minifloppy storage devices to help solve data your handling problems. DataMate II has extensive editing & search features for store & forward applications. The new MiniMate III is ideal for bulk storage & data collection. Both are packed with features for easy operation, system configuration—and above all—reliability you can depend on!

APPLICATIONS

- Save on-line costs: Prepare & edit data off-line, transmit stored data to computer at speeds to 9600 bps.
- Transfer data from one computer system to another.
- Store demo programs for exercising data terminals and equipment.
- Store program code for microprocessors and Eprom programmers.
- Record data from PBX systems and electronic instruments.
- Store parts & address lists, sales information or any data changed or updated often.

IMPRESSIVE QUALIFICATIONS

Both units include;

- A 5-¼" floppy drive, system controller, software and power supply.
- Dual RS232 ports for easy insertion between your Terminal and Modem.
- Easy to use File Management system.
- Automatic and Manual controls for "stand alone" applications.
- 12-month factory warranty!

DataMate II Features:

- Up to 328K of storage on a single sided diskette.
- High speed single and continuous search modes.
- Global search and replace, delete, erase functions.
- Extensive text editing features.

MiniMate III Features:

- Low cost
- Up to 408K of storage on a single sided diskette.
- 7 bit ASCII or 8 bit binary operation, code switchable.
- Automatic disk motor timeout to extend disk life.
- Power up restart in case of AC power failure.
- Dual baud rates and answerback message.

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Call WTI **toll free** and let us help solve your data handling problems. Our solutions have helped hundreds of customers—after all we've been designing and manufacturing floppy disk storage devices longer than anyone!

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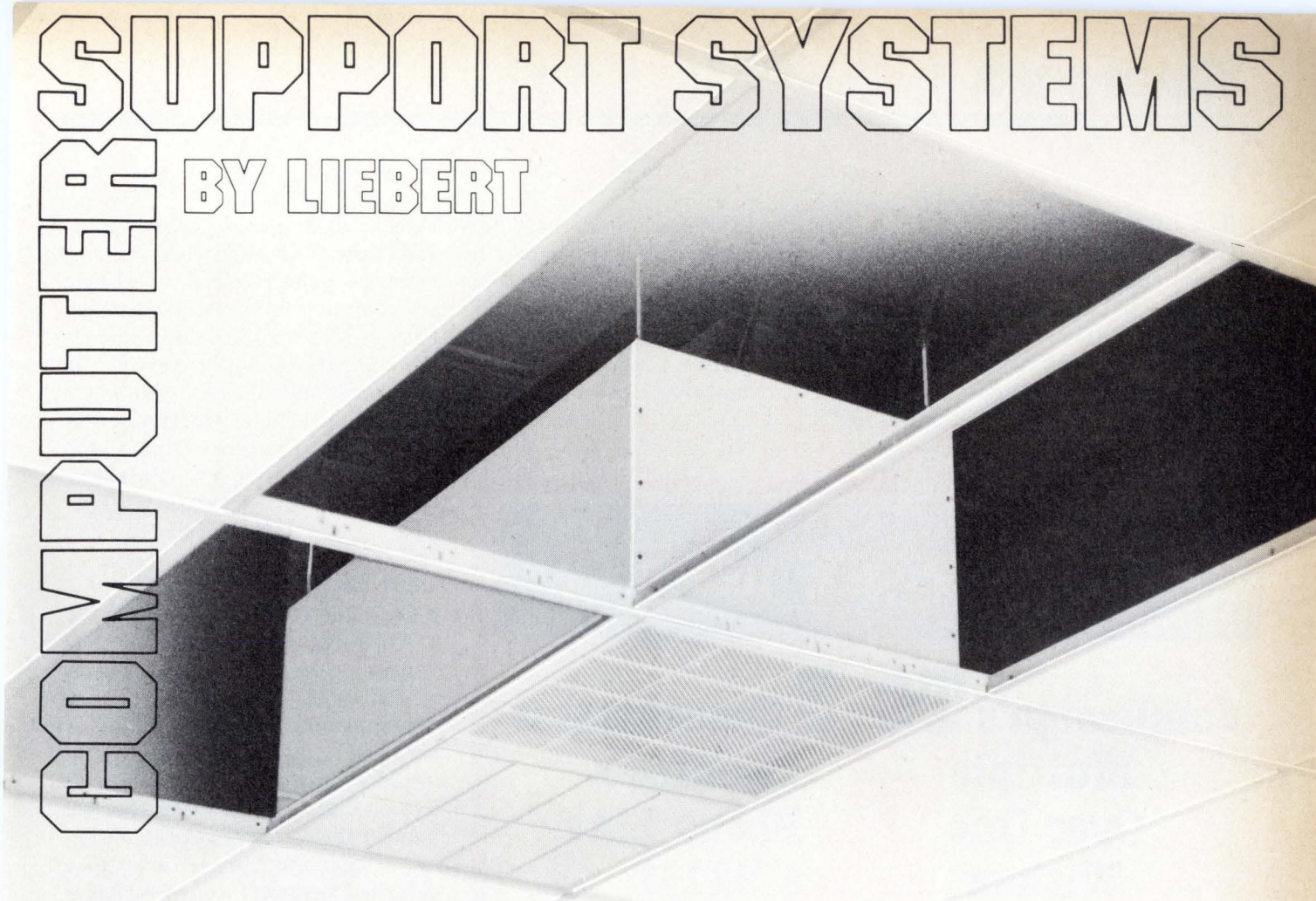

The mini-MATE.™ A cooling system designed for the mini.

Because mini-computers generate heat, cooling is necessary to insure the up-time of both equipment and personnel. Here is the perfect solution.

The mini-MATE is a precision spotcooler, complete with humidity control. It is compatible with any mini-computer installation. Each unit is a self-contained, modular system, flexible to meet any growth requirement. The mini-MATE is controlled by solid state electronics to insure precise, maintenance-free operation. A unique compact design offers one-man installation and service to minimize cost.

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MM32

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ICS announces direct-connect modem

The PDS103A direct-connect auto-answer and originate repertory-dialer asynchronous modem uses an Intel 8049 μc and 2K bytes of ROM. The menu-driven device enables users to select from 18 user-programmable 14-digit numbers by typing a single letter. The modem automatically senses the terminal's baud rate, sets itself to it, and dials the computer. Users can change phone numbers or select half or full duplex, dialing pulse rate, parity, and cancel (logoff) code. Phone numbers, pulse rate and cancel code are stored in nonvolatile memory. Price is $359 for the OEM version or $379 for the end-user version, in single-unit quantities, with OEM discounts available. **Interplanetary Computer Systems Ltd.,** 950 Denison St., Unit 17, Markham, Ontario, Canada L3R 3K5

Circle No 382

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Only $240/mo. for a TC-3 . . . Connect 8 Terminals on 1 Phone Line, Without a DZ11.

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CIRCLE NO. 135 ON INQUIRY CARD

Lear Siegler introduces integral modem for ADM 32

An integral modem for the vendor's ADM 32 terminal operates at full duplex in asynchronous or synchronous 1200-bps mode or low-speed 300-bps mode. The unit includes an autodialer that stores five 30-digit numbers and the last number dialed in nonvolatile memory. Other features include a detached keyboard, conversation or block-mode operation, two pages of memory, programmable function keys, visual attributes, X-ON, X-OFF, smooth scroll, a 25th status line, business graphics, a serial printer port, a program mode, typewriter tabs, self test, a numeric keypad, a 15-in. white or green

screen; and a six-position tilt mechanism. Price is $995. **Lear Siegler, Inc., Data Products Division,** 714 N. Brookhurst St., Anaheim, Calif. 92803.

Circle No 383

Ten reasons why your floppy disk should be a BASF FlexyDisk®.

More than four decades of experience in magnetic media – BASF invented magnetic recording tape, the forerunner of today's wide range of magnetic media, back in 1934, and was the first independent manufacturer of IBM-compatible floppy disks.

Tough Tyvek sleeve – no paper dust, no static electricity.

Special self-cleaning jacket and liner help eliminate data errors and media wear and tear.

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100% certification – every single disk is tested at thresholds 2-3 times higher than system requirements, to be 100% error-free.

Bi-axially oriented polyester substrate – for uniform and reliable performance year after year.

Cross-linked oxide coating – for low head wear and long trouble-free media life.

Total capability – one of two manufacturers in the world that makes both 8″ and 5.25″ models, has tape and disk experience, and manufactures floppy disk drives.

Double lubrication – lubricants both in the formula and on the disk surface, to minimize media wear due to head friction.

For the name of your nearest supplier, write BASF Systems, Crosby Drive, Bedford, MA 01730, or call 617-271-4030.

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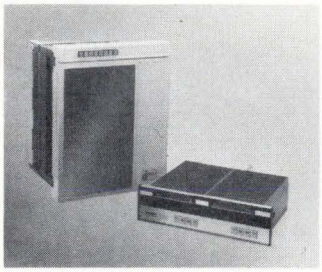
DEC...HP...TI...DG...TRS? **Yes.**
IBM...WANG...GA...SEL? **Yes.**
IEEE...INTL...APPLE...RS232C? **Yes.**

IDT has never met a computer it couldn't provide with IBM compatible ½" mag tape.

The advantage of complete tape drive subsystems by IDT is plain: IDT designs are the most recent and are fully compatible with **anybody's** requirements. Features include diagnostics and bus to drive support.



IDT offers the Series 1050 ½" tape subsystem, a full-capacity, 10½" reel, 72K byte/sec system for management of massive data volumes . . . and the Series 3000 ¼" cartridge drives, cost effective alternatives for smaller users.

In IBM-compatible, or standard recording formats including ANSI, ECMA and ISO and 8000 hour MTBFs, these problem-solvers are too attractively priced to overlook. Call or write for a complimentary descriptive brochure and see why you should think IDT when you think tape.

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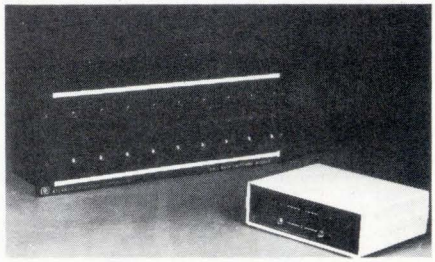
CIRCLE NO. 138 ON INQUIRY CARD

Datacomm

Atlantic Research unveils spare-modem switch

The FBM-4-1 manual push-button-operated modem switch switches a spare modem in place of a faulty one. The digital and analog side of the modem are switched at the same



time, and connections are made at the rear of each unit by three two- or four-wire screw terminal barrier strip connectors and three EIA RS232/V.24 female connectors. The passive modules can be mounted in a single-switch desk-top or in a 19-in. rack-mount unit that holds as many as eight modules. **Atlantic Research Corp.,** 5390 Cherokee Ave., Alexandria, Va. 22314. **Circle No 384**

Prentice offers statistical multiplexers

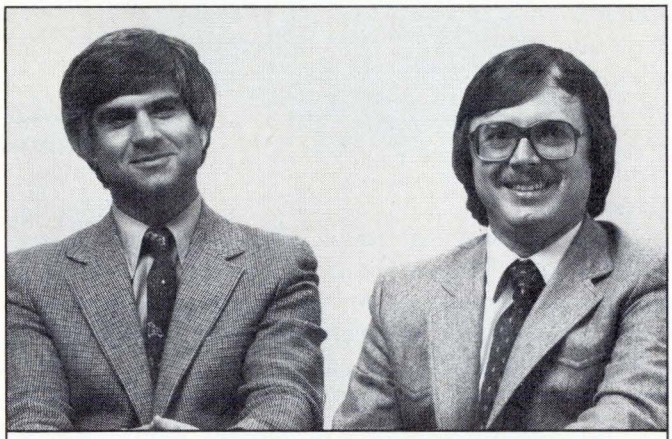
The Minimux, Unimux and Multimux statistical multiplexers feature automatic request for repetition, data-link error correction, local echoplex, remote-channel loopback and aggregate and individual channel data rates as high as 9600 bps. The Minimux, available in two-, four- or eight-channel multiplexing, includes an automatic down-line loading feature to control remote-unit channel speed from the master unit. The single-channel Unimux can be used as an asynchronous-to-synchronous converter and with dial-up or private line synchronous modems. The Multimux provides multiplexing on multipoint circuits; master units have four- or eight-channel multiplexing, and slave units have one-, two- or four-channel multiplexing. **Prentice Corp.,** 266 Caspian Dr., Sunnyvale, Calif. 94086. **Circle No 385**

WESTERN DIGITAL REPORTS ON ADA

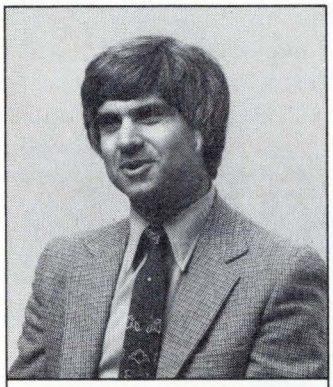
Ada: How to Get Started

NO. 1 IN A SERIES

Interest and activity in Ada, the new programming language, is gathering momentum. Now, two prominent computer science professors have prepared an Ada textbook and an intensive three-day programming course based on the recently announced Western Digital MicroAda compiler. Dr. Richard Sincovec and Dr. Richard Wiener, professors at the University of Colorado at Colorado Springs, and co-founders of Western Software, talk about the advantages of evaluating Ada now.

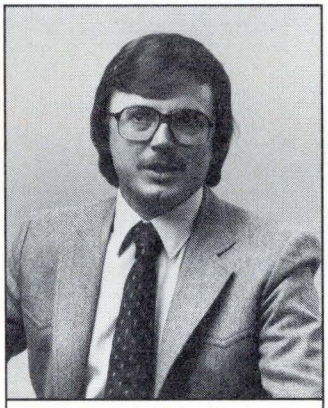


"You can't really appreciate how Ada can cut your software development and maintenance costs until you evaluate it in an applications context."



"Ada has the features — separate compilation, generics, dynamic dimensioning of arrays — that enable it to overcome the limitations we discovered with Pascal."

WD: How did you first get interested in Ada?
SINCOVEC: Actually, we first became interested in Pascal, for its structural modularity and ease of software maintainability. We wrote the nucleus of a mathematical programming library in Pascal. But, as a language, it had some limitations. Such as the inability to dynamically dimension arrays.
WD: Ada solves that?
SINCOVEC: Absolutely. Ada is a natural evolution of Pascal. It has unique features — unconstrained arrays, separate compilations and generic packages, for example, that are too attractive to ignore. We're upgrading all our existing programs to Ada. And it should make additional programs for our library much easier to implement.
WD: You seem sold on the language. Wouldn't some argue that it's a bit too early to commit to Ada?
WIENER: The U.S. Government has clearly committed to it. Both here and in Europe, Ada is gaining acceptance as a universal language. The sooner you evaluate Ada, the sooner you'll understand the potential impact and benefits it can have on your software development. And those who begin developing Ada programs now are likely to reap the rewards that accrue to early adopters of new technology.
WD: What makes Ada so attractive?
WIENER: Sheer economics. It should lower the cost of software development and maintenance for anyone who uses it. It's simple, yet powerful. And it's highly standardized, so your software costs really become a good investment.
WD: How does one get started?
SINCOVEC: There's no substitute for getting your hands on a compiler and beginning to write actual programs.
WD: That sounds like a plug for your course.
SINCOVEC: It is. We've structured a hands-on, three-day class focusing on programming in an applications context, using Western Digital's



"There's no substitute for hands-on programming for learning a new language. It's the quickest way to get started, and the foundation for the course we've put together."

MicroAda compiler and SuperMicro computer work stations. Participants will get instant feedback for practical, effective learning.
WD: How did you choose the SuperMicro?
WIENER: We've used Western Digital systems for over a year to develop our mathematical, statistical and data base programs, originally in Pascal. Frankly, we're impressed with its performance — typically 1,000 lines per minute compilation speed. Our evaluations indicate compilation and execution speeds tenfold what you would expect from a microcomputer, more along the lines of the performance of a multi-user mainframe.
WD: Tell us more about your course.
SINCOVEC: It's designed for scientific programmers, systems programmers, D.P. professionals, computer science educators, researchers, software managers and anyone with either commercial or military interest in Ada.
WIENER: We've scheduled a number of sessions in cities across the country to make it possible for a broad cross-section of people to attend.
WD: One final question. What can a participant expect to get from your class?
WIENER: A detailed insight into actual programming techniques. Our aim is to provide people with a basis for beginning their Ada projects. In the move to Ada, they'll be in a position to lead, not follow.

Western Digital is sponsoring this series of reports to keep you abreast of important Ada issues and developments. For details on the SuperMicro systems, the MicroAda compiler or the Wiener/Sincovec ADA courses, write:

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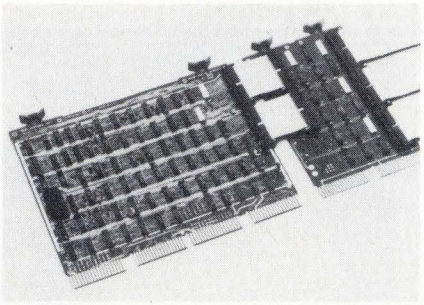
Modem permits 9600-bps operation

The model 71 "Tin Can" short-haul modem permits full-duplex operation at baud rates as high as 9600 bps using two twisted pairs, or simplex using one twisted pair. Two units can communicate over a distance of 2 miles at 9600 bps or 10 miles at 1200 bps. The asynchronous device has a switch to interface with DCE or DTE devices. Transmission is via a ±12-mA current loop controlled by opto couplers. Price is $87, with quantity discounts available. **Remark Datacom Inc.,** 4 Sycamore Dr., Woodbury, N.Y. 11797. **Circle No 386**

MDB unveils DMA module for PDP-11, VAX

The DR11-BLL direct-memory-access module provides bidirectional



exchange of 16-bit data between a DEC PDP-11 or VAX computer and an external device employing RS422 long-line differential levels. The device is compatible with DEC DR11-B operating and diagnostic software. Features include interrupt request, bus-master control logic, address selection and device-interface logic. Device-interface logic is comprised of four registers, including I/O buffers, control/status, word count and bus address. Price for the DR11-BLL is $1995; a dual-sized unit, the BLL11, sells for $795. **MDB Systems, Inc.,** 1995 N. Batavia St., Orange, Calif. 92665. **Circle No 387**

Anderson Jacobson announces data coupler

The AJ 1233 originate-only, full-duplex acoustic coupler communicates with Bell 212, 103/113, VA 3400 and the vendor's AJ 1200 series modems. The switch-selectable device transmits data at rates as high as 1200 bps synchronously or asynchronously, and as high as 450 bps asynchronously. It can be directly connected to the switched network via a modular RJ-11C jack. Price is $995 in single-unit quantities, with quantity discounts available. **Anderson Jacobson, Inc.,** 521 Charcot Ave., San Jose, Calif. 95131 **Circle No 388**

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UP TO 40M BYTES!!

The SMS Disk System 11X is a powerful tabletop DEC microcomputer system. Using Winchester disk storage, DEC's RT-11, RSX-11M software and DEC application software run without the expense, inconvenience and space requirements of disk cartridge peripherals. Weighing only 80 pounds and requiring only 10½" of table top or rack space, it also offers the following benefits:

MAXIMUM PERFORMANCE AND CAPACITY

- 8.9Mb, 17.8Mb, 26.7Mb or 35.6Mb of formatted Winchester disk storage plus 1.2Mb of useable floppy disk storage.
- Fast data transfer of 427K bytes/sec increases performance of field proven DEC software.

INDUSTRY COMPATIBILITY

- Automatic recognition of DEC RX01, RX02 and IBM diskette formats.
- Uses industry's leading 16 bit microcomputer—LSI-11/2 and LSI-11/23.
- Supports up to 256K bytes memory—future expansion to *4M bytes!*
- Expandable industry standard RS-232C serial ports.

CONVENIENT "MINUTE-PER-MEGABYTE" BACKUP

- Only *40 seconds* required for Winchester backup onto 1.2M byte floppy diskette.
- Standard RT-11, RSX-11M, and SMS utility software supports partial or selective file backup and load operations.

RELIABLE AND MAINTAINABLE

- Modular construction and minimal parts count ensure long *MTBF* and short *MTTR*.
- Automatic bootstrap tests CPU, memory and Q-bus operation before software loading.
- Off-line and on-line systems and drive tests verify correct disk and controller operation.
- Automatic error retry, ECC (Error Correction Code) and Winchester disk flaw management insure exceptional data integrity.

FIELD PROVEN SOFTWARE

- User-friendly *real time* RT-11 and CTS-300 operating systems requires minimum overhead.
- *Multi-task, multi-user* RSX-11M operating system supports hierarchical file structure.
- FORTRAN IV, FORTRAN IV-PLUS, BASIC language support.
- Wide range of available DEC application software including DYNIX* (based on UNIX V7.0), RTFILE* data base management, WP SATURN* word processing, CAP-CPP MicroCobol.*

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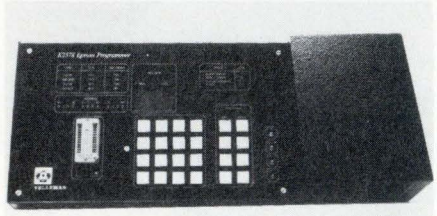
*WP SATURN Trademark of Saturn System Inc.
*CAP-CPP MicroCobol Trademark of Portable Software Inc.

CIRCLE NO. 140 ON INQUIRY CARD

EPROM programmer is switch selectable

The μp-based model K2578 EPROM programmer programs and copies 2716, 2516, 2732 and 2732A (HMOS) EPROMs. Features include switch-selectable EPROM types; a 24-key pad, including hexadecimal keyboard and eight function keys for blank testing, verification, data-field sizing, loading RAM from a pre-programmed ROM, inputting or modifying data in RAM at any address location or performing vector address jumps; a dual-digit seven-segment LED display that indicates HEX data located at the address selected and displayed by 12 discrete LEDs; and additional LEDs that display system status, correct verification of a pro-

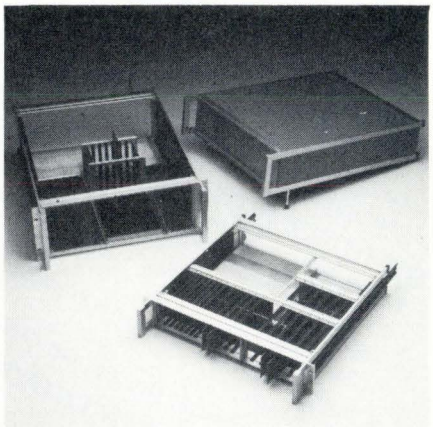


grammed EPROM and error conditions. Prices for assembled and kit versions are $649.95 and $549.95, respectively. **Energy Electronic Products Corp.,** 5441 W. 104th St., Los Angeles, Calif. 90045.

Circle No 393

Optima unveils packaging products

The Instrumate line of packaging products combines instrument case, chassis and card cage in an integrated system. The products are available in heights ranging



from 3.47 to 10.47 in., with panel-to-panel depths of 16.60, 21 and 23 in. Available products include panels, panel dividers, slides, card guides and card cages. **Optima Division, Scientific-Atlanta, Inc.,** One Technology Parkway, Box 105600, Atlanta, Ga. 30348.

Circle No 394

FAST & FLEXIBLE

TCS Software's TOTAL LEDGER with its own built in data base manager is not just another second generation software package, it's better!

With the data base, TOTAL LEDGER has unlimited options with new monthly, quarterly and yearly comparison functions. Fast, flexible and accurate reporting allows the user to verify entries with greater efficiency. Balanced batched transactions can be edited and deleted prior to posting. Chart of Accounts is kept current at all times so that financial statements can be generated on demand.

The data base manager allows the unsophisticated user to "browse" at will through the data files for up-to-the minute detailed information.

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CIRCLE NO. 141 ON INQUIRY CARD

...Over one megabyte of user available RAM for your HP9845! *

Yes, you read it right! Over 1 megabyte of user available RAM for your 9845! The Infotek AM 45B memory consists of two circuit boards, each containing 524K bytes of memory. The boards are form, fit and function interchangeable with the 131K byte boards designed for your machine. The installation can be made in minutes and does not involve any modification of your HP 9845.

Just imagine what you can do with a diskette of data IN RAM. Data-base routines, sorts and searches can run many times faster. No need to buy a second disk drive just to make backup disks—copy from memory and do it much faster. And how about those real-time instrumentation applications where data is generated faster than you can dump to disk.

Now for the best part, the price:

$3,500 per 524K byte board.

Availability is now!

For a demonstration in your machine, call collect in California, (714) 956-9300.

Nationwide call toll free, 1 (800) 854-3469.

Or return the coupon.

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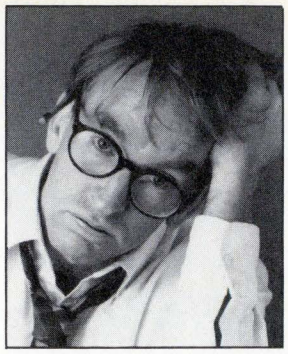
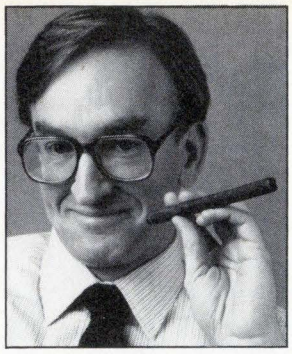


Barney Stevenson,
Programmer

PROGRAMMING LANGUAGES USED:
High-Level and Assembly Code

PROGRAMMING PROCEDURES FOLLOWED:
Loads Editor, edits
Loads HLL, compiles
Loads Assembler, assembles
Links Object Files
Loads Object Files
Runs Program

RESULT:
Barney works for
his program



Ralph Stevenson,
Programmer

PROGRAMMING LANGUAGE USED:
polyFORTH™

PROGRAMMING PROCEDURE FOLLOWED:
Edits
Runs Program
Moves on to next task

RESULT:
Ralph's program
works for him

If it's not heredity,
it must be the

PROGRAMMING ENVIRONMENT.

What's the difference?
polyFORTH.™

Liberated from the mechanical loading and linking procedures that slow down and distract his twin brother Barney, Ralph edits, tests, and de-bugs his routines at nearly the speed of human thought. . . his productivity limited only by his own intellect and creativity, not by the computer.

Faster compilation times? How about 8K of object code on an 8080 in less than a minute; 8K on an 1802 in under two minutes; and 8K on an 11/44 in 11 seconds flat?

With an assembler, compiler, interpreters, virtual memory, editor, and multi-user operating system all resident, polyFORTH provides control of the total programming environment through a single, powerful syntax.

Yet unlike other high level languages, FORTH imposes no penalty in slower operating times for its flexibility, simplicity, and programming speed. In fact, as OEM clients in aerospace, defense, business and industry have discovered, programs written in FORTH offer a matchless combination of compactness, transportability, and operating speed.

Presently available for the Intel 8080/8085, 8086, and Z-80/8080 and 8086-based CPM systems; DEC LSI-11, PDP-11; Motorola 6800, 6809, 68000; and RCA 1802, polyFORTH products are also under development for Data General, Honeywell, Apple, TRS-80, and IBM Personal Computer systems.

Hard to learn? No. Hard to believe? Maybe. So why not see for yourself. Call (213) 372-8493 for details on the upcoming FORTH seminars in your area. Or write FORTH, Inc., 2309 Pacific Coast Highway, Hermosa Beach, California 90254.

Can we guarantee that FORTH will make a difference for Ralph, Barney, and other programmers, designers, and project managers?

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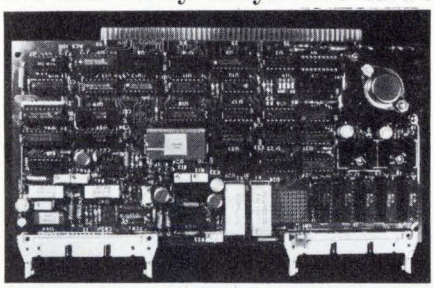
...the real-time saver.

CIRCLE NO. 143 ON INQUIRY CARD

Components

Board supports analog and digital I/O

The VIP versatile instrumentation peripheral for S-100-based process-control or data-acquisition systems combines 12-bit analog; high-current, high-voltage digital I/O; and two dual-utility relays. The card's



software-configurable analog portion includes an instrumentation amplifier input with resistor programmable gains from 0.1 to 1000, an analog gain block with trimmer-adjustable offset, a 12-bit A/D converter, offering 25-μsec. conversion time and software-selectable input ranges, and a 12-bit multiplying D/A converter with simultaneous voltage and current source outputs, double buffered for signal-synthesis capabilities. Digital features include eight TTL inputs and 48 TTL-compatible, 30V, 100-mA open-collector outputs. Price is $595, including instruction manual, plus a $4 shipping and handling charge. **Automated Control Systems,** 1105 Broadway, Somerville, Mass. 02144. **Circle No 402**

Vertical-scale units record three measurements

The Spec 200 vertical-scale recorders continuously record as many as three process measurements on a 100-mm. rectilinear roll chart and displays them on 100-mm. vertical ribbon indicators. The recorders feature high-torque pen-servo systems, disposable fiber-tip pen cartridges and removable chart drives. Models 227S and 227P are identical, except that the 227S is a shelf-mounted companion to the vendor's 230 series panel display,

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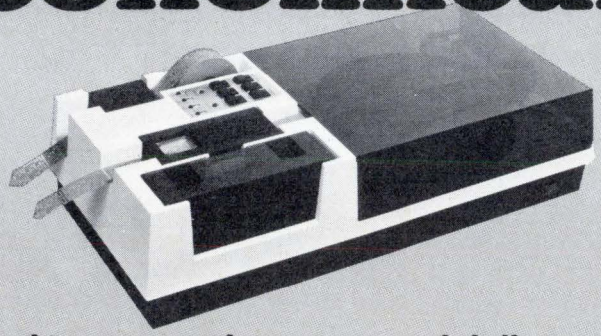
Economical



Designed to economize space and dollars — GNT's 4601 Tape Punch/Reader Combination

Tape reader and punch, housed in the same compact case, operate simultaneously and/or independently. For design, price, and performance, the 4601 tops the competition.

- Size: 19" x 10" x 5" — 14 pounds
- Punching speed: 75 Cps
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- RS-232-C serial interface
- CR/LF delay
- Reliability: MTBF 100 million characters
- Search/edit control
- Utilizes all types of Mylar® and paper tape
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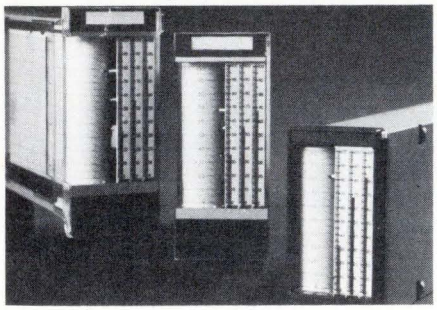
1560 Trapelo Road, Waltham, MA 02154 (617) 890-3305 Telex: 923318

CIRCLE NO. 147 ON INQUIRY CARD

Components

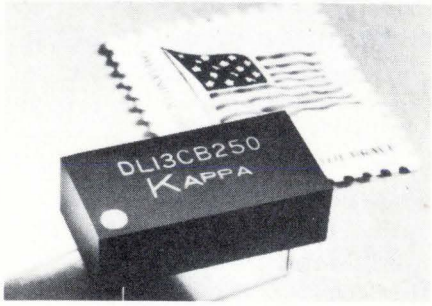
and the 227P conforms to the DIN standard format of 72 × 144 mm. for panel mounting with the 250 and 270 series. Both feature internal alarms and indicator lights with separately adjustable set points. The model E27R single-station recorders for use with single-station controllers



feature standard DC transmitter power supplies, optional external alarm lights and two-speed chart drives. **The Foxboro Co.,** Foxboro, Mass. 02035. **Circle No 403**

Digital-delay modules are TTL compatible

The series D113 14-pin, TTL-compatible, computer/military-grade digital-delay modules uses passive, lumped-constant delay components and an active input driver and output buffer. The circuit architecture also includes compensation for propagation delays and internal termination of the output. The modules feature ±5 percent or ±2 nsec. typical delay accuracy and typical 3-nsec. rise time. The device drives as many as



10 TTL loads. Delay times range from 25 to 100 nsec. **Kappa Networks, Inc.,** 165 Roosevelt Ave., Carteret, N.J. 07008. **Circle No 404**

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Anaheim, California

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Mini/Micro 82

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Since *Mini/Micro* will now be produced and managed by Electronic Conventions, Inc. (ECI), it has been expanded to three times the size of last year's show and will be held concurrently as the major companion event to ECI's *Wescon/82*, America's largest high technology electronics trade show (with a projected attendance of over 70,000 professionals). The combined impact of Wescon and the proven show management expertise of ECI in producing highly successful marketing events will result in an OEM attendance unmatched by any other computer show.

This year, Mini/Micro means big business. Already more than 100 of the country's leading manufacturers in the computer/data communications industry have chosen *Mini/Micro-82* for their September sales connection.

As a potential exhibitor, your company can count on *Mini/Micro-82* and ECI to deliver the largest qualified OEM audience possible. You won't be disappointed.

To receive your *Mini/Micro-82* show prospectus and complete exhibit information, just fill out and mail the coupon above, or call TOLL FREE 800/421-6816. In California call 800/262-4208.

CIRCLE NO. 148 ON INQUIRY CARD

smarter

Multiplexing at its best

Datagram sets a new standard in multiplexers by allowing error free transmission of data while at the same time providing the necessary diagnostics and statistics package required to prevent system failures.

Features

Asynchronous channel support
- Selectable per channel
  - 110 to 9600 bps
  - Autobaud up to 9600 bps
  - X-ON/X-OFF or RTS/CTS flow control
  - Echoplex
  - DTE/DCE jumper block
- 3, 5, 7 or 9 asynchronous channels support (Cost efficient 2 channel upgrade)

X.25 High speed composite link
- Error free concentration utilizing X.25 for its high speed composite link at speeds up to 19,200 bps (internal or external clock).
- Aggregate of 76,800 bps

The extra bonuses provided at no additional cost are:

- **Statistics providing for each individual async channel:** the total number of connections (DTR or DSR Transitions) and the amount of data transmitted and received — **and the X.25 composite link:** the total number of packets, reject packets and data packets transmitted and received
- Supervisory Console Port — user switch selectable
- Diagnostics to test individual system components, to on-line monitor any data channel, to accomplish individual **local or remote X.25 and terminal port loopbacks**

Datagram

Datagram Corporation:
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CIRCLE NO. 125 ON INQUIRY CARD

Components

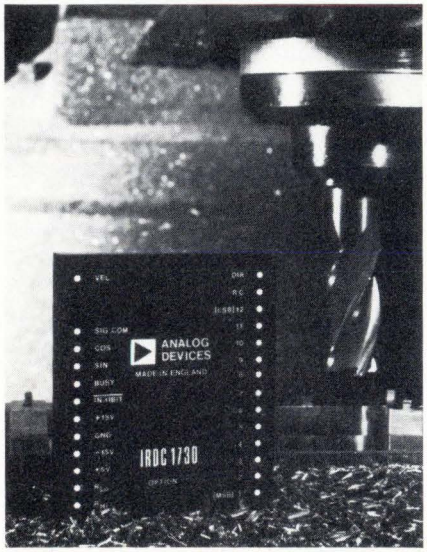
Ranyan introduces Q-bus repeater

The BMA-1 bus manipulator permits DEC LSI-11 users to interface additional devices to the Q-bus of their system by providing an external interface to the LSI-11 backplane. The repeater consists of two dual-height PC boards connected by a 50-pin ribbon cable. One board resides in the Q-bus backplane, and the other resides in the BMA-1 extension chassis. As many as 20 additional unit loads can be interfaced to the new device, which terminates the receiving bus, reshapes all signals and reestablishes the proper timing relationship for the Q-bus. Price is $980. **Ranyan, Inc.,** P.O. Box 790, Huntington Beach, Calif. 92648.

Circle No 395

Resolver to digital unit tracks at 10,200 rpm

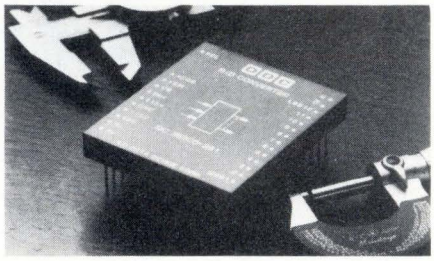
The IRDC1730 converter for industrial machine-tool control is a tracking Inductosyn or resolver to digital converter that continuously converts angular or linear position data into a 12-bit parallel digital format. Tracking at rates as high as 10,200 rpm, the converter provides a bit update rate of nearly 700 KHz. The device uses a Type II servo loop that provides continuously updated output data. A full-scale output represents travel through one pitch of a linear or rotary Inductosyn or one revolution of a resolver. Digital-directional and zero-crossing signals enable counting multiple pitches of an Inductosyn or revolutions of a resolver. The unit measures the ratio of sine and cosine input signals from the Inductosyn or resolver. Price is $255 in single-unit quantities. **Analog Devices, Inc.,** Two Technology Way, Norwood, Mass. 02062.



Circle No 396

ILC unveils tracking converter

The model IDC-35300 Inductosyn or resolver to digital converter for industrial applications is a 12-bit resolution tracking converter with an accuracy of ±8.5 min. and repeatability of 1 LSB. Reference and signal frequency range is 2 KHz to 22 KHz with a tracking rate as high as 180 rps. Features include a velocity output scaled to 15 rpsV and carry, count and direction outputs for multi-turn and incremental applications. The device uses a Type II tracking loop. Price is $205 in 100-unit quantities. **ILC Data Device Corp.,** 105 Wilbur Place, Bohemia, N.Y. 11716.



Circle No 397

Linear actuator uses electromagnetic induction

This linear actuator uses electromagnetic induction, enabling constant force throughout an entire stroke. The unit provides as much as 105 lbs. of force at short duty cycles with any stroke length as

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What's the answer? Floor mats, grounding straps, static-treated garments are only isolated, temporary and often expensive solutions. The only really effective, long-term solution is total environmental static control, using a proven topical antistat—**STATICIDE.**

In tests by leading manufacturers, **STATICIDE** has proven it can reduce field service calls by over 60% and static-related problems by as much as 92%!

STATICIDE brand antistatic solution provides total environmental static control in all electronic areas. It is the only product of its kind with the features specified by many electronics manufacturers:

- Meets static decay criteria of military and medical specifications
- Is effective at relative humidities below 15%
- Is effective on all materials: textiles, plastics, tile, glass, metal, printed surfaces, wood, etc.
- Is long-lasting, easy to apply and economical to use.
- Non-toxic, non-flammable, safe to use.
- Non-staining, completely biodegradable.

Economical Static Control. One application of **STATICIDE** on a carpet in a heavy traffic area can last from two to four months, and six months or longer in lighter traffic areas. On hard surfaces it lasts from weeks to years. And "The Liquid Floormat" covers much more than floors! Apply **STATICIDE** on your furniture. Wipe it on your CRT. Use it on fixtures, trays, cassettes—even the clothing of personnel. Stop static build-up at every source, for a cost of less than $8 per quart. Why waste time and money on solutions which aren't nearly as complete—or as effective?

STATICIDE is available through your local office products dealer. Or call toll-free:
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Staticide®

acl incorporated

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Elk Grove Village, IL 60007
Telephone: 312/981-9212

Dealer inquiries invited

Staticide is a registered trademark of ACL, Incorporated.

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CIRCLE NO. 150 ON INQUIRY CARD

IS YOUR COMPUTER DOWN MORE THAN IT'S UP?

LINE TAMER™

FERRORESONANT TRANSFORMERS MAY BE THE ANSWER!

Excessive computer downtime could be the result of power line spikes, brownouts and inaudible noise. Line Tamer™ ferroresonant transformers protect sensitive computer equipment from such power pollution by isolating the noise and stabilizing the voltage.

Line Tamer™ ferroresonant transformers need little space and require no step up/step down transformers or complicated wiring. They are available in sizes up to 250 KVA in both single- and three-phase to satisfy the requirements of virtually any system. Most sizes are U.L. listed.

Call us for complete specifications and the name of your local distributor.

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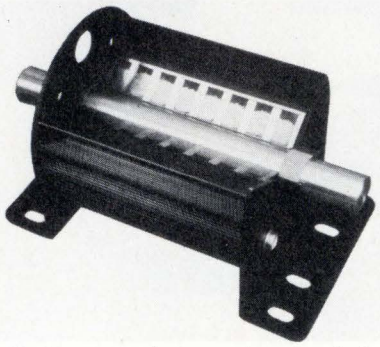
MAGNETRONICS, INC.

901 DuPage Avenue, Lombard, IL 60148
Phone 312/620-8394 • TWX 910-991-2352

CIRCLE NO. 149 ON INQUIRY CARD

Components

long as 12 ft. Actuation response occurs within 10 msec., and rod velocity is almost 90 ips. The direction of rod travel is reversible, using a single actuator. The device can actuate high-current transfer



switches, staplers, valves and door and gate openers; reset large circuit breakers; move and eject parts; control dispensers, metering pumps and HVAC dampers; and vibrate filter bags. **Innovex Inc.,** 1313 Fifth St., S., Hopkins, Minn. 55343.

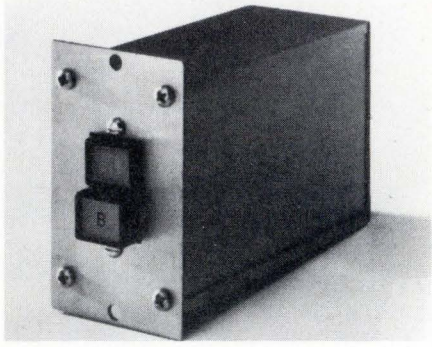
Circle No 398

PMI announces Bifet buffer

The BUF-02 Bifet buffer specifies maximum output error, including offset voltage, input bias current, finite gain, common-mode-rejection and output-impedance induced errors. The unit is pin compatible with the LM110-type voltage follower in unnulled applications. Features include a 0.003Ω typical output impedance, a 0.015-percent maximum voltage gain error, a 100 dB typical power-supply-rejection ratio, a 1.5-mV maximum output error, a 0.2-nA maximum input bias current, a 12V/μsec. minimum slew rate and a 1-mV maximum offset voltage specification. Prices range from $3.50 to $17.40 in 100-unit quantities. **Precision Monolithics Inc.,** 1500 Space Park Dr., Santa Clara, Calif. 95050. **Circle No 399**

RS232 digital switch has monitor option

The model 1081-0005 manual RS232 digital-transfer switch allows switching of modems between front-end processors, and an option is available for monitoring switched lines. The single-pole, double-throw, push-button unit switches all 24 lines of an RS232 connection;



RS422 switching is optional. The panel-box version measures 3½- × 2- × 4½-in. with three rear 24-pin connectors and two-screw mounting. It can also be supplied as eight units in a 19- × 3½-in. rack panel. The monitor version adds a single RS232 connector to the face of the unit. By cabling from this connector to any digital monitoring instrument, all switched lines can be monitored. Price is $95 in single-unit quantities, with quantity discounts available. **MarLee Switch Co.,** 933-D N. Central Ave., Upland, Calif. 91786. **Circle No 400**

Burr-Brown announces 16-bit D/A converter

The PCM50 D/A converter for audio applications offers 16-bit resolution with a 96-dB dynamic range. Typical total harmonic distortion is 0.003 percent, and typical settling time is 5 μsec. Typical differential linearity error is 0.0015 percent of FSR. The device's ceramic 24-pin dual-in-line package also contains an internal voltage reference and an output operational amplifier. It uses IC and laser-trimmed thin-film components. Price is $49.75 in 100-unit quantities. **Burr-Brown,** International Airport Industrial Park, P.O. Box 11400, Tucson, Ariz. 85734.

Circle No 401

HERE ARE THE COMPUTER INDUSTRY PUBLICATIONS THAT KNOW SPECIFICALLY WHAT THEIR READERS BUY

1. Mini-Micro Systems
2.
3.
4.
5.

Only *Mini-Micro Systems* can give you the specific buying plans of its readers. Each year, for the past ten years, we've surveyed our readers on their actual purchases during the past year and their projected buying plans. The survey covers the full spectrum of minicomputer and microcomputer systems equipment from hardware to peripherals to software. More than 25 product categories are covered.

From this survey information, we can accurately project what our readers spend each year on minicomputer and microcomputer equipment, and the specific quantities they will be purchasing during the year. For example, in 1980, our readers spent more than $10 billion* for minicomputers, microcomputers, CRT terminals, printers, tape and disk drives, data communications equipment, and a variety of peripherals, software and services. No other industry publication knows more about its readers purchasing plans, or the minicomputer and microcomputer markets, than we do. To prove it, call your *Mini-Micro Systems* regional sales manager and ask to see our latest Market Report. It'll put us #1 on your list.

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*Projections based on statistics compiled for the 1980 Mini-Micro Computer Market Report.

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CIRCLE NO. 151 ON INQUIRY CARD

MAPSOFT manages Intellec software development library

Life becomes a bit more bearable for developers of μc software with MAPSOFT, a utility designed to maintain source, object and binary code libraries on Intel Corp.'s Intellec μp development system.

MAPSOFT, offered by Glen Cove, N.Y.-based Morvan Software Corp., maintains records of the components of all linked files and keeps a picture of program production and test versions under development. When the "reference base" (the best working version of a given binary file) is updated, the identification of all source and object codes that produced the binary is also updated. An audit trail is provided for the reference base, enabling changes to be documented.

When the user alters a source file, MAPSOFT automatically produces all necessary object and binary files. A tabular listing shows the results of each step.

The package also provides users with a record of every source or object file used to produce each test version of programs under development. These records facilitate debugging, enabling the programmer to verify, from an examination of memory, that the program listings correlate with the program memory map.

MAPSOFT enhances quality control by denying storage to programs that exhibit errors in compilation or assembly. The package also incorporates a selective INCLUDE capability and a conditional compilation facility to save time in compilation, linking and testing.

Each time a source, object or binary file is modified, a new copy of the file is generated and assigned an identification number. The file name and identification number uniquely define a specific copy. MAPSOFT also saves the names and IDs of all components of the modified file. For example, if several object files are linked to create a binary file, MAPSOFT assigns a unique ID to the new copy of the binary file and stores the names and IDs of each of the object files. Users can retrieve these items and obtain a picture of the complete linkage tree structure for any program. Tesci Software, a French consulting company, developed MAPSOFT, and Morvan Software is U.S. distributor. The package, already in use in Europe, sells for $10,000.

—Malcolm Stiefel

Morvan Software Corp., 2 Hemlock Lane, Glen Cove, N.Y. 11542.
Circle No 390

Package off-loads work to Series/1

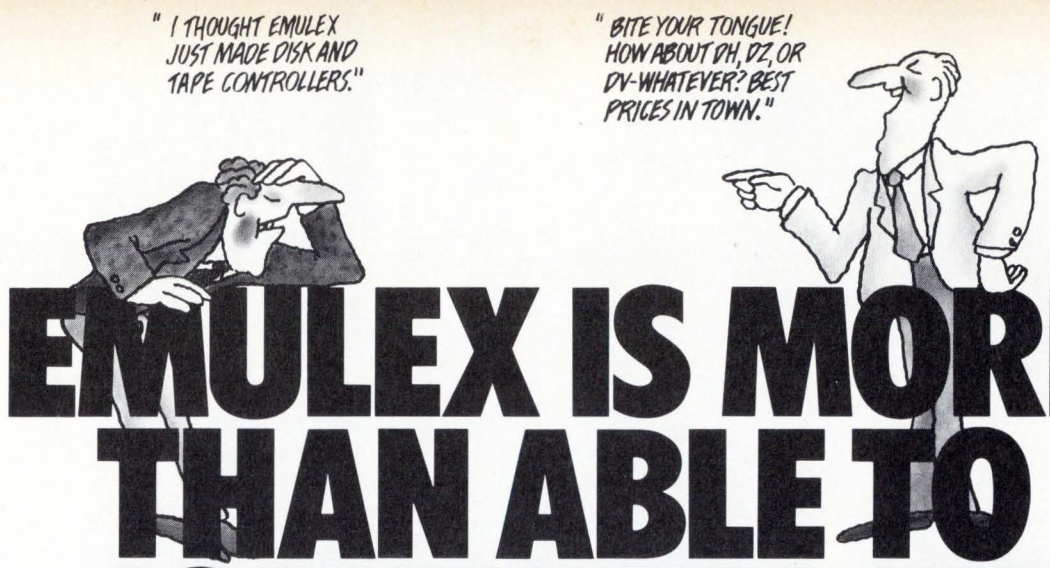
RJE (+), for the IBM Series/1 computer, is designed for distribution of host workload to remote Series/1s. Running in 2780 or 3780 mode, the program supports reader and list queues, automatically routing jobs in the list queue to assigned printers or disk-spool files. Data from one to seven files can be transmitted to the host and merged with respective optional job-control language statements. RJE station operator commands can be entered on the console. Printer-carriage control tapes are supported via a control file—printers need not have carriage-control tape. Base source-code license fee is $6000, with volume discounts available. **Carney Associates, Inc.**, 3114A W. Marshall St., Richmond, Va. 23230.
Circle No 391

Utilities run on 6800 μps

One program in this set provides reentrant register handling on 6800 μps. Another group of routines for the 6800 and 6809, provide block handling, math and conversion, special functions and routines. Additional 6800/6809 programs include: a routine that provides menu generation, data entry, data editing, display generation and report generation; a high-level CRT screen editor that permits access to individual lines for adding, deleting, inserting and searching by line number, content and relative position; and a multi-field, multi-criterion comparison subroutine that indicates to the calling routine whether a particular series of comparisons meets the compare criteria. **PDS Technologies, Inc.**, 2000 Black Rock Turnpike, Fairfield, Conn. 06430. **Circle No 392**

ASCI announces 3277 emulation

ICON provides intersystem communication between DEC and IBM computers using 3271 BSC protocol. The package includes a virtual-terminal facility that allows the DEC VT-100 or VT-52 terminal to function as an IBM 3277 block-mode terminal, supporting 3277 screen formatting, field validation and protection and program-function/access keys. An inter-program communication mode enables application programs running on a DEC system to talk to active IBM programs, enabling such applications as remote database inquiry/update or remote resource sharing. ICON runs on DEC, VAX and PDP-11 computers, under the VMS and RSX-11M/M+ operating systems. The PDP-11 version sells for $9000, and the VAX version sells for $10,500. **Advanced Systems Concepts, Inc.**, 1017 Kingsland Ln., Fort Lee, N.J. 07024.
Circle No 389



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We're also able to save you plenty: For instance, you get DH11 performance for a DZ11 price. Four new space-saving single-board communications multiplexers. And an increase in VAX-11 terminal handling capacity by up to 50%. Maintained nationwide by Control Data.

Microprocessor-based architecture and common hardware deliver faster, more flexible line-handling. Self-test on power-up. Full software transparency. And Emulex reliability standards.

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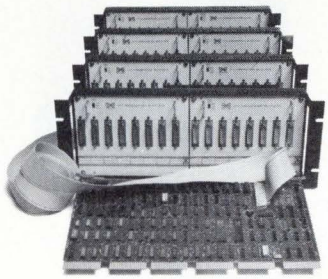
For immediate off-the-shelf delivery, call our national distributor: First Computer Corporation, 645 Blackhawk Dr., Westmont, IL 60559; (312) 920-1050. In Europe: Emulex Corp., 10th floor, Cory House, High Street, Bracknell, Berkshire, England. Telephone: 0344-84234; Telex 851-849781.

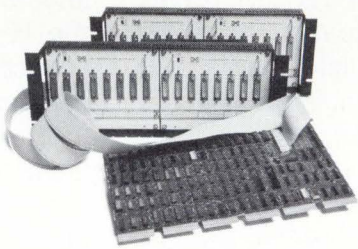
CS11/H (PDP-11) $7560 for 48 lines*
CS11/U (VAX-11) $7884 for 48 lines*



Up to 64 DH11 channels from one board.

DH11-compatible MUX lets you mix RS-232 & current loop interfaces in 8-line groups. Built-in DM11-compatible modem control. DMA output eliminates host interrupts. Self-test capabilities. Transparent to PDP-11 software. Emulex' own software on VAX.

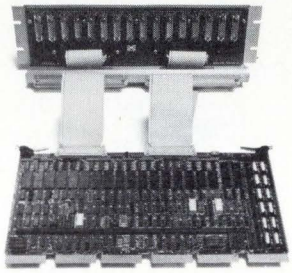
CS11/V $4464 for 16 lines*



Higher DV11 performance, lower price.

DV11-compatible multiplexer. Mixes 8-lines synchronous & asynchronous on PDP-11s. Ideal for Bisync & DECNET. 8-32 lines per controller. DMA input & output. Software transparent under DECNET. Compact package offering higher line-handling speeds & improved throughput.

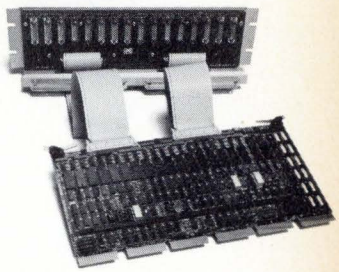
CS21/Z $2520*



Replace DEC DZ11/E and save.

Perfect if you don't need DH11 performance. Software-transparent to all DEC operating systems. Easy PROM change enables quick upgrade to DH-11 performance. Saves one slot per 16 lines.

CS21/U (VAX-11) $2844 for 16 lines*
CS21/H (PDP-11) $2520 for 16 lines*



New economical DH11-type multiplexer.

Lowest cost, high-performance communications MUX. Priced way less than DEC's DZ11, with DMA to boot. 16 RS-232 lines per board, modem control included. Can use H317 distribution panel. Transparent to PDP-11 software; Emulex software on VAX.

*Price each in 100 quantities. All Emulex disk, tape, and communications products can be combined to reach quantity price breaks.

EMULEX

The genuine alternative

CIRCLE NO. 152 ON INQUIRY CARD

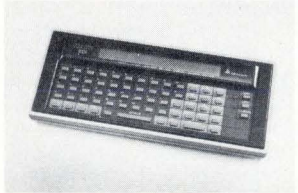
THE QUASAR HHC TAKES COMPUTERS WHERE THEY'VE NEVER BEEN BEFORE.

Your Personal, Portable Database.

There were places you couldn't take a computer, or use one. Not any more. The Quasar HHC gives you the power of a computer anywhere you go. Planes, cars and boats, vacations, or wherever you may want to use it. The HHC can be your constant companion. So whatever data files or information you may need or want are always right at hand.

The Quasar HHC gives you the full power of a 6502 microprocessor. Programming in Microsoft Basic or the FORTH-like SNAP. And personal features like file creation, a calculator, and a real-time clock/secretary you can program to display reminder messages.

File data can be passed from one HHC to another or back and forth between an HHC and another computer. Just connect both computers through the HHC RS-232C interface, or transmit/receive over telephone lines with the HHC acoustic coupler.



There's never been a computer like the Quasar HHC. And never a better way to make you more effective.

For information on the Quasar HHC Hand-Held Computer, including how to become a dealer or distributor, write on your letterhead to Quasar Group Director HHC.

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QUASAR COMPANY, Division of Matsushita Electric Corporation of America, 9401 West Grand Avenue, Franklin Park, Ill. 60131. (312) 451-1200

CIRCLE NO. 153 ON INQUIRY CARD

Literature

Brochure explains tape-library storage

Automated Tape Libraries are described in a color brochure. The 16-page brochure provides operating specifications and sample configurations for tape libraries ranging from small installations holding 10,000 tapes to large set-ups with 56,000 reels and 48 tape drives. The publication also details benefits to users, including cost reductions for personnel, reductions in the number of tape and disk drives and improvements in media management and data processing. **The Braegen Corp., Automated Tape Library Division,** 3320 E. La Palma Ave., Anaheim, Calif. 92806.
Circle No 347

Brochure describes UPS application

The use of a 15-KW uninterruptible power system to protect integrated computer systems against power outages is described in a two-page Applications INFO Bulletin. The bulletin describes the application, where the vendor provided turnkey services in installing the UPS to isolate three IBM computer systems from blackouts, brownouts, line transients and voltage fluctuations. The publication also covers performance requirements and selection criteria. **Lortec Power Systems, Inc.,** 5214 Mills Industrial Parkway, North Ridgeville, Ohio. 44035.
Circle No 348

Brochure describes IBM-compatible system

The model 290 IBM 3270-compatible system is described in a brochure. The eight-page, four-color brochure features 32 display stations and printer in BSC or SDLC modes. The brochure also describes the system's human-engineered features, adjustable keyboard, dual-adapter and paper-feed abilities. **Northern Telecom Inc.,** P.O. Box 1222, Minneapolis, Minn. 55440.
Circle No 349

COBOL program described in brochure

XREF, a new programming tool to increase programmer efficiency in modification and debugging tasks, is described in a brochure. The brochure details the product's uses and includes an example of a cross-referenced source-code program. **Hopper Associates, Inc.,** 30680 12 Mile Rd., Farmington Hills, Mich. 48018. **Circle No 350**

Brochures describe self-study, lecture training

Self-study and lecture course training for the vendor's end users and OEMs is described in two brochures. "Keeping Ahead of Your Data General Computer" describes

LITERATURE THAT COSTS

Directory covers graphics supplies

Computer graphics vendors in the U.S. and Canada are listed in a directory. The publication lists addresses, phone numbers, key contacts, years founded, sales and employee information and the companies' products and services. A second section, comprising a computer-processed cross-index, lists vendors under products and service, technology employed or applications served. The directory lists CAD/CAM, business graphics and image processing applications. The directory also lists sponsors of computer-graphics seminars, conferences, courses and technology and market-research reports. An executive summary analyzes the computer-graphics industry based on information gathered in compiling the directory. Price of the 100-page directory is $47 (prepaid) in the U.S., Canada and Mexico, and $53.35 (prepaid) elsewhere. **1982 Computer Graphics Directory, c/o Technology & Business Communications, Inc.,** 730 Boston Post Rd., P.O. Box 392, Sudbury, Mass. 01776. **Circle No 352**

World's Biggest Exposition of DEC-Compatibles!

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The First National DEC-Compatible Industry Exposition

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May 10-12, 1982

The Only Show Big Enough for All Your DEC-Directed Needs

At DEXPO 82 every exhibitor will be demonstrating products and services that are compatible with your DEC system. Now, there's no reason to visit any other show.

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- Compare thousands of the newest DEC-compatibles — more than you've ever seen before — all under one roof.
- Select alternatives, enhancements and special solutions from an *international* group of vendors.
- Attend free "Product Forums" demonstrating the latest capabilities, applications and ideas.
- Meet more than 100 vendors of DEC-compatible software, hardware and related services and supplies.

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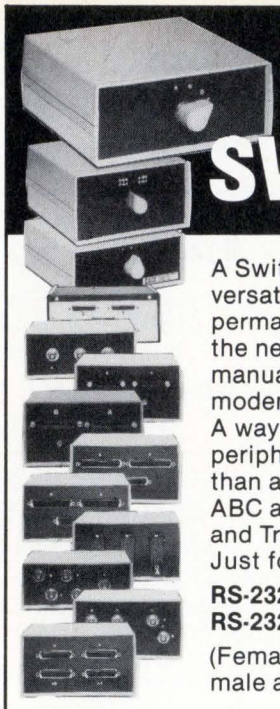
CIRCLE NO. 154 ON INQUIRY CARD



Make the most of your hardware

SWITCH-IT

A Switch Box can add to the versatility of your equipment—permanent connections avoid the need to change cables manually to and from terminals, modems, CRT's, for example. A way to make CPU's or peripherals do extra duty. More than a dozen different kinds of ABC and ABCDE switch boxes, and Transfer Boxes in stock. Just for instance:

RS-232 ABC box $99.50
RS-232 ABCDE box $198.00

(Female connectors standard; male available on special order.)

Call or write for information and new catalog

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(203) 438-9684 TWX-710-467-0668

West
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Las Vegas, Nevada 89101
(702) 382-6777

CIRCLE NO. 156 ON INQUIRY CARD

ELECTRONIC FUNDS TRANSFER (EFT) IN EUROPE

Frost & Sullivan has completed a two-volume, 436-page report which analyzes and forecasts Electronics Funds Transfer and the associated market for products and services in the European banking infrastructure. The growth in paperless interchange transactions is forecasted through 1990 along with the electronic data processing systems and equipment to be used in automated clearing houses and for the teleprocessed interchange of payment transactions and money transfer.

Public switched data networks are identified and a detailed analysis of the SWIFT services and its member banks is presented. The market environment for each country is documented through 1990 and is used as the basis for the forecast of terminals and teleprocessing interchanges. A computer model was developed to estimate sales based on beginning and ending installed base, known initial growth rates, cost of units and transaction volumes.

Price: $1,400. Send your check or we will bill you. For free descriptive literature, plus a detailed Table of Contents, contact:

FROST & SULLIVAN
106 Fulton Street
New York, New York 10038
(212) 233-1080

Literature

21 self-study courses, and includes ordering and contact information. "The Quarterly Course Schedule" contains a seven-month schedule of courses, including enrollment and price information. The schedule also contains information about on-site and customized courses, and availability of free educational planning assistance. Ordering and price information on self-study courses is also included. **Data General Corp., Education Services,** M.S. F019, 4400 Computer Dr., Westboro, Mass. 01580. **Circle No 351**

Micrographic readers described in booklet

Selection and applications of micrographic readers are detailed in a booklet. The guide describes the key elements to consider when purchasing a reader, including screen size, material and color; projection, resolution, light source lenses, indexing method, warranty

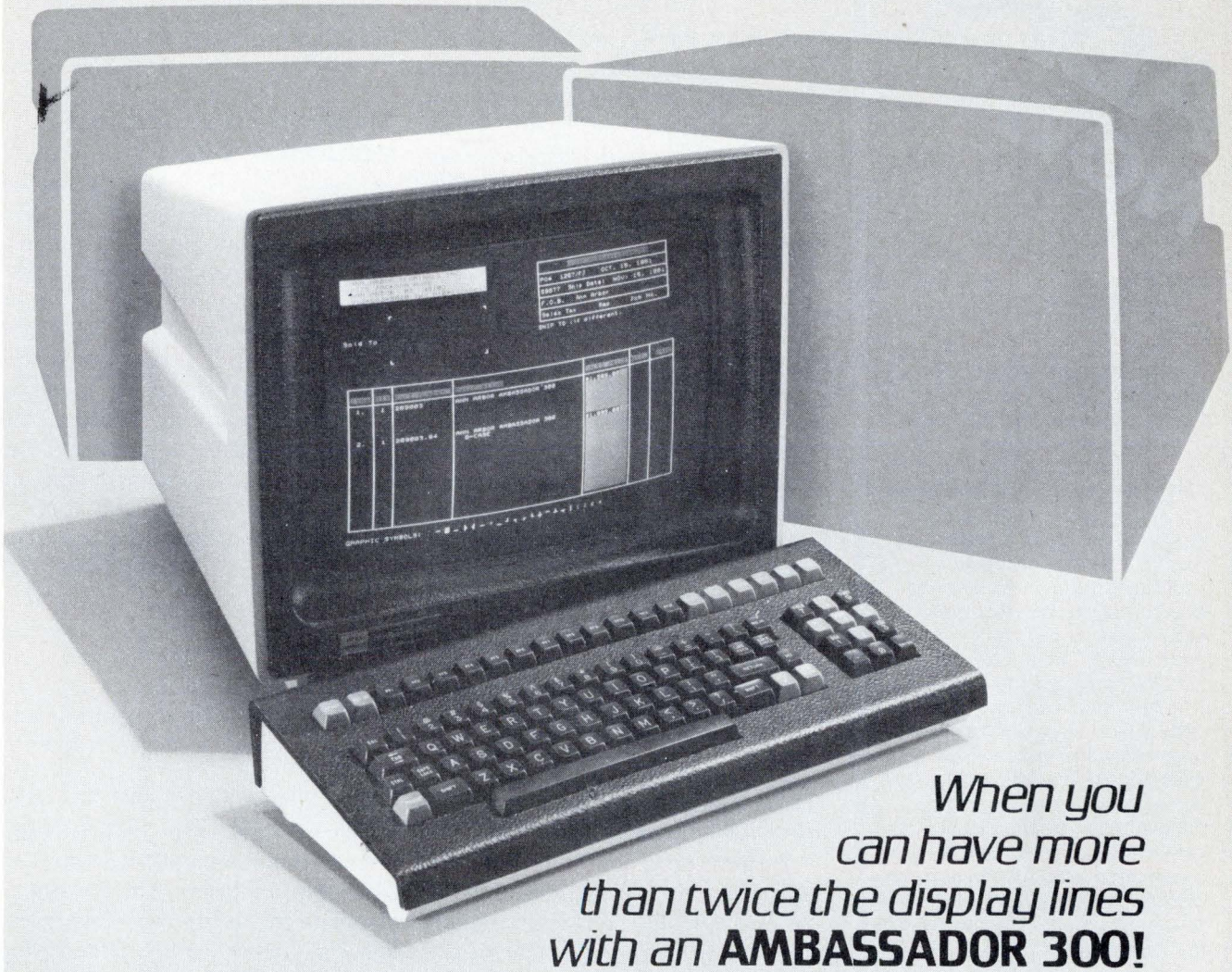
LITERATURE THAT COSTS

Journal reviews Apple computer software

Educational software programs for personal computers, is described in *The Journal of Courseware Review.* The quarterly publication provides qualitative reviews of commercially available educational programs for use on Apple personal computers. The journal, designed as a reference source for educational software purchasers, addresses the needs of novice software buyers, including school administrators, teachers, media specialists, parents and students. It also features articles written by education experts and authorities in the field of computer education and reviews of programs in mathematics, sciences, reading, language arts and special education. Each program is evaluated on its educational and instructional content and computer design. Price is $5.95. **Apple Education Foundation,** 20863 Stevens Creek Blvd., Cupertino, Calif. 95014. **Circle No 354**

THE ANN ARBOR AMBASSADOR™ 300

WHY SETTLE FOR AN EMULATION?



When you can have more than twice the display lines with an **AMBASSADOR 300!**

- 60 line (4800 character) display
- Large 15-inch non-glare screen
- Line drawing character set
- Area qualifications: protect, guard, numerics, justify and security
- Operator convenience modes
- Erase and editing controls
- Supports DEC*VT52*/ANSI Mode, Origin Mode and scrolling regions
- Printer output: local and remote copy, print format control
- Block and character transmission
- 48 programmable function keys
- Self diagnostics

Now you don't have to give up a full page display to use your VT100*-oriented software. The Ann Arbor Ambassador 300 has all the features of the standard Ambassador—with a few modes added to make it easy to use with DEC* software. You'll also find ways to use the other advanced capabilities of the Ambassador—editing, formatting, programmable function keys, block transmission. So why buy just another emulation when you can get the Ambassador 300? At a competitive price, with quick delivery.

Call Ann Arbor Terminals for more information at (313) 663-8000

*DEC, VT100 and VT52 are trademarks of Digital Equipment Corporation.

ANN ARBOR TERMINALS, INC 6175 JACKSON ROAD • ANN ARBOR, MICHIGAN 48103 • TEL: 313-663-8000 • TWX 810-223-6033

CIRCLE NO. 157 ON INQUIRY CARD

ADAPT NOW!

ADAPT* —
The Ada compiler
already in use!

Ada is coming! That's fact. And advanced Digital Products is at the forefront with ADAPT, the Ada compiler already in use!

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ADAPT supports these Ada features: Attributes, unconstrained and dynamic arrays, slices, explicit and default initialization, qualified record aggregates, separately compiled packages, exception handling, named and default parameters, restricted generic subprograms, and subprogram and operator overloading when operand types can be determined by "bottom up" analysis.

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CIRCLE NO. 158 ON INQUIRY CARD

Literature

and noise level. Applications listed include fields such as insurance, banking, libraries, government work, retailing, real estate, hospitals, utilities and the computer industry. **Realist Micrographic Systems,** N93 216288 Megal Dr., Mennomonee Falls, Wis. 53051.
Circle No 353

Brochure features Star 64 system

The Star 64 insurance-agency management system is described in a brochure. The brochure provides information about the system's capabilities, which include accounts payable/receivable, integrated accounting, automated letter writing, forms processing, claims processing, property appraisal and electronic interfacing with insurance carriers. **Durango Systems, Inc.,** 3003 N. First St., San Jose, Calif. 95134. **Circle No 355**

Brochure describes product capabilities

Design and product information is offered in a four-page brochure. The brochure details fiber optics, miniature halogen and vacuum lamps and bar-code identification systems. The publication also includes photos and application information. **Welch Allyn, Inc., Industrial Products Division,** Skaneateles Falls, N.Y. 13153. **Circle No 356**

Verification system featured in bulletin

This Touch-Tone data-entry/voice-response verification system is described in a six-page bulletin. The publication details the vendor's intelligent front-end processor and interactive database-access systems, project-time cost accounting, payroll processing, process-control alarm systems, credit checking, order entry, cash-balance reporting, route accounting and a speech-development package. **Perception Technology Corp.,** 50 Shawmut Rd., Canton, Mass. 02021.
Circle No 357

Electronic components featured in catalog

A line of electronic packaging hardware, components and systems are described in a condensed catalog. The catalog details edge-board/PC connectors, connector hood assemblies, Multi-Term IDC connectors and cable, switches, cylindrical connectors, IC sockets, component mounting boards, EMI filters, card files, logic panels and back panels. **Stanford Applied Engineering, Inc.,** 340 Martin Ave., Santa Clara, Calif. 95050.
Circle No 358

Brochure features integration station

The model 9516 integration and debug station is described in a product brief. The six-page brochure describes how the 9516 supports μps with real-time in-circuit emulation and hardware and software analysis. The brochure also lists the 9516's real-time-trace, logging, menu and command-line capabilities. **Millennium Systems,** 19050 Pruneridge Ave., Cupertino, Calif. 95015. **Circle No 359**

Micro Power Systems announces catalog

A line of power supplies is listed in a 200-page catalog. The catalog details D/A and A/D converters, precision operational amplifiers, precision voltage references, analog switches and multiplexers and dual transistors. Two sections provide bonding diagrams and packaging information. Detailed specifications include electrical characteristics, diagrams (test, function and timing), waveforms and schematics. **Micro Power Systems, Inc.,** 3100 Alfred St., Santa Clara, Calif. 95050. **Circle No 360**

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Endpoints

Wet Ink Department: Disk- and tape-controller manufacturer **Wespercorp,** Tustin, Calif., has signed a two-year, $1-million contract with the Woodland Hills, Calif.-based Peripherals Division of Pertec Computer Corp. to purchase various tape transports and rigid-disk drives. Wespercorp plans to integrate the drives with its controllers, creating a line of peripheral subsystems for Digital Equipment Corp., Data General Corp. and Perkin-Elmer Corp. minicomputers and for the International Business Machines Corp. Series/1. ... **Tandon Corp.,** Chatsworth, Calif., has netted a $55-million sales agreement for its disk-drive products with Tandy Corp., Fort Worth, Texas, which represents more than 7000 Radio Shack retail stores. Coupled with a $25-million contract signed with Tandy last September, the agreement represents $80 million in new-product shipments for Tandon. ... **Century Data Systems,** Anaheim, Calif., has signed a $986,000 contract with Amperif Corp. to supply the Chatsworth, Calif., manufacturer of plug-compatible Univac peripherals with its Trident removable-pack disk drives. ... **The Kennedy Co.,** Monrovia, Calif., has landed a $1.3-million, one-year contract with Geophysical Systems Corp., Pasadena, Calif. Geophysical will integrate Kennedy's model 9300 vacuum-column tape transports and model 9700 tape drives into its truck-portable seismic systems used in oil and gas exploration. ... **Intel Corp.,** Santa Clara, Calif., has signed an agreement authorizing its Software Distribution Operation (SDO) to distribute Digital Research, Inc.'s CPM, CP/M-86 and MP/M-86 operating systems. SDO will also distribute MS-OOS, a 16-bit operating system from Microsoft, Inc., Bellevue, Wash. ... Torrance, Calif.-based **Computer Communications, Inc.,** which manufactures a line of front-end processor systems, is expanding its sales force to include ISOs. CCI previously relied on direct sales only, but has signed marketing agreements with ISOs Thorson Co. of Bellevue, Seattle; Barry Sales Inc., Dallas; Advanced Technology Associates, Inc., Vienna, Va.; and Intron Corp., Springfield, Va. ... **Peritek Corp.,** Oakland, Calif., will provide more than $700,000 in multiprocessor hardware and associated products to E-Systems, Dallas, which will use the products in a $78-million flight automation system for the Federal Aviation Administration. ... Anaheim, Calif.-based **Rockwell International Corp.'s Electronic Devices Division** has been awarded a contract by Matsushita Electric Industrial Co., Ltd., to provide R6502 CPUs for use in the Japanese company's Panasonic hand-held computer.

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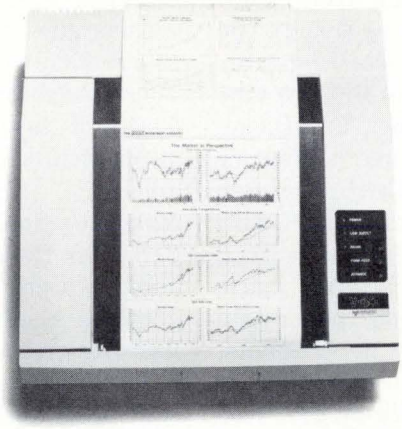
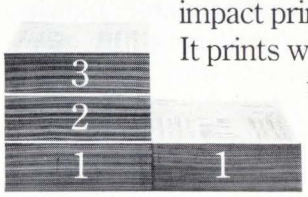


The Versatec V-80 is three times better than a conventional printer. It prints more than three times faster—1000 vs. 300 LPM for comparably priced matrix impact printers. It prints with three times the character resolution —256 vs. 81 points to define a standard character. Three machines in one—a printer, a plotter, a hard copy device for display terminals —V-80 does all three jobs without compromising speed or quality. And it does them all quietly, without the nerve-racking clatter of hammers.



V-80 plots graphics, maps, even halftone pictures, with resolution of 40,000 points per square inch. A simultaneous print/plot feature allows you to generate reports that combine words and pictures without cutting and pasting. And no matter how complex the plot, each page is produced in just seven seconds.

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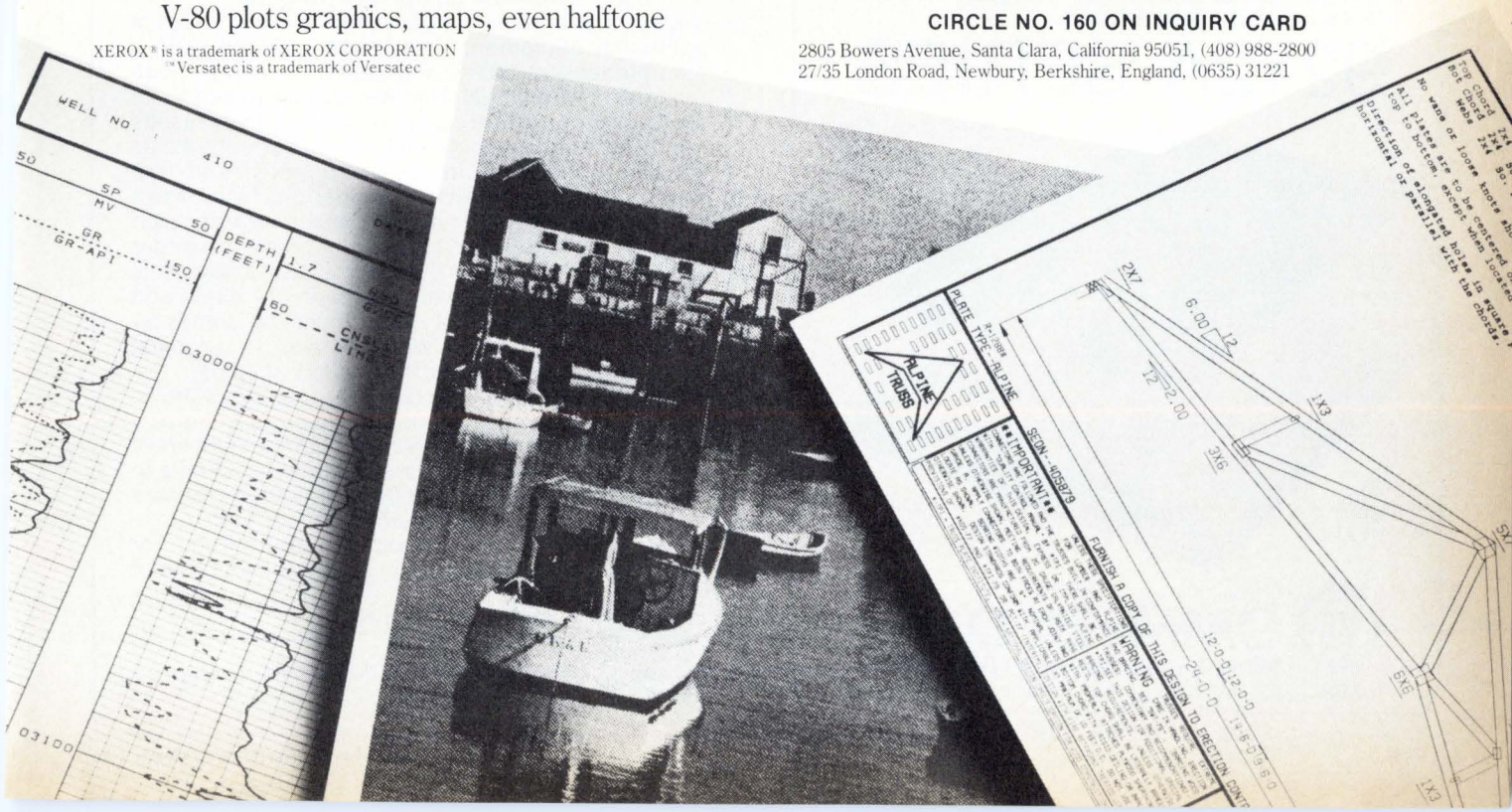

Endpoints

Ground-Breakings: Graphics work-station manufacturer **Avera Corp.** has moved into a 24,000-sq.-ft. facility in Scotts Valley, Calif., which will house the company's headquarters and its marketing, administration and manufacturing divisions. Avera recently secured $2 million in venture capital from Institutional Venture Associates and Venture Technology Investors. ... H-P-compatible magnetic-tape-system manufacturer **Dylon Corp.**, San Diego, Calif., will be represented in California and Nevada by Inglewood, Calif.-based Basic Systems Corp., which will sell and service Dylon's line of GPIB/IEEE reel-to-reel and cartridge recorders, the Series Ten, HP-1000 and the Series Five, HP-3000 tape systems. ... **Cipher Data Products, Inc.**, San Diego, has acquired all the assets of Perkin-Elmer's Memory Products Division, Garden Grove, Calif., for $20 million. ... **Personal Software, Inc.**, Sunnyvale, Calif., doubled its floor space to more than 30,000 sq. ft. when it relocated to San Jose. The new facilities house software development, sales, marketing, publication production, customer support and other departments, and plans for a second building are under way. ... Controller house **Minicomputer Technology,** Palo Alto, Calif., has been purchased for $600,000 by instrument maker E-H International, San Jose.

Money Talk: **Informatics, Inc.,** Woodland Hills, Calif., has a $12-million unsecured line of revolving credit, thanks to Chase Manhattan Bank, New York, and Security Pacific Bank, Los Angeles. After three years, loans under the revolving credit turn into four-year term borrowings, according to the terms of the seven-year agreement. ... **Applied Materials, Inc.,** Santa Clara, Calif., announced record sales for 1981 of $77.5 million, up 12 percent from 1980. ... **Sharp Corp.** of Japan is reportedly one of the companies under consideration by Rockwell International as a second source for its CMOS process, recently developed at its Microelectronics Research and Development Center. Rockwell says the process will be aimed at the production of μp, μc and specialized communications devices.

Randomly Speaking: The **Systems Division,** California Computer Products, Inc., Anaheim, Calif., has established a users group to aid owners of its interactive graphics systems. ... **The Semiconductor Industry Association** has initiated a program called the Semiconductor Research Cooperative, with the goal of stimulating joint research in advanced semiconductor technology by industry and U.S. universities.

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Frost & Sullivan has completed a 185-page report which examines the operational energy cost of computer peripheral equipment from the perspective of both manufacturers and end-users of computer equipment. The report is based upon a comprehensive survey and personal contacts with end-users with actual annual expenditures of $178 million for peripheral equipment. The survey results indicate that a large potential market currently exists for low power consumption equipment and that many end-users currently consider this factor as an integral part of their overall procurement decision process. In addition to discussing potential vendor marketing and product development strategies, this report presents a method to compute the direct and indirect operating cost differences of computer peripheral equipment. When applied to a typical medium sized computer installation, the cost differences between different equipment was shown to be significant and warrants keen attention by vendor marketing personnel who both wish to know future end-user trends as well as to assist clients in determining what the equipment operating costs are competitive with other vendor's equipment.

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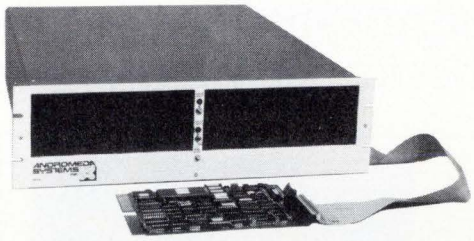

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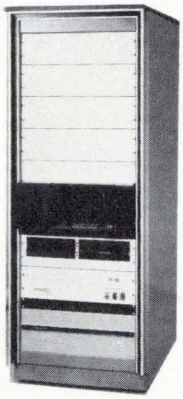

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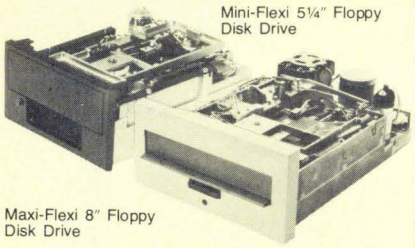

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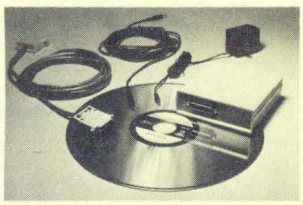

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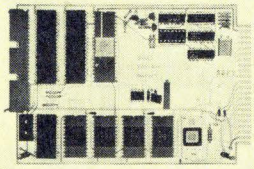

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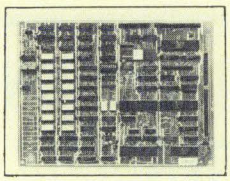

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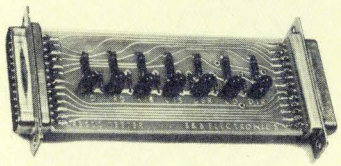

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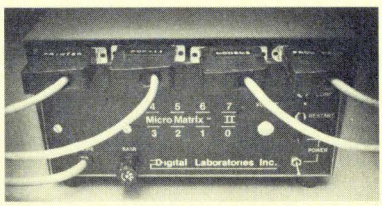

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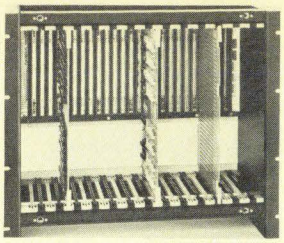

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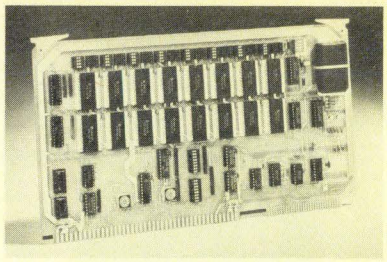

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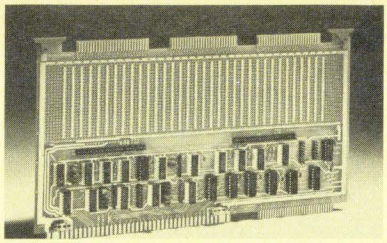

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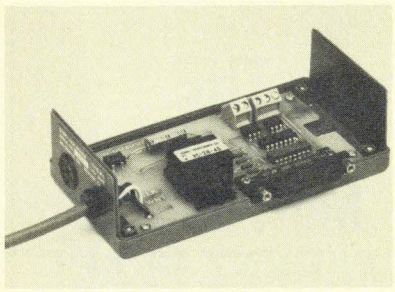

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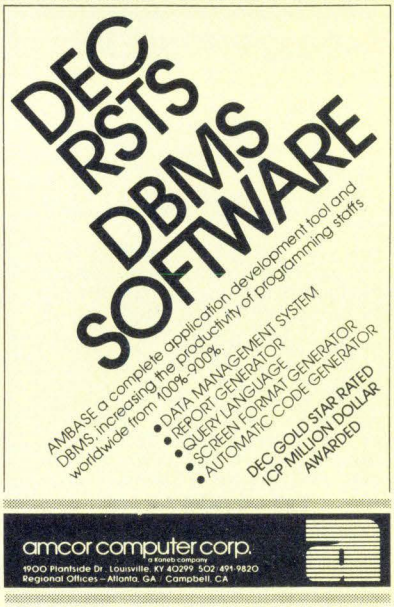

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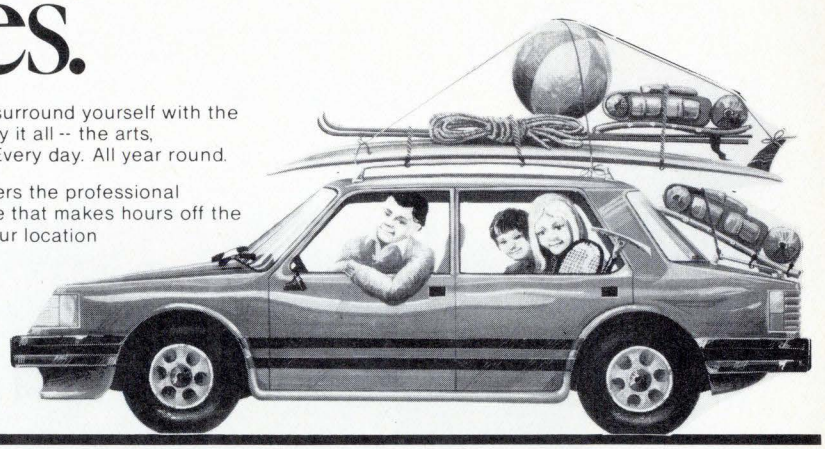

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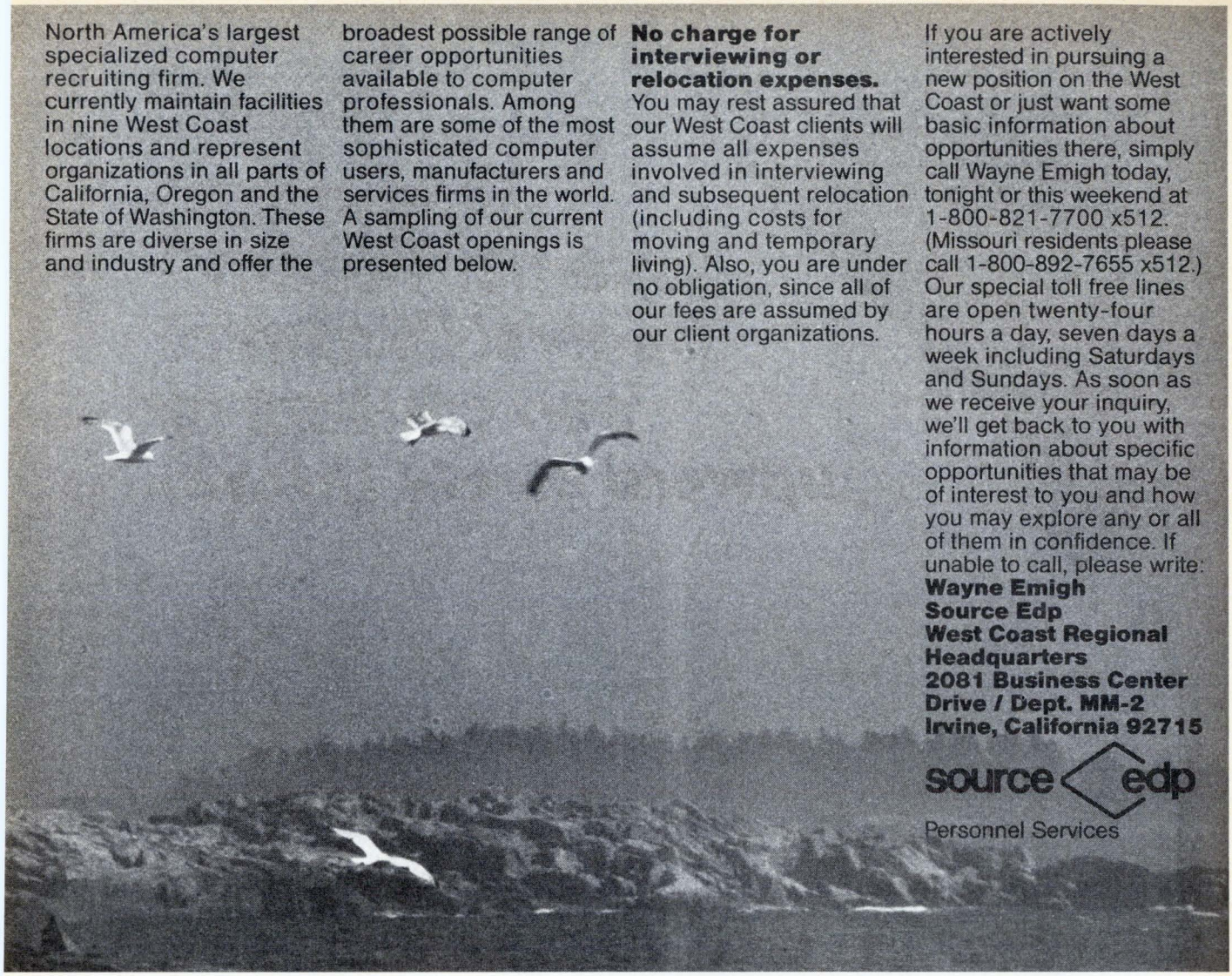

North America's largest specialized computer recruiting firm. We currently maintain facilities in nine West Coast locations and represent organizations in all parts of California, Oregon and the State of Washington. These firms are diverse in size and industry and offer the broadest possible range of career opportunities available to computer professionals. Among them are some of the most sophisticated computer users, manufacturers and services firms in the world. A sampling of our current West Coast openings is presented below.

No charge for interviewing or relocation expenses. You may rest assured that our West Coast clients will assume all expenses involved in interviewing and subsequent relocation (including costs for moving and temporary living). Also, you are under no obligation, since all of our fees are assumed by our client organizations.

If you are actively interested in pursuing a new position on the West Coast or just want some basic information about opportunities there, simply call Wayne Emigh today, tonight or this weekend at 1-800-821-7700 x512. (Missouri residents please call 1-800-892-7655 x512.) Our special toll free lines are open twenty-four hours a day, seven days a week including Saturdays and Sundays. As soon as we receive your inquiry, we'll get back to you with information about specific opportunities that may be of interest to you and how you may explore any or all of them in confidence. If unable to call, please write:

Wayne Emigh
Source Edp
West Coast Regional Headquarters
2081 Business Center Drive / Dept. MM-2
Irvine, California 92715

source edp
Personnel Services

lines are open 24 hours a day, 7 days a week.

Scientific Programmer Analyst. One of the most advanced technical firms in San Francisco seeks a professional with FORTRAN experience and engineering systems background. To $35,000.

Telecommunications Project Leader. San Francisco peninsula company, one of the fastest growing micro computer manufacturers in the world, is seeking an individual with extensive telecommunications experience to assume a leadership position in the development of telecommunications software. This position will include the responsibility for project planning, project development and project management. To $40,000.

Programmers—Learn IMS. Rapidly expanding San Francisco area organization provides a unique opportunity for experienced Programmers to learn new skills in a major new IMS project. All program development is on-line in an IBM 3033/MVS environment. To $35,000.

Southern California

New Corporate Data Center—Orange County. Fortune 500 organization is undergoing a major expansion and is in the process of centralizing all systems planning, programming, software and computer operations into a new corporate data center. The center, which is located in a highly desirable suburban Orange County area, will house the latest in IBM computer hardware and software technology including advanced data base, telecommunications, and distributed processing applications. Current openings include Programmer Analyst, Systems Analysts, Project Managers, EDP Auditors, System Programmers and Hardware/Software Planners. Starting salaries range from $18,000 to $35,000.

MI Director—New Data Center. Progressive firm in the electronics industry seeks a proven Manager capable of building a data processing organization from the ground floor. Will select equipment, hire staff and set direction for successful and growing firm. Suburban Los Angeles community. To $45,000.

EDP Audit Specialist—Extensive In-House Training. Fortune 500 organization headquartered in Southern California seeks an EDP Audit Specialist experienced in designing accounting applications in an IBM OS environment. Training in auditing techniques and advanced computing provided. To $25,000.

Sales Representative—High Income. Orange County office of a leading computer manufacturer is seeking a Marketing Representative with a proven track record of selling business systems. The average income of its sales force last year was over $50,000.

Software Development—Minicomputers. Successful Orange County minicomputer manufacturer seeks professionals with operating system, compiler, data communications, data base or microprogramming experience. Company is committed to developing and sustaining a complete line of state-of-the-art systems software products. To $40,000.

COBOL Programmer—Newport Beach. Well-known diversified financial services firm seeks a professional with a minimum one year COBOL programming experience. Outstanding work environment overlooking Pacific Ocean, CICS, MVS training provided. To $28,000.

Programmer Analysts—Santa Barbara. Fortune 500 company located in a beautiful coastal setting two hours north of Los Angeles needs both mini and large systems Programmer Analysts. The organization provides excellent benefits including an exceptional relocation package. To $32,000.

Minicomputer Programmers—World-Wide Network. Prestigious organization near Santa Monica beach seeks experienced, on-line real-time Minicomputer Programmers to participate in the development of a world-wide financial communication network. To $40,000.

Senior Minicomputer Systems Programmer. Manufacturing company headquartered in San Diego has a requirement for an experienced PDP-11 Programmer who has worked on RSX-11M, RT-11 or IAS. Will be involved in a major effort to develop a state-of-the-art real-time system. To $26,000.

Systems Analyst—Move into Sales. Opportunity exists for a Systems Analyst or Programmer Analyst to move into the challenging role of a Sales Representative for a fast-growing computer services organization. Qualified applicants must have the ability to work independently and interface with various levels of technical and management people. San Diego location. Estimated first-year earnings $35,000.

Systems and Programming Manager—San Diego. One of the fastest growing companies in its industry is seeking an experienced professional to direct its systems and programming functions. Qualifications should include experience in project management in a large-scale systems environment. In-depth knowledge of financial systems preferred. To $35,000.

On-Line Programmers—OS Environment Major San Diego based organization has several openings for On-Line Programmers to participate in a system utilizing a large network of terminals tied to one of IBM's latest computers. Selected candidates will work in an OS/MVS CICS, IMS environment. To $30,000.

CAD/CAM/Graphics Programmers. National firm in the process of expanding its software development staff in San Diego has an immediate need for several individuals with graphics and/or CAD/CAM experience using minicomputers. To $40,000.

Programmer Analyst—Learn Data Base. Growing Los Angeles energy company seeks OS/COBOL Programmers who want to learn IMS and manufacturing applications. Presently developing new IMS systems for plant and building maintenance and shop floor scheduling. To $30,000.

FORTRAN Programmer—Business Systems. Fast-growing Los Angeles suburban financial firm seeks a professional with FORTRAN experience. Company is installing dual computers for on-line transaction-driven systems. To $35,000.

Minicomputer Programmer—San Diego Suburb. Division of a Fortune 500 corporation seeks a Programmer Analyst proficient in any high-level language (e.g., FORTRAN, PL/1, ALGOL, or PASCAL) to work on a variety of minicomputers (including PDP-11 and HP computers). To $26,000.

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SOFTWARE SYSTEMS PROFESSIONALS

Now choose "Internal Mobility"— General Dynamics' new concept for upward career growth.

Here's how it works for you. We'll encourage you to move systematically from project to project until you find the ideal match for your skills and career goals. All the while, you'll be working on some of the most challenging assignments in data processing.

You should have a college degree and experience in: **◊LARGE IBM/CYBER MAINFRAMES ◊MINI/MICRO COMPUTERS ◊DATA BASE ◊REAL-TIME ◊CAD/CAM APPLICATIONS.**

Our excellent compensation program includes a full-range of company-paid benefits.

Please send resume to ***D.H. Huckaby, Director, Central Center, General Dynamics, Data Systems Division, P.O. Box 748-25SSP, Mail Zone 5400, Ft. Worth, Texas 76101.***

GENERAL DYNAMICS

Data Systems Division

An equal opportunity employer, M/F.
U.S. Citizenship required.

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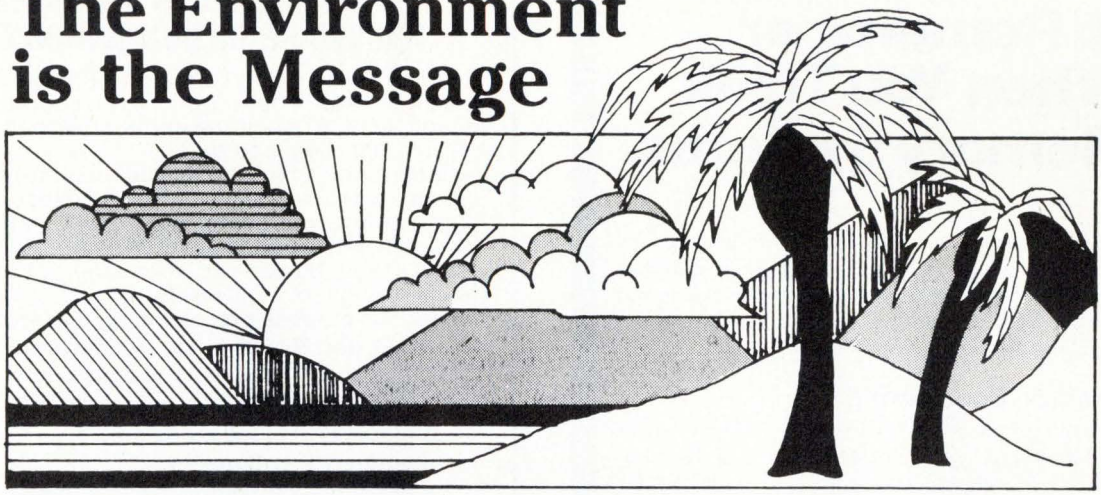
Programmers

The Environment is the Message



Our Climate Encourages Creativity... Inside and Out

At TTI, our environment, inside and out, stimulates the creative technical thinking that sets us apart from the rest. We can't, of course, take credit for the year-round sunshine and the warm ocean breezes -- What we can take credit for is the careful construction of an internal climate that does for the professional spirit what sunshine does for the personal one.

Backed by Citicorp, with over $100 billion in assets, our resources enable the development of sophisticated systems, create access to the most advanced equipment available, and provide individual computer terminals.

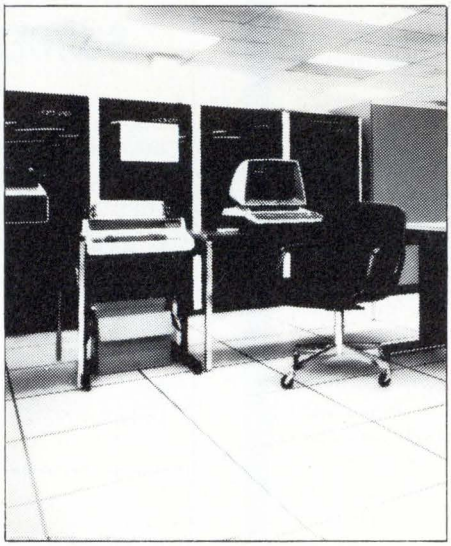
If you're a professional seeking a change of climate inside and out, consider working on the design and development of advanced computer systems and networks at a company that's revolutionizing the banking industry all over the world.

PROGRAMMING ANALYSTS

Will design and develop on-line transaction processing systems. 5-10 years experience in several of the following areas required: operating systems; structured system design; on-line transaction processing (e.g., CICS, ENVIRON/I, GEMCOS); distributed networks (e.g., Tandem, HP, PE, DEC); or systems documentation. Assembly language or COBOL preferred.

DATA BASE PROCESSOR DEVELOPERS

Design and develop a high throughput, high reliability Data Base Management System. The Data Base Processor consists of multi-super-mini's and various intelligent peripherals utilizing PASCAL. Requires 5-8 years experience in several of the following areas: data base management systems; operating systems; compiler development; or system utilities.



SOFTWARE ARCHITECTS

Design architecture for an on-line real-time transaction-oriented system. Expertise in the design of a large-scale, multiple release, software system such as ticketing, reservations, financial transactions, and/or information network systems -- especially in a distributed mini-communications network environment.

COMMUNICATIONS SOFTWARE DESIGNERS

Will design front end processors and communication networks. Requires 5+ years experience in telecommunications software, both networking and protocol definition.

TEST AND INTEGRATION ANALYSTS

A background in software and systems testing methodology for large-scale systems. Prefer 2 years on-line programming experience.

MICROPROCESSOR DESIGNERS

Design and implement applications on microprocessors or home computers. Requires 5-10 years design and programming experience; minimum one year experience with microprocessors, (preferably 6502 or 8080/280/8086 assembly language).

TTI offers one of the finest salary, benefits and vacation plans in the industry, relocation assistance, medical and dental insurance, financial services, a van pool from most outlying Los Angeles areas, and a special health club membership. Forward your resume to:

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A Commitment To Remember When You Think Memory Systems

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Director Engineering

We are seeking an individual who is interested in an opportunity which includes providing technical assistance as well as managing a 16-man R&D staff for board level memories and controllers plus system level bulk memory.

Senior Member Technical Staff

Here's an opportunity to provide architectural development for firmware, software and hardware for I/O control products. If you have a background in hardware, firmware and software design of high performance bus-oriented I/O interfaces, you could qualify for this position. An MSEE or equivalent experience is desirable.

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You will design interface hardware and firmware for NURAM-based bulk memory products as well as traditional I/O devices. Three years' I/O microprocessor design experience for OEM bus-oriented hardware and a BSEE or equivalent would be a plus.

CPU Design Hardware

This is an excellent opportunity to design, develop, test and integrate advanced 16K microprocessor-based systems. You must have a BSEE and at least 2-3 years' experience in microprocessor-oriented design, memories and I/O.

Tape Disc Controllers

We're looking for intelligent, ground development-oriented individuals who will provide fresh designs for Winchester disc controllers. You will interface with controller microcode and software design personnel. A BSEE or CS plus 3 years' experience in development, high speed logic design and tape or disc controller design is required. A familiarity with bit-slice microprocessors is desirable.

Please send your resume, with salary history, to Diane Hart, Professional Employment, National Semiconductor, P.O. Box 60879, Sunnyvale, CA 94088. We are an equal opportunity affirmative action employer.

CIRCLE NO. 250 ON INQUIRY CARD

National Semiconductor

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CIRCUIT DESIGN ENGINEERS
SYSTEMS DESIGN ENGINEERS
HARDWARE DESIGN ENGINEERS

If you're not looking forward to 1982 as your personal "year of opportunity" you should be talking to us about one of the above positions with our Fortune 500 client company.

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- **Special purpose programming and architecture (INTEL and MA800 microprocessors)**
- **Circuit design and program control**
- **Closed loop feedback design**
- **Microprocessor logic design**
- **Integrated circuit design**

Our client is located in a low cost (no state income tax, reasonable housing) area offering an ideal combination of rural, suburban and metropolitan lifestyles.

Salaries will reflect your ability to contribute.

For more detail, phone or write to:

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Agawam, MA 01101
(413) 789-0907

CIRCLE NO. 251 ON INQUIRY CARD

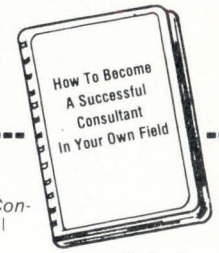
How to become a SUCCESSFUL CONSULTANT in your own field.

Have you ever wished you could quit your job and start working for yourself?

Well, maybe you can! Many people are amazed when they discover the tremendous amount of professional experience and specialized knowledge they've accumulated — experience and knowledge that others will gladly pay for. Literally thousands of people who made that discovery are now prospering as **Independent consultants.**

Perhaps no one is better qualified to have written this book than Hubert Bermont. He has served as consultant to more than 70 major corporations and trade associations, including the U.S. Chamber of Commerce, McGraw-Hill, the Electronic Industries Association, Evelyn Wood Reading Dynamics and the Smithsonian Institution. Yet he made the decision to become a consultant only after being fired from an executive position at the age of 43. You'll learn first-hand how he did it — and how **you** can do it, too!

How many times have you told yourself that you're not getting anwyhere — that it's time to think seriously about a major change in your career? **Don't put it off another day!** Clip and mail the coupon now!



Enclosed is my check or money order for $20. Rush me, postpaid, *How to Become a Successful Consultant in Your Own Field,* by Hubert Bermont. I understand that I have the right to return the book within three weeks for a complete refund if I'm in any way unhappy with it.

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Address_____

City_____ State_____ Zip_____

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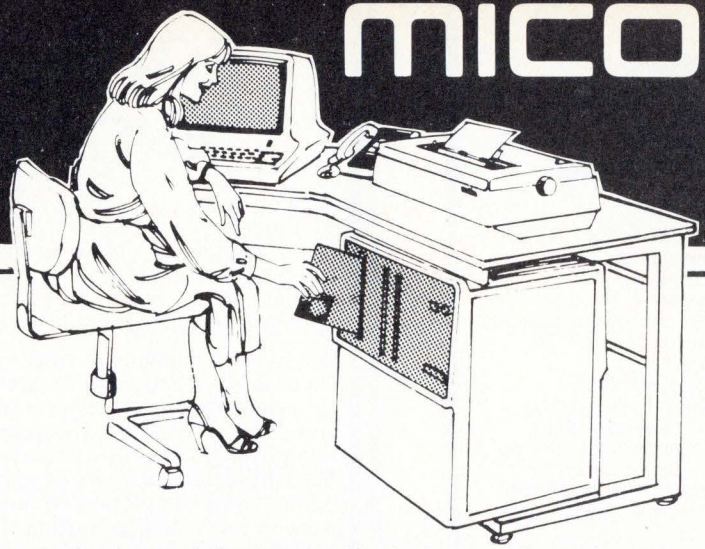
999 Summer St.
P.O. Box 3809
Stamford, CT 06905

Send Box No. replies to: **MMS**, 999 Summer St., P.O. Box 3809, Stamford, CT 06905

MICOM



Micom, a pace-setter in the rapidly developing industry of word processing is corporately committed to the development of systems for the integrated office of the future. Our continued rapid expansion depends on filling the following positions:

For one project dealing with the development of an information management facility with features such as electronic mail and text retrieval.

Software Designers

To work in a team environment to carry out the design, implementation and testing work on software products as well as documentation.

These positions require knowledge of computer languages such as PASCAL or C and ASSEMBLER.

Senior Software Designers

These individuals will take responsibility for the design and implementation of complicated software products. They must possess leadership and communication skills.

These positions require the candidate to possess a University Degree in computer science coupled with 2-5 years of experience.

Another of our projects is the development of a low cost successor to our Micom M2000 line with more ergonomic features. To work on this new product we need.

Intermediate Software Designer

Required to take part in the design and implementation of word processing application software, 2-3 years experience in microcomputer software plus a Bachelor's Degree in computer science or Math. is required.

Senior Software Designer

Requires 4-5 years of experience in the design of human interfaces and word processing related software. Must have strong knowledge of OS/DOS related software.

The incumbents need leadership qualities and must enjoy working in a team environment.

If you meet any of these above requirements and if you want to be part of an exciting and progressive company who knows how to recognize talent and loyalty, we would be pleased to receive your curriculum vitae.

Please forward resume, in full confidence, to:

Susan Morrissette

MICOM CO.

5250 Ferrier Street
Montreal, Quebec, Canada
H4P 1L4

CIRCLE NO. 252 ON INQUIRY CARD

MICOM A Philips affiliate

PHILIPS

Engineers

ELECTRONIC DEVELOPMENT ENGINEERS

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We may have the opportunity you're looking for.

A lot of good things are happening at Taylor. . .Taylor is growing. Things have never been better in any period during our entire 130 year history. Our Electronic Division is headlining state-of-the-art electronics with technology and new products second to none in the entire process control industry. The emphasis is on systems. . .the latest in microprocessors/computer based systems and conventional instrumentation. Sales in our systems areas have tripled over the last three years. . .that's growth and opportunity! Couple that with our diverse product line and technologies. . .our reputation for excellence in the field, an aggressive attitude, and an environment with emphasis on the individual. . .and you have a winning combination.

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- **Layout of High Density PCB's**
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- **Firmware for Multi-Processor, Multi-Computer Based Communications Interfaces**
- **Communications Interfaces Between 8-16 Bit Microprocessor, Mini-Computer Based Systems and Intelligent Instrumentation**
- **Complex Control Algorithms for Microprocessor Based Instrumentation**
- **High Speed Communication Data Links**
- **Continuous and Discrete Distributed Process Control Software Design**

SOFTWARE DEVELOPMENT

- **Computer Product Systems Software to Operate in Stand - Alone or Distributed Environments**
- **Operating Systems Structures, Graphic Packages, Continuous and Discrete Control Packages**
- **Assembly Level and Higher Level Programming with Real Time Pascal, C, and Fortran**
- **Knowledge of Structured Design and Techniques**

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Technical and Professional Placement
Dept. 300-2
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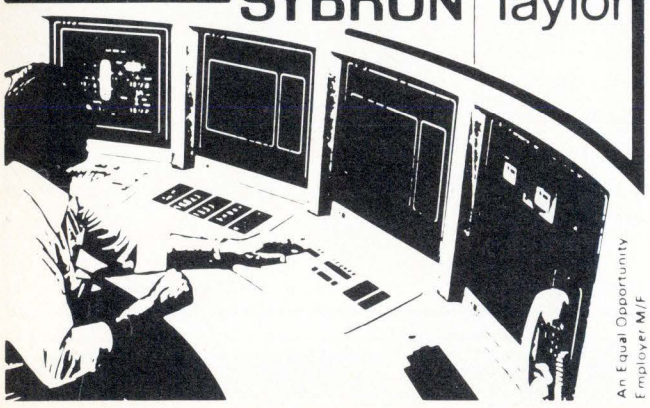
CIRCLE NO. 253 ON INQUIRY CARD

SYBRON | Taylor



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We have an immediate opening in our Biomedical Division for a Software Engineer. This position will be responsible for planning, designing, scheduling and developing large software projects. This position requires a BS or MS in computer science or math. Must have several years of experience in the development and completion of large-scale software projects in an industrial setting. Must have a working knowledge of and experience with C, UNIX, and Z80. Prefer experience with biomedical instrumentation systems. This position requires strong interpersonal skills.

Salary plus commission; car and travel expenses; medical, dental, life and LTD insurance; pension, profit sharing and stock purchase plan. For confidential consideration, send resume to: Robert W. Lovely, 5225 Verona Road, Madison, Wisc. 53711.

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NICOLET INSTRUMENT CORPORATION

CIRCLE NO. 254 ON INQUIRY CARD

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This position has great growth potential within our engineering department. We are looking for individuals with microprocessor experience to apply poly-FORTH to automotive diagnostics.

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- Hardware Design/Microprocessor

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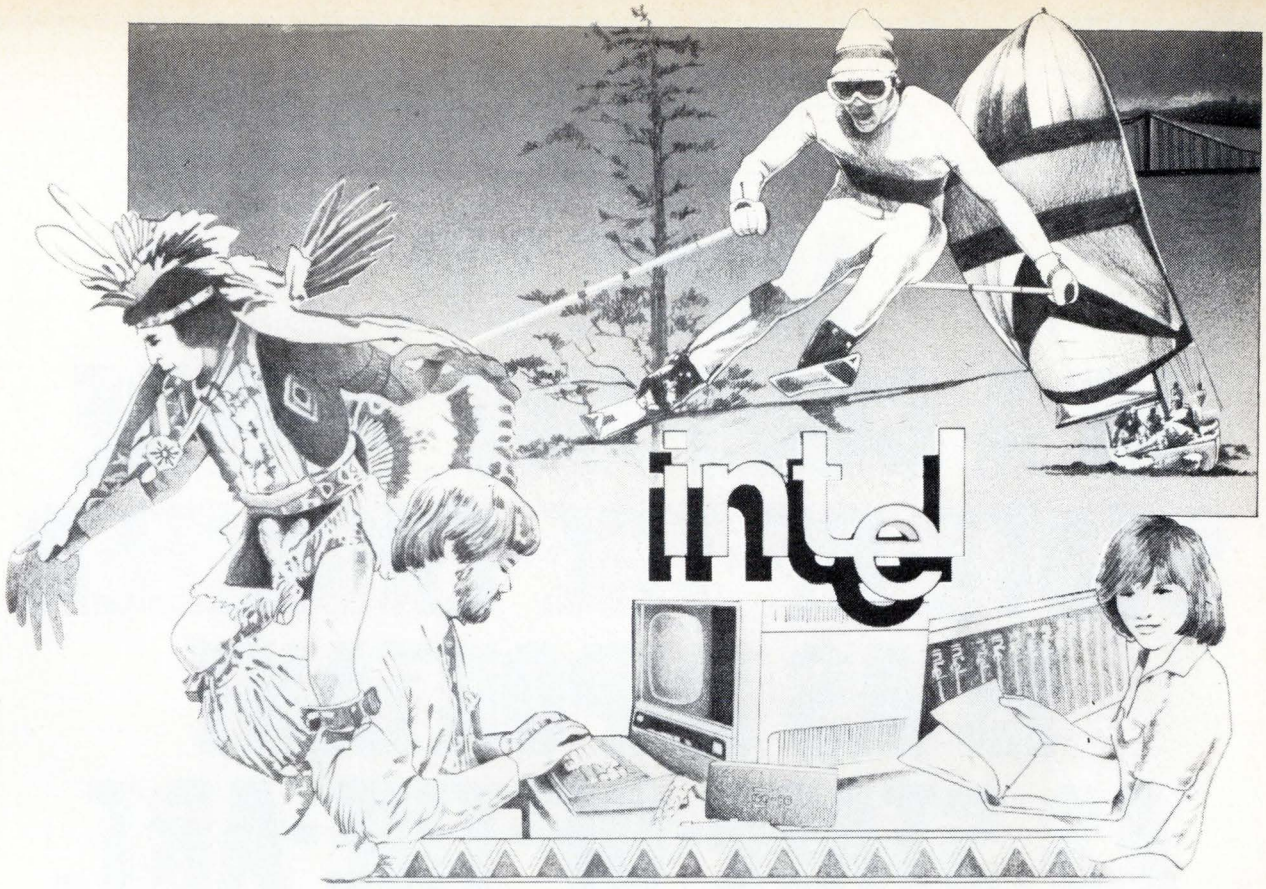

Rare Challenge In Two Great Settings!

We're traveling uncharted areas...seeking new solutions for complex microcomputer systems and components, and totally new ways to provide these to the user. At Intel, we have developed new industries...made giant strides in process technology, and we're not stopping because we recognize no boundaries. We can offer some rare challenges to engineering professionals in two excellent geographic areas.

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The crown jewel of the "Valley of the Sun," Phoenix is one of the fastest growing cities in the Sunbelt. Blessed with a dry, warm climate year around, Phoenix living is an invitation to enjoy the excellent outdoor recreation found in and around the area. A number of lakes provide recreation for the boat enthusiast, angler or swimmer. Nearby mountains provide hiking and hunting in cool pine forests, and the winter skier will find several top resorts within easy reach. The city has excellent housing, schools and a host of cultural and entertainment opportunities. Currently we have the following openings:

SENIOR SOFTWARE ENGINEERS
SENIOR STAFF DIAGNOSTIC ENGINEERS
SENIOR MECHANICAL ENGINEERS
SENIOR HARDWARE SYSTEMS ENGINEERS
HARDWARE DEVELOPMENT ENGINEERS

For immediate confidential consideration, call COLLECT to Chuck Shepherd (602) 869-4499, or send your resume or letter of interest to: Intel Corporation, Dept. 9 AQ, 2402 W. Beardsley Rd., Phoenix, Arizona 85027.

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SOFTWARE ENGINEERS
IBM SYSTEMS ENGINEERS
SOFTWARE PRODUCT EVALUATION ENGINEERS
DATA COMMUNICATIONS ENGINEERS

- **Strategic Technology Planning Managers**
- **Senior Network Architects**
- **Software Project Leaders**

For immediate confidential consideration, call COLLECT to Lyn Boone (408) 987-6118, or send your resume or letter of interest to: Intel Corporation, 2625 Walsh Ave., Santa Clara, California 95051.

The only limits are your own. The 80's will see radical changes in computer power, structure, and software application, and Intel will be there first! Let's get together and talk about your place in our future.

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OPPORTUNITIES FOR SOFTWARE ENGINEERS:

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  - -a real-time distributed/embedded software systems involving command and control, switching, communications, signal processing/analysis, DBMS, graphics, and man-machine interfaces
  - -also: research, systems engineering, requirements definition, design, implementation, testing
- state-of-the-art technology:
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  - -minis: VAX 11/780, PE 3230, DG S/330, PDP 11/34, PDP 11/23, HP 21 MX, TANDEM
  - -micros: Motorola 68000, 6809
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- broad range of languages:
  - -high order languages like Pascal and Structured FORTRAN
  - -assembly languages and Microcode
  - -PDL and Programmer's Workbench

If you have a degree and 3 or more years of experience, don't delay—send your resume to: **Professional Placement, E-Systems, Inc., Garland Division, P.O. Box 226118, Dept. MU43, Dallas, Texas 75266.**

E-SYSTEMS

Garland Division

The problem solvers.

An equal opportunity employer M/F, H, V.

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65 XX ENGINEERING

Use or adapt our existing hardware/software to save costs in 6500/6800 applications. In house programming tools include FORTRAN, PASCAL, FORTH, BASIC & Assembler. Facilities to design, prototype, test, manufacture. **HDE, INC.**, Box O, Allamuchy, NJ 07820.

201-362-6574

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MOKENA, IL 60448

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- Medical instrumentation
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- Structured, top-down design of software

Mark B. Gagner
312-479-1460

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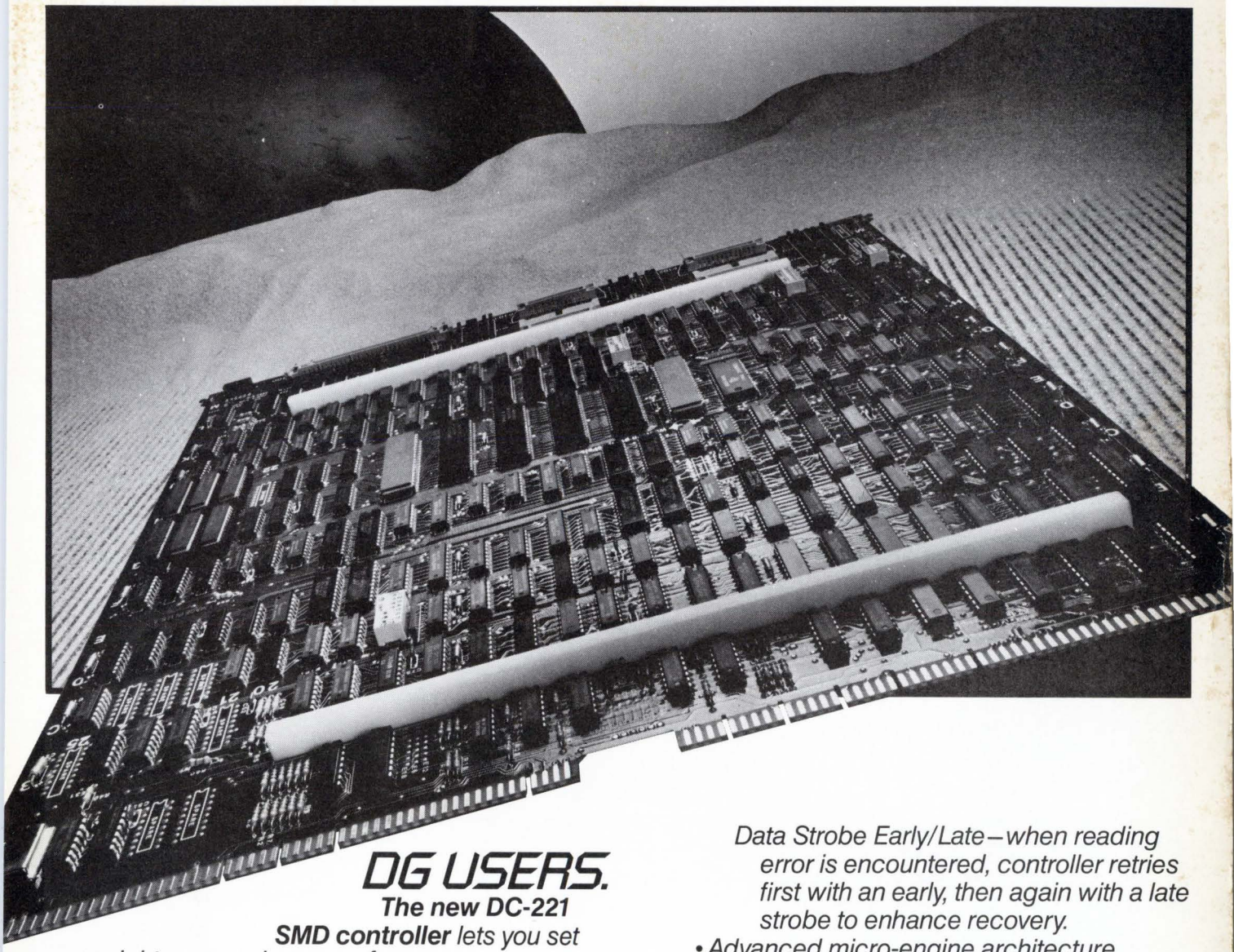

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