Mini-Micro Systems
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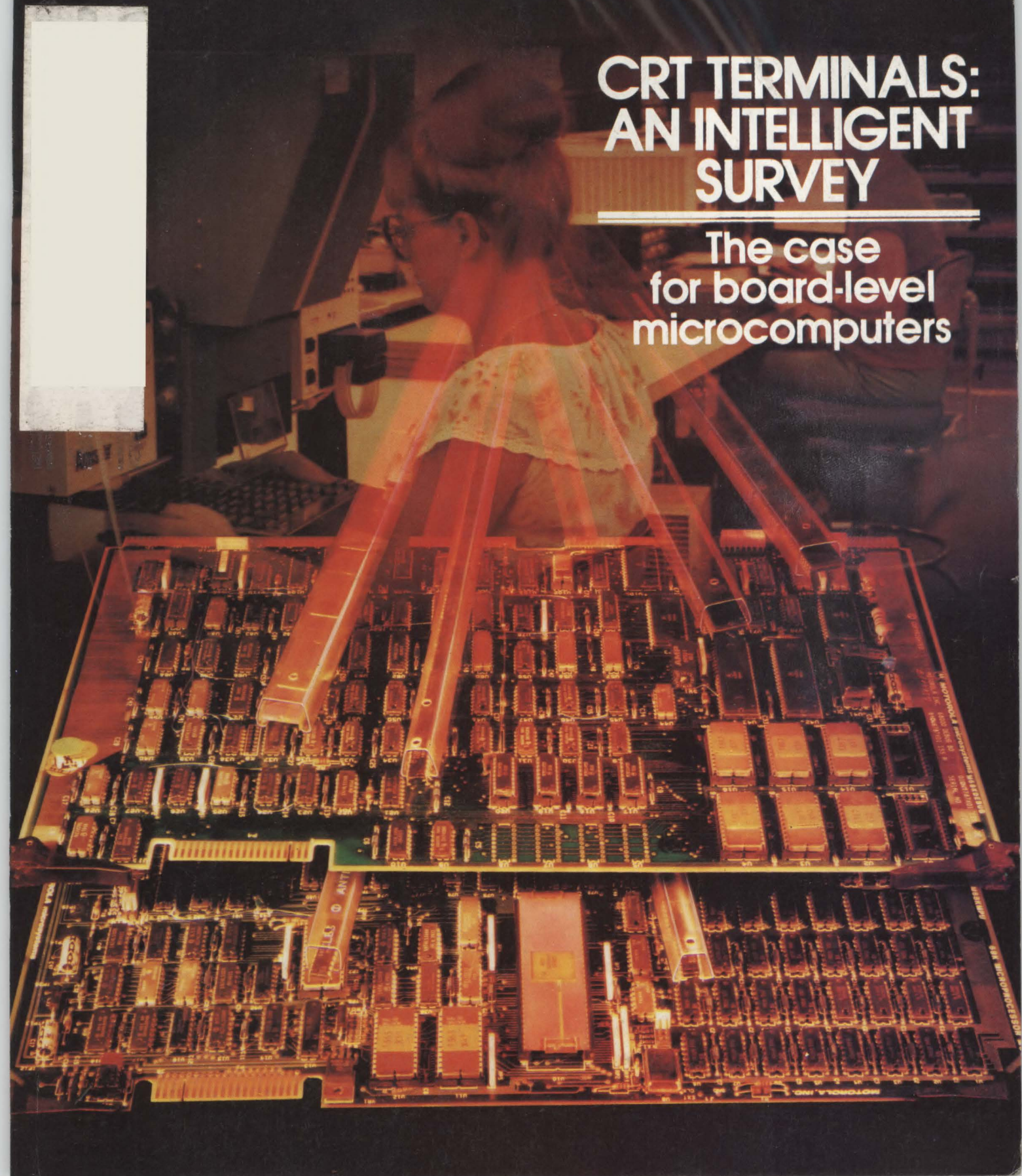
NOVEMBER 1980



CRT TERMINALS: AN INTELLIGENT SURVEY

The case for board-level microcomputers

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Model 6450 High Density Cartridge Tape System

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CIRCLE NO. 1 ON INQUIRY CARD

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M.C.C. Powers transforms electric bills with TI's 763.

M.C.C. Powers, one of the largest manufacturers of building automation and energy management systems, is cutting energy costs for their customers by putting TI's *Silent 700** Model 763 Bubble Memory Data Terminal in their S170/80 Energy Management System. The system, along with TI's 763, is used in colleges, shopping centers, hospitals and industrial complexes to control and regulate air conditioning, heating, ventilation, lighting and electrical loads.

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With the 763's easy-to-use typewriter-like keyboard, users can input and edit commands to the system's database to achieve maximum energy efficiency of their equipment. Up-to-the-minute reports can be requested and obtained from the 763 on energy consumed in a specific section of a building or complex.

With the 763's magnetic bubble memory, important energy data is retained in the event of a power failure. So, no pertinent information is lost.

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Supporting TI's data terminals is the technical expertise of our worldwide organization of factory-trained sales and service representatives, and TI-CARE†, our nationwide automated service dispatching and field service management information system.

For more information on the Model 763, contact the TI sales office nearest you or write Texas Instruments Incorporated, P.O. Box 1444, M/S 7784, Houston, Texas 77001, or phone (713) 937-2016. In Europe, write Texas Instruments, M/S 74, B.P. 5, Villeneuve-Loubet, 06270, France.

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PDP-11 users save space and save money! MDB's DZ11AC is the first and only asynchronous multiplexor that lets you combine up to eight lines of RS232 and current loop in any configuration on a single hex board. No more doubling up on boards, distribution boxes, rack spaces or price. The MDB DZ11AC is fully compatible with DEC DZ-11 operating and diagnostic software and, at the same time, performs at 16 standard data rates from 50 to 19.2K baud with optical isolation for enhanced noise immunity.

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From plain vanilla to state-of-the-art, all MDB products are built with exceptional quality. We warranty them for one year, can deliver most items in 30 days or less and offer them under GSA contract #GS-00C-02423.

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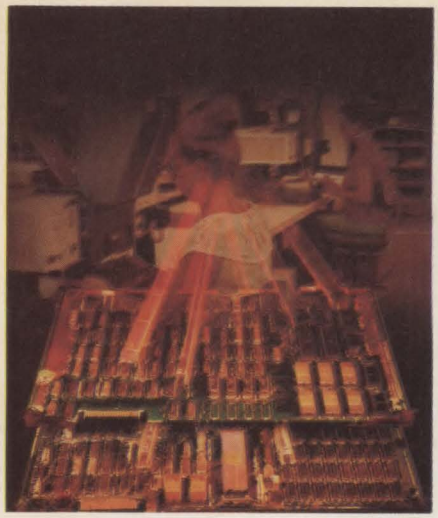
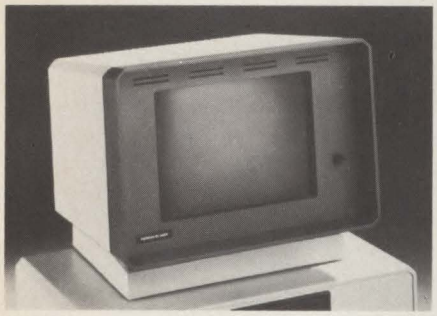
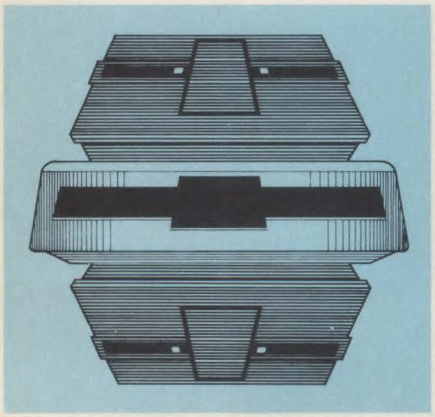


Board-level microcomputers, such as Motorola's VERSAmodule, offer system designers and OEMs a wide range of advantages. See p. 81. Cover designed by Bill Preiss, photographed by John Fernez; courtesy of Motorola, Inc., Semiconductor Group.



Page 97 . . . . . A look at intelligent terminals



Page 13 . . . . . New 5¼-in. drive standards?

VBPA ABP

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FEATURES

MINI-MICRO WORLD

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CIRCLE NO. 143 ON INQUIRY CARD

MEMOREX SHIPPING MODEL 101 DRIVES, HINTS AT PLANS FOR 301

Although Memorex Corp. is only now ramping up production of its long-awaited model 101 8-in. Winchester-disk drive (introduced at the 1979 National Computer Conference), the Santa Clara, Calif., company has begun talking about what it calls a top-of-the-line 8-in. drive, the 301. A spokesman for the drive maker says the 301, still in engineering phases, will be an 8-in. SMD-compatible device with a storage capacity in the 80M- to 100M-byte range. Meanwhile, Memorex is slowly bringing its 101 production up to the firm's target of 250 drives per day. Current output is about 20 drives a day, not all of which are reaching customers. The company also expects to begin shipping samples of the model 201 8-in. fixed/removable drive by the middle of next year. Production quantities are expected before year-end 1981.

DATX TO BUILD 5¼-IN. DRIVES

Look for Santa Barbara start-up DATX Systems Corp. to announce its entry into the 5¼-in. Winchester market sometime this month. Detailed plans were undefined at press time, although it is known that the company does not plan a high-capacity plated-media device such as that unveiled last month by Irwin International, Inc. Read/write head technology for the new drive will be old hat to three DATX co-founders. President Dick Troutte is the former marketing vice president of Information Magnetics Corp.; vice president of engineering Dave Sutton formerly held that position at INFOMAG; and vice president of quality control Don Minami had the same function at the Goleta, Calif., read/write head supplier. The fourth co-founder, Don Cachelin, formerly of Storage Technology Corp., Louisville, Colo., will handle DATX's finances.

DEC SLASHES COMMERCIAL SYSTEM PRICES, UNBUNDLES SOFTWARE

With the announcement of substantial price cuts on its entry level WS-78 series commercial systems and the unbundling of WS-78 software, Digital Equipment Corp. this month signaled its intent to become more aggressive in the fiercely competitive small-business computer market. As a result of the price reductions, which range as high as 35 percent, the base price on a WS-78 system, which includes a processor, dual diskette drive, letter-quality printer and COS-310 operating system, has dropped from $12,545 to $8095. In addition, because of the software unbundling, the entry-level system is now available without software at an even lower $7295 base price ($4795 without printer). The COS-310 operating system and a WPS-8 word-processing package, both now available separately, sell for $4800 ($1600 unsupported) and $500, respectively. According to a DEC spokesman, the price reductions were made possible by economies of scale resulting from volume production of the PDP-8-based system, which was introduced three years ago.

HP-85 DESK-TOP SYSTEM SPAWNS MODULAR CONTROL COMPUTER

With an eye toward a developing market for simple computers in industrial and instrument control applications, officials at Hewlett-Packard Co.'s Desktop Computer Division, Fort Collins, Colo., have adapted the HP-85A personal desk-top computer to perform such tasks. The outgrowth of the adaptation, being introduced next month, is called the 9915A modular computer, a rack-mountable device that reflects its orientation toward production-control use. Where the HP-85A provides a CRT display, full keyboard, printer, tape drive and speaker as standard peripherals, reflecting its program development role, the 9915A offers an annunciator LED display, special function keys and EPROM mass storage as standard. Options include a cartridge-tape drive and an additional operator interface that allows system designers to attach custom keyboards and peripherals.

H-P officials say the 9915A is the first of a family of automation computers/instrument managers, and foresee it being used in a variety of applications. In conjunction with an HPIB interface, it might be used to control audio instrumentation; with a binary-coded decimal interface, it could control medical and coordinate-measurement systems. There's also a serial interface to connect the instrument manager to RS232 and current-loop devices. The 9915A will sell for $1675 singly, about half the price of a full HP-85A. OEM discounts are available.

Breakpoints

SHUGART TECHNOLOGY NOW SEAGATE

Shugart Technology, the Scotts Valley, Calif., pioneer of 5¼-in. Winchesters, will start off next year with a new name, eliminating any lingering confusion between the year-old company and Sunnyvale, Calif., Xerox subsidiary, Shugart Associates (MMS, September, p. 6). New name for the company: Seagate Technology. Seagate may also move into 1981 with higher-capacity hardware, say a number of industry sources. According to one report, the ST500 5¼-in. drive, now operating at 6M bytes using conventional ferrite read/write heads, may sport thin-film heads supplied by Dastek Corp., Los Gatos, Calif. Use of thin-film read/write head teachnology on the Seagate drive could extend the upward range of the year-old hardware to the 10M- to 12M-byte range—the capacity announced for Irwin International's plated-media 5¼-in. device (see related stories, p. 45, 61). The ST500 is being shipped in evaluation quantities.

SPECTRA LOGIC WILL SHIP P-E-COMPATIBLE EMULATING DISK CONTROLLER

Spectra Logic Corp., a year-old Santa Clara, Calif., controller board maker, says it will begin delivering a Perkin-Elmer-compatible emulating disk-controller board by December or January. The Spectra 14, shown for the first time at last month's Mini Micro Show in San Francisco, closely follows the introduction of the company's Spectra 20 and 21 Data General and Digital Equipment Corp. disk/tape controller boards. Company co-founder and executive vice president Steve Roberts says his firm is debugging the new board and has begun taking orders. Claimed to be the first emulating disk-controller board for P-E systems, the Spectra 14 will handle as many as four SMD disk drives and will fully emulate the P-E MSM80 and MSM30 disk subsystems running under the maker's 16- or 32-bit operating systems. Price in single-unit quantities will be $6000. Price for OEM quantities will be $4200, says Roberts.

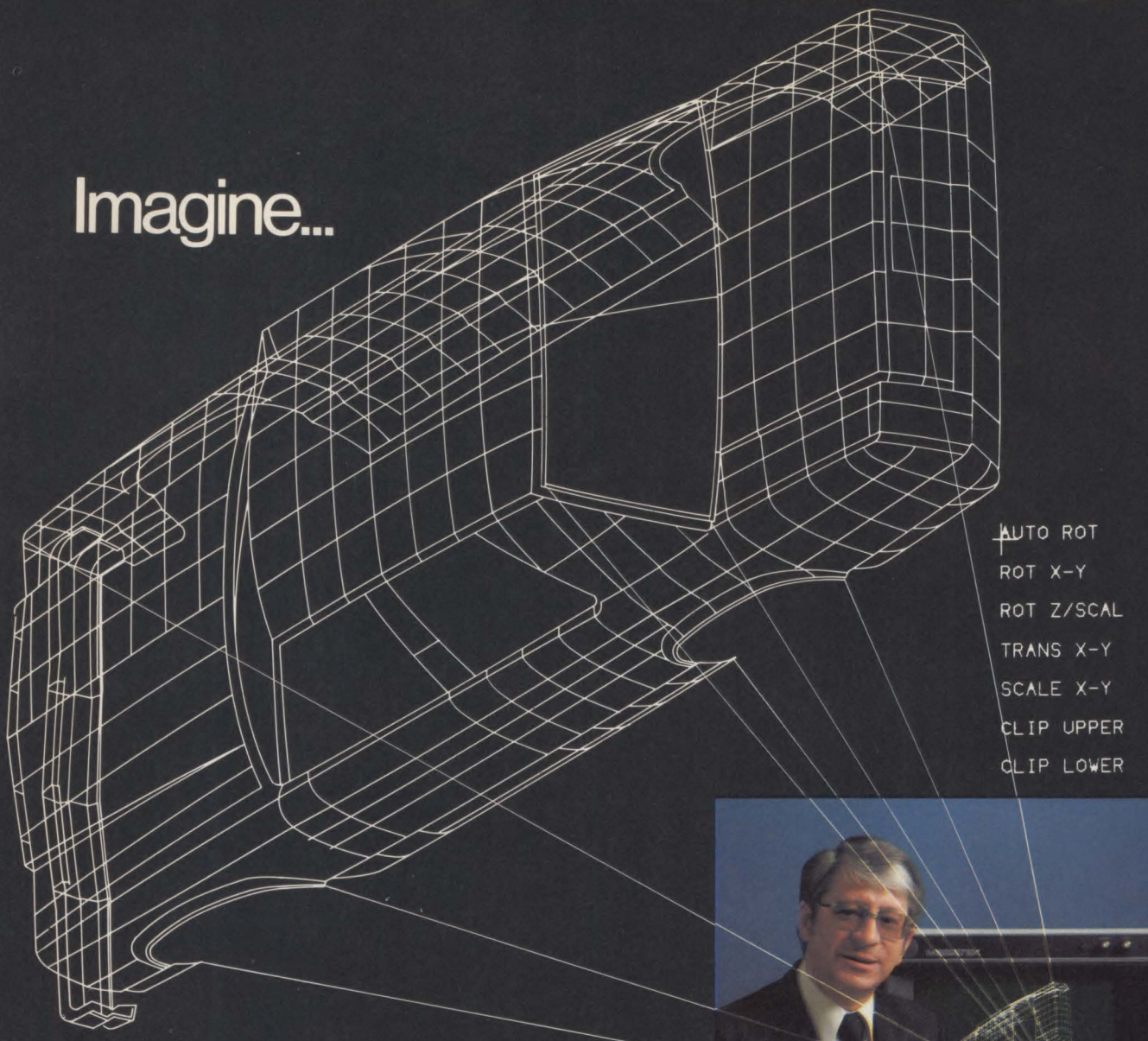
NEW ½-IN. TAPE-CARTRIDGE BACKUP DUE NEXT MONTH

High-capacity Winchester backup in the form of a ½-in. tape cartidge may make its appearance on the commercial market sometime next year. Developed by Newell Research Corp. (NRC), Saratoga, Calif., the 2400-ft. NC-500 cartridge is being delivered in prototype quantities to several commercial vendors and to Genisco Technology Corp.'s Systems Division, Rancho Dominguez, Calif., where it will be incorporated into a start/stop MIL-spec drive designated the BCR-40. The patented cartridge features two drive belts for higher acceleration and minimum tape slewing, say sources close to the company, and can use either 6250-bit-per-in. group code recording (GCR) techniques or 6400-bps phase-encoded formats. Total storage capacity as a streaming Winchester backup device could reach 100M bytes, says one observer; speeds could reach 120 in. per sec. Newell's offering will be the third ½-in. cartridge to make its appearance so far, and follows the 8-in. Winchester/tape transport combination announced last year (but since removed from the market) by Microcomputer Systems, Inc., Sunnyvale, Calif., and the ½-in. cartridge and drive unveiled in 1979 by Interdyne Co., Van Nuys, Calif. Also said to be available from NRC next year will be a ¼-in. version of the cartridge that will be mechanically compatible with the commonly used 3M DC-300. Prices for the Newell cartridges have not been set.

'ULTRASONIC' TYPEWRITER MAY BOOST SMITH-CORONA IN OFFICE MARKET

Despite official reports that Smith-Corona's new "ultrasound-driven" electronic typewriter is designed as an office typewriter, some industry observers say the company would be missing a potentially big market if it ignored applications for the unit as a printer or information-processing terminal. The Typetronic is the first electronic typewriter to use high-frequency sound waves that transmit keystrokes to actuate a daisy-wheel element. Custom LSI is used to decode signals from the ultrasonic keyboard. The use of a rod under the keyboard produces a sound wave unique to each key and eliminates the need for one-third to one-half the mechanical parts used in conventional typewriters. The last 10 characters typed can be retained for error correction. A company spokesman says the typewriter will not now be used as a printer for computers, or for small-business or word-processing systems, but one industry source says that could be a mistake. "The device is more exciting when considered potentially as part of an office-automation system as an on-line printer or information-processing terminal," says Michael Dortch of the Yankee Group, Boston. Smith-Corona's business in the office market has dropped off in recent years. "It's not really possible for them to stop (at a typewriter)," says Dortch. "If they don't go further, someone else will."

Imagine...



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"Megatek's refresh display is an extremely powerful tool for visualizing, manipulating, experimenting and altering design parameters.

"Megatek systems interface easily to a broad range of computers and enhance the engineer's feeling of direct interaction with his design."

Dr. Hanratty summarized his enthusiasm for Megatek with this graphic display of confidence:

"Customers for our software package can select any graphics terminal they want. A large percentage choose Megatek. Price/performance is the reason why. If I were going to put down dollars for a production refresh terminal, I'd put my money on Megatek."

For details call or write Megatek Corporation, 3931 Sorrento Valley Boulevard, San Diego, California 92121. (714) 455-5590.

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	RL01 Controller	RX02 Controller	MSV11-DD 32KW Memory	MSV11-DD 32KW Memory
	RL01 Controller	DLV11-J Serial (4)	RL01 Controller	RX02 Controller
	DLV11-J Serial (4)	OPEN	RL01 Controller	DLV11-J Serial (4)
	OPEN	OPEN	DLV11-J Serial (4)	OPEN
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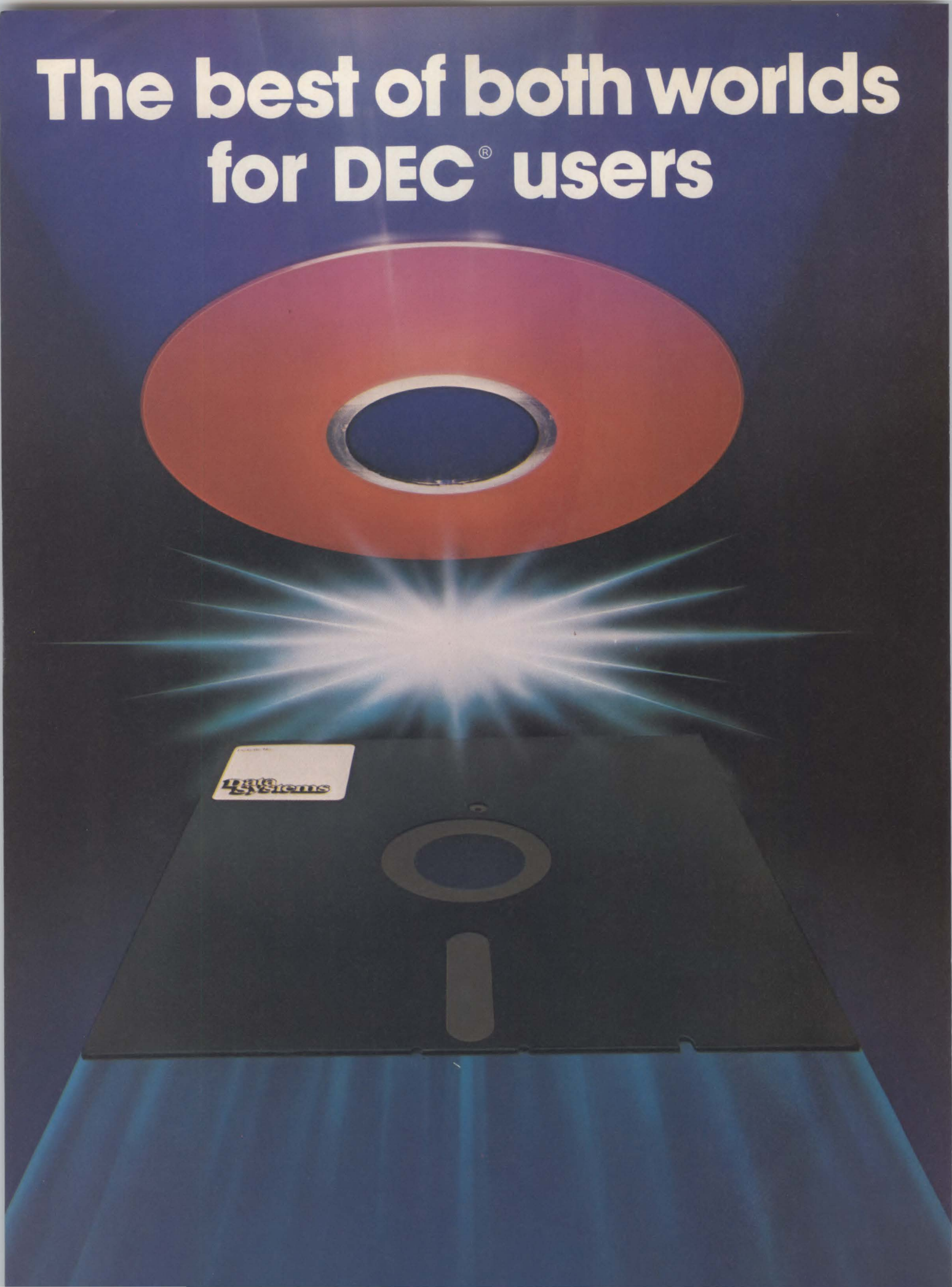

Data Systems Design's DSD 880

Introducing the DSD 880 — A DEC-compatible disk system combining eight-inch Winchester and flexible disks

For DEC users who need more capacity and performance than a dual RX02, the DSD 880 now offers a more cost effective alternative than a dual RL01. Consider these benefits offered by the DSD 880:

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- unique "hyperdiagnostics" enabling fast and easy trouble-shooting to the modular level
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- versatile interface card for easy integration with any LSI-11 backplane, unlike DEC's RLV11 interface that needs a special backplane and cannot be used with the VT 103 terminal

Compare for yourself and see why nothing compares to the DSD 880.

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CIRCLE NO. 9 ON INQUIRY CARD

5¼-in. 'slimline' floppies may impose new drive standard

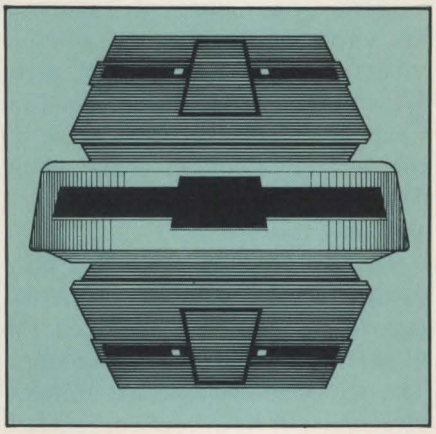
The market for 5¼-in. double-sided floppy-disk drives may undergo a shake-up next year, as vendors announce 48- and 96-track-per-in. "slimline" hardware. Designed to match the width and depth dimensions of Shugart Associates' SA450 double-sided drive, the new devices are only ⅔ as high. Three of the drives will fit into the slot spaces required for two conventional 5¼-in. devices, boosting the auxiliary memory capacity of floppy-driven systems with no increase in the total space required or in power consumption.

Besides floppy-based small systems, vendors also expect the hardware to make a quick entry into the office-automation market where it will be supplied on an OEM basis for use in intelligent typewriters, daisy-wheel printers and other equipment.

Two slimline floppies from BASF have been on the U.S. market for more than a year. Called 6106 (single-sided) and 6108 (double-sided), the drives measure approximately 2.1 in. high, compared to 3.25 in. for an SA450. Both drives incorporate cam actuators and operate at 48 tracks per in. Storage capacities are 125K and 250K bytes, respectively.

But the slimline devices planned for 1981 will offer higher capacities, several observers say. One of the first such drives is a 2.1-in.-high, 1M-byte device that will be introduced in the first quarter of 1981 by the Remex Division of Ex-Cell-O Corp. Executives at the Irvine, Calif., company confirm that the 96-tpi, drive, code-named "Pico," will undergo testing at beta sites later this quarter. The Pico is intended for use with word-processing stations designed to handle two SA450-type drives, and prices are said to be competitive with SA450-type hardware.

Shugart Associates may announce three slimline drives in 1982. The drives are the single-sided SA300; the double-sided,



48-tpi SA350; and the double-sided, 96-tpi SA360. Sources close to the Sunnyvale, Calif., company say that a 2M- to 3M-byte drive could ultimately result from its slimline program, but product definitions, including bit and track densities and encoding schemes, have not been set.

The company also has not decided on the height of the drive. Some see this as a reflection of fears that a drive ⅔ as high as a conventional device could end up as hardware in search of a market. "Using a drive this high would require a new cabinet design, and OEMs are reluctant to change the mechanical specifications of existing systems," points out Jim Porter, Mountain View, Calif., consultant and publisher of *Disk/Trend Report*. He says the market for the new drives would be based on newly designed systems. "It hasn't been demonstrated that such a market exists."

Raymond Freeman Jr., a Santa Barbara, Calif., consultant, agrees. He anticipates that drives that height will receive a lukewarm reception in the market. "The trend toward increased capacity per drive is clear," he says. As examples, he indicates the dual-diskette 5¼-in. floppy-disk drives from Data Master Corp., Camarillo, Calif., and from T & E Engineering, Inc., Gardena, Calif., the dual-diskette 8-in. hardware from Persci, Inc., Los Angeles; and the model 82 floppy-disk drive from Micro Peripherals, Inc., Chatsworth, Calif. (MMS, July, p. 58). "What is not clear is whether or not this increased capacity will be achieved by creating a different slot size," Freeman says.

Officials at Remex reportedly see things differently, however. "The concern is not slot size but total space available for drive hardware," says one observer. "The way Remex sees it, 2/3-high, 96-tpi drives will give the user 6M bytes of storage where previously he could have gotten only 4M bytes."

Most observers agree, however, that a ½-size, 5¼-in. floppy-disk drive offers far more potential. Two drives could then be stacked together in the space occupied by one SA450-compatible device, obviating the need for a redesign of the disk-drive cut-out and dramatically increasing total storage.

But several sources say there is not enough room in a ½-high, 5¼-in. drive to mount the clutch and centering mechanism needed to align the media with the accuracy required for operation at high track densities. "The question of how to center the media accurately on such a short spindle has yet to be answered," says Stuart Mabon, president of Micropolis Corp., Chatsworth, Calif. He says that his

firm has no plans for a 2/3-high drive.

Pertec Computer Corp., Woodland Hills, Calif., is approaching the question of slimline 5¼-in. floppy-disk drives in much the same way, says product line manager Dave Kalstrom. "Given the present cut-out standards, a slimline floppy must be ½-size," he says, "and there's not enough room to get the clutch engaged and disengaged." He adds that Pertec likewise has no immediate plans for slimline hardware.

Spindle motors are another consideration, and shorter motors will be required if the goal of a ½-high floppy-disk drive is to be achieved, Kalstrom says. Such a drive would measure 1¾ in. high, which is too short for the motors now available at prices that would keep the Slimline drives competitive with 3¼-in.-high hardware.

Slimline floppies will require shorter, high-energy motors, says Bernhard Schuh, executive vice president of Papst Motor Corp., Simsbury, Conn. "These motors are available now," he says, "but they are too expensive to be considered in the price-sensitive floppy-disk drive market." More competitively priced brushless DC spindle motors may be available next year, he goes on, although drive makers can still expect to pay a premium for them. "These vendors may be able to absorb the added cost, however," he explains, "given the higher prices anticipated for the newer 96-tpi drives."

Shugart Associates is aiming at a ½-high drive, some sources say. But Remex appears more interested in current motor technology, and apparently will sacrifice the market advantages of ½-high drives for the reliability and producibility of 2/3-high devices. "We can't see how a device can be made squashed down to ½-size and still be reliable," says one source.

Whether trading-off slot size for producibility will work remains to be seen. Freeman feels that users who want increased storage capacity may turn to 5¼-in. micro-Winchesters rather than a new floppy-disk drive concept. Other executives stress the advantages of high-capacity, compact, removable-media floppy-disk drive subsystems. One such advantage is that they eliminate the backup hardware required in systems using hard-disk drives. "The key question for users of small systems will be 'how much removable storage do I have?'" says one vendor. "Questions of slot size may well be secondary."

—John Trifari

Quantum's jump into Winchesters due in 1981

While some vendors of disk drives are uncertain about what direction interfacing standards for 8-in. Winchesters may take, Quantum Corp. has decided to capitalize on the de facto standard being set by Shugart Associates' 5M- and 10M-byte SA1000.

The one-year-old San Jose, Calif., company is offering SA100-compatible drives, designated the Q2000 series, as its first product. The drives will be available in 10M-, 20M- and 30M-byte versions and will have one, two or three disks. All will use 200-mm. oxide-coated media and 3340-technology read/write heads. The Q2000 drives will be packaged in an envelope measuring 8.55 × 4.62 × 14.25 in.—the same dimensions as Shugart's 8-in. Winchester hardware, and the same as its SA850 1M-byte, double-sided floppy-disk drive.

The Quantum drives will be pin-compatible with the SA1400 controller announced by Shugart at this year's National Computer Conference in Anaheim (MMS, May, p. 24). This controller enables designers to tie the 8- and 14-in.

Quantum's McCoy, left, *and president Jim Patterson: improving on a standard.*

Winchesters to backup floppy-disk drives and to tape-cartridge transports from Data Electronics, Inc. (DEI), San Diego.

Quantum is the second company to introduce SA1400-compatible hardware. This past May, a start-up in Costa Mesa, Calif., Archive, Inc., announced its "Sidewinder" SA1400-compatible ¼-in. tape-cartridge drives (MMS, July, p. 28).

Compatibility between the Q2000 and the SA1000 extends beyond mechanical and interfacing levels, says Jim McCoy, Quantum cofounder and marketing vice president. The drives are designed to operate with the same power supplies and to incorporate the same internal airflow and temperature characteristics as the Shugart device.

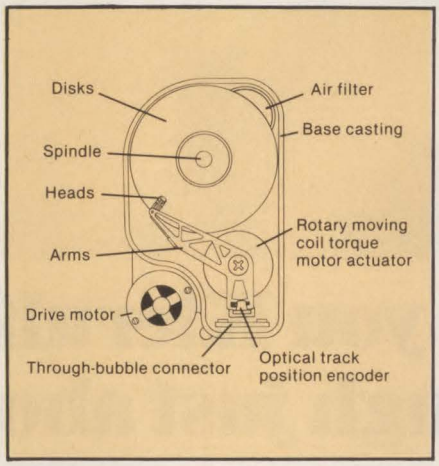
McCoy stresses, however, that Quantum has not produced an exact copy of the SA1000. He says that, besides being offered in higher capacities, the new drives operate faster than the SA1000. Average access time is 50 msec., compared to 70 msec. for the SA1000. The new drive also has lower power dissipation—120W versus 150W for the Shugart drive.

Head actuator systems are also significantly different. The SA1000, incorporating floppy-disk technology, uses a stepper motor tied to a split-band positioner that moves the drive's read/write head in a linear direction. But Quantum's drive uses an actuator concept like the E-magnet voice-coil motors and rotary positioners found on some larger-capacity 8-in. Winchesters.

However, the Q2000's proprietary torque motor connects directly to a rotary swing arm (see diagram). This actuator cuts drive costs, McCoy says, and provides "voice-coil performance at the price of a stepper motor."

Used in conjunction with one wedge-shaped embedded servo segment per disk surface, the torque motor boosts total per-disk storage capacities. The Q2000 operates at 345 tracks per in. compared to 172 tpi for the SA1000. Tracking accuracy is updated 50 times per sec.; an on-board microprocessor handles all servo operations, which are transparent to the host computer.

Finally, use of a torque motor "fine-tunes" Quantum/Shugart compatibility, McCoy says. "The controller sees a stepper motor when it is tied to a Q2000." Both the Q2000 and the SA1000 drives operate at the same transfer rates—4.34M bits per sec.—and both use AC spindle motors and belt drives. Concurrent with the Q2000 announcement, Quantum is unveiling an optional data separator, the Q2200. The single-board device splits timing information and data, and handles write precompensation and address-mark writing and detection. Price is set at $275 in single-unit quantities. Quantum plans to supply the separator for evaluation purposes only and will also offer circuit designs for OEMs planning to incorporate the Q2200 into proprietary controllers.



Looking down on a Q2000 *series drive shows the configuration of the torque motor and swing arm actuator. Three drives are available, with capacities ranging from 10M to 30M bytes.*

Quantum also announced a single-board Q2400 controller, comprising an integral data separator and formatter for both its 8-in. Winchesters, 8-in. floppy-disk drives and ¼-in. tape-cartridge transports. Both the separator and the controller can handle multiple Q2000 or SA1000 drives and will be available in the first quarter of 1981.

Price for a 10M-byte Q2000 drive starts at $1200 in OEM quantities—the same as a 10M-byte SA1000. A 30M-byte version sells for $1800. Evaluation units have been shipped, and production versions are due late in the first quarter of 1981.

—John Trifari

Foonly challenges DEC patents with emulator

Imagine a three-year-old company working out of two rooms in a converted school building taking on a foe like Digital Equipment Corp., which is approaching the $2 billion mark. That's exactly what Foonly, Inc., is doing. The Mountain View, Calif., company has introduced its model F2, a machine that emulates the PDP-10, now the DECSystem 10. And DEC says that the F2 violates its patents.

No lawsuits have been filed, but the companies have exchanged several letters. The best way to characterize the situation at this point, says a DEC source, is as "a gentlemen's dialogue."

According to Foonly's general manager Jay Lowe, DEC claims that the F2 violates 96 patents for the PDP-10, DEC's first mainframe-sized machine. Its architecture is the basis for the DECSystem-10 and -20 families. A DEC company spokesman indicates that DEC has various patents on the DECSystem-10 and has brought these to Foonly's attention.

Foonly, says Lowe, claims the patents are vague, and the points in question—the PDP-10 byte-level instructions—have been made public in DEC's technical literature. Further, Lowe claims that the F2 does not use any DEC bus—the

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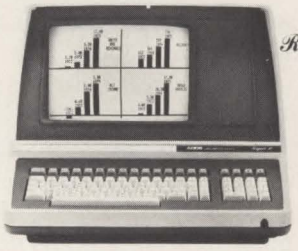

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MASSBUS in this case. Instead, the machine uses Foonly's F-bus. Because the system is microcoded, the F-bus "lets us take any DEC I/O processor and make it do anything we want it to do," says Lowe. This overcomes the problems of DEC software recognizing non-DEC peripherals, for instance. "If we thought we have infringed DEC's patents, we'd be crazy to be doing what we're doing," Lowe says.

That sentiment seems to have affected Foonly's customers, who so far have purchased 11 machines. Lowe says that Foonly has 16 more on order, with one headed for the National University of Mexico in Mexico City.

Foonly's largest customer is Tymshare, Inc., a Cupertino, Calif., timesharing firm. Tymshare has purchased seven F2s, says Lowe, and another one is in the final stages of manufacturing. A source at Tymshare confirms that and says the company is using the Foonly machines for research and development on Augment, a timeshared office automation system. However, the source points out that Tymshare is not running any DEC software on the F2s, and that the F2s "happen to be hardware that suits our current development efforts." Tymshare may order more F2s, the source continues, "but it all depends on how well the R & D goes." He sees no problem for Tymshare regarding possible patent violations by Foonly.

The F2 is the result of Foonly's first project. Founded as a hardware consulting firm, Foonly was contracted by Information International, Inc., Los Angeles, to develop a PDP-10 emulator that was three to four times faster than DEC's machine, and that could be used in a photocomposing application. The first system was called the F1.

The F2 is a microprogrammed machine that can emulate any processor in the DECSystem-10 or -20 line. According to Lowe, the F2 can execute the PDP-10 instruction set with a speed equal to that of the DECSystem-20/2, but at a considerable savings.

For less than $100,000, says Lowe, a customer can get a basic F2 system consisting of a processor, 256K words of 36-bit MOS error-correcting memory, a 160M-byte Winchester-disk drive, a 125-ips tape drive, 16 terminal ports and system software. The F2 runs TENEX, an operating system developed about 10 years ago by Bolt, Beranek and Newman for the U.S. Defense Department's ARPANET. Foonly claims that TENEX will run most TOPS-20 applications programs with few changes. A TOPS-20 compatibility package is available.

Foonly is targeting F2s primarily at the research, scientific and educational timesharing markets, says Lowe. The PDP-10 has already made its mark in that market, but targeted users are ready for a more powerful machine like the F2. "The PDP-10 is an old architecture," says Lowe, "but there's a lot of very fine software out there." He says the company's challenge is to ensure a large enough market for the F2.

But the market is still small. According to DEC sources, about 1500 DECSystem-10s have been sold since its introduction 10 years ago. Lowe says Foonly would like to get 10 to 20 percent of that market, or "a couple of hundred systems."

The rumor that DEC plans to leave the mainframe business is probably affecting Foonly's market penetration. DEC denies the rumor. But Lowe asserts that within the next 18 months., DEC will introduce the "last PDP-10, the DECSystem-20/80."

DEC wants to downplay the issue and hopes, "to work something out," according to a company source. But one industry insider wonders why Foonly decided to emulate the DECSystem-10. "Of all DEC hardware, you would think they would pick something better," he says.

Nevertheless, Foonly is encouraged by F2 sales, and expects to announce at least two more products during the coming year—both DEC emulators. One will be aimed at the small systems market.

—Larry Lettieri

LEGAL HASSLES DON'T SLOW FOONLY

Activity at Foonly, Inc., hasn't slowed even with the threat of a confrontation with Digital Equipment Corp. The two companies are still corresponding, but that hasn't kept the Mountain View, Calif., company from taking orders for two of its newest machines—the F4 and the F5—which it expects to deliver in six months.

The F4 is twice as powerful as the company's flagship F2, says sales manager Jay Lowe, and delivers about 70 percent of the performance of a DECsystem 10/90 or 20/60. An instruction pre-fetching routine makes this performance possible, he says. This routine effectively brings the speed of the system's processor closer to the speed of its memory. An F5 processor is priced at $86,000, says Lowe, and a typical F5 system—similar to an F2 configuration—will sell for about $180,000.

The F5 is a DECsystem 20/20-compatible machine for one to four users, which, says Lowe, "brings powerful PDP-10 software into the world of single-user, under-$50,000 systems." Since the TENEX operating system emulation code has yet to be completed, Lowe is reluctant to give performance figures, but he thinks the F5 will deliver 60 to 70 percent of the performance of its DECSystem counterpart. A one-user F5 will sell for $35,000. A fully loaded single-user F5—color graphics, packet-switching interface and memory—will sell for $50,000, which is also the price of a "no-frills" four-user system.

Family of video displays aimed at distributors, OEMs

Reflecting a decision to expand the market for its line of video display terminals, Soroc Technology, Inc., has introduced two "moderately smart" devices targeted at both distributors and OEMs.

Available as the IQ 130 (for OEMs) and the IQ 135 (for peripheral and industrial distributors), the two terminals are based on Z80 microprocessors and were developed in part to deal with two problems facing vendors of video terminals, one Soroc executive says. "First, all the dollars have been taken out of this type of hardware," says Les Spitzer, director of sales and marketing at the five-year-old Anaheim, Calif., company. "Terminals simply can't be made any cheaper."

As a result, he adds, terminal makers have been forced to increase the capabilities of their hardware, giving customers more performance, rather than seek ways to cut hardware costs further. To do this, Soroc, like a number of other suppliers, has turned to microprocessors and applications-oriented PROM memories. "We offer more features than any other terminal in this price range," Spitzer says, citing built-in word-processing and text-editing capabilities, as well as reverse video, underscoring and blinking features.

Soroc's new entries are also designed to reach an accommodation between what Spitzer says can be conflicts in the two markets the company wishes to reach. "OEMs don't like to see hardware they sell listed in a distributor's catalog," he maintains. The reason: OEMs add value, pushing up the price of a terminal when it's sold to an end user. If that end user sees the same terminal offered by a distributor at a lower price, he may feel that the OEM has overcharged him.

Soroc's Les Spitzer, *director of sales and marketing, says a "moderately smart" terminal has all cost dollars squeezed out.*

Soroc's solution has been to introduce two different terminals. As the IQ 130, the new offering includes a standard ASCII keyboard and a 14-key numeric and special character pad. By pressing the CTRL key and one of these 14 keys, a user can automatically call up a number of user-programmable functions, such as setting screen formats and making special data calls. By activating an ESC sequence, the user can call up other preprogrammed functions, such as inserting and deleting lines and characters and clearing the screen.

Soroc plans to make the IQ 135 version of the terminal more attractive to those who buy lower quantities, typically the customers of peripherals distributors. The terminal includes the standard alphanumeric and numeric keypads, plus an array of 16 keys. Four of these keys (like the first four CTRL/number combinations on the OEM terminal) are user-programmable. The eight remaining keys above the alphanumeric keyboard are used for preprogrammed control functions. Four keys above the numeric keypad handle communications functions (print screen, send line, send page and send message). That design, Spitzer says, makes the 135 as easy to use as possible.

Both terminals will feature an RS232 port for printer and communications output, and both may sport the flip-top corporate logo that reflects the origins of the company's name. According to one source, the name Soroc was developed at one of the first board meetings of the then-unnamed company. The subject of a name was discussed, and one of the co-founders, drinking a can of Coors, took the five letters making up the name of the Colorado brewery, wrote each down on a separate napkin, and switched them around until they made some sense. The result: Soroc.

Both terminals will be unveiled this month at the Comdex show in Las Vegas. Evaluation units will be shipped by the end of the fourth quarter at $1049 for the IQ 130 and $1095 for the 135. Volume prices reportedly will be less than $700. Production versions of both drives are set for the first quarter of 1981.

—John Trifari

Britain enters Winchester backup market via Perex

A subsidiary of the British Sintrom Group, Reading, England, has entered the booming Winchester-disk backup market with the HD6400 ¼-in. cartridge-tape drive. The San Jose, Calif., company, Perex, Inc., claims that the new drive is plug- and media-compatible with Data Electronics, Inc.'s Series 3400 "Funnel," a 17M-byte start-stop device.

The company delivered 10 OEM evaluation units of the drive in September, and expects to make

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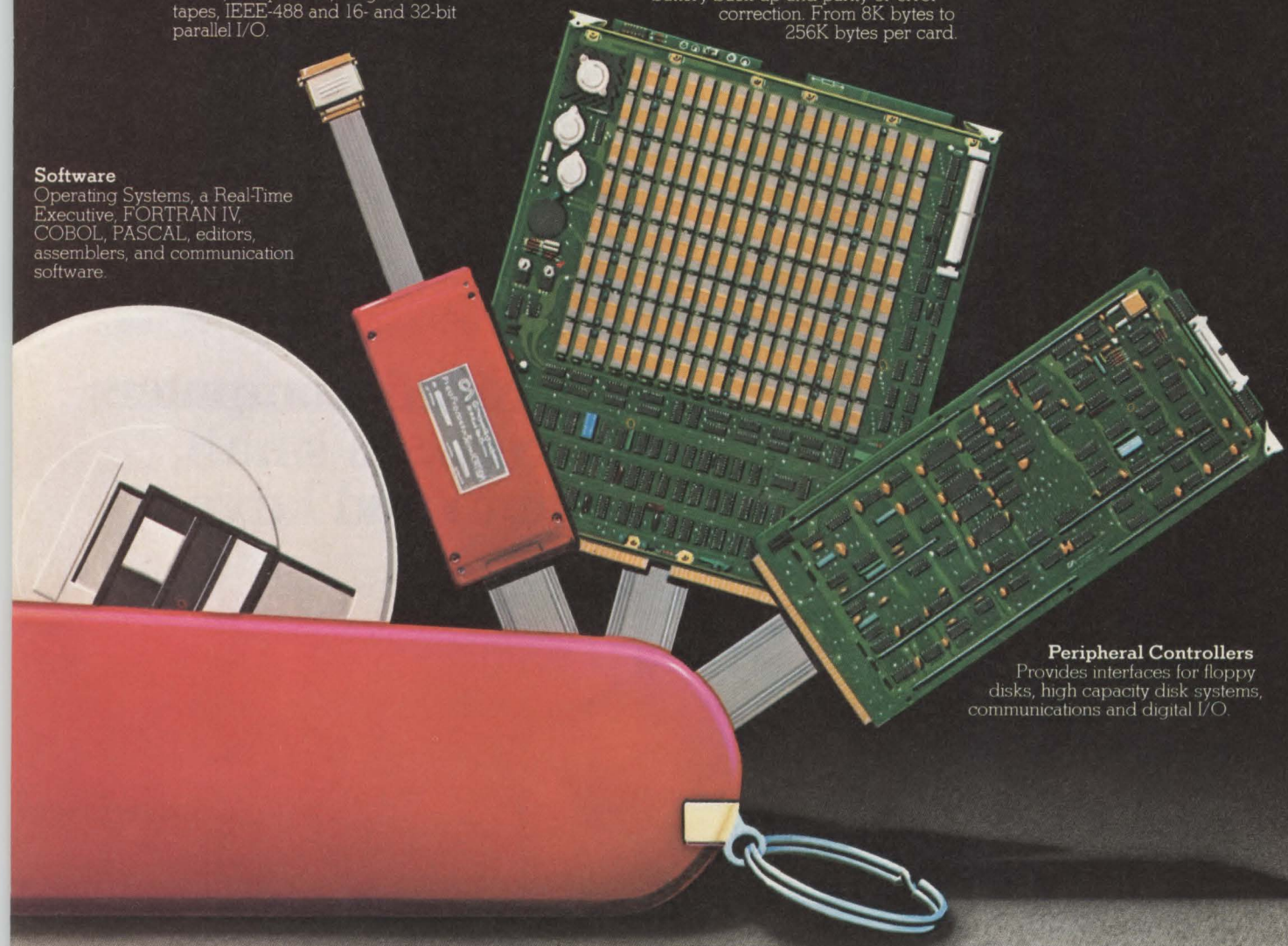

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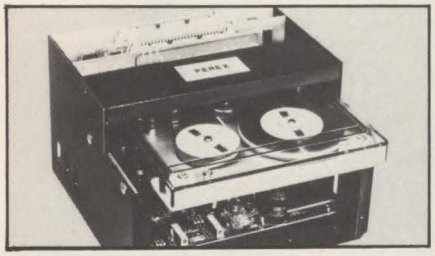
first volume deliveries by December, says Perex president David Sear. He says that all HD6400s will be manufactured initially in the U.K., and U.S. production should begin by mid-1981. Perex's U.K. parent, Perex, Ltd., has been manufacturing cartridge-tape drives for the data-logging industry for nearly six years and decided a year ago to enter the Winchester-backup business, Sear says.

Perex will find itself competing with Qantex Inc., for DEI's business. The Hauppauge, N.Y., company claims its model 400 cartridge drive is also compatible



Perex plans *to start volume deliveries of its ¼-in. cartridge-tape drive by December.*

with DEI's Funnel. The HD6400 is a 6400-bpi, 17M-byte device that uses a standard ½-in. cartridge from 3M Co. The file-oriented drive uses a three-gap, four-track head manufactured by DRH, Ltd., England. Sear says the HD6400 rivals the DEI drive in both performance and price. Including read/write electronics, the drive sells for $1900, with OEM discounts available. Interface and controller cards are optional. When U.S. production is under way, pricing will be reevaluated Sear says.

DEI's reaction to Perex's price/performance claims are summed up by the San Diego, Calif., company's vice president for marketing, Sam Thompson. "Assuming their performance specifications are correct," he says, "we view their entry as a positive point. It confirms that there is a sizable market for such products, and it also confirms that DEI has set the standard."

—Larry Lettieri

MINIBITS

READER'S DIGEST ACQUIRES THE SOURCE

Source Telecomputing, Inc., the personal telecomputing pioneer, gained powerful financial backing in Spetember when it was acquired by The Reader's Digest Association, Inc. STC, which operates the Source, the first telecomputing service aimed at individuals for personal use, is expected to receive a much-needed infusion of expansion capital from its new owner. "The acquisition will allow us to add data bases and services that we couldn't offer previously because of our limited resources," says Jack Taub, chairman and CEO of the McLean, Va., firm. Inaugurated last year, the Source enables its 7000 subscribers to access news, financial data, airline schedules and other information via remote terminals. Although STC now becomes a Reader's Digest subsidiary, it will remain in McLean and will operate "fairly independently," Taub says.

DATAPRO RESEARCH, DATA RESOURCES JOIN FORCES

Datapro Research Corp. and Data Resources, Inc., both McGraw-Hill companies, have entered a joint project to provide on-line information at subscriber sites, including prices and specifications of office and data-processing equipment. Datapro will contribute its library of product reports to the project, while DRI will provide an international on-line telecommunications network, computers and applications systems. Although some industry sources have questioned the need for comparatively expensive on-line rather than printed information, Auerbach Publishers, Inc., announced an on-line pricing service earlier this year (MMS, July, p. 61). GML, Lexington, Mass., which already has an in-house, on-line data base, is also examining the possibility of allowing outside access by subscribers to a data base. However, a company source says that approach is not yet proven in the field. Pricing, availability and service information for the Datapro/DRI offering are not yet available.

DATAPOINT RELEASES AIM TO BUSINESS CUSTOMERS

For more than a year, Datapoint Corp. has been shipping a file access software package, called AIM, with its office-information and communications-management systems. Now the San Antonio, Texas, computer firm has decided to make AIM available on its business systems as well. Jonathan Schmidt, Datapoint's director of advanced planning, says AIM can significantly reduce programming time because, unlike other access techniques, it does not require the use of predefined keys to find information in a file. Instead, a user can employ the contents of any record field as a file-search key, and each record can have as many as 64 fields. In addition, Schmidt says, AIM consumes less disk space than other file-access methods because it requires only one index per data file and does not use pointers to link data records. AIM is available to Datapoint's business customers as part of DATASHARE 6, the latest version of the company's business timesharing system.

ETHERNET TRIUMVIRATE RELEASES LOCAL NETWORK SPECS

Fulfilling a promise made last May, the three sponsors of the Ethernet local area network standard have released design specifications for the standard (MMS, July, p. 17). In addition, Xerox Corp., the original developer of Ethernet, has announced a licensing policy intended to promote its use by other companies. Xerox will make the basic Ethernet patent available for a $1000 one-time payment. Xerox says the license will cover all present and future Ethernet products developed by the licensed companies. Licensing information may be obtained from the manager of licensing, Xerox Corp., Stamford, Conn. 06904. Copies of the Ethernet specifications may be obtained from the Ethernet literature departments of any of the three sponsoring companies: Digital Equipment Corp., 1925 Andover St., Tewksbury, Mass. 01876; Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051; Xerox Corp., 3333 Coyote Hill Rd., Palo Alto, Calif. 94304.

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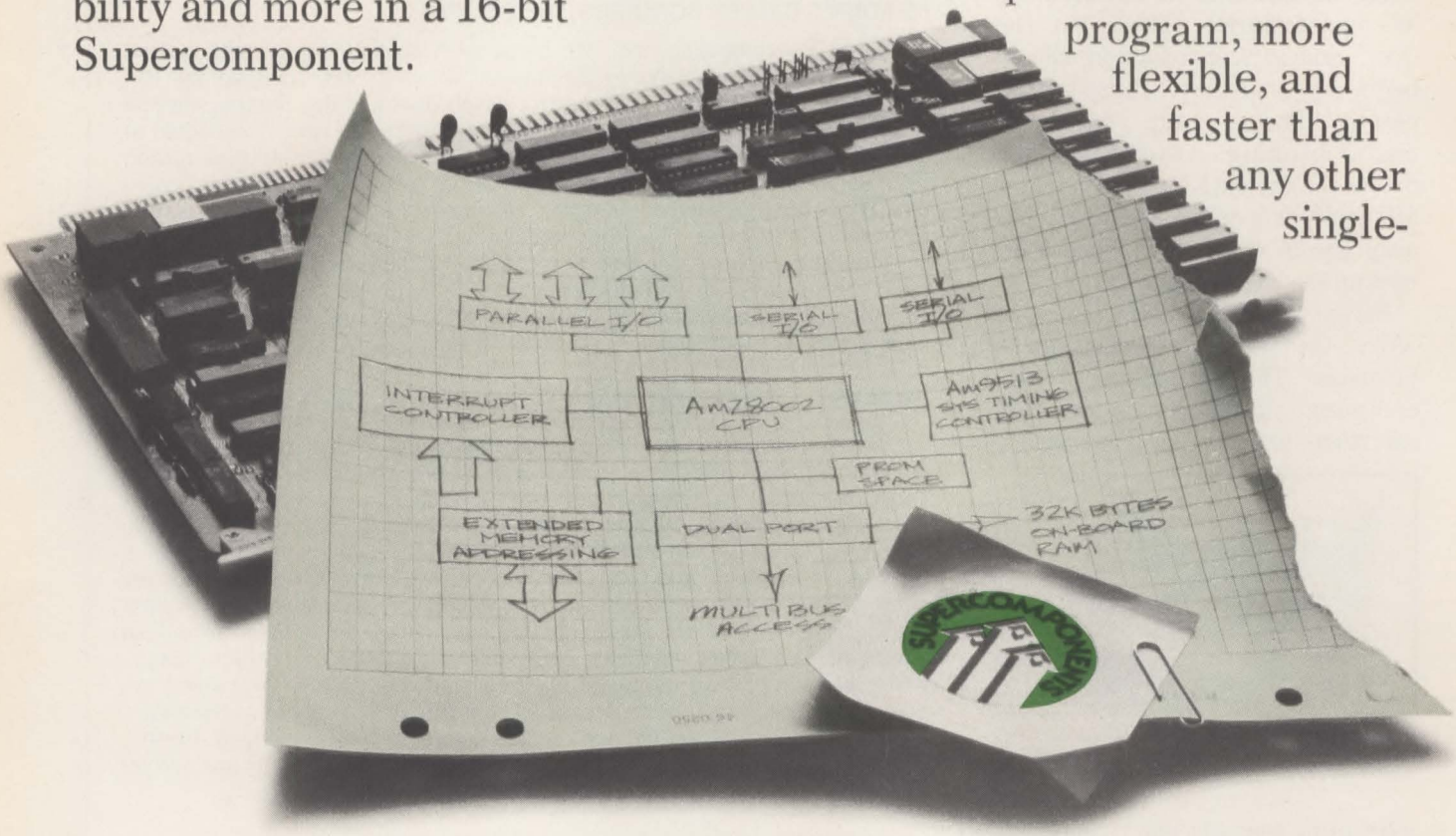

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*Multibus is a registered trademark of Intel Corporation.

Xerox 5700 combines laser, digital technologies

A multifunctional system from Xerox Corp. that seems to be as much a computer as it is a copier and printer is regarded by its developers as "the next logical step for the management of information and office automation." That's what Robert V. Adams, president of Xerox's Printing Systems Division, El Segundo, Calif., says of the model 5700 electronic printing system. The 5700 employs a 16-bit microprocessor that can intermix fixed and variable data to perform printing, copying and communications functions.

Deliveries of the 5700, which is intended for word-processing and office applications, will begin in selected cities next month.

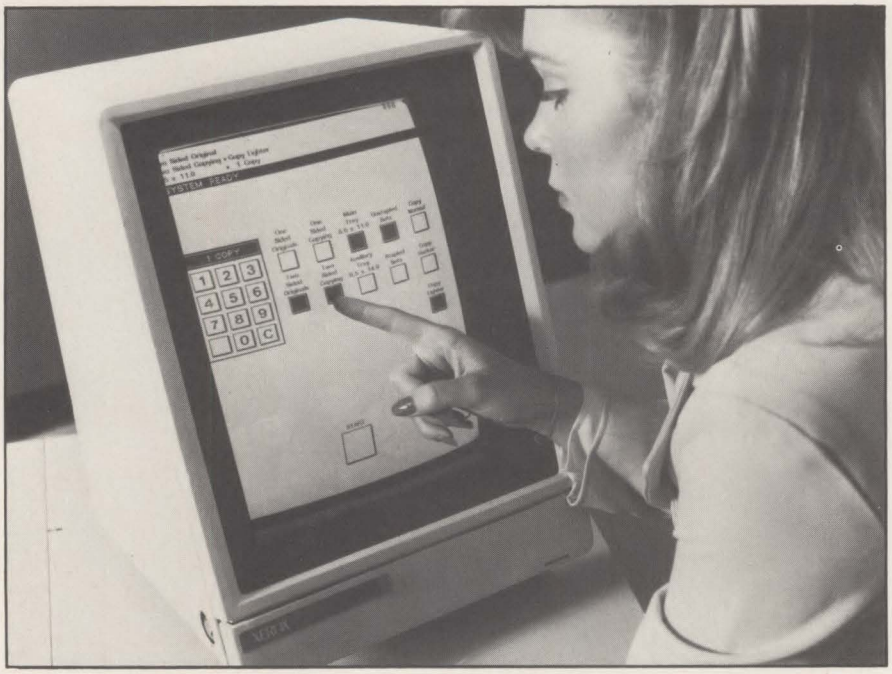
It is said to print as much as 40 times faster than typical word-processing printers and can send or receive a page of text in 3 sec. Resolution is 90,000 dots per sq. in., which the company claims is comparable to offset-printing quality. Additionally, the 5700 will offer an interface that enables it to be used with Xerox's Ethernet local data-communications network (MMS, July, p. 17.)

The system is housed in two separate units. One contains the digital processor, 18M bytes of hard-disk storage, a system diskette station used for diskette or magnetic media input from a word processor, a controller for the touch screen (see "Incorporating touch technology," p. 26), and the touch-control screen itself, which serves as a function control panel and is mounted on top of the unit. Two disks are available: an internal unit with 28M bytes of unformatted information, and one for media exchange. Communications input is via an RS232C interface, operating at data rates as high as 9600 baud, which can access other 5700s or operate under IBM 2770 communications protocol. The input also provides linkage for as many as eight Xerox 850 word processors.

The second unit contains imaging, printing, and output trays. The copier imaging device can reproduce two-sided copies and interleave copies with word processor text pages.

The printer can produce 200 font styles and sizes ranging from 6 to 24 points. An internal 16-bit microprocessor, developed by Xerox, controls a laser scanner that produces 90,000 dots per sq. in. Signatures, line drawings, graphics and numbers can be printed at high resolution because placement of each dot is controlled. However, nonstandard print, such as logos and signatures, must be digitized at Xerox.

"The 5700 makes use of Xerox's best talents in reproduction and reprographics," says Amy Wohl, a principal at Advanced Office Concepts Corp., Bala Cynwyd, Pa., an office-automation consulting firm. One major problem with the 5700, Wohl says, is its lack of broad interfaces to other word-processing equipment in its initial form. The



The Xerox 5700 printing system *consists of two separate units: the touch screen and controller (left) and the printing system.*

INCORPORATING TOUCH TECHNOLOGY

The first commercial application of the "touch" technology unveiled late last year by Carroll Manufacturing Co., Champaign, Ill., (MMS, March, p. 76), will be Xerox's recently announced model 5700 laser printer.

The Carroll system is based on a matrix of LEDs mounted around the frame of a CRT screen. The result is a grid of light beams forming hundreds of X-Y coordinates, or touch points. The viewing area is then scanned by pulsing the LEDs sequentially and detecting at what point the beam has been broken by a user's fingertip.

Xerox is using "touch" on the 5700's CRT control console for a number of functions. Carroll Manufacturing reportedly has delivered more than 100 of the touch systems to Xerox so far. *—John Trifari*

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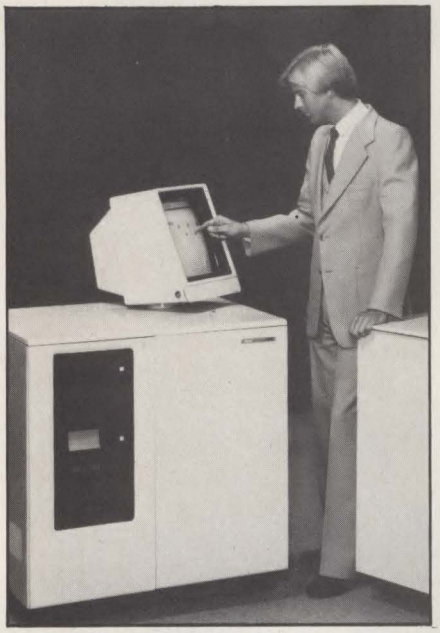
CIRCLE NO. 17 ON INQUIRY CARD

5700 can be interfaced to the Xerox 850 and 860 word processors and the IBM System/6. But its strongest competitor, the IBM 6670 information distributor, can interface to other systems, including Wang systems.

"It (the 5700) has some hooks to the IBM magnetic-card environment, but it does not have a clean interface into Wang systems," says Wohl, adding that Xerox wants to take this road also. Xerox's Adams declines comment on that competition. The 6670 prints 12 to 36 pages per min., compared to the 5700's 43 ppm. Further, prices for the 5700 start at $66,300. That's $8700 less than the 6670.



The 5700's touch screen *serves as a control panel. A "help" button also is available to explain instructions to the operator.*

Judith Hurwitz, a researcher at International Data Corp., a Waltham, Mass., market research firm, says that the 6670, introduced about two years ago, has about 500 units installed in end-user sites, and about 1500 at IBM. She adds that the 5700 has some features that the 6670 lacks, including a touch screen, the ability to staple and collate copies and the ability to generate standard forms electronically. But Wohl says that the touch screen, designed to make user interface to the 5700 easier, may result in users having one more display screen than necessary. Currently, there is no alternative input to the 5700.

Wohl and Hurwitz say users have expressed an interest in a device that can print and copy easily as part of their word-processing centers. Adams concurs that the 5700 will be used in operations requiring substantial paper manipulation. Such applications include institutional banks, insurance companies and large law firms.

The 5700's use for electronic mail is also a strong point. Messages and documents can be sent between 5700s in different locations. For example, a 50-page report could be sent from New York to Los Angeles in less than 2 min. An alarm feature in the 5700 can "awaken" the system after office hours to send or receive as many as 1000 pages of stored information. *—Lori Valigra*

Development of high-quality dot-matrix printers speeds up

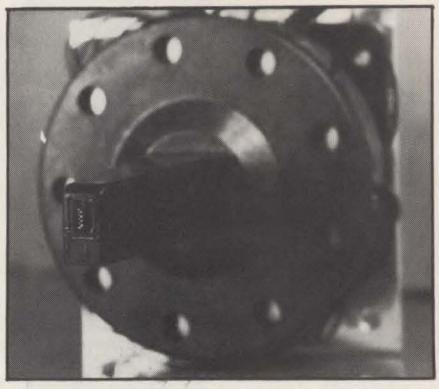
Despite a relatively amorphous and untested market, manufacturers are jumping on the bandwagon to develop high-density dot-matrix printers.

Touting the benefits of high speed, low cost and essentially unlimited character fonts, dot-matrix printer manufacturers such as Okidata Corp., Mount Laurel, N.J., and Integral Data Systems, Natick, Mass., intend to sell their high-quality products to data-processing and low-end word-processing users. However, they have not yet received the blessing of word-processing manufacturers, who question the quality of dot-matrix print (see "Breaking down the office market barriers," p. 37).

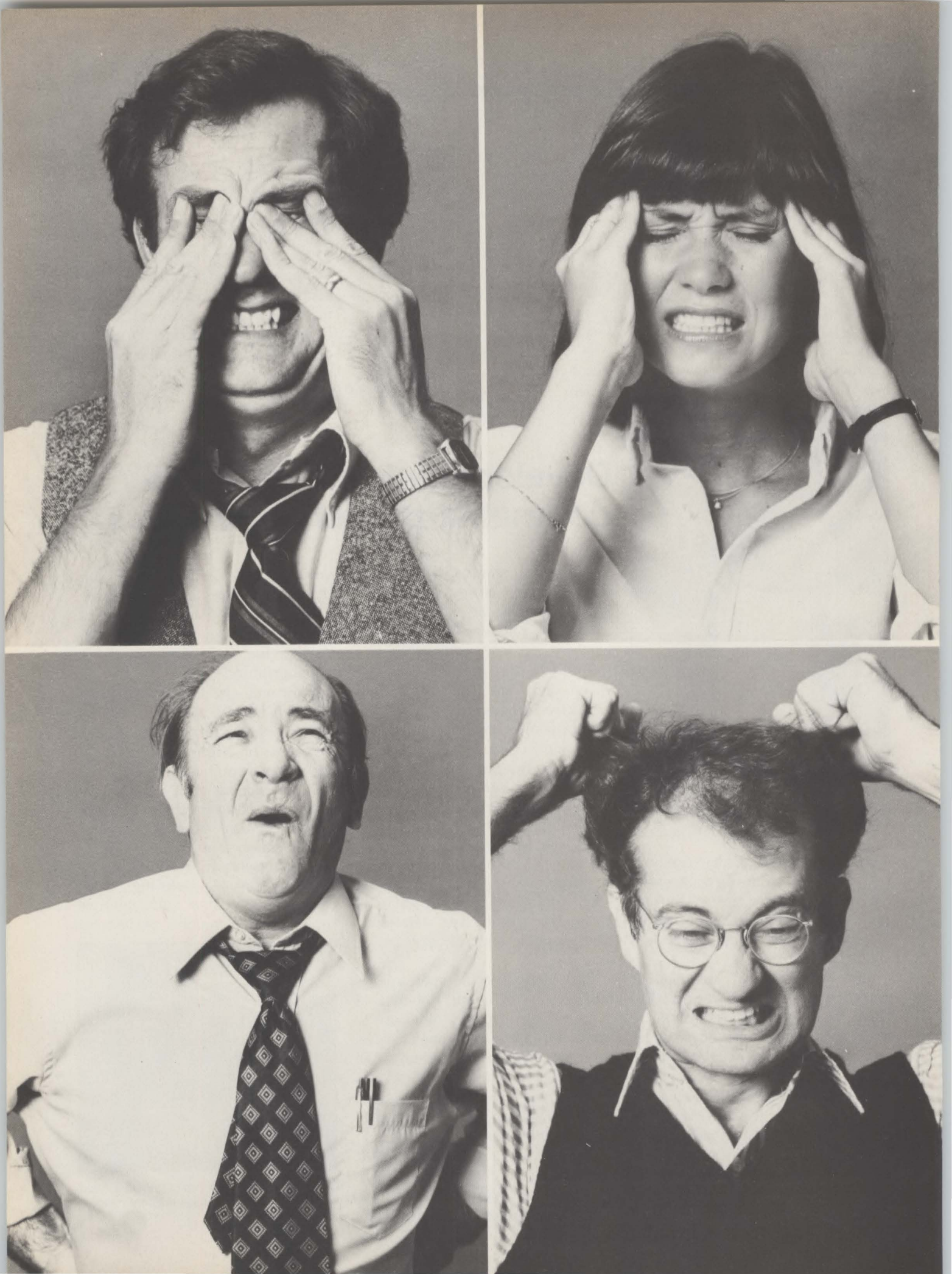
That blessing could open a large market by offering dot-matrix printers as support devices to produce reports and rough drafts. One industry executive says the domestic market for low-end printers that cost less than $1500 could grow from 50,000 units in 1979 to 450,000 by 1984.

Companies traditionally not dedicated to dot-matrix printers are beginning to take a look at that technology. Among them are Wang Laboratories, Lowell, Mass., and Diablo Systems, Inc., Hayward, Calif. Diablo—along with Qume Corp.—holds 90 percent of the market for fully formed, daisy-wheel printers.

Many industry participants agree that dot-matrix printers will not replace fully formed character printers in high-quality word-processing applications. Instead, they are aiming their products at what one observer calls a broad middle segment between high-end and "quick-and-dirty" data-processing output, including mixed data- and word-processing tasks, electronic mail and quck multiple copies of staff reports or internal



Close-up of IDS 460 *prototype print head shows two rows of staggered print needles used to overlap dots.*



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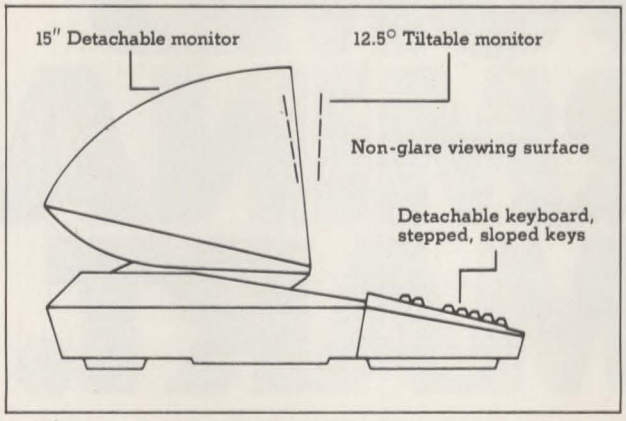

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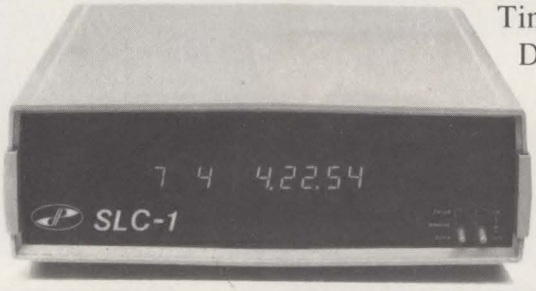


GET INTO THE TIME MACHINE.

DIGITAL PATHWAYS

CIRCLE NO. 19 ON INQUIRY CARD

documentation. The trade-off of lower-quality for dot-matrix print is offset by an average printer price of $1000 and speeds of 100 to 200 cps, compared with $2500 or more and 30 to 55 cps for fully formed character printers. About 10 high-density matrix printers were shown at this year's National Computer Conference, and they will open the door for more at next year's show. Three major approaches to high-density printing are multiple pass of the print head, multiple pins or needles in the print head and/or staggered-pin print heads. The most notable products seemed to be the Integral Data Systems IDS 460, the Okidata Microline 8300 and two Siemens printers.

The IDS 460 incorporates two rows of staggered pins, one with five and one with four pins, to overlap dots and create a fuller dot image. The printer operates bidirectionally at 150 cps in a proportional-spacing mode and at 110 cps in a monospaced mode. Price is $1295.

"We're betting on it (high-density printing) as a viable technology for the next five years," says Peter Eisenhauer, director of marketing at IDS. He adds that the company that comes closest to providing good print quality, performance and price in one package will be the winner in the lower-cost printer market.

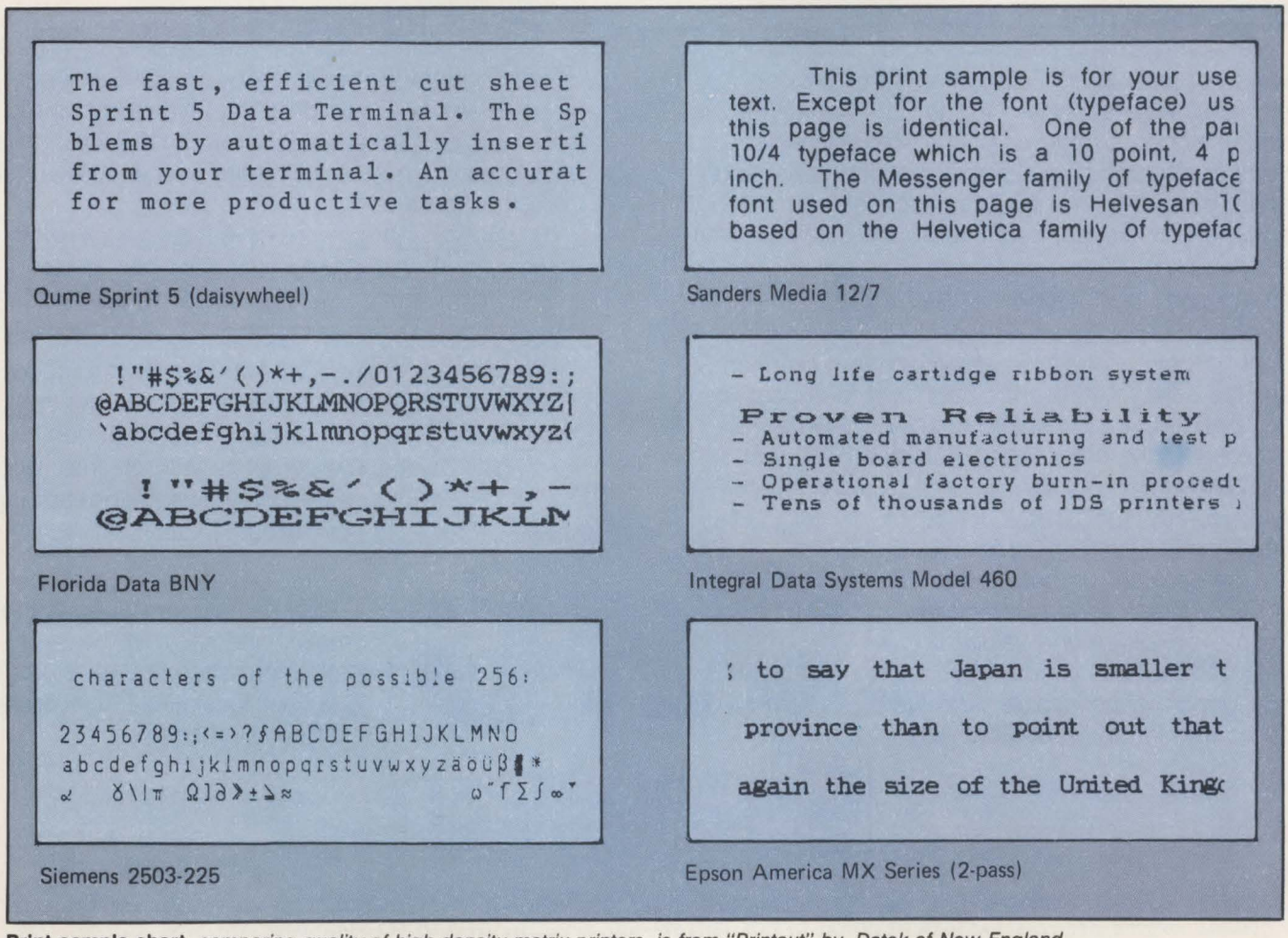
Although Eisenhauer says there is a significant long-range application in word processing, he realizes that users in "true" word-processing environments will demand letter-quality print. "If word processing were the only opportunity in the market, then IDS would be ill-advised to pursue it," he says.

IDS was scheduled to begin shipping some of its several thousand backlogged products in August. The initial application for the IDS 460 is current dot-matrix-printer users who will buy better print quality at a comparable price/performance ratio.

Eisenhauer realizes IDS will sell to its own customers to some extent, but says, "I'd rather sell into our own base than have someone else do it. That's what innovation is all about."

As the demand for better print quality grows, Eisenhauer says IDS will improve its product to meet those requirements. He says the company's best efforts should be in print-head design, and the company is examining other approaches, including multipins. IDS will also add more graphics software.

Okidata showed a prototype



Print sample chart, *comparing quality of high-density matrix printers, is from "Printout" by Datek of New England.*

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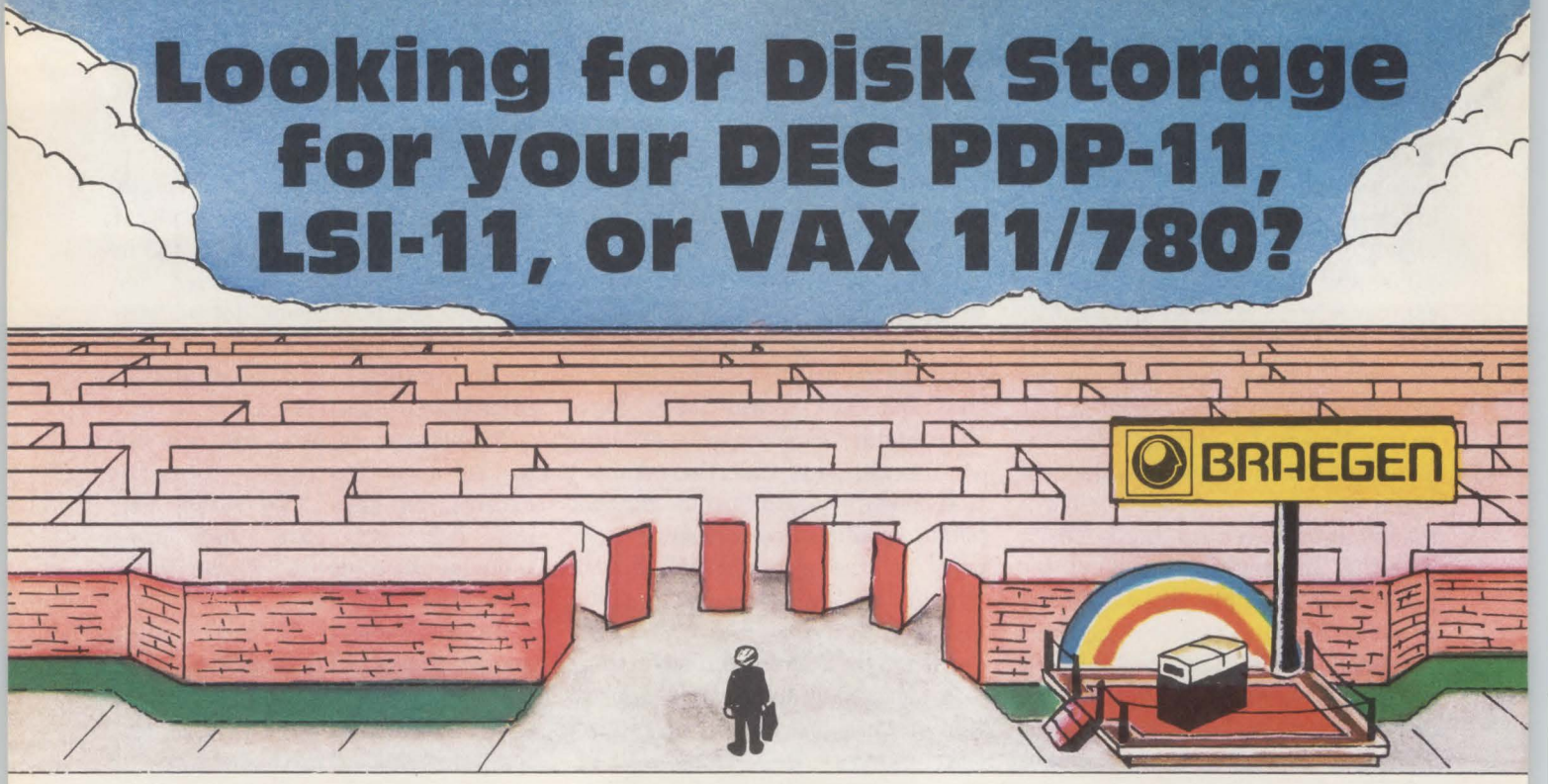

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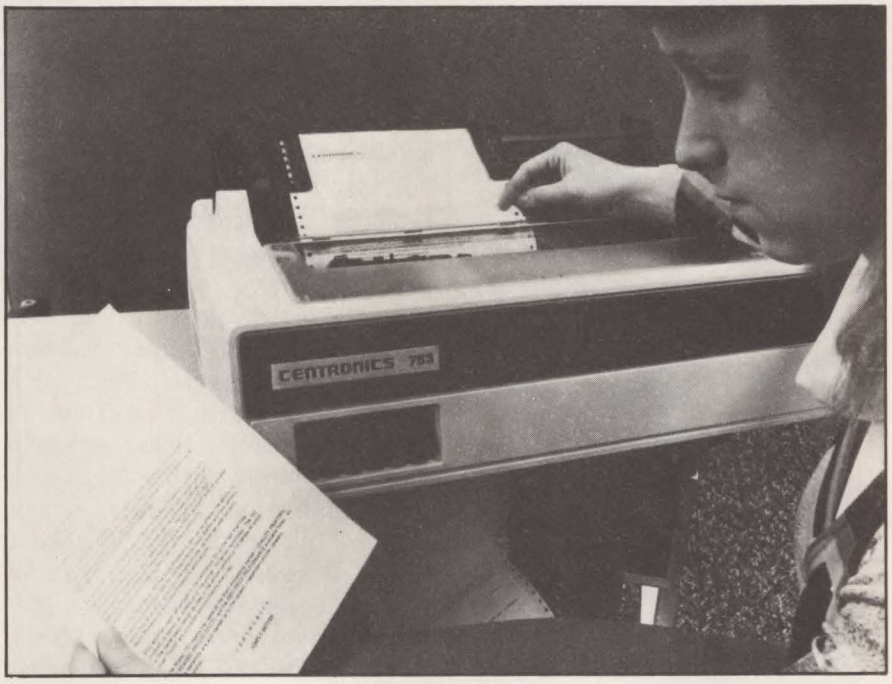
CIRCLE NO. 20 ON INQUIRY CARD

high-density matrix printer at NCC, claiming it produces the same quality as a Diablo or Qume printer at a 20- to 30-percent lower price. Called the Microline 8300, it consists of a 22-wire multipin matrix print head with two rows of staggered pins. It prints 40 cps unidirectionally and will be priced at about $1200 in OEM quantities. The production model, which is scheduled for introduction in the first quarter of 1981, is expected to be bidirectional and will print almost twice as fast as the unidirectional model. IDS's Eisenhauer says the 8300's speed must be increased, but bidirectional printers require a better design to avoid character-and dot-alignment problems.

Jacob Powell, Okidata's vice president of marketing, says the company can sell the 8300 to "anyone using a Qume printer." The company surveyed 121 NCC attendees regarding the quality of the 8300. Almost 70 percent of those polled rated it close to or comparable to fully formed printers.

Powell adds that IBM has helped pave the way for Okidata's ambitions in the word-processing market. He says that the 8300's quality is as good as that of the IBM ink-jet printer. Even so, Powell has not yet tried to sell the 8300 to word-processor manufacturers.

Another multipin or multiwire head design was shown in two printer models from Siemens. The 18-wire head, believed to have been designed by DH Associates and used by at least six other companies in various printers, is incorporated in two models. The 2503-220 employs single- or double-pinfeed tractors, and the 2503-225 has automatic-sheet feeding. Three print-head



Centronics' model 753 *employs an N × 9 matrix that can produce as many as 18 dots by nine-wire-high characters.*

BREAKING DOWN THE OFFICE MARKET BARRIERS

The market for high-quality dot-matrix printers is not well-defined, some market observers claim, but it will become clearer when word-processing vendors make a commitment to that technology.

"There has not been much evaluation of what quality is or is not acceptable by word-processing users," says Edward Webster, editor of *Printout* newsletter. Support from those already in the word-processing arena will probably help to usher in the technology more quickly. That support will come from word-processing manufacturers, software houses and daisy-wheel printer manufacturers.

Wang Laboratories, Lowell, Mass., offers a matrix printer, the 5520, as a draft-quality printer for word-processing systems. Focusing on the end user, the company intends to take a different marketing tack from that of dot-matrix printer manufacturers. It will supply a high-quality matrix printer that will serve as a substitute to daisy-wheel printers, not as a backup, according to Fred Wang, vice president of marketing, planning and development. Wang says the benefits of dot-matrix printers are graphics and electronically handled fonts that can produce multiple languages, various sizes of characters and scientific formulas.

He says the new Wang matrix printer will incorporate the 5520's staggered print head, which has two rows of five and four pins each, and will be triple pass. Scheduled for production in a year, the printer will sell for about $1700 ($4000 to $5000 end user), and print at 45 to 50 cps.

Wang says the printers will be used in large word-processing systems that include eight work stations and two to three printers. The company is also evaluating an 18-pin head printer for lower-quality print.

Software houses are another stumbling block, according to Peter Eisenhauer, director of marketing at Integral Data Systems. "In some cases the printer is too capable. Existing character printers are dumb printers. So IDS must get software houses used to having software in the printer, which saves on software in the system."

Daisy-wheel printer manufacturers are also evaluating high-density matrix printers. "There is a niche for that product in the market, and it will provide some competition to the daisy wheel," according to Rigdon Currie, vice president of field operations at Diablo Systems, Inc.

Mini-Micro World

options are available with the 2503 models: 9 × 7 characters at 250 cps, 9 × 9 characters at 160 cps and "text-quality" 18 × 18 characters at 100 cps. According to one source, the printer is quieter than daisy-wheel printers; it is rated at 60 dBA when operating alone and 70 dBA when operating with mulitple printers.

These contenders must be seen in perspective. Future models and one existing model should also be considered. A new printer from Florida Data Corp. will use a multipass approach. Centronics Data Computer Corp. is also planning a new printer, but its approach is not known.

The Media 12/7 from Sanders Technology Systems, Inc., is a quality-setting printer and one of the first to use multipass technology. It is believed to offer the closest quality to that of daisy-wheel printers. But the Media 12/7 has not gained market acceptance because it has difficult interfacing requirements and manufacturing problems. Further, it seems to offer no clear price or performance advantage.

But the Media 12/7 proved one point, says James Adkisson, president of Florida Data, Melbourne, Fla. It proved that "matrix printers could produce word-processing quality, but in an expensive way." He adds that Sanders could have sold more Media 12/7 printers if it had included an interface that was compatible with word processors.

Florida Data sells a two-pass printer, the BNY, and the company will introduce a higher-quality two-pass model next spring, Adkisson says. The BNY prints 600 cps in a 7 × 9 dot matrix, and 300 cps with two passes in a 16 × 16 matrix. The product under development is an overlap matrix printer that does not use tractor feeds and solenoid print heads, but instead employs a fast print head with magnetically stored energy. A few of the new printers are now in beta test sites. High-quality speed is 150 cps, and data-processing speed is 300 lpm, Adkisson says.

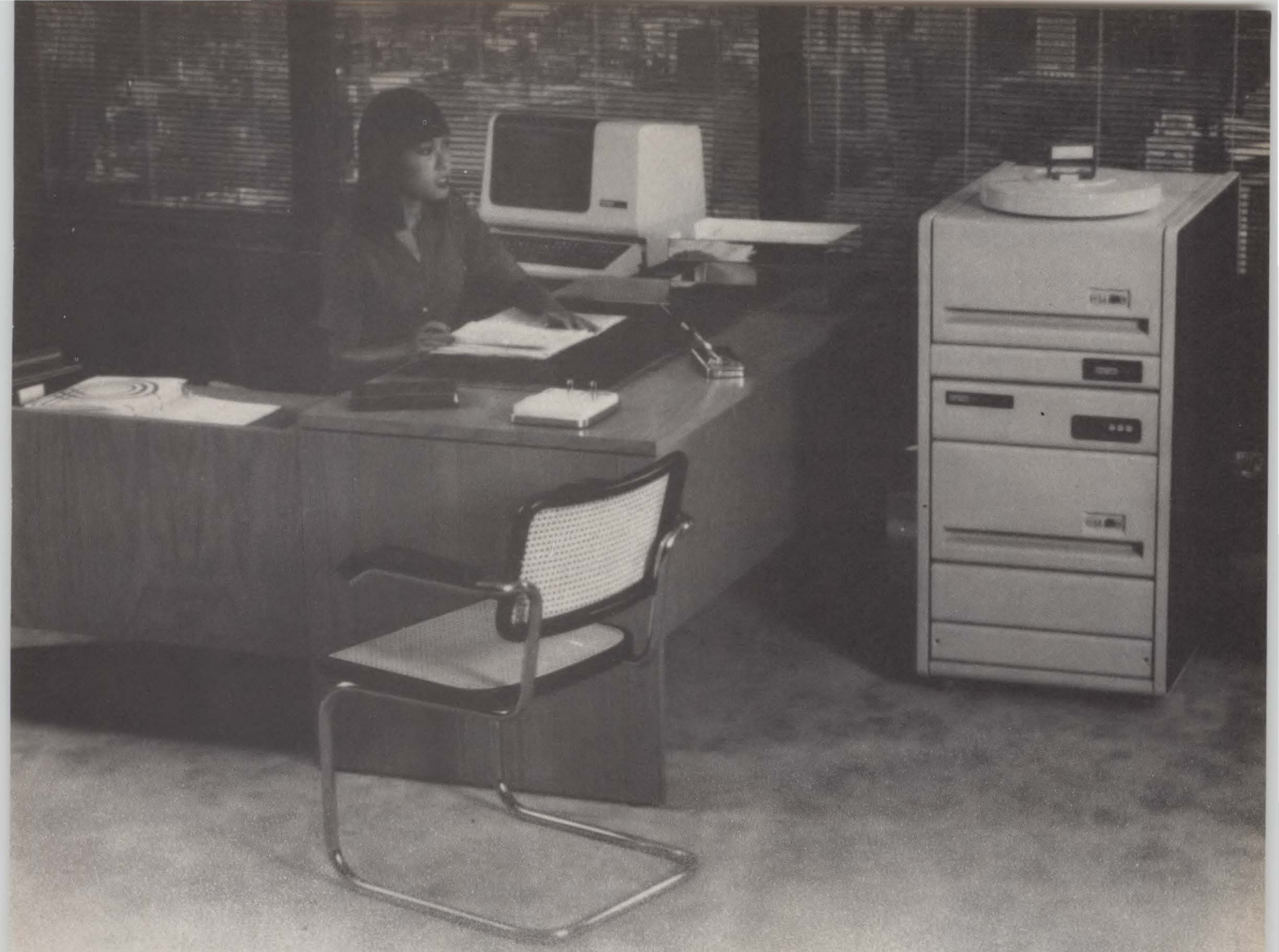
Centronics, which is evaluating all three print-head techniques for a high-density printer, claims to offer two high-quality matrix printers—the model 753, which prints at 120 cps and costs $3070, and the model 737, which prints at 70 cps and costs $995 in end-user quantities. Both printers incorporate functions that enable clear character impressions. The N × 9 matrix enables as many as 18 dot positions at nine wires high. The model 737 also includes proportional spacing.

Centronics chairman and CEO Robert Howard states that he wants OEMs to depend on Centronics for all their needs, and the new printer is being built with that objective in mind.

It provides letter quality for use in word-processing, text-editing and business applications, but it is not a daisy-wheel replacement. The printer will fill 80 to 90 percent of word-processing applications, says George Rea, vice president of the microcomputer division at Centronics. He adds that Centronics is not convinced that staggered pins are the best answer to better print quality.

But probably the fiercest market contender to emerge from Centronics will be the much-awaited Quietwriter (MMS, January, p. 35), which combines elements of impact and non-impact printing, and operates like a pen. Digital signals are electrostatically transformed into analog form via three voice coils that control a pen-like stylus. The result is quiet operation, but disadvantages include low speed—averaging 16 cps—and a price comparable to that of daisy-wheel printers. The print speed reportedly has been doubled, but Rea would not comment except to say production will begin in 1981.

—Lori Valigra



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Calendar

SHOWS & CONFERENCES

NOVEMBER

18-20 Information Management Exposition & Conference for Manufacturing Companies, Chicago. Contact: Clapp & Poliak, Inc., 245 Park Ave., New York, N.Y. 10017.

18-21 COMDEX '80, Las Vegas, Nev., sponsored by the Interface Group. Contact: Peter B. Young, The Interface Group, 160 Speen St., Framingham, Mass. 01701, (617) 879-4502.

20-23 Northeast Business & Home Computer Show, Boston. Contact: National Computer Shows, P.O. Box 678, Brookline, Mass. 02147, (617) 524-4547.

DECEMBER

1-3 Computer Crime Info Conference, Arlington, Va., sponsored by The Information Exchange. Contact: Gil Merritt, Computer Crime Info., 1730 North Lynn St., Suite 400, Arlington, Va. 22209, (703) 521-6209.

8-10 National Conference on Public Information Systems, Washington, sponsored by the Center for Policy Research. Contact: Public Systems Conference Manager, 12611 Davan Dr., Silver Spring, Md. 20904, (301) 622-0066.

10 1980 Computer Networking Symposium, Gaithersburg, Md., sponsored by the Technical Committee on Computer Communications in the Institute of Electrical and Electronics Engineers (IEEE) Computer Society and the NBS Institute for Computer Sciences and Technology. Contact: Stan Lichtenstein, U.S. Department of Commerce, National Bureau of Standards, Washington, D.C. 20234, (301) 921-3181.

11-13 Computer & Engineering Job Fair, Los Angeles, sponsored by Computer & Engineering Job News. Contact: Paul Sullivan, Public Relations Director, Computer & Engineering Job Fair, 470 Boston Post Road, Weston, Mass. 02193, (617) 899-2702. Other dates and locations available.

JANUARY

7-9 Second Annual Western Conference & Exposition, Anaheim, Calif. Contact: Judith H. Shreve, Armed Forces Communications and Electronics Association, One Skyline Place, 5205 Leesburg Pike, Suite 300, Falls Church, Va. 22041, (703) 820-5028.

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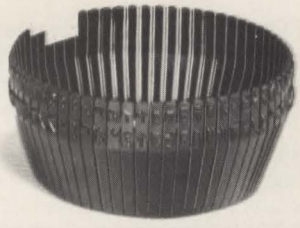

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CIRCLE NO. 24 ON INQUIRY CARD

Calendar

8-9 14th Hawaii International Conference on System Sciences, Honolulu, Hawaii, sponsored by the Department of Decision Sciences, the Department of Information and Computer Science and the Department of Electrical Engineering at the University of Hawaii. Contact: Prof. Dennis J. Streveler, University of Hawaii of Manoa, Advanced Management Program, 2404 Maile Way, Honolulu, Hawaii 96822, (808) 948-8135.

13 Invitational Computer Conference, Costa Mesa, Calif. Contact: B. J. Johnson & Associates, 2503 Eastbluff Drive, Suite 203, Newport Beach, Calif. 92660, (714) 644-6037. Other dates and locations available.

13-15 Communication Networks 1981, Houston. Contact: Terri Hamilton, Communication Networks '80, c/o The Conference Company, 60 Austin St., Newton, Mass. 02160, (617) 964-4550.

13-15 Southcon Electronic Show and Convention, Atlanta, Ga., sponsored by the Georgia and Florida units of the Institute of Electrical and Electronic Engineers (IEEE) and the Electronic Representatives Association (ERA). Contact: Robert Myers, 999 N. Sepulveda Blvd., El Segundo, Calif. 90245, (213) 475-4571.

16-17 Microcomputer Conference, Tempe, Ariz. Contact: Dr. Gary G. Bitter, Conference Director, Arizona State University, Payne 203, Tempe, Ariz. 85281.

19-22 Bank Administration Institute P.A.T.H. (Productivity through Automation, Technology and Human Resources) Conference, Dallas. Contact: Alice M. Moore, Director, Public Affairs, P.O. Box 500, 303 S. Northwest Highway, Park Ridge, Ill. 60068, (312) 693-7300.

SEMINARS

NOVEMBER

17-19 "Project Management for Engineers" seminar, San Francisco, sponsored by the New York University of Continuing Education. Contact: Heidi E. Kaplan, Department 20NR, University Conference Center, 360 Lexington Ave., New York, N.Y. 10017, (800) 223-7450.

20-21 "Designing Software Education" seminar, Washington. Contact: Shirley Mixon Seminars, 4549-E Northside Parkway, Atlanta, Ga. 30339, (404) 955-3183.

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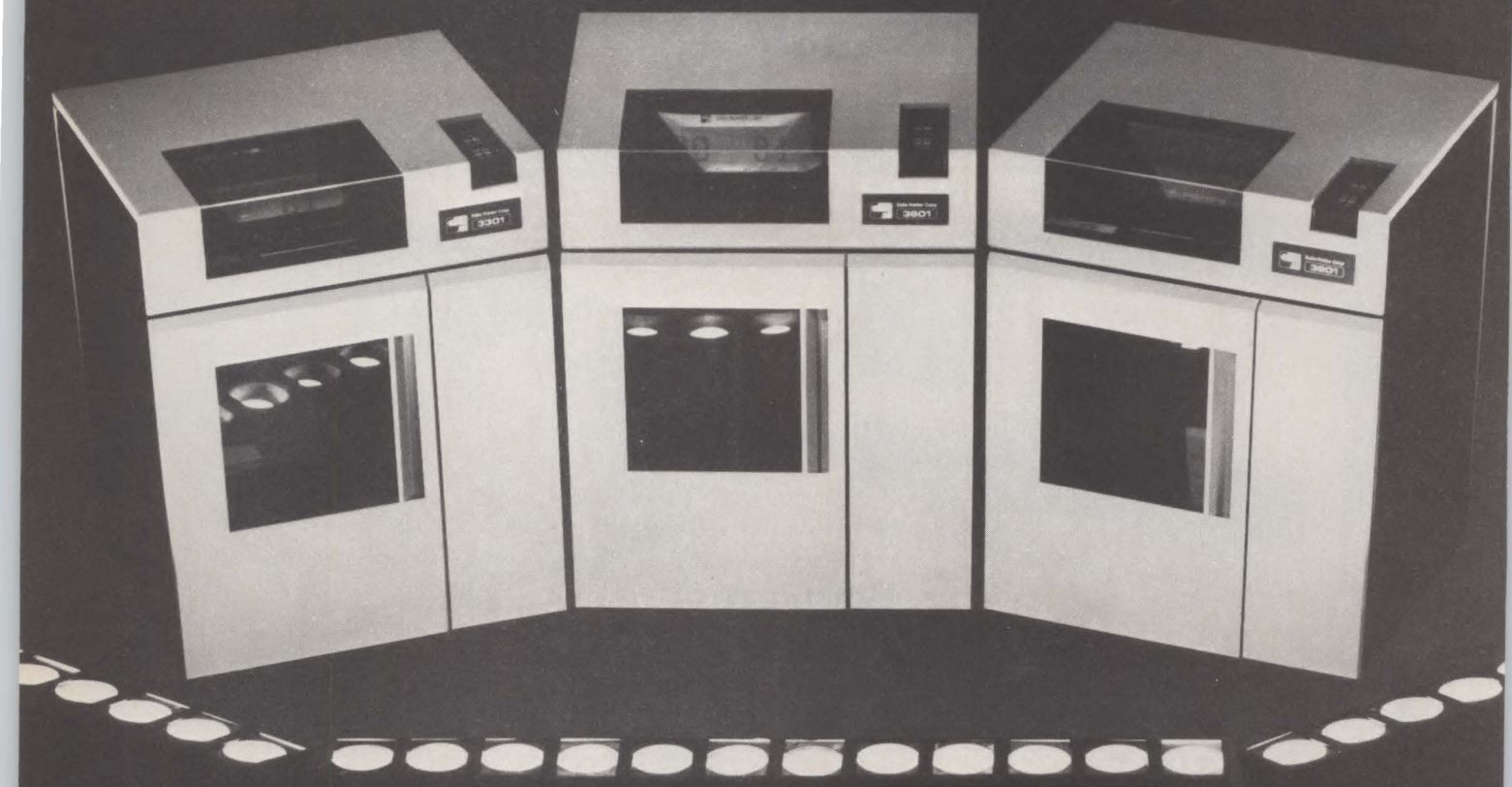

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Irwin's micro-Winchester: an ambitious beginning

Not content to play a "me-too" role in the fledgling 5¼-in. Winchester-disk drive business, Irwin International, Ann Arbor, Mich., is taking the high road of technology leadership with a drive that stretches the state of the art in micro-Winchesters in capacity, speed and backup approach. Evaluation versions of Irwin's highly innovative model 510 will be available in January, but a number of industry observers question the ability of a start-up company, which has only a modest background in disk drive manufacturing, to produce in volume a drive that is so ambitious in conception.

inIrwin is only the second company to introduce a 5¼-in. Winchester-disk drive. Shugart Technology, Scotts Valley, Calif., was the first firm into the market in April, when it announced the ST500 micro-Winchester drive (MMS, April, p. 79).

Both units continue the evolution to smaller Winchester disks that began two years ago with the introduction of 8-in. Winchesters. For example, both use a 5¼-in.-diameter aluminum disk to shrink the size of the Winchester to the dimensions of a minifloppy disk.

But the Irwin unit offers a striking performance improvement. It has twice the storage capacity (12.3M bytes unformatted versus 6.38M bytes) and nearly seven times the speed (25 msec. average access time versus 170 msec.) of the Shugart drive.

Moreover, the Irwin drive includes an integral cartridge-tape drive for backup, while the Shugart Technology drive has none. The integral Irwin tape unit enables a user to back up the entire contents of this disk drive on a single mini-cartridge (DC-100A) tape.

As might be expected, the Irwin unit is more expensive, but the margin is surprisingly small when the cost of backup is included. For example, the Irwin drive sells for $1500 in 500-unit quantities. A Shugart Technology ST500 drive with a Shugart Associates SA150 minifloppy-backup disk drive is priced at $1250 in similar quantities, according to pricing information supplied by Irwin International. Moreover, Irwin is quick to point out that the cost of its drive is lower on a cost-per-kilobyte basis (12.2¢ versus 19.6¢) because of its greater storage capacity.

Exploded view details *placement of key components, including the cartridge tape drive used for backup.*

To achieve this price/performance edge, Irwin has turned to design features that have been confined until now to high-performance 14-in. Winchester drives. For example, both the disk drive and the tape drive use a closed-loop embedded servo mechanism to increase storage density. In addition, the disk drive is the first by a U.S. manufacturer to use a nickel-cobalt-plated medium.

In contrast, Shugart Technology uses a conventional ferrous-oxide-coated medium and an open-loop head-positioning scheme based on a stepper motor—a method whose manufacturability has been proven with floppy-disk drives.

Finis Conner, co-founder and executive vice president of Shugart Technology, says that the company decided to go with the stepper motor and ferrous-oxide-coated disks, which limit storage capacity and speed, because it was more concerned with manufacturability. "Our objective is to build in very high volume," Conner says. "By going to a leading-edge technology, Irwin has increased its exposure to manufacturing and reliability problems," he adds. For example, Conner claims that an embedded servo mechanism is difficult to control in manufacturing.

Indeed, manufacturability is becoming a key concern with micro-Winchesters because the projected demand for the drives is so huge. Ray Freeman, a Santa Barbara, Calif., management consultant, who closely monitors the disk drive market, expects the demand for micro-Winchesters to reach 250,000 a year by 1983, and his estimate is conservative compared to those made by disk-drive manufacturers. Irwin, for example, is projecting the demand at 500 million units a year by 1983.

For this reason, industry observers believe Irwin is taking an enormous gamble by turning to advanced technology while the micro-Winchester market is still in its infancy. "The drive presents tremendous risks. It's off on a technology island, and that's no place for a high-volume OEM manufacturer to be," says a potential competitor.

The gamble seems especially risky because Irwin International is a start-up company with only a modest background in disk-drive manufacture. The company was

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started a year ago by a group of Northern Telecom Systems, Inc. (formerly Sycor), employees headed by Samuel N. Irwin, the founder and former president of Sycor, who left the company shortly after selling out to Northern Telecom in 1978 (see "Sam Irwin enjoys technology frontiers and creating jobs," p. 61).

Irwin is confident that his company can produce the 510 in volume. He points out that the founders of Irwin International gained disk-manufacturing experience at Sycor, which manufactured disk drives in-house for use in its intelligent terminal systems. He also maintains that skeptics exaggerate the difficulty of manufacturing Winchesters. "The physics get easier as the drives get smaller," he claims.

The company expects to produce 7500 units in 1981 and to ramp production up to 50,000 units a year by 1982.

To produce the drives, Irwin plans to build a manufacturing facility at an as-yet-undesignated location in northern Michigan. The company hopes to have the facility operating in time to meet the scheduled date for volume delivery—May, 1981. Meanwhile, Irwin plans to open a pilot plant in Ann Arbor this fall, which the company expects to be producing 600 units a month by January when evaluation quantities of the drive are slated to begin shipment.

One start-up problem that Irwin does not expect to face is capitalization. He says the company, which thus far has been financed out of the founders' pockets, is debt-free and has lined up ample bank credit to finance its planned expansion. "If we fail, it won't be for lack of funding," Irwin says.

—Paul Kinnucan

Formation's end-user mini aids manufacturing planners

Substantial publicity in the past two years has focused on the need to automate office procedures. That publicity has been accompanied by an increasing flow of computer-based hardware toward the perceived office of the future for applications in word processing, combined word and data processing and communications. But only a few makers of small computers appear to be specifically addressing the need for increased factory automation. The latest of these is Formation, Inc., Mount Laurel, N.J., which is aiming its FORMAN manufacturing resource planning system (MRP) at manufacturing plants with revenues in the $5 million to $50 million range.

FORMAN is the first end-user product introduced by Formation, and it's built around the company's first OEM computer product, the Formation 4000 minicomputer, which made its debut last spring (MMS, April, p. 58). Formation thus joins such companies as Digital Equipment Corp., which continues to tailor systems for factory applications, and Lanier Business Products, Inc., Atlanta, which has branched out from office-automation products into factory data-collection hardware.

Formation's 32-bit 4000 incorporates eight 2901 bit-slice microprocessors. In addition to the F4000 with 512K-byte memory, a typical MRP system includes two 70M-byte 14-in. Winchester disks, a 45-in.-per-sec. tape drive, a printer operating at 180 cps, 300 or 600 lpm and a CRT console. Price is $100,000, plus $30,000 for software. Shipments will begin this month.

The system is touted as an easy-to-use tool to boost the productivity of white-collar workers. Users will include product engineers, planners, inventory clerks, buyers and shop foremen. The 1980s will see "computer power move out of the arena of closed data-processing shops into everyday business operations," says Arthur Beard, Formation president and chairman. He elaborates that an office system must be "amiable" and affordable to its users.

There are two reasons why small- to medium-sized manufacturers have not had ready access to the benefits of MRP systems, says Ralph Mele, vice president of business systems marketing. Software and hardware are expensive. Secondly, existing systems are designed to be run by data-processing professionals, and many small manufacturers don't have a data-processing department.

Formation is targeting its systems at "growing manufacturers" and expects to sell 24 systems this year. Competitors include IBM, Hewlett-Packard and Sperry Univac, each of which has an MRP system in the same price range, but the systems are not transaction-driven, Formation says.

FORMAN can help to alleviate manufacturers' growing pains by performing tasks such as master production scheduling, inventory scheduling, shop-floor control, order entry, capacity planning for the future, purchasing, receiving and accounting. It is on-line, interactive and operates in real time. Benefits of MRP include better planning, operational improvements and shorter lead times and deliveries, says Ted Levy, senior sales representative for FORMAN.

For example, with a manual or

infrequently updated automated system, two orders could be placed by two different salesmen and processed, which may deplete that item's stock. With FORMAN, that would be less likely to occur. FORMAN processes each transaction as it happens and updates in-stock information. If the first order depleted or lowered the stock significantly, the second order would be flagged and the item's availability date questioned. In this manner, FORMAN can help control inventories and remind operators to reorder an item when its stock reaches a certain level. The system can also identify potential bottlenecks.

However, on-line transaction-oriented MRP Systems can be overly sensitive, according to Jack Gips, a Roswell, Ga., MRP consultant. "Companies are headed toward transaction-oriented systems, which are definitely a wave of the future. But they (the systems) can be carried too far." For example, replanning schedules can cause premature reordering if people and materials are not closely monitored. Gips adds that these systems are valuable for dynamic companies that need information in their hands, no matter what their size. Real-time transactions, he explains, are especially beneficial in stockrooms and for order entry and receivables.

Levy says FORMAN also provides the benefits of hindsight to users who want to see the results of changes in working plans without implementing those changes first. By using a simulation feature, planners can impose "what-if" situations on FORMAN and view the impact.

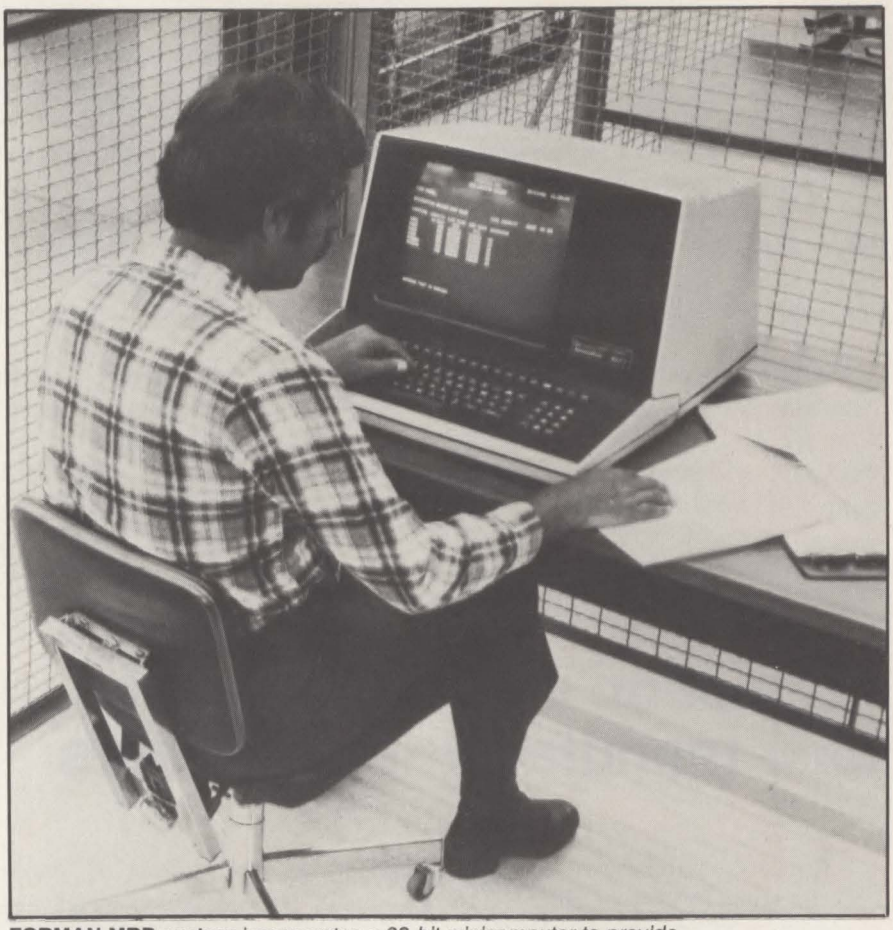
Formation designed FORMAN as a "friendly" system that includes function keys for often-used tasks, conversational English that incorporates manufacturing terms and prompting.

The company is attempting to solve what president Beard terms the primary challenge of the 1980s: applications programming. It is actively working to make its system completely support IBM/370 software. The F4000 accommodates the IBM DOS/VS, OS/VS1 and VM operating systems. It also runs a Formation-developed data base-management and transaction-processing system called TMS. This 370-compatability gives F4000 and FORMAN users access to what Beard calls "the largest software library in the world." Formation used an IBM 370/138 for software development before developing its own hardware. Gips says that most MRP competitors are also working toward some IBM compatability.

In October, Formation announced F4000 communications capabilities using a 270X emulator for local and remote communications. As many as 33 terminals can be hooked locally to FORMAN, and with the 270X emulator, clusters of FORMAN systems could be linked. Price of the communications option is about $3000, says Dale Sutton, Formation 4000 product manager.

Formation intends to sell FORMAN, which includes diagnostic and redundancy facilities, as a turnkey system that can meet 80 percent of its users' needs, says George Kolesar, FORMAN product marketing manager. Sutton says the system can bring typical inventory accuracy rates of 60 percent to as much as about 95 percent. The company does not encourage customization of FORMAN by users who might want to program in additional functions, because problems can be introduced into the system. FORMAN software will not be sold to non-Formation system users.

— Lori Valigra



FORMAN MRP system *incorporates a 32-bit minicomputer to provide instant status reports on manufacturing.*

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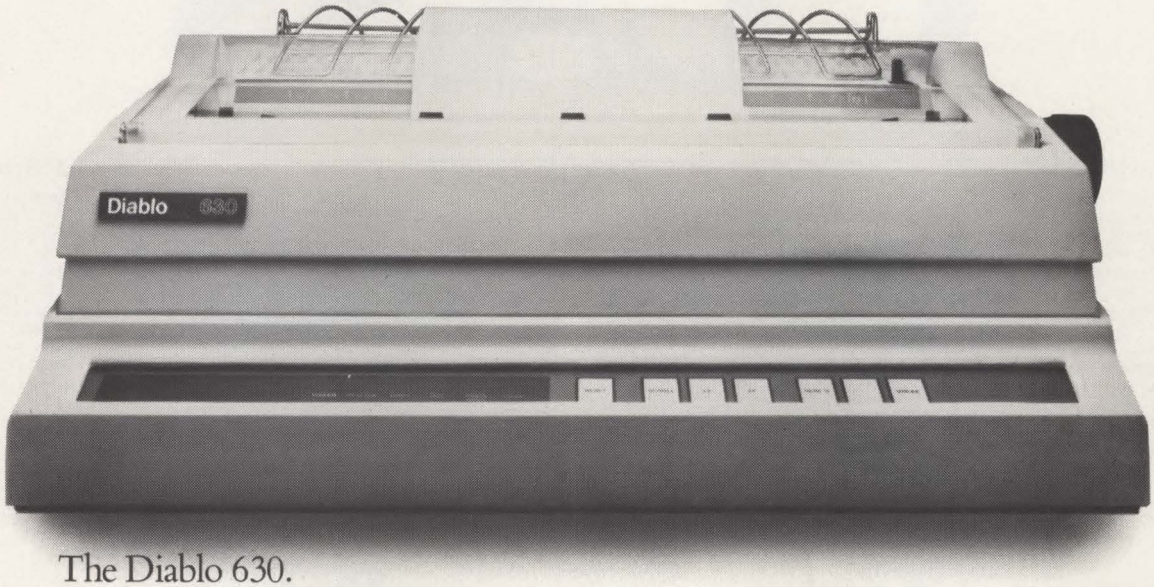
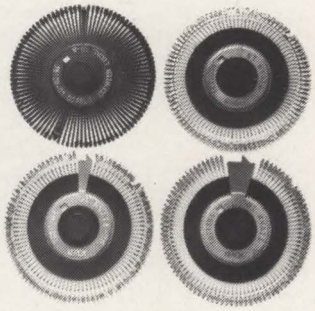


The Diablo 630.

It's the only one that lets your customers use either metal or plastic print wheels. Which means they can choose the print wheel that's just right for the job.

The 630 works as well with a 96-character plastic daisy print wheel as it does with an 88-, 92-, or 96-character metal daisy print wheel. In over 100 different type styles.

Every 630 has a fully strappable power supply. It's as easy to use in Paris, Kentucky as it is in Paris, France. So you only need to stock one printer for international and domestic markets.



It has fewer moving parts than competitive printers, which makes it more reliable. And it offers unsurpassed print quality. Compatibility with Diablo supplies. And bi-directional printing capability.

The 630 is the only printer in the world that uses both metal and plastic wheels.

Once your customers hear they can change their print wheels, they're going to be changing their printers.

To Diablo 630 printers.

Diablo Systems

XEROX

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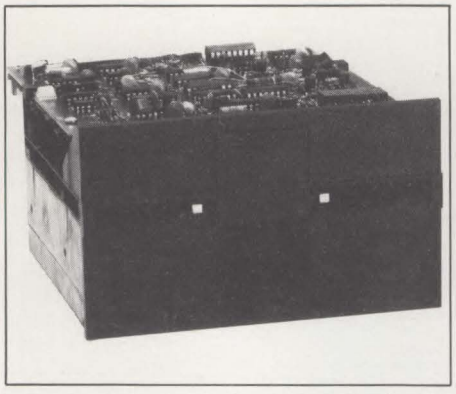
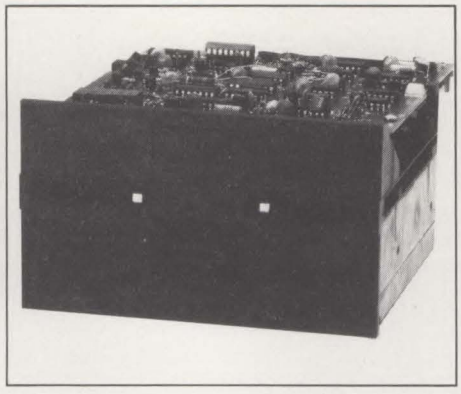
CIRCLE NO. 30 ON INQUIRY CARD

GO FIRST CLASS

½ MByte
TM-100-3 (Single-sided)
Capacity (unformatted):
500K bytes
TPI: 96 or 100
Tracks per side:
80 maximum
Recording density:
5535 BPI
Access time:
• Track to track: 3ms
• Average: 90 ms





1 MByte
TM-100-4 (Double-sided)
Capacity (unformatted):
1,000K bytes
TPI: 96 or 100
Tracks per side:
160 maximum
Recording density:
5877 BPI
Access time:
• Track to track: 3 ms
• Average: 90 ms

At an economy Price

It doesn't cost anymore to go first class when it's a Tandon 5¼" flexible disk drive. The reason is simple. We're the recognized leader in mini-floppy read/write head technology. In fact, our patented, double-sided head design is used by all the other major mini-floppy suppliers. And, it makes no difference if you buy one or one-thousand drives, you'll always get the first class price/performance that's made Tandon first choice among OEMs of word processing, small business systems, and personal computers. Tandon is rapidly becoming the first name in mini-floppies because we offer up to *one megabyte* of storage capacity, the fastest access time, a choice of single or double-sided recording, and 96 or 100 tracks per inch. All with proven reliability at an unbeatable price. Because we are the leaders in head technology, Tandon mini-floppies are designed beginning with the head to assure dependability throughout each drive. With Tandon, going first class is both sensible and economical.

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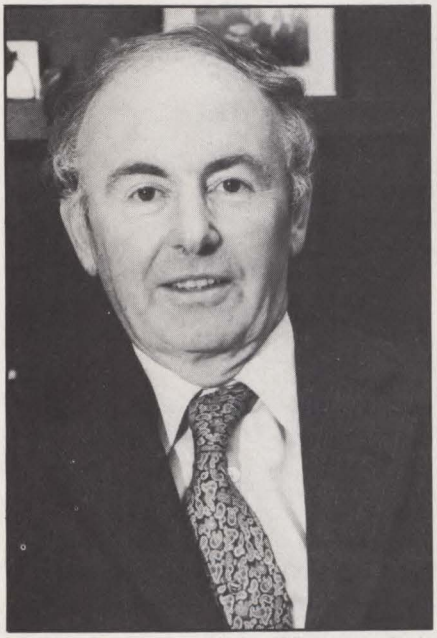
Heads Above The Rest in Disk Technology

CIRCLE NO. 31 ON INQUIRY CARD

Gould/SEL marriage: taking the good with the bad

Like the marriage of two people, the acquisition of one company by another requires "taking the good with the bad." If the proposed acquisition of Systems Engineering Laboratories, Inc. (SEL) by Gould, Inc., is approved by both companies' stockholders in mid-December, Gould will gain a new, high-end "supermini," a computer company to add to its electronics group...and some management problems, one source says. SEL will benefit from more financial and management support, although a source says Gould may realign some management. The acquisition of the Fort Lauderdale, Fla., minicomputer manufacturer, which developed one of the first 32-bit minicomputers, by Gould, the corporate giant headquartered in Rolling Meadows, Ill., involves a two-for-one exchange of Gould for SEL stock, and is valued at about $150 million.



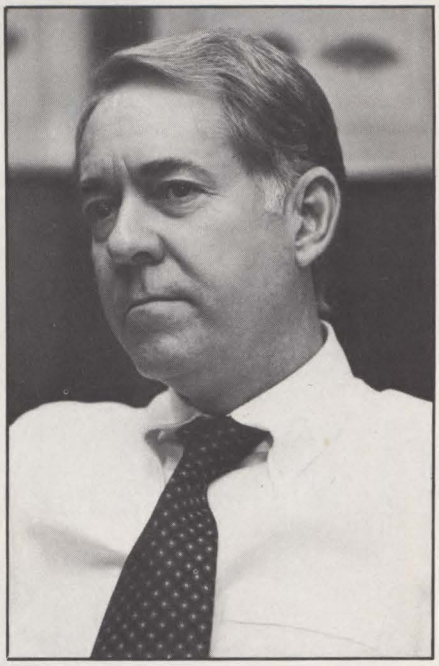
Gould president David Simpson *feels SEL's products will fit in nicely with Gould's offerings in its industrial-automation business.*

Gould has been eyeing ways to expand its electronics group, having previously failed in attempts to acquire Mostek Corp. and Fairchild Semiconductor. Some observers believe the acquisition price is high, but Gould made a "smart acquisition," says Charles L. Hill, vice president of Kidder Peabody, Inc., Boston. To get that kind of acquisition, one "must pay some type of premium," he says.

"While acquisition prices may initially appear to be high, internal development (of products) within major corporate structures generally takes a long time and is expensive," explains Stanley E. Pratt, editor and publisher of *Venture Capital Journal*, Wellesley Hills, Mass. "Large corporations can often capitalize on and expand demonstrated market opportunities faster and more efficiently than small businesses," says Pratt.

Gould, which is one of SEL's customers, has already found ways to comfortably fit SEL offerings into its product line. "We have been interested in superminis for a while as an adjunct to our industrial-automation business and simulation division," says Gould president David Simpson. For example, Gould's Modicon Corp., which sells programmable machine tool controllers, will find a nice complement in SEL, because minicomputers are often tied to the controllers.

Simpson intends to enhance SEL's software offerings, concentrating on industrial-applications packages. He also intends to increase SEL's exports to Europe to 30 to 40 percent of revenues over the next five years, up from the current level of 25 percent. He says that SEL will act as a focal point for other divisions, and it will increase Gould's electronics group revenues from $600 million to $700 million. Simpson says SEL has a good portfolio of new products for the next few years, and at least one source says Gould may be getting more than it bargained for.



SEL's "Gus" Randolph *came out of retirement to rebuild the company he founded. Now, with the sale of his company, he may be able to retire again.*

An SEL spokesman says the company will expand its 32-bit product line with a top-of-the-line minicomputer in the first quarter of next year. One source close to SEL says Gould is buying "one hell of a product." He explains that the new product, which uses high-speed emitter-coupled logic, is 10 times faster than existing SEL products and four times as fast as Digital Equipment Corp.'s VAX-11/780 supermini for scientific computations. The product will be one of the fastest on the market, executing 5 million instructions per sec. It will have an expanded address space to 16M bytes, and sell for less than $500,000.

Along with an exciting new product, however, Gould is inheriting a company that has had some financial and management problems, according to some industry

concept display terminals from Human Designed Systems. Loved. For all the right reasons.

Human Designed Systems removes the last barrier to unbridled applications capability in a display terminal with its new concept series that puts four full pages of memory — 96 80-character lines — at your fingertips...at the price of one page!

If you always recognized the value of four full pages of memory — for use in storing lengthy forms, programs, or text, and easily accessing them by scrolling forward or backward, a line or page at a time — but couldn't justify the extra cost, read on.

Because Human Designed Systems has made the technology of the 80s work to your benefit: making it possible to eliminate the additional charge for four full pages of memory, and make this important capability available to you for the standard one-page price. It adds up to more pages, more capabilities...at less cost than any terminal in the industry today!

And Human Designed Systems offers more than just price as a reason to buy the industry's best price-performing display.

Other standard features include: • full windowing (multiple pages per window, multiple windows per page) capability • multiple user-selectable character sets • I/O capability for networking between multiple communications lines • large buffer for high-speed operation • expanded memory for function key programming • advanced text editing, data entry/retrieval and business graphics software.

These features plus a $1230 price (OEM quantity 75) are some of the reasons why the concept family is the leader.

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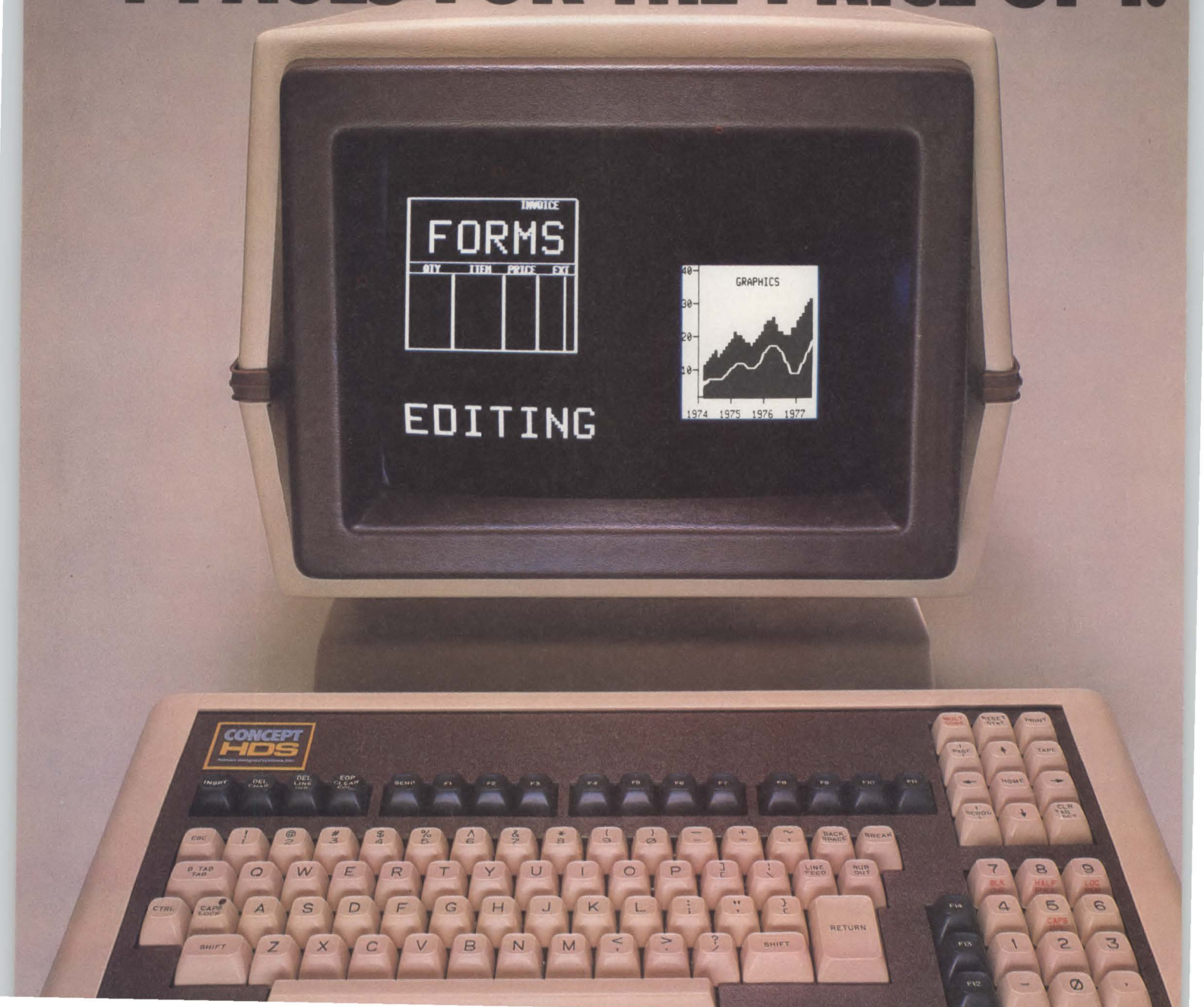
CIRCLE NO. 32 ON INQUIRY CARD

4 PAGES FOR THE PRICE OF 1.



observers. SEL began in 1961 to serve the space program by providing scientific computers for simulation applications to the National Aeronautics and Space Administration. Its founder and president, A.G. "Gus" Randolph, left the company in 1970 as an operating officer, but continued as board chairman. Over the next four years, SEL had two presidents and failed in an effort to approach the commercial data-processing market.

In the fall of 1974, Randolph resumed presidency of the company, brought it back on track and announced its first 32-bit minicomputer in January, 1975 (MMS, May, 1979, p. 57; November, 1979, p. 52).

Within a year, revenues jumped more than 50 percent, from $20 million to $31 million, and the following year, they jumped 72 percent. In the last few years, however, growth slowed to 23 percent. With Gould's support, SEL hopes to maintain a 30-percent annual growth rate over the next five years.

One source claims that SEL has had profit margins that did not allow the company to grow on internal funds. The source points out that Gould not only has money, but also knows the systems business.

Although SEL has claimed it was not searching for an acquirer, it made no secret of its need for outside development capital. Rumors at SEL prompted Randolph to issue a letter to employees in the fall of 1979 reiterating that he was not looking for a buyer. However, several industry observers say that Randolph did want an acquisition so he could return to retirement. While Gould's Simpson claims SEL's management will remain intact, others expect Gould to rearrange some of SEL's management. Randolph's departure would seem to open the door for such a move. Randolph was not available for comment, but a company spokesman says he knows of no intentions by the 48-year-old Randolph to retire nor of any indications by Gould to change management.

—Lori Valigra

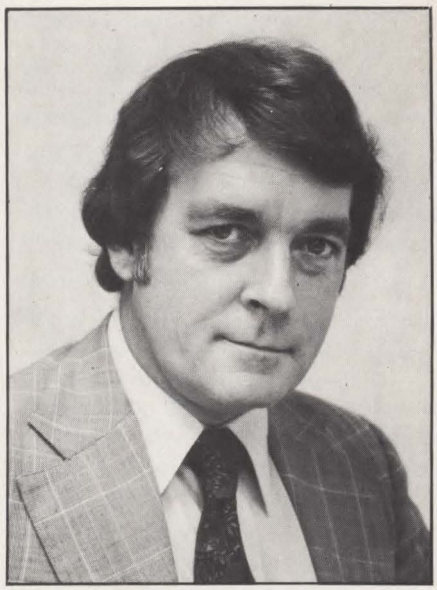
ADDS' Wiltshire is directing a new foray into systems

The first foray into the small-business systems market by Applied Digital Data Systems, Inc. (ADDS), in 1978 ran afoul of a number of problems. There didn't appear to be any top management commitment to a market that differed greatly from ADDS' traditional CRT terminal business; the initial product—called the System 70—was hurriedly launched, and was still basically an intelligent terminal. The System 70 also incorporated a floppy disk that gave the system a bad reliability reputation.

As a result, ADDS sold only 1000 of those systems in two years—a disappointing result for a company that is counting on the systems business to fuel its growth from $52 million in revenues in 1979 to $250 million by 1984. Now ADDS is trying again, but with a new division, a new product line and a new manager — 44-year-old Brian Wiltshire—who contends that the company's recent moves reflect a management commitment that will make the difference this time.

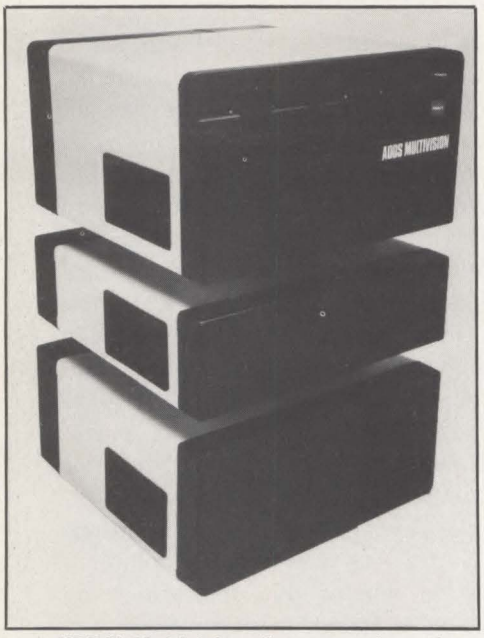
Wiltshire says that all the reasons for the initial false start can be traced to a lack of commitment to the systems business on the part of top management at ADDS. He feels that commitment is now there as evidenced by the creation of a separate systems division with its own development group and sales force. Wiltshire was recruited from On-Line Systems, Inc., a Pittsburgh-based timesharing bureau, where he was marketing vice president, to head the new division as its first vice president and general manager.

In that position, Wiltshire will be responsible for carrying out a marketing strategy that he defines as one of "controlled entry" into the small-business computer market. More specifically, Wiltshire explains, ADDS will target markets where dealers—the company's primary customers—already have a large investment in applications software. ADDS will then market systems that can run that software without modification.



Wiltshire: fostering *"controlled entry" the second time around.*

ADDS already has begun to implement this strategy at the low



ADDS' Multivision *line comprises three upwardly compatible systems. All run the CP/M operating system.*

end of the small-business systems market with the introduction of its Multivision systems line in April. The new line comprises three upwardly compatible systems ranging in price from about $8000 to $12,000. All three systems run the CP/M operating system—the most widely used system for business applications in the under-$15,000 computer market, Wiltshire says.

A new product line slated to be unveiled at the Comdex dealer show in Las Vegas this month will carry ADDS' software-oriented strategy into the mid-range of the small business market as well. The new system line, called Mentor, incorporates a Z8000 16-bit microprocessor and 14-in. Winchester disks. More importantly, however, it runs the same operating system as that used on Microdata Corp.'s highly touted Reality business system. The ADDS system is aimed at the some 40 to 50 Reality dealers, many of whom Wiltshire says are looking for a lower-priced system to expand their markets. The ADDS system is about 25 percent slower than the Microdata system, which is minicomputer-based, but it will sell for about half the price at $30,000 to $50,000.

Wiltshire says ADDS decided to enter the Reality-compatible market in part because the low end of that market is currently unoccupied. Two other companies—Prime Computer Inc. and the Ultimate Corp.—market Reality systems, but they compete directly with Microdata in the high end of the market. ADDS also is familiar with the market. It supplied Microdata with the CRT terminals originally used in the Reality system, and when Microdata brought its CRT manufacturing in-house, ADDS continued to supply CRTs directly to Microdata dealers.

Some industry observers question ADDS' wisdom in launching two incompatible product lines simultaneously. However, Wiltshire says the company will eventually integrate the lines by moving CP/M software up to the Mentor line and Reality software down to the Multivision.

In addition to zeroing in on specific markets, Wiltshire plans to adopt a more focused distribution strategy. In the past, he says, ADDS tended to sign its dealers one by one. Now, the company will concentrate on distributors who will market the systems to individual dealers. Wiltshire has identified eight types of distributors, including industrial electronics distributors and real estate and fast food franchisers acting as OEMs for their franchisees. Wiltshire intends to avail himself of all these potential distribution channels. "My objective is to have a healthy mix."

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
Computer Devices	6 mos.	6/30/80	10,046,000	504,000	.18
	6 mos.	6/30/79	7,933,000	349,000	.14
Cray Research	6 mos.	6/30/80	31,446,000	6,851,000	1.65
	6 mos.	6/30/79	24,032,000	5,755,000	1.39
Data Terminal Systems	6 mos.	8/3/80	64,452,000	3,754,000	.74
	6 mos.	8/5/79	46,742,000	7,061,000	1.41
Documation	26 wks.	8/1/80	59,189,000	(6,566,000)	(2.15)
	28 wks.	8/17/79	47,928,000	3,326,000	1.09
General Instrument	26 wks.	8/31/80	407,726,000	31,567,000	3.55
	26 wks.	8/26/79	317,373,000	22,415,000	2.64
Lanier	Yr.	5/30/80	253,166,000	17,380,000	2.35
	Yr.	6/1/79	185,513,000	13,676,000	1.88
Magnetic Controls	9 mos.	7/31/80	38,874,000	2,456,000	1.24
	9 mos.	7/31/79	28,580,000	2,073,000	1.24
National Data	3 mos.	8/31/80	16,522,000	1,757,000	.36
	3 mos.	8/31/79	13,573,000	1,247,000	.26
Perkin-Elmer	12 mos.	7/31/80	996,149,000	68,245,000	3.34
	12 mos.	7/31/79	733,002,000	50,338,000	2.53
Ramtek	12 mos.	6/30/80	25,149,000	1,156,000	.57
	12 mos.	6/30/79	15,221,000	283,000	.19
Sci-Pro	Yr.	4/30/80	124,024	(213,478)	(.01)
	Yr.	4/30/79	72,209	(23,285)	(.00)
Sperry	12 mos.	6/30/80	4,968,389,000	286,089,000	7.65
	12 mos.	6/30/79	4,297,034,000	233,200,000	6.58
Wavetek	40 wks.	7/5/80	29,933,000	1,562,000	.86
	40 wks.	7/7/79	23,999,000	1,606,000	.87
Wespercorp	Yr.	6/30/80	9,632,400	765,200	.67
	Yr.	6/30/79	7,923,200	845,300	.94

The Zenith Smart Terminal.

Compare the features.

Reverse video by character can be used to emphasize words, lines, phrases or paragraphs.

High Resolution CRT reduces eye strain and operator fatigue.

Z80 Microprocessor-control brings easy editing, cursor flexibility and reverse video highlighting to your on-line system.

Professional touch keyboard follows standard typewriter layout with 72 keys, including 12 special function keys, (8 user programmable) plus 12 key numeric pad.

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80 character by 24 line format, plus a 25th line for operator messages and prompts.

Cursor and special functions are accessible by keyboard or outside computer.

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MMS11

CIRCLE NO. 33 ON INQUIRY CARD

Mini-Micro World

Wiltshire also is bringing an emphasis on reliability to ADDS. "Before, the push was to get the product out the door," he says. His first action on coming to ADDS was to order a delay in initial deliveries of the Multivision system because he felt that not enough attention had been paid to the system's reliability. The system is now being modified to include self-diagnostics. In addition, Wiltshire ordered mechanical changes to make the system easier to service and more durable. Originally scheduled to begin in August, Multivision shipments will now begin next month, he says.

Despite Wiltshire's faith in the commitment of ADDS management to the systems business, he admits that the prospective acquisition of ADDS by NCR Corp. has wrapped the future of his division in a cloud of uncertainty. NCR also markets small-business computers, and this raises the specter of interdivisional competition if ADDS becomes an NCR subsidiary. Wiltshire says he has not been privy to negotiations between the two companies. As a result, he says, "I'm operating on a 'business-as-usual' basis."

—Paul Kinnucan

NEXT MONTH IN MMS

The December issue of Mini-Micro Systems will focus on graphics terminals and systems. Articles in the feature section will include:

- A survey of interactive graphics systems
- A look at a product that combines vector/raster technologies
- An update on the raster state-of-the-art
- A briefing on IBM's approach to business graphics
- A tutorial on monolithic display controllers

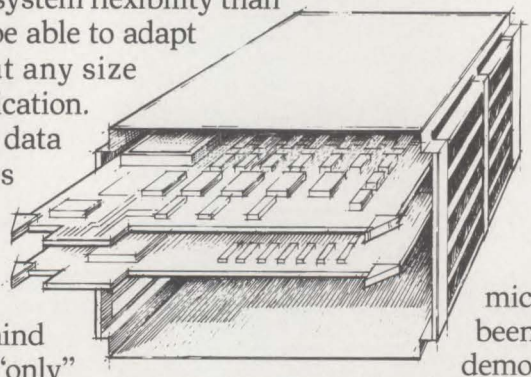
Also scheduled for December: a comparison of the three leading 16-bit microprocessors.

Hewlett-Packard announces another small breakthrough.

The two-board, 1/2 megabyte microcomputer.

Our HP 1000 L-Series now offers state-of-the-art 64K RAMs. They're the reason we've been able to put 512 kilobytes of memory on just one 6¾" x 11" board.

With the CPU on the other board, the L-Series opens a whole new dimension in microcomputers. Because with so much memory in so little space, you have more system flexibility than ever before. In fact, you'll be able to adapt the L-Series for just about any size job—and any kind of application. Including communications, data management and process control.



Big software for small hardware.

You may have to remind yourself that the L-Series is "only" a microcomputer. With powerful software features like our multi-programming, multi-user RTE operating system and language support that includes Assembler, FORTRAN 4X, BASIC and PASCAL, there's almost no limit to the high performance products you can build. Especially if you take advantage of our proven data base management system and networking software—also upwardly compatible throughout the entire HP 1000 line.

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Choose your configuration.

The HP 1000 L-Series comes in a wide range of board, box and system packages. Which means you'll be able to choose the configuration that's best for your application. Development units are available at $13,250* for the CPU and a full 1/2 megabyte of memory.

If a two-board, 1/2 megabyte microcomputer sounds like what you've been looking for, come in for a hands-on demonstration. Call the nearest HP sales office listed in the White Pages. Or write Hewlett-Packard, Attn: Roger Ueltzen, Dept. 886, 11000 Wolfe Rd., Cupertino, CA 95014.

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*Price is U.S. list.

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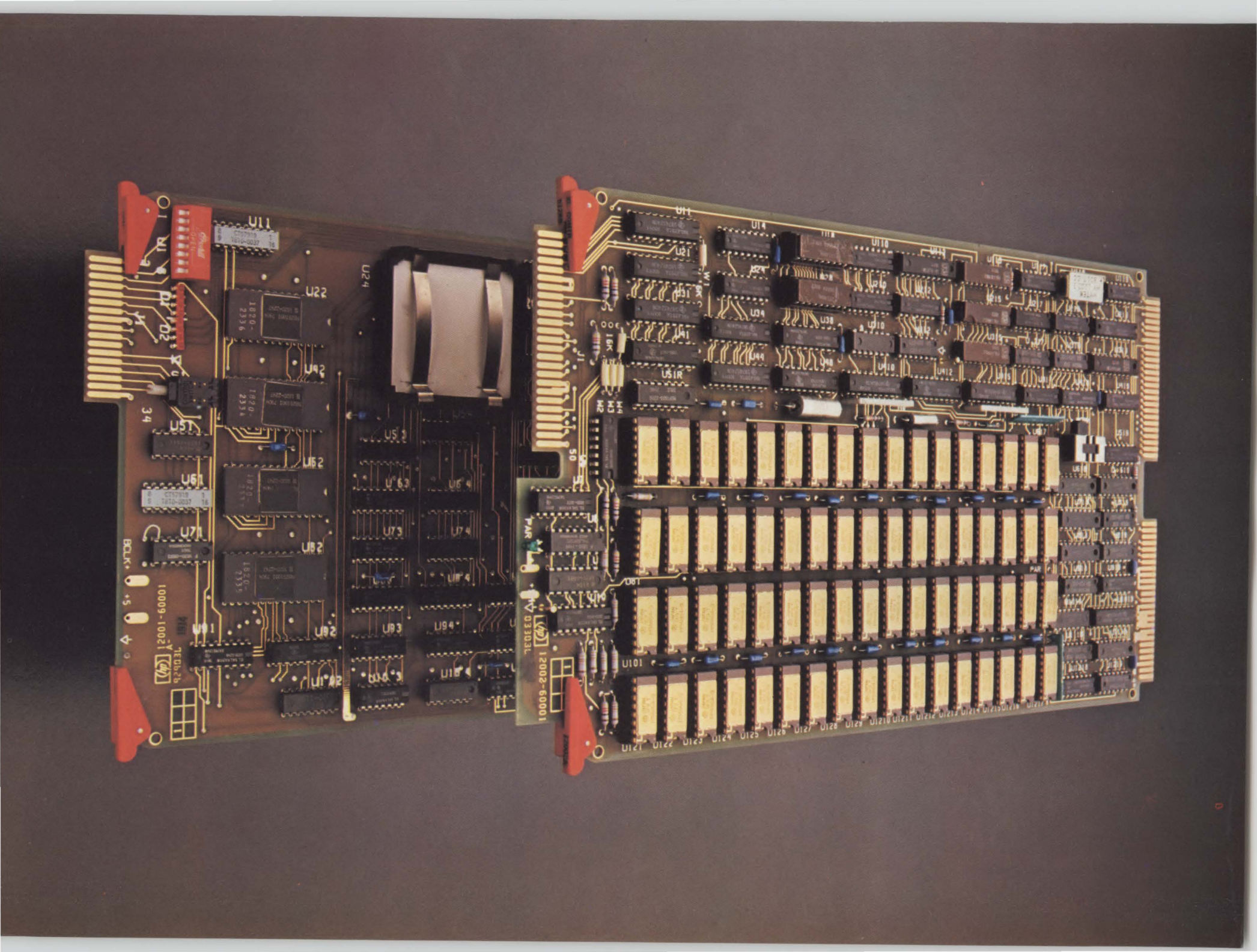
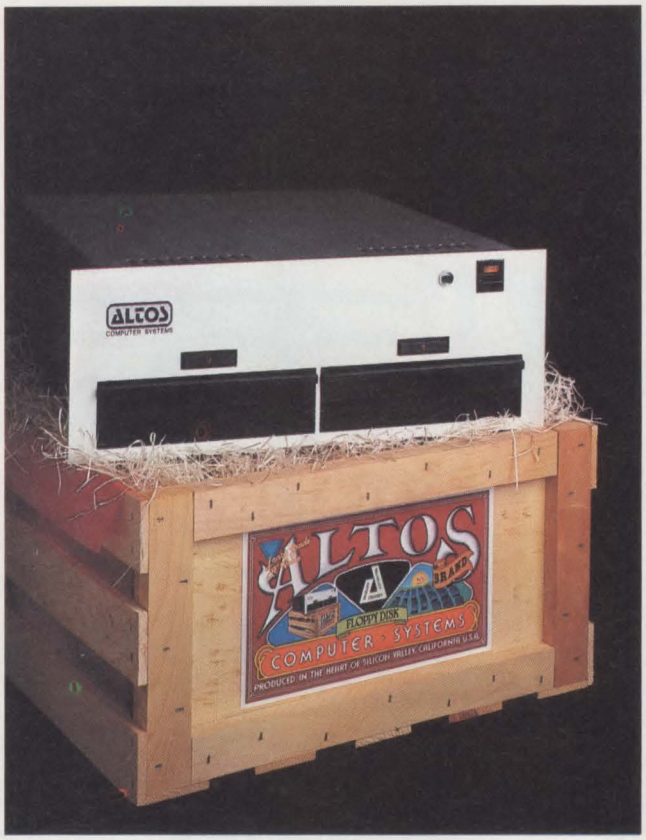


WHY GROWING CONCERNS PICK OUR FLOPPY BASED SYSTEMS



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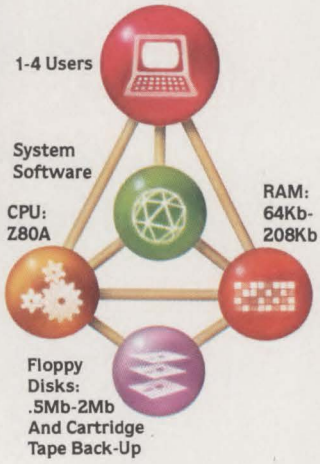

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CIRCLE NO. 36 ON INQUIRY CARD

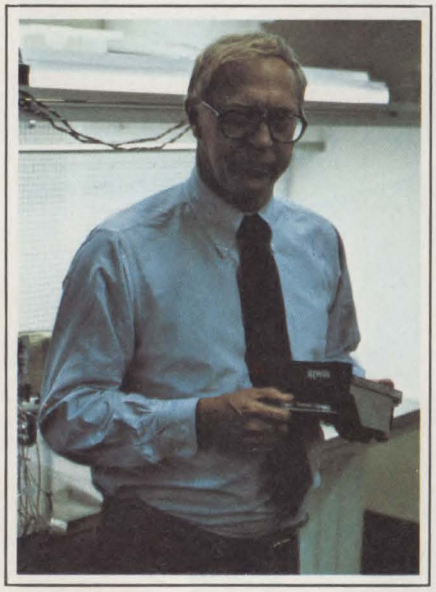
Sam Irwin enjoys technology frontiers and creating jobs

Samuel Irwin enjoys the excitement of working on a technology frontier. He also enjoys nurturing a company into being—a process that he calls "creating jobs." In short, Irwin fits the classic entreprenuer-engineer mold, and he's once again doing what such a man likes best—starting a high technology company, Irwin International, Inc., Ann Arbor, Mich. (see "Irwin's micro-Winchester: an ambitious beginning," p. 45).

Irwin believes that a high-technology company is worthy of the name only if it fits two criteria. Such a company must have a unique product, and it must also possess a special "feel" for a market that enables it to sense a market trend even before it becomes apparent.

Irwin maintains that his latest venture fits this definition on both counts. For one, Irwin International is founded on the premise that the future of the computer industry belongs to the under-$10,000 system. Key to the growth of the market, Irwin says, is the availability of inexpensive memory. "Every major move in the computer market in the past 30 years has been preceded by a big improvement in memory technology," he points out. For example, he cites the invention of core memory in the early fifties, which led to the growth of the commercial mainframe market, and the development of semiconductor memory in the sixties, which spurred the growth of small computer systems.

Now, Irwin believes, the computer industry is on the verge of another technology breakthrough with the advent of 5¼-in. Winchester-disk drives, which is his company's first product. Irwin explains the significance of the 5¼-in. Winchester: "It enables us to get a lot of memory in a physically small package." Indeed, the Irwin drive will be able to store 10M bytes of data in a space smaller than a shoe box.



Sam Irwin: *Small drives mean attractive physics.*

And that's only the beginning, Irwin notes. He expects the capacity of single-platter micro-Winchester disks to increase five-fold by 1985, with the advent of thin-film read/write heads and nickel-cobalt-plated disks that support greater storage densities.

Irwin expects the micro-Winchester to remove the biggest barrier to the spread of ultra-low-cost computer systems—the lack of cheap, high-speed mass memory. This, in turn, has hindered the development of the sophisticated software required to perform complex tasks. Such software requires large amounts of high-speed memory, as Irwin points out. "Software and memory feed on each other," he observes.

Irwin feels that his own contribution to the emergence of the micro-Winchester lies in bringing to the small drives advanced design features, such as embedded servo head-positioning mechanisms and plated media, which are only just beginning to be tried on large Winchester drives.

Many industry observers think Irwin is taking an enormous risk in embracing these techniques in a high-volume product like the micro-Winchester before their manufacturability has been demonstrated. Irwin, however, claims that the risk is not as big as it seems. He says it is actually easier to manufacture small Winchesters than their full-scale counterparts. "As the drive gets smaller, the physics gets easier," Irwin says. For example, he points out that a small drive has a higher resonant frequency, and this makes it easier to implement head-positioning mechanisms. He also notes that small drives use smaller motors, and hence there is less of a heat-dissipation problem.

Irwin says that his primary objective in the next six months is to bring the manufacturing arm of Irwin International into being—a move that would allay the fears of those who believe the Irwin 510 is too difficult to produce in volume.

Irwin is no stranger to high-technology gambles. He pioneered the intelligent terminal in the late sixties at a time when the microprocessor was still over the technology horizon, and low-cost mass storage was just becoming available in Philips cassette tape.

Irwin saw these developments coming and got into the intelligent terminal market early, when he founded Sycor, Inc., in 1967. He then demonstrated his entrepreneurial skill by building Sycor to a $90 million company before selling it to Northern Telecom, Ltd., in 1978. Irwin left the company shortly afterward, because, he says with characteristic dryness, "Northern

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CIRCLE NO. 37 ON INQUIRY CARD

Telecom had a different understanding of the dynamics of the computer business than I did."

Although Irwin was offered the presidency of a multi-million-dollar company, his heart was set on a start-up venture, which he first began discussing with some former Sycor colleagues in the spring of 1978. The Irwin founders at first did not have a specific product in mind except that it would be a peripheral—either a printer or disk. But some basic library research at the University of Michigan—Irwin's alma mater—helped to make up their minds. "We rejected printers because we thought printer technology had gone as far as it could go to improve price and performance," Irwin recalls.

However, it was a different story with disk technology. "Research reports and doctoral theses showed that a number of developments—especially in thin-film heads and plated media—would come together in the 1980 to 1985 time period to produce a major technological breakthrough," Irwin says. Their imaginations fired by this coming convergence, Irwin International's founders decided on the product that was to emerge more than a year later as the model 510 micro-Winchester. *—Paul Kinnucan*

People in the news . . .

Richard W. Anderson, has been named general manager of Hewlett-Packard Co.'s computer systems division, Cupertino, Calif. He was formerly general manager of the data systems division at the company. **Gaylan I. Larson,** formerly operations manager for the HP 1000 computer product line of the data systems division, has been named to replace Anderson as general manager of that division. **Roger F. Ueltzen,** formerly marketing manager for the data systems division at the company has been named to the newly created position of marketing manager for the technical computer group.

Douglas A. Davidson has been named president and chief operating officer of Display Data Corp., Hunt Valley, Md. The position was formerly held by **Robert Leatherwood,** who remains chairman and CEO. Davidson was formerly senior vice president of marketing for Mohawk Data Sciences Corp.

William Robinson has been appointed vice president and head of Commodore Business Machines' computer systems division. Robinson formerly was system sales director for NEC Information Systems, Inc.

Dr. Donald R. Haring has been appointed vice president, research and development for General Automation, Inc., Anaheim, Calif. Haring was previously vice president, engineering at the company, and formerly served as a member of the Massachusetts Institute of Technology faculty.

Hal Georgens has been named chairman of the board and CEO of Data Electronics, Inc., San Diego, Calif. He was one of the founders of the company and has served as president since its inception.

Richard Sanquini has been appointed as director of National Semiconductor Corp.'s microprocessor group, Santa Clara, Calif. Sanquini worked at RCA Solid State for the past 21 years, serving most recently as director of LSI operations.

David Pava has been promoted from general manager to president and **Bob Miller** has been promoted from controller to secretary-treasurer of Byte Industries, Hayward, Calif.

Gerald L. Peterson has been appointed director of marketing for Tandem Computers Inc., Cupertino, Calif. Prior to joining Tandem, Peterson held marketing management positions for 13 years with the Hewlett-Packard Co. and was most recently marketing manager for small business systems at HP's General Systems Division.

William J. Kelly has been elected to the new post of vice president, computer development of Lanier Business Products, Inc., Atlanta, Ga. Kelly was formerly vice president, engineering at ICL, Inc.

Thomas J. Lawrence has been appointed general manager of Apple Computer Inc.'s European operation. He will be responsible for the marketing, sales and service of Apple products in Europe. Lawrence was previously general manager and vice president of Intel Corp.'s European operation.

Marvin Crumb has been named as president of U.S. operations at Mannesmann Tally Corp., Kent, Wash. He previously was general manager of NCR's engineering and manufacturing facilities in San Diego, Calif.

Qume Corp. has announced the appointment of five new officers. **David Mans** has been named vice president, finance, comptroller and treasurer; **Jack Jamieson** has been appointed vice president, research, development and engineering; **Gail James** has been named vice president, marketing, memory products division; **Allan McVicar** has been named vice president, operations, memory products division; and **John DeSantis** has been appointed vice president-operations, printer products division.

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CIRCLE NO. 38 ON INQUIRY CARD

Micro-controlled elevators lift spirits at Seattle hotel

This is an up story about elevators. It's about ringing out the old era of discrete, TTL logic and mechanical relays and opening the doors to the days of microprocessors. It's about the elevators at the new Park Hilton Hotel in Seattle.

The 34-story, 430-room hotel is being serviced by a bank of four elevators built by U.S. Elevator Corp., a division Cubic Corp., San Diego, Calif. The elevators are controlled by U.S. Elevator's 1200MP microprocessor-based system. The four-car system, which cost about $820,000 and includes all electronics plus two elevators that serve the hotel's underground parking garage, is the first production system from the manufacturer, which began development more than four years ago.

The 1200MP consists of several 8- × 17-in. boards built around a Fairchild F8 microprocessor. Besides the 8-bit CPU, the boards contain a RAM controller and several I/O processor chips. The system can handle as much as 16K bytes of memory, but uses only 12K to 13K bytes to control the elevator cars, says Bill Hoelscher, chief electrical engineer and director of the project.

The Seattle Park Hilton's four-car system uses nine F8 boards. A supervisor board controls four slave boards located in the control room. Each car also has one board that provides emergency-control functions. Each supervisor board can handle eight slaves.

Building elevator requirements, such as how long the doors remain open and priority service to certain floors, are programmed into the slave boards' PROM, says Hoelscher. With the PROM it is possible to customize a 1200MP system to each building's needs, he says.

Problems can be detected immediately via a bank of LEDs on each control panel in the control room. Diagnostic and sysyem perfomance data, such as traffic analysis and car assignments, are available in hard-copy from a Teletypewriter.

The redundant system provides careful self-checking facilities, Hoelscher points out, so that in the event of a failure on one board, control is transferred to another processor to assure passenger safety and uninterrupted service.

As efficient and safe as the 1200MP is, however, Hoelscher points out that electromechanical relays haven't been entirely eliminated. Some mechanical control is still required, he says, mainly because of building safety codes. He hopes the 1200MP will prove itself and overcome the need for the mechanical parts.

John Howell, president of U.S. Elevator, says that microprocessor control results in more efficient elevators. The cars travel at 700 ft. per min., and floor-to-floor response time is 7.2 sec. "The elevators do not travel any faster with the 1200MP than with other control systems," he points out, "they simply become more efficient."

The control system can analyze the picture of people waiting at various floors throughout a building. Cars are assigned to the calls at various floors so that average waiting time is minimized. The bottom line, says Howell, is that, as in the case of the Park Hilton, four cars can provide the same level of service as five cars under conventional control.

For Park Hilton architect Tony Callison, the efficiency of the four-car system was a major factor in choosing the elevators. "We were drastically limited in space," he says, explaining that the shape of the property, subsequent design considerations and simple econonics forced him to fit the largest number of rooms possible into the space

A control system employing microprocessors *has been installed at the Park Hilton Hotel, Seattle.*

available. Plans called for 15 to 16 rooms per floor in the 34-story building to be serviced by five elevators. "Had we stayed with a conventionally controlled system," Callison says, "we would have needed five elevators. That would have cost us one room per floor."

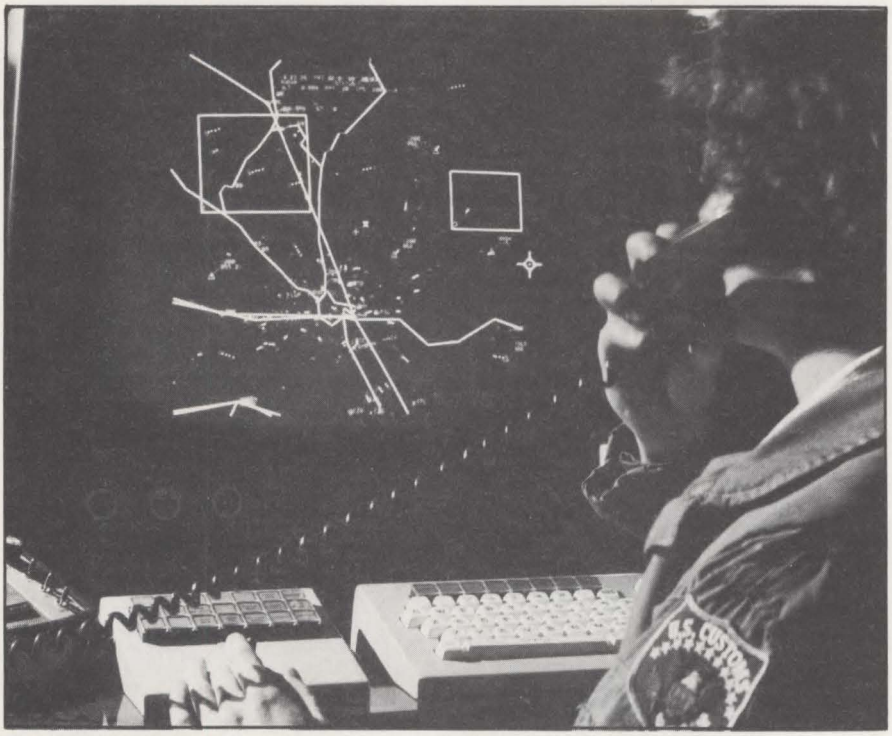
Additional construction economies are realized because the microprocessor-controlled cars require considerably less machine room and service tower space than do their mechanical counterparts. Labor costs are reduced as well because each car requires only two wires for its call signals. Electromechanical systems use more than 100.

U.S. Elevator plans to install 106 more 1200P-controlled elevators in 20 hotels over the coming year. There are also plans to convert five buildings currently using electromechanical control systems to 1200MP systems. Howell expects a 30-percent improvement in service when the microprocessor based systems are running. —*Larry Lettieri*

Graphics system aids U.S. Customs Service

A computer-driven graphics display system is helping the Customs Service to detect aircraft carrying drug smugglers and other people illegally entering the United States. The system, a Graphic 7, manufactured by Sanders Associates, Inc., Nashua, N.H., is being tested at a Customs Air Support Group site in Tucson, Ariz.

The Graphic 7 integrates and displays information from the Federal Aviation Administration, North American Air Defense and other radars. The system's radar display console is similar to those used by air-traffic controllers. Digitized information enters an



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In demanding processing environments GCR (6250 bpi) is the obvious choice. For example, a GCR tape drive can handle a 100 Mbyte disk dump/restore with a single reel in as little as 4 minutes. (Compared to 4 reels and 20 minutes for PE.) On long sequential files, a 125 ips GCR drive will actually outperform most disk drives. Best of all, GCR performance comes with a significant bonus in read/write reliability.

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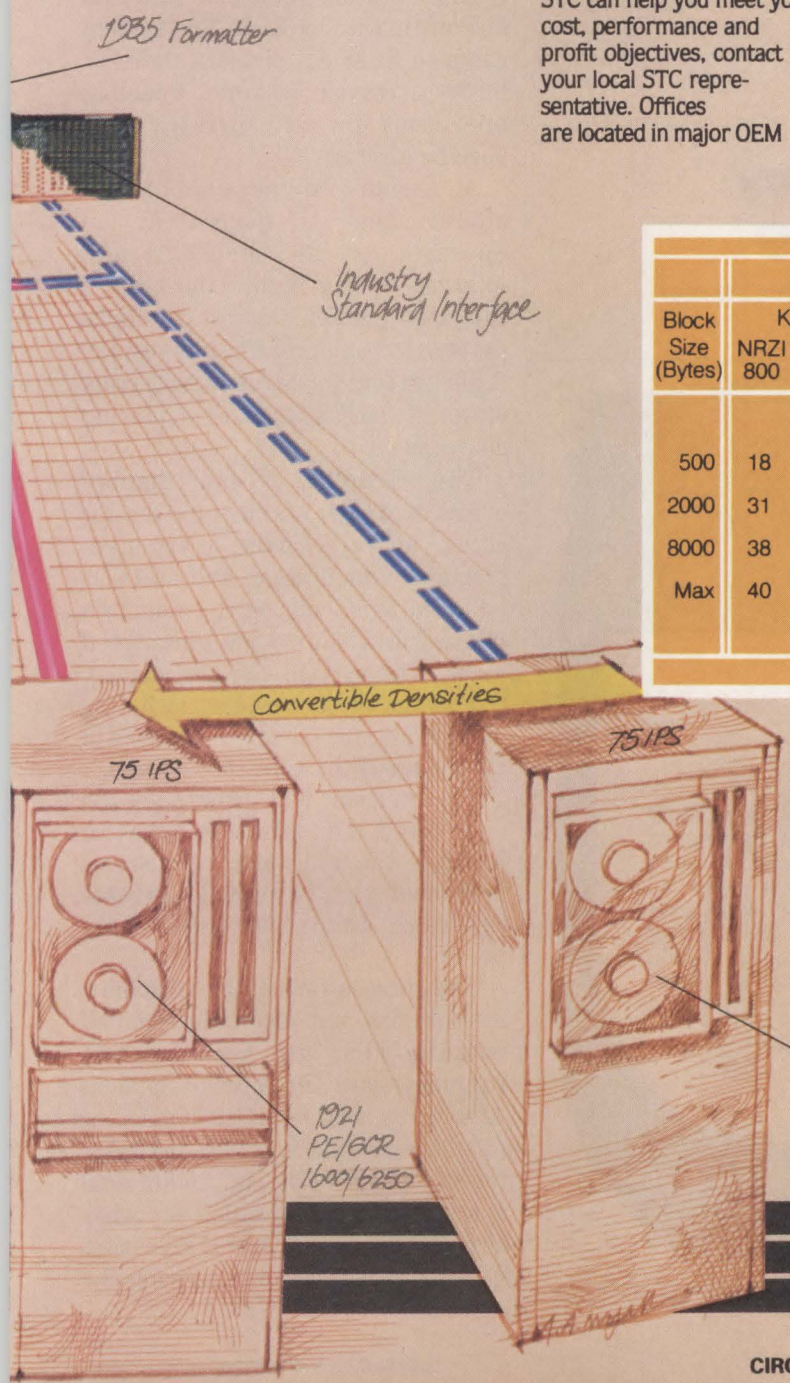
Block Size (Bytes)	50 ips KBytes/Sec NRZI 800	PE 1600	GCR 6250	75 ips KBytes/Sec NRZI 800	PE 1600	GCR 6250	125 ips KBytes/Sec NRZI 800	PE 1600	GCR 6250
500	18	27	62	28	42	94	47	70	156
2000	31	52	156	46	78	235	77	130	390
8000	38	71	249	57	107	379	96	178	624
Max	40	80	312	60	120	470	100	200	780



Channel throughput as a function of data block size.

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CIRCLE NO. 40 ON INQUIRY CARD

Mini-Micro World

Interdata 1632 computer system, which coordinates the radar information with scheduled flight information from the FAA. But the Graphic 7 system has capabilities that are not common to air-traffic controller systems. In addition to military radar data blocks, for example, the system handles computer-stored map overlays.

Users of the system can display as much as 250 mi. of map area, enlarge a 2-mi. area and focus on aircraft in that location. The system can also filter out aircraft above or below a certain altitude, enabling operators to concentrate on a specific aircraft.

A cursor device enables an aircraft that is spotted by an operator to be "hooked" and followed during flight. The system can also predict the future flight pattern of an aircraft and display flight vectors for an intercept, from either a fixed station or a moving chase plane.

The Graphic 7 can display overlays of state outlines and border cities, airways, VOR (very-high-frequency omnirange) and restricted locations, airports, mountain peaks and operator-generated maps. The system can also display the status of each radar, including its location, frequency, tilt angles of antenna and the time it was seen.

The system will eventually be connected to other radars to increase the efficiency of customs personnel and to provide greater coverage than was previously possible.

The success rate of the Graphic 7 system has not been determined because "it's just been up and running," says Jim Joyce of Sanders Associates. But John Schoolmeester of U.S. Customs says, "If the tests meet design criteria, additional systems will be installed at other sites in the U.S." Joyce says that Florida is one possible site for the system after it is tested.

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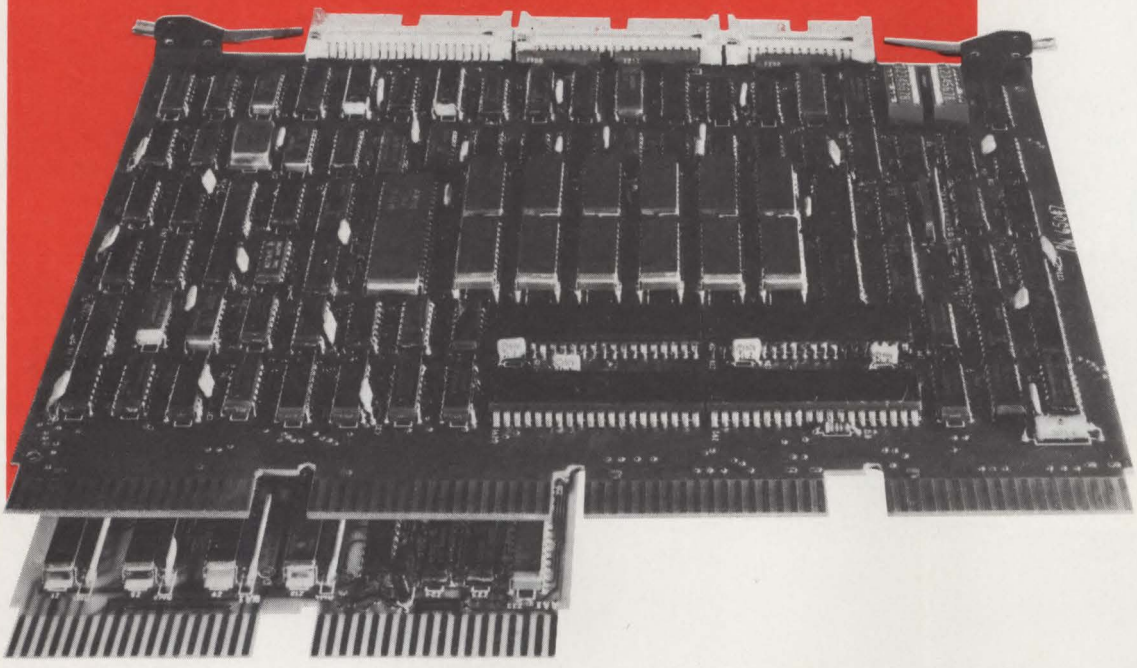

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Seconding an Ethernet motion

(Paul Franson, editor of *Electronic Business* magazine, a sister publication at Cahners, included an editorial in the October issue in which he expresses an opinion that we share and heartily recommend for computer industry perusal. Paul proposes that the Xerox Corp. Ethernet standard communications bus and protocol be broadly adopted. We'll go a step further: we suggest that IBM Corp. would perform a great service by embracing Ethernet, as unpalatable as that might be to the IBM corporate psyche. Such a move would go a long way toward establishing Ethernet as a true local communications network standard. Excerpts from Paul's editorial follow. — L. J. Curran)

If you make any products that must communicate locally—whether in an office or factory—with other equipment, you should take a careful look at the Ethernet standard communications bus and protocol developed by Xerox and now adopted by Intel and Digital Equipment Corp. It permits different kinds of computers, computer peripherals, data terminals and office equipment to communicate over a single coax line at quite high data rates. More important, however, is that widespread use of Ethernet will likely prevent the chaos that might result if the office automation industry doesn't adopt a standard.

We've seen in the much smaller instrument market what the adoption of the general purpose interface bus (GPIB) has done to simplify use of programmable equipment. Think, then, of the impact a standard bus would have in the potentially huge office—and later, factory—automation market. A standard would also allow small companies to compete on an almost equal footing with giant firms, even when the latter are responsible for most of the system.

Fortunately, it appears that it will be very easy to get on the bus. Intel is developing the required protocol chips; DEC, the line-tap transceiver. Other companies are sure to supply the market as well.

The three firms are also publishing full data on Ethernet, with Xerox offering a license for a nominal fee. Here Xerox is following the lead of Hewlett-Packard Co., which developed the instrument bus but made it easy for everyone else—including competitors—to use it. With Xerox doing the same, you don't have to be a sage to see that although Xerox should gain a great deal from wide acceptance of its development, other firms with much more limited resources will also benefit.

MORE DEBUNKING

To the editor:

Holy cow, a Luddite speaks out in a computer magazine (Edwin Lee's article: "Debunking the development system myth," MMS, August, p. 107).

Fun stuff this, no compilers, no assemblers, just good ol' numbers. Did Pro-Log use a "high-level" number base—say octal or hex? Or did they stick to binary? Potential article here, perhaps: "Debunking the hex myth."

I have to admit to not quite following all of Lee's arguments (for example: using Andrew Grove's average of 13,000 words per system to conclude that Pro-Log's project, if implemented using a development system, would have consumed 13,000 words), but no matter. I enjoyed the article, it's kept me jolly for more than a week.

J. C. Huntington
Principal Software Engineer, Advanced Systems
Honeywell, Inc.
Phoenix, Ariz.

To the editor:

Your special report (on development systems, MMS, August, p. 68) is an excellent presentation with neat tabular data of current manufacturers and equipment capabilities. Such a presentation is very helpful to mini-micro system users regardless of whether they will use the development systems directly in a cookbook fashion, or whether they are resourceful enough (like Ed Lee, Pro-Log, Inc.) to play the game by ear.

In the same issue you publish Ed Lee's "Debunking the development system myth" (p. 107) together with all its pedantry. In doing so, you are evidently aware that any subject thrives with controversy, and it atrophies with consensus. We are glad to have your multisided presentation, so that we could tackle the ball game in our own way.

Frederick Marich
Senior Analyst
Amdahl Corp.
Sunnyvale, Calif.

To the editor:

My role as both a hardware and software designer has allowed me to become intimately familiar with the microprocessor development system as both a design aid and software debugging tool.

I couldn't disagree more with the majority of Edwin Lee's ideas on the usefulness of the MDS in all aspects of software design and the marriage of hardware and software in the final design (MMS, August, p. 107). There is no magic documentation machine available, but I find the MDS to be a most convenient aid in documentation. Mr. Lee and his antiquated ideas on hand assembly of software are reminiscent of vacuum tubes and high-button shoes.

I know now how lucky I must be not to be one of those poor souls at Pro-Log doing hand assembly to please the boss. I know for sure I'll never work for Pro-Log as long as a Mr. Lee remains.

Bobby J. Jones
Lawrence Livermore National Lab
Livermore, Calif.

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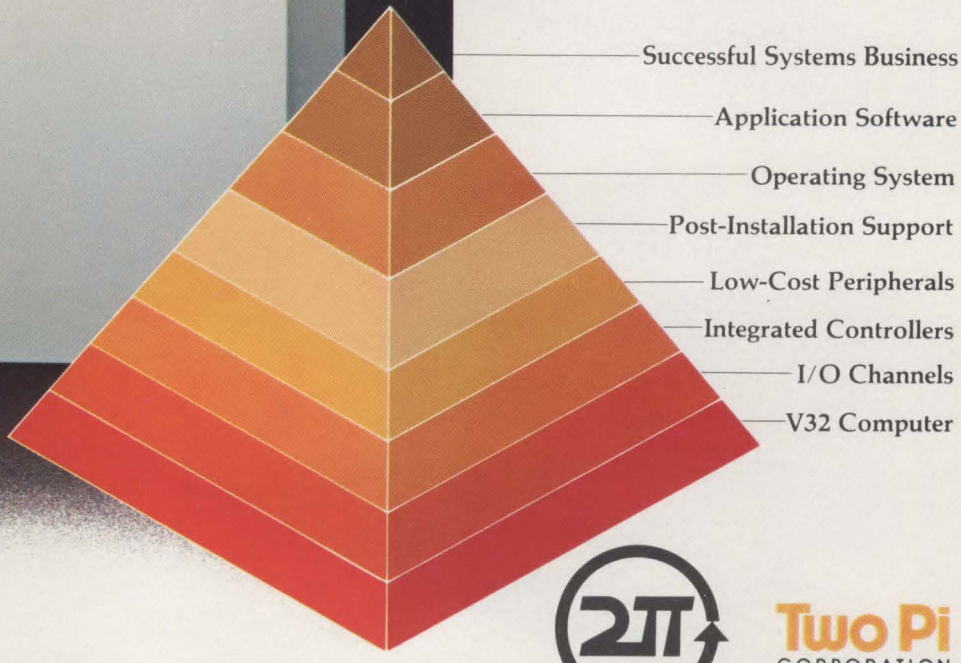

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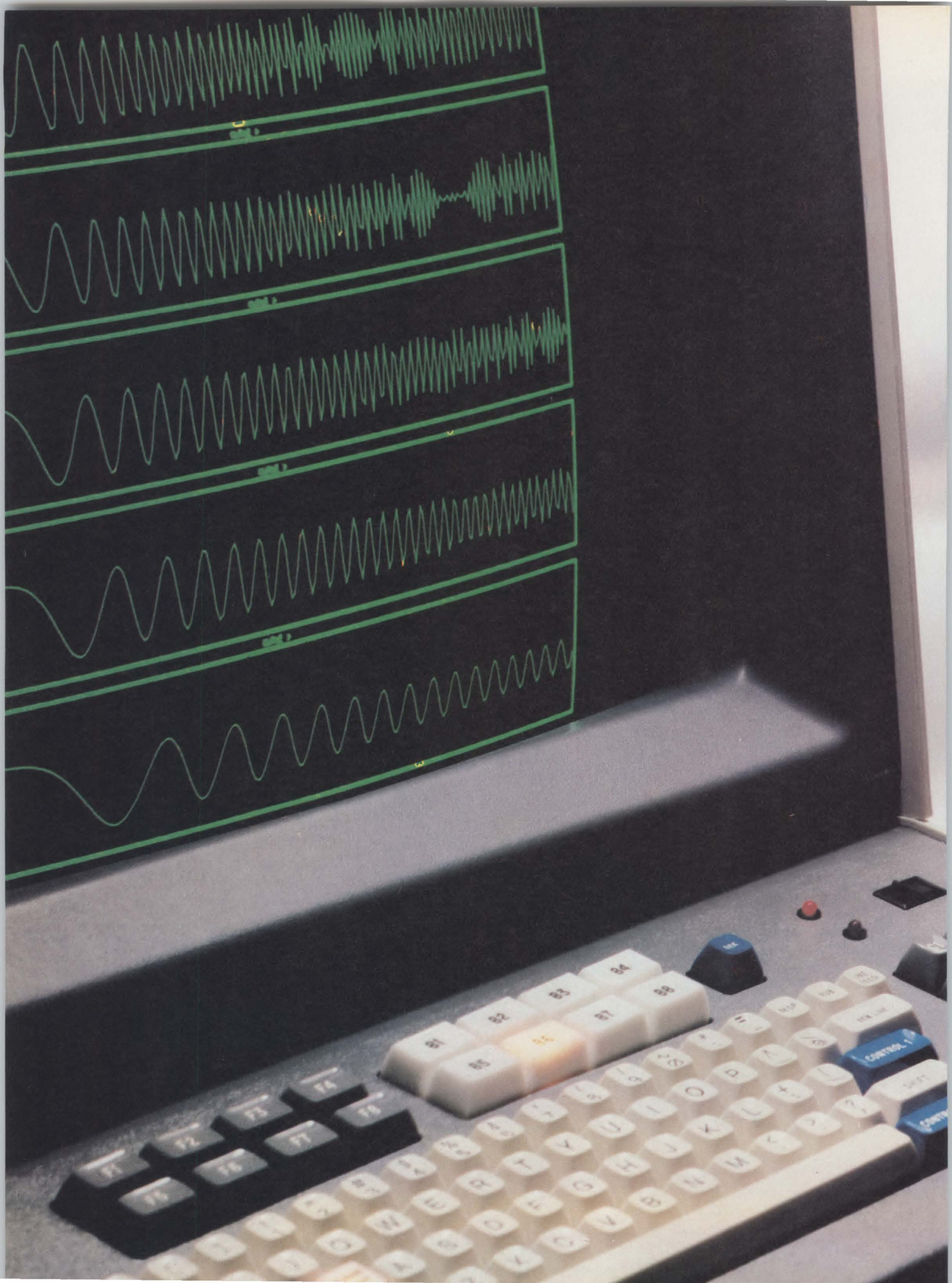

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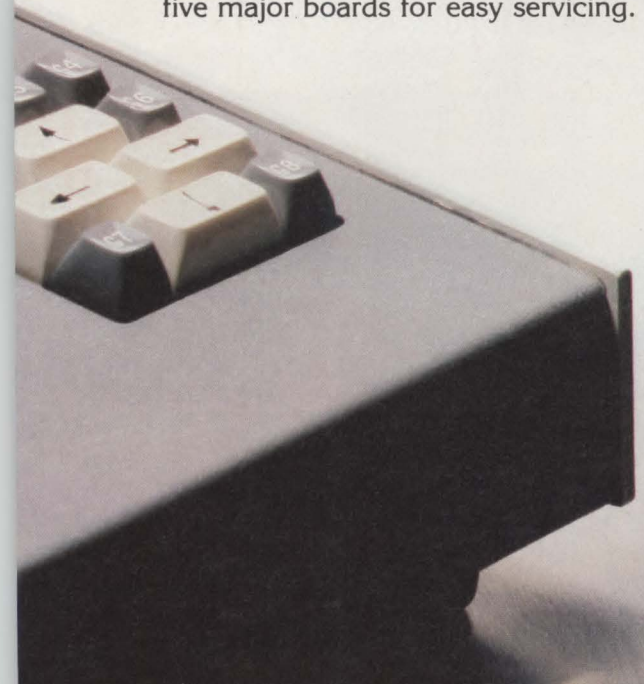

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To the editor:

In 1974, I attended one of Mr. Lee's half-day seminars in Philadelphia. At the time, he mentioned the expression SMOP—"simply a matter of programming"—which has become one of my favorite phrases.

I recently saw your article. With several years of data-processing and computer-science experience, I find it difficult even to imagine writing large programs without automated aids.

Still, I am prepared to learn new methods from "The Microprocessor User's Guide." Convince me.

Richard E. Brown
Telecommunications Engineer
Dartmouth College

DON'T BE SHORTSIGHTED

To the editor:

In the September issue, you report a complaint that young people and babies in strollers tied up some exhibitors for hours ("Siggraph reflects growth in computer graphics market," p. 17). These exhibitors are the same people who fought to be one of the 400 companies that conducted 10,000 job interviews at RPI last year. Some even wrote me plaintive letters asking for lists of graduates. Thus I find their attitude at Siggraph, and at other exhibitions like Electro 80 that exclude teenagers, unbelievably shortsighted. The continuing technological leadership of the U.S. depends on more youngsters becoming interested in math and hard science. I encourage my students to get into these shows in any way possible.

W. Randolph Franklin
Assistant Professor
Rensselaer Polytechnic Institute

A THIRD ALTERNATIVE

To the editor:

Walter A Levy's article in the September issue ("Too many networks, not enough gateways," p. 104), pointed out much of the problem in deciding between vendor-oriented networks and X.25-oriented ones. His comments about connecting 3270s to packet networks were especially appreciated, since this firm is in the midst of development work of that type. (I should explain that Tran does support 3270s on packet links, but through a packet assembly/disassembly product purchased on an OEM basis.)

I wouldn't be writing if I were not about to say, "Hey, don't forget us." In fact, there is a third alternative—the "transparent" network, which is neither host-based nor common carrier-based, and which is available now.

The point about Tran is that it can—and regularly does—supply a network for linking any variety of terminals and computers. It cannot, within the network, perform the translations so that incompatible units can interface (this is sometimes done at nodes), but it does provide the switching from any and to any compatible device.

Tran supports X.25 as well, and thus is part of the larger group of PDN suppliers you mention, but it is not a service bureau supporter à la Tymnet, nor a carrier.

Thus it is in a position to argue with some of Levy's points, while agreeing with the basic thrust of his article . . . and I'd have felt a tad better if the "third alternative" had been mentioned in passing.

Richard A. McLaughlin
Director of Corporate Information
Telecommunications Corp.
Marina Del Ray, Calif.

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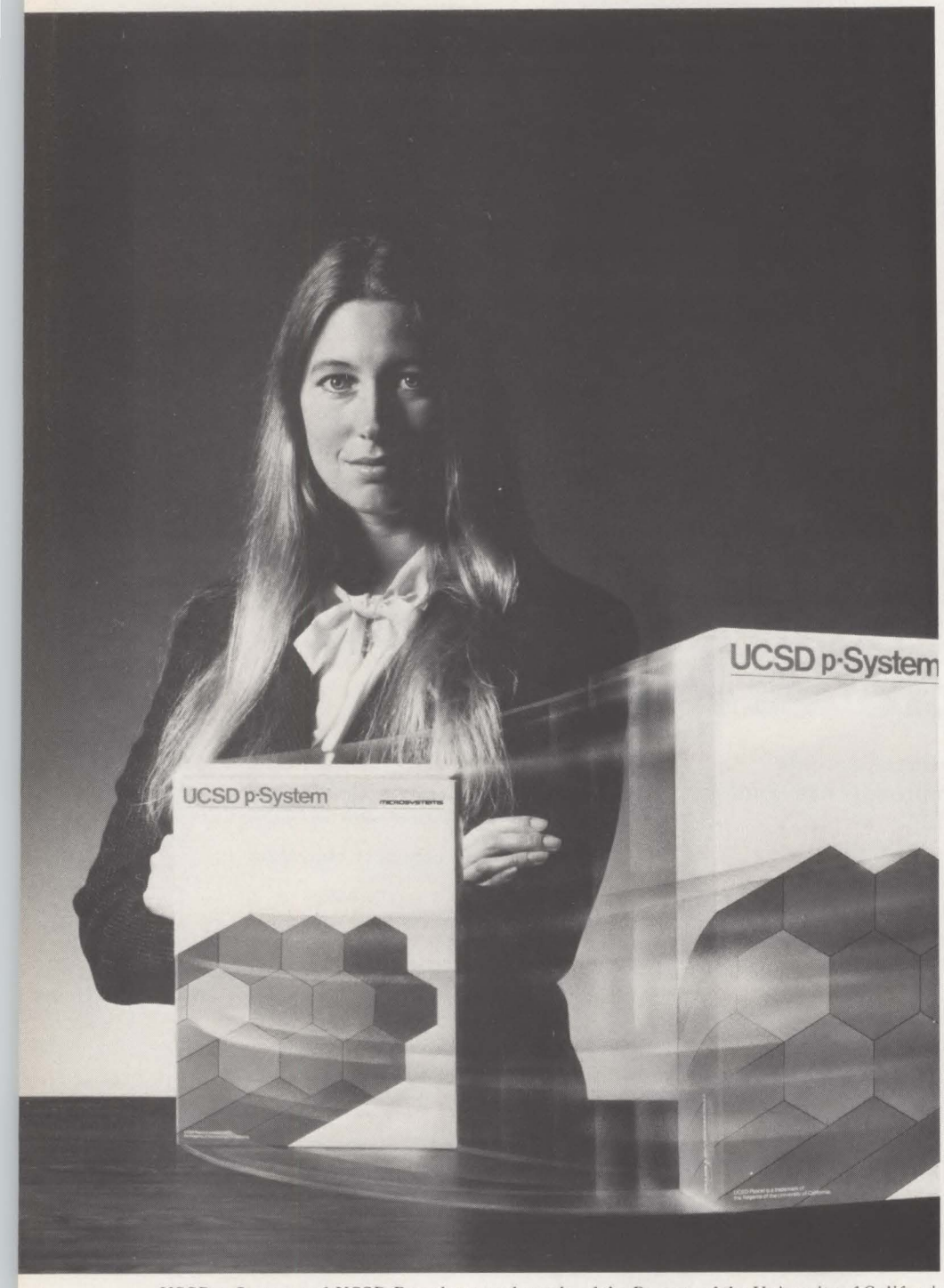
JULIE ERWIN, Director of Marketing, SofTech Microsystems



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SYSTEM INTEGRATION

The case for board-level microcomputers

JEFF GORIN and LOTHAR STERN,
Motorola Semiconductor Products, Inc.

Whether to buy at the board level or build from components is an important decision; here are some helpful suggestions

The microcomputer's rise in popularity as a dynamic replacement for fixed, complex logic systems has been directly proportional to the growth in related integrated circuits that have evolved to support it. Today those circuits permit virtually any desired degree of microcomputer power to be implemented with a relatively smlll number of IC packages in a desk-top-sized system configuration. The other side of the coin, however, is that the OEM or industrial end user is now faced with an overwhelming selection of component- and subsystem-level products. Obviously the choice of vendor is critical. But equally important is choosing between the various levels of products offered within the selected vendor's product lines. The system integrator must decide:

1. Whether to design his system with basic IC packages (the "scratch system" approach) or to implement it with a complement of more integrated board-level subsystems. (Some combination of both of these approaches may be selected.)

2. Whether to implement the system with a 4-bit, 8-bit, 16-bit (current state-of-the-art) or 32-bit (on the horizon) microprocessor.

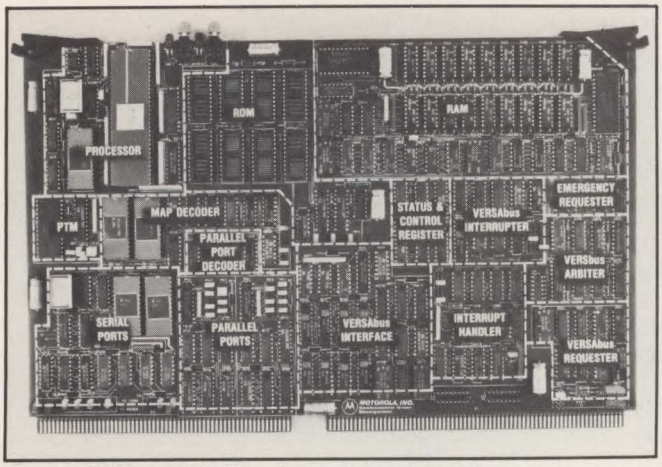

Fig. 1. VERSAmodule *Monoboard microcomputer, showing modular functional elements.*

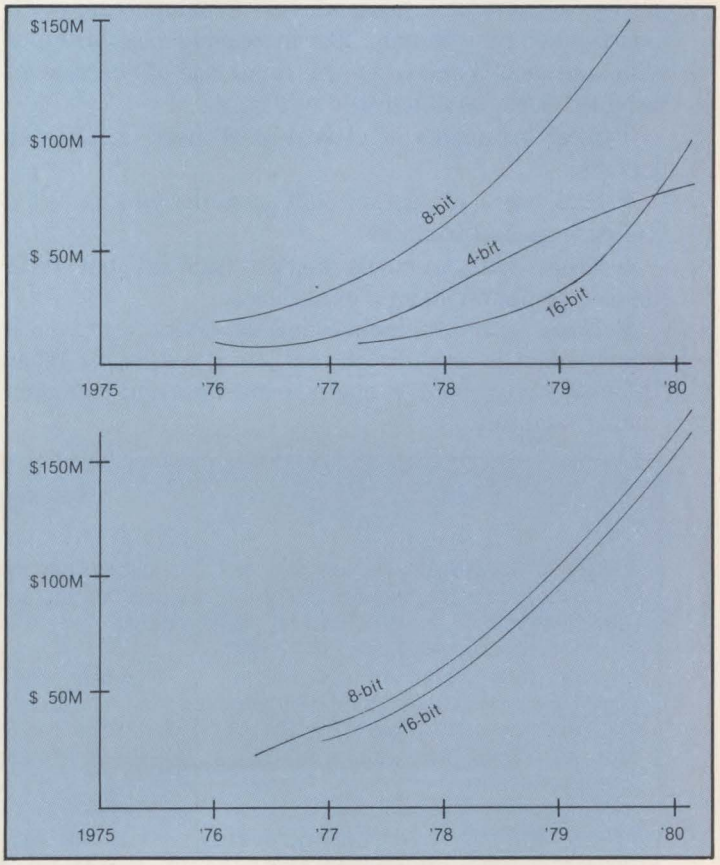

Fig. 2. Market growth *for board-level microcomputers (below) and for microprocessors and microcomputer chips (top).*

For many microcomputer users, designing with basic components becomes either too tedious, too expensive or too time-consuming.

The industry sells two basic types of microcomputer elements: a microprocessor unit (MPU) and a microcomputer unit (MCU). The first of these is simply the central processing portion of a microcomputer and contains neither built-in memory nor I/O circuitry. The latter usually contains some on-chip memory (both RAM and ROM), as well as some basic I/O interface features. Except in very rare applications, neither of these choices constitutes a complete, self-contained, operational system.

The user, therefore, supplements his choice of MPU/MCU with a myriad of peripheral components—more memory, perhaps, or additional I/O functions—to evolve a typical microcomputer as shown in Fig. 1. In this instance, the MPU represents only one of 147 IC packages required for the desired function. Obviously, a lot of design work goes into the development of the final functional system.

To the OEM whose end product is large-volume and computer-related (terminals, for example), the design and manufacture of the custom board demanded by his product becomes an in-house effort. For many other microcomputer users, however, designing with basic components becomes either too tedious, too expensive or too time-consuming. Such system manufacturers prefer to start at a higher level of manufacture with board-level subsystems. The increasing popularity of this approach is shown by the rapid rise of board-level product sales, as illustrated in Fig. 2.

Typical examples of board-level user candidates include:

- End users of custom-built systems who have no in-house design facilities.
- Users with in-house design facilities but with limited computer design experience.
- Users with computer design experience but whose end product is produced in too low a volume to offset in-house investment in engineering time and manufacturing facilities.
- Users who wish to avoid a relatively large investment in development systems of the complexity needed for chip-level design support.
- Users whose markets require quick turnaround of new products.

In these cases, system development with subsystem boards represents the ideal compromise between building a system from scratch and having it built on the outside in a turnkey operation. The advantages of board-level products are that they are more cost-effective when end quantities are moderate, are simpler and quicker to implement, conserve engineering time and talent, employ the latest components and design techniques, afford maximum use of supporting software and peripherals.

Let us develop the factors behind each of these benefits in some detail.

- **More cost-effective for moderate quantities.** Whether the microcomputer system is being designed for resale or for internal use, its cost is a key factor in

NONRECURRING DEVELOPMENT COSTS—TYPICAL 8-BIT SINGLE-BOARD MICROCOMPUTER

COST COMPONENTS	LABOR		MATERIALS AND SUBCONTRACTED WORK
	MAN-DAYS	$	$
Design Engineering			
Circuit Design	35	7000	
Design Documentation	20	4000	
Board Layout	15	3000	2000
Prototype Debug	20	4000	3000
User/Maint. Manual Inputs	15	3000	
Test Design Inputs	10	2000	
Product Test Engineering			
Product Design Familiarization	10	2000	
Test Design	35	6000	
Test Debug	20	4000	
Production Engineering			
Production Documentation	10	2000	1000
Assembly & Test Fixturing	20	4000	3000
TOTAL ($50,000) =	$41,000		+ $9000

Fig. 3. Nonrecurring *development costs for typical 8-bit single-board microcomputer.*

DEFINITIONS

Single board microcomputer (or "monoboard microcomputer")—A single printed circuit board containing, as a minimum, processor, memory (ROM and/or RAM) and input/output—usually a combination of serial and parallel ports. May also include a counter/timer function and bus interconnection scheme. A "single-board microcomputer family" may also include other functional system elements (such as memory and I/O functions) on circuit boards of the same format as the microcomputer board.

Modular—Refers to a partitioning scheme for a family of a single-board microcomputer family circuit cards wherein system and I/O functions of various types are grouped and organized into "modules" (a memory module, for example). Each of the modular circuit board elements also includes a "bus interface" to allow intercommunication. The benefit to the system designer is that various functions can be included only to the degree needed for a specific application.

Bus—A mechanical, logical and electrical interconnection scheme for modular microcomputer circuit elements; provides a common path for address and control information between those modular elements.

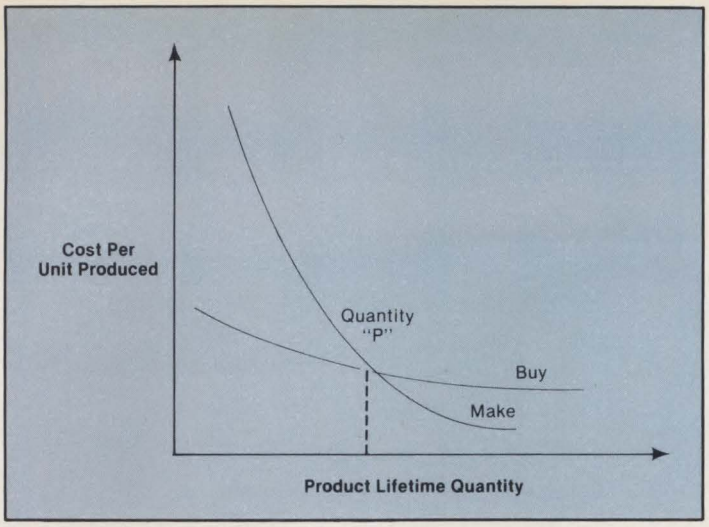

Fig. 4. *A make-or-buy analysis.*

the make-versus-buy decision. Consider the typical case of a microcomputer system whose principal sub-element is an 8-bit single-board microcomputer that can be purchased outside or designed and manufactured internally. In either case, the application software (or firmware) will be designed in-house so the computer board hardware is itself the principal variable. What, really, is the "cost" of that board for each of the two options?

For the purchase option, the cost is merely the price paid to acquire the board. However, for the "make" option, the total cost is not as obvious. It is all too common for the system designer to conclude that he can save money by designing and producing the monoboard microcomputer himself, instead of paying $600 or so for it on the open market. He observes that it contains only $70 worth of components soldered into a $30 PC board. What he does not consider fully is that the production cost of his own monoboard microcomputer is much more than just the total parts cost, and that the total cost per manufactured unit is much more than just the production cost when the total production run is only a moderate number of units.

The total *production* cost will include both parts and labor. With a moderate overhead rate, assembly and test labor can easily add another $50 to that $100 of components. Moreover, the "*total*" cost must include an amortized amount of the total nonrecurring development cost. A single-board microcomputer can easily cost $50,000 in nonrecurring charges considering design engineering, test development and production engineering requirements (Fig. 3). The system designer must comprehend the realities of today's labor costs: engineering overhead of 40 percent to 70 percent on top of straight salary brings the daily cost of a microcomputer design engineer to $150 to $200 depending on skill level and specialty; production-shop overhead of 200 percent to 500 percent brings the cost of a production person to more than $200 a day (even though his direct hourly pay is much less than that of the engineer). Actual overheads vary, but these are good estimates of "typical" overhead structures in medium to large companies.

With an anticipated low-volume production run of 100 units (not an unlikely number considering many types of factory control systems), the amortized development cost per unit would be $500. Add this to the direct production cost of $150 and you can see that the advantage would be in favor of buying at a unit cost of $600 or less per unit in volume.

The make-versus-buy analysis will typically result in the pair of curves shown in Fig. 4. The curves indicate decreasing cost-per-unit as a function of the total-product lifetime-production quantity. The point "P" is the particular lifetime quantity where the per-unit cost would be exactly the same whether the board-level product were designed in-house or purchased. For any greater anticipated lifetime quantity, it would make more economic sense to design and manufacture the product in-house. Conversely, for a smaller quantity it would make sense to purchase the product. The shaded area represents the amount of cost per unit saved by purchasing rather than manufacturing.

For the most common applications of 8-bit microcomputer systems in industrial and lab automation and in general data-acquisition functions, the point "P" as shown on the curve usually falls in the range of 200 to 500 units. For 16-bit systems in these same general applications, because of their greater complexity and, therefore, development cost, "P" will usually fall within 300 to 800 units.

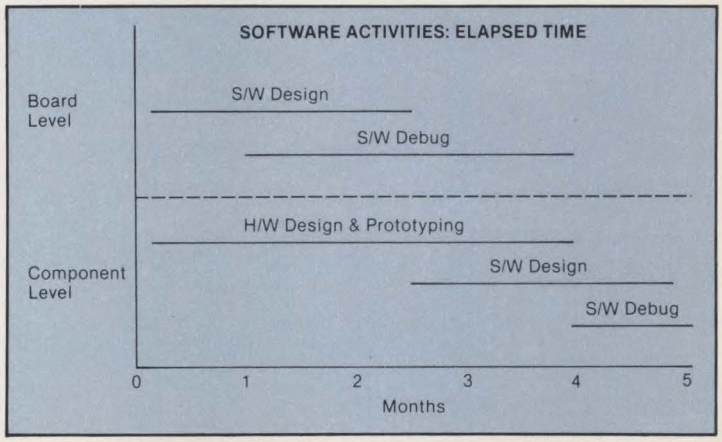

Fig. 5. Activity chart *illustrates the potential elapsed-time saving that can be achieved when designing at the board level.*

• **Simpler/quicker to implement.** Elapsed time is a valuable commodity, more so when one is looking at a window for getting a product on the market ahead of the competition, or for implementing some cost-saving automation feature internally. How does use of board-level products help? Simply by allowing the serious development phase of the application software to begin earlier than is otherwise possible if the hardware is an in-house design. Typically, the "serious" software-development phase cannot begin until the prototype hardware is debugged to a certain stage. With a purchased board-level product, this software debug can usually begin as soon as the purchased unit is delivered, typically less than 30 days after order (and many times it is off-the-shelf). With the in-house

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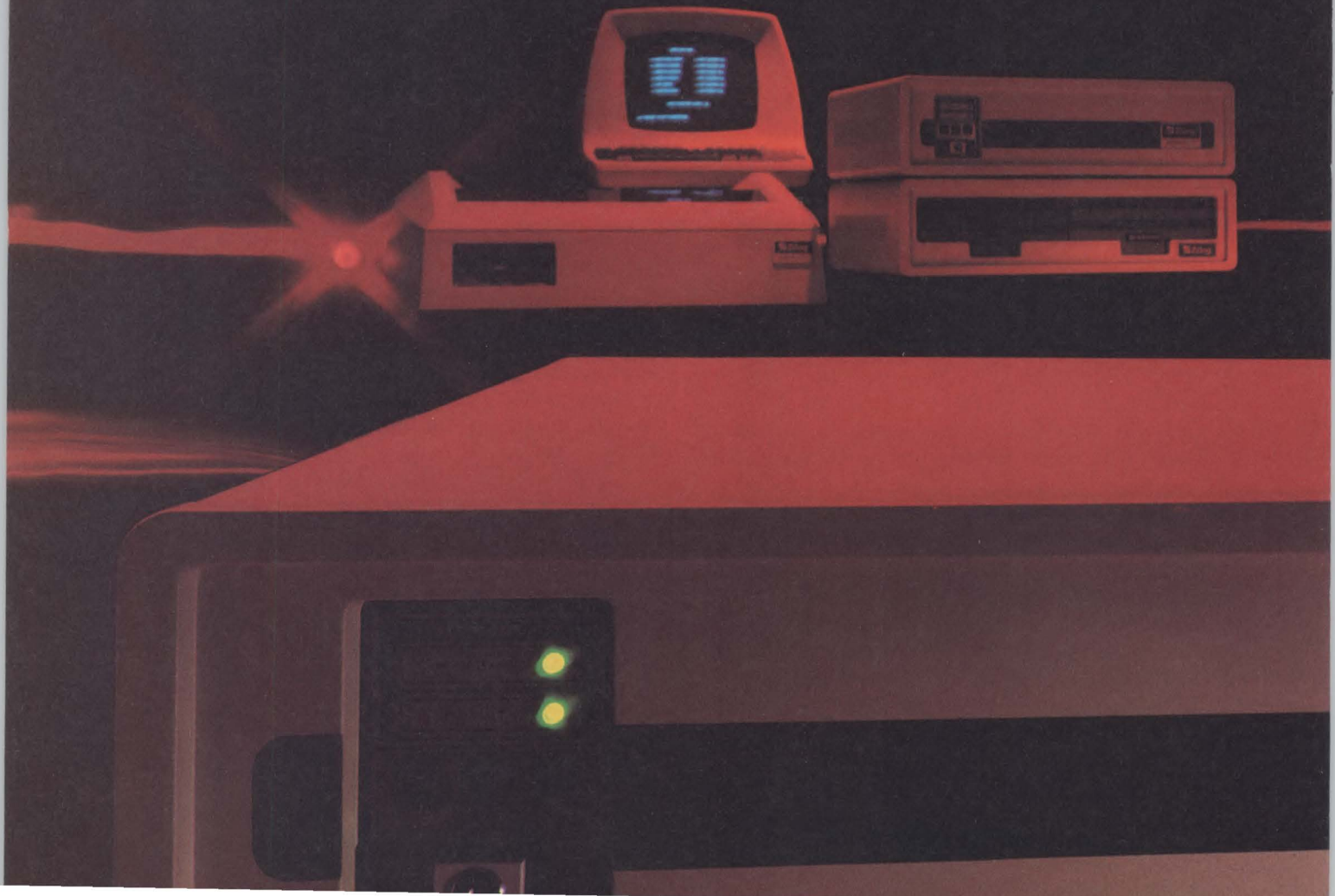

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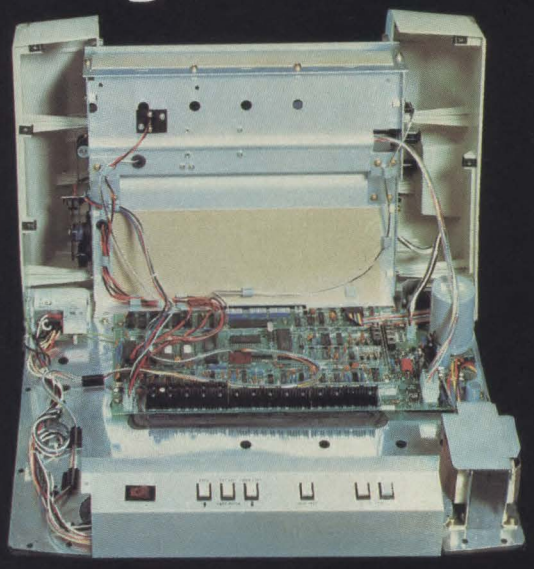

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For the purchase option, the cost is merely the price paid to acquire the board. But total cost isn't as obvious with the 'make' option.

designed hardware product, the delay to debug hardware could be three to six months (Fig. 5)—a long time if the competition is using the board-level approach in their system integration.

• **Conserves engineering time and talent.** It is no secret that microprocessor hardware and software engineers are very scarce. Consequently, there is even more impetus to make the most productive use of their talents. An organization with enough design talent to undertake one component-level design project over a specific period of time, but not enough for two over the same period, could potentially execute the design of both new microcomputer system products if at least one project is executed with board-level subcomponents. The ability to amplify scarce design talent in this way can mean the difference between bringing a product to market or missing the market window. And this, in turn, can mean more profit dollars for those who use board-level products judiciously.

• **Employs latest components and design techniques.** Each successive generation of LSI and VLSI devices normally offers greater design and operating efficiencies in the final system product. However, new components frequently require new design techniques for their best use, and new design technique imply an improvement in or expansion of the skills of the designers who will be using those components. Again, use of board-level products can obviate the need to apply hardware design resources, or to upgrade the skills represented in those resources, while still taking advantage of the latest components and techniques.

• **Maximum use of software and peripherals.** Because the development of the specific application software is frequently the most time-consuming part of the overall microcomputer system development project, there is a potentially great advantage in acquiring support software that can help streamline the total effort. The typical development software as embodied in compilers, assemblers and editors forms a large part of that needed by the system developer. But these tools are normally equally applicable to designs-from-scratch or board-level system designs. In the overall application software system design, big savings can result from the application of monitors, executives and operating systems that take the burden of many of the system's detailed control and resource management functions from the application software designer. For instance, the use of packaged real time, multitasking executive software package can save as much as two-thirds of the total software-development effort needed for sophisticated microcomputer applications.

Choosing a product line

Each line of computer modules is based on a specific type of microprocessor. Motorola, for example, carries two separate module lines: Micromodules—based on its family of 8-bit M6800 processors—and VERSAmodules, using the newer and more powerful 16-bit M68000 chip family. Other manufacturers have similar selections.

It must be recognized, however, that the ultimate capabilities of systems implemented with modules are somewhat more restricted than those implemented

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MC6802	MC141200	
MC6803	MC146805	
MC6805		
MC6808		
MC6809		
MC68000		
MC3870		

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1-Bit	4-Bit	8-Bit	16-Bit	32-Bit
MC14500B	MC141000	**MC6800**	**MC6809**	**MC68000**
	MC141200	MC6801		
	MC10800	**MC6802**		
		MC6803		
		MC6805		
		MC6808		
		MC3870		
		MC146805		

Choice of Functional Completeness:

MPU/CPU/ALU	MPU with On-Chip RAM	MCU MPU with On-Chip RAM, ROM & I/O
MC6800	**MC6802**	MC6801
MC6803NR	MC6803	MC6805
MC6808		MC3870
MC6809		MC141000
MC68000		MC141200
MC14500B		MC146805
MC108000		

Choice of Language Orientation:

Low-Level Language	High-Level Language	Designer's Choice
MC6800	**MC6809**	MC14500B
MC6801	**MC68000**	MC10800
MC6802		
MC6803		
MC6805		
MC6808		
MC3870		
MC141000		
MC141200		
MC146805		

Fig. 6. Motorola's *MPU/MCU options for system design.*

Board-level products allow the serious development phase of the application software to begin earlier than possible if the hardware is an in-house design.

with basic components. Fig. 6 shows the wide range of MPU/MCUs manufactured by Motorola, with those available in module form printed in boldface. Systems requiring the very low power consumption of CMOS technology or the very high speeds associated with bipolar devices, are not presently supported by the Motorola modular products. However, other suppliers of board-level products may use a different mix of basic processor capabilities with which to implement their lines so that, in most instances, the system designer should encounter little difficulty in selecting a suitable module line.

The decision to "go modules" eliminates most of the tedious operations involved in system design and manufacture. There is no component selection or (in most instances) interface circuit design; no PC board layout or assembly lines. The hardware system design becomes simply a matter of selecting the board complement for a given performance requirement, and inserting these boards in a ready-made, pre-wired chassis or card-cage, as illustrated in Fig. 7. But there are two preliminary decisions. The first is determining which MPU/MCU will offer him the most convenient way to achieve his goal; the second is selecting the most cost-effective board complement from the large available repertoire.

• **Which microprocessor?** The bewildering array of MPU/MCU type numbers in Fig. 6 is more significant to the "scratch" designer than to the designer with modules. This is because many of the type numbers represent designs that are based on a specific base unit (e.g., the MC6800) but are tailored to be most cost-effective for unique situations. Thus the MC6802 is nothing more than an MC6800 to which an on-chip clock and memory have been added—a design improvement very important to the scratch designer, but of only casual interest to the module user because any on-chip deficiency is certain to be compensated by on-board circuits.

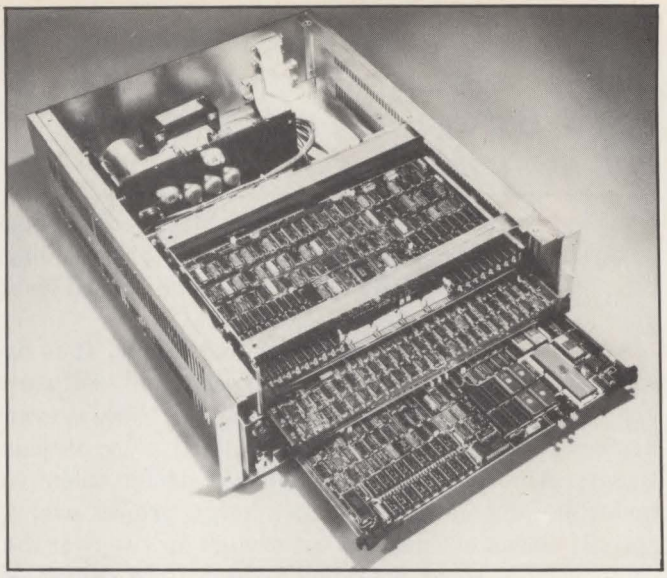

Fig. 7. VERSAmodule *Monoboard microcomputer modular elements in a pre-wired chassis.*

Of infinitely greater importance to the module user is the choice between boards using processors of basically different characteristics. For example, the MC6800 versus the MC6809. While the 6809 is designed to work compatibly with 6800 peripheral chips, it is inherently a much more powerful processor—using 16-bit rather than 8-bit internal registers for greater speed, and capable of more efficient handling of high-level languages like Pascal. Its higher price tag, which could be of concern to designers of equipment intended for high-volume manufacture, can easily be justified to module users for low-volume equipment where the cost of the processor borders on the insignificant compared with the much greater cost of software and peripherals. Thus a careful analysis of available processor boards should precede any selection process.

• **Selecting the board complement.** The overwhelming popularity of the 8-bit NMOS processor has given rise to very heavily populated module lines. The large variety of type numbers under each function category gives the illusion of much greater complexity than actually exists. Again, as in the case of the MPU/MCUs, most of the variations consist of differences in memory capacity, memory mix (RAM/ROM), I/O and related structural differences.

SOFTWARE CATEGORY DEFINITIONS

Assembler—Program that converts source-code (Mnemonic) input into op-code (binary) machine language instructions. If such a program were not available, the programmer would have to enter all instructions in ones and zeros, a much more tedious and error-prone procedure.

Editor—A program that permits a series of mnemonic instructions comprising a user program to be displayed, analyzed, corrected and otherwise modified quickly and easily on a CRT screen or other suitable terminal device.

Debug monitor—An interactive program that allows the design engineer to intercommunicate in a "friendly" manner (through a terminal device) with the microcomputer system under development, and to control closely the execution of an untested microcomputer program in order to check its correct operation.

Interpreter—A high-level language processor that "reads" the source statements and immediately executes machine - language subroutines in order to perform the functions designated by the source statements.

Compiler—A high-level language processor which converts a sequence of source language statements into a corresponding sequence of machine language instructions which may be *later* loaded into memory and executed by the processor to perform the desired functions.

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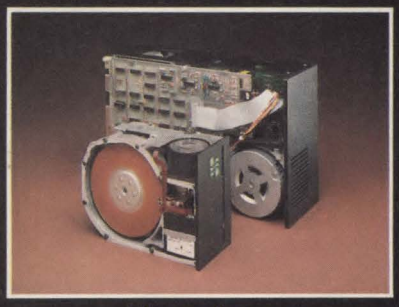

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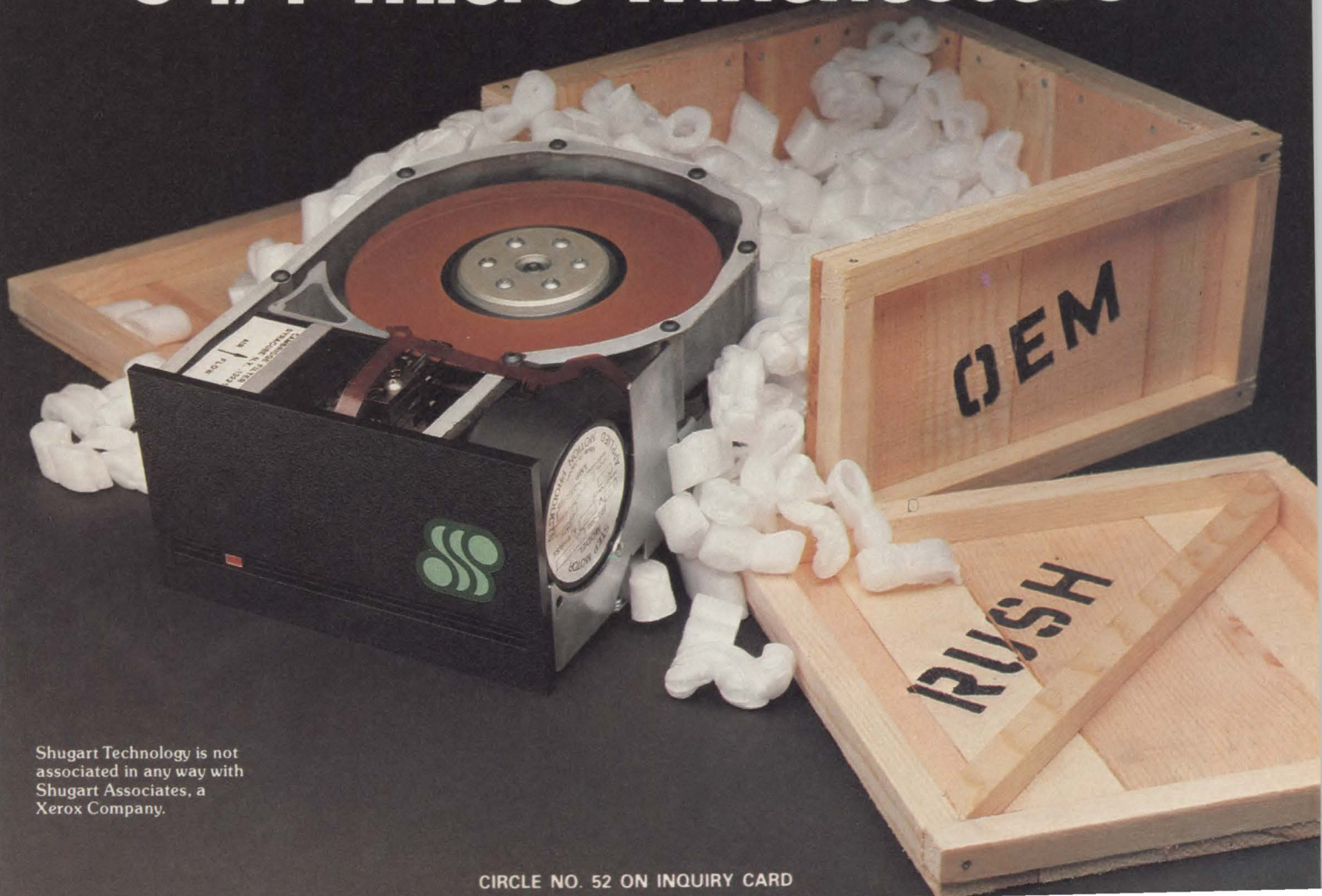

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DECwriter IV Model AA. The new forms-handling terminal that doesn't limit your choice.

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Well, now you can have that same flexibility in handling forms.

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And you can control this new terminal either directly from its keyboard or from a computer.

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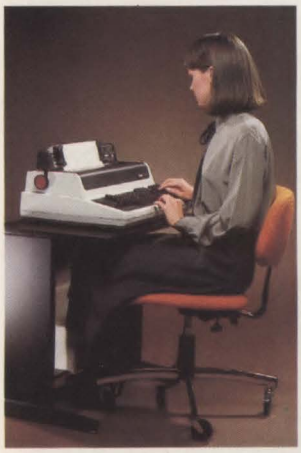

Best of all, Digital has put all this capability into a terminal that fits right into a wide range of environments—either on its custom stand or on a desktop. And the DECwriter IV's solid-state components and microprocessor controls continue to build on the reliability standards set by the DECwriter II. All at a surprisingly low price.

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CIRCLE NO. 53 ON INQUIRY CARD

There is a potentially great advantage in acquiring 'support' software that can help streamline the total effort.

An example of these differences is given in Fig. 8, where the Monoboard microcomputer category is defined. Note that the only major difference is in Micromodule 19, which uses a 6809 processor rather than the 6800 (or 6802). All other variations are in memory and I/O, as previously mentioned. Although apparently mundane, these variations are by no means trivial, since they permit the structuring of systems that can be tailored to each custom requirement at the lowest cost.

- **Software support.** For purposes of this discussion, there are three categories of software that the user must consider and apply to help him achieve his desired end result of a fully operational microcomputer system performing the desired function:

- **Application software.** Whether resident on cards, disk or in ROM, this is the software that causes the machine to react in a predetermined fashion to a variety of stimuli. In other words, the application software performs the end function of the machine. The user must almost always provide his own application software in the microcomputer environment, because he typically has a unique function to perform with the system.

- **Operating system software.** This is the software that handles the myriad details of controlling the multiple tasks and activities that may be occurring simultaneously in a higher-performance microcomputer application. The operating system can also handle the details of interfacing to complex peripheral devices, and present a very straightforward and simple "logical" interface to the application software. It eases the job of the application software designer and saves total time in producing the end application. System software could be designed by the end user, but frequently it is available from the vendor of the Monoboard microcomputer product.

- **Development software.** This term encompasses the programming tools (assemblers, editors, monitors and debug programs) that permit the designer to formulate, enter, test and correct his application program. No processor is complete without some such software, but the more extensive this software offering, the faster will be the development of the user program—and that is often the most expensive part of a system design.

In many product lines, development programs are available on a number of different storage media for the convenience of the user. Such media include paper tape, diskettes, cassettes (magnetic tape) and programmed ROM devices. It affords the user a variety of means for accessing a system for the purpose of hardware and software development, and can result in significant cost savings in terms of peripheral equipment. But the available development software/firmware must be matched to its specific microcomputer board in order to assure a successful interface. As one example, the Motorola Monitor/DEbug program called Microbug is available in ROM in two different kits: M68MM08 and —08A. The first of these (08) consists of a MICRObug ROM and a communications interface adapter module, and is intended for use with Monoboard microcomputer modules having no serial I/O Monoboard computers that have on-board serial interface adapters.

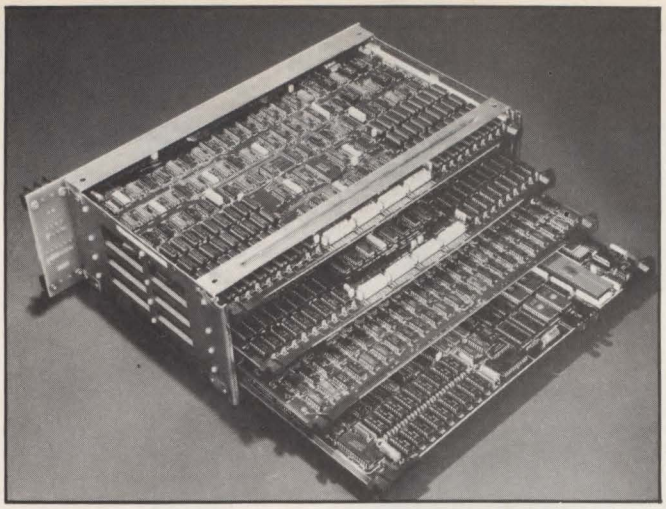
Advances in LSI have generated tremendous prog-

MONOBAORD MICROCOMPUTERS

Part No.	Parallel Input/Output	Serial I/O			Memory		MPU	Clock (MHz)	Options
		RS232	RS422	20mA	ROM	RAM			
M68MM01	3PIAs/60 Lines				4K	1K	68]]	1	MM01-1;4.7K Termination Networks & 4 Connectors MM01-2; 330/220 Termination Networks & 4 Connectors
M68MM01A2	2PIAs/40 Lines	1 ACIA		Use MM11*	4K or 8K EPROM/ROM	1K	6800	1	MM01A2-1; MM01A2 with 4 Connectors
M68MM01B	1PIA/20 Lines 1 PTM				4K	128	6802	1	Not Expandable
M68MM01B1A	1 PIA/20 Lines 1 PTM	1 ACIA		Use MM11*	4K	384	6802	1	Cassette I/O
M68MM01D	Printer Port 1 PTM	1 ACIA	(Opt.) †	Use MM11*	10K		6800	1, 1.5	Use 2K RAMS in ROM Sockets
M68MM19/19A	1 PIA/20 Lines 1 PTM	1 ACIA or SSDA	(OPT.) †	Use MM11*	8K-16K	2K	6809	1(MM19) 2(MM19A)	Replace ACIA with SSDA †

NOTES:
PIA = 16 Programmable I/O Data Lines and 4 Control Lines
PTM = Three 16-bit Programmable Counter/Timers
ACIA = Asynchronous Communications
SSDA = Synchronous Communications
† = Option-requires slight board modification
* = Option-requires additional Micromodule (MM11) (RS232C to 20 mA Current Loop Adapter)

Fig. 8. The differences *between Monoboard microcomputers.*



Motorola's VERSAmodule *uses the newer and more powerful 16-bit M68000 chip family.*

MORE POWER, MORE SPEED

Processor	Number of Instructions Needed	ROM bytes	Relative Execution Time For Large Array
MC6800	45	63	1.0
MC6801	26	34	1/2
MC6809	13	24	1/5
MC68000	10	28	1/25

Fig. 9. Comparing the *anticipated execution of a test program on various M68-type processors for perspective of relative importance.*

ress in microcomputer architecture. Eight-bit microcomputers have scarcely been digested by system designers, but new and far more powerful 16-bit microprocessors have already been introduced. And with them have come new lines of modular subsystems that cram the processing power and speed of the low-end minicomputer into the space formerly required for the micro. Moreover, the semiconductor industry has clearly set its sights on reproducing the capabilities of even the more sophisticated minicomputers within the size and cost restraints of the microcomputer. Thus, while Motorola's most powerful microprocessor, the MC68000, has 16-bit data I/O capability, its internal registers already operate on the 32-bit level—a harbinger of the next generation of 32-bit machines.

With each new advance, the question arises of how much processing power a user really needs. Certainly 8-bit processors can handle the vast majority of microcomputer applications. But not as well, perhaps, as a 16-bit machine. And in the fast-moving electronics industry it has become almost axiomatic that if you supply a new product with vastly greater capabilities, engineers will figure out ways to use those capabilities to the fullest. The great interest in 16-bit processors illustrates this point.

One of the benefits derived from going to greater processing power is program execution speed. This becomes vitally important in many real-time applications where the computer must react instantly to an activating stimulus. But it's also important in most complex processing operations where a large number of successive operations could delay the final response by seconds or even minutes. The relative increase in execution speed for three generations of Motorola processors is given in Fig. 9, which compares the anticipated execution time of a test program for the three devices.

But speed is by no means the only criterion. The more powerful 16-bit machines are designed to support structured high-level languages, which greatly increase their operating efficiency and streamline user-program development. Operating efficiency is defined in terms of the speed with which the desired processing cycle occurs, and of the number of instructions required. Other features, such as *position-independent coding* and *reentrant programming capability* encourage the development of "canned" software with modular program interchangeability. This relatively new capability will soon lead to a line of generic application *software modules* that should greatly simplify software development.

Moreover, the speed and power of these newer 16-bit processors are so great that the use of a single machine by a number of different operators, simultaneously, is quite practical.

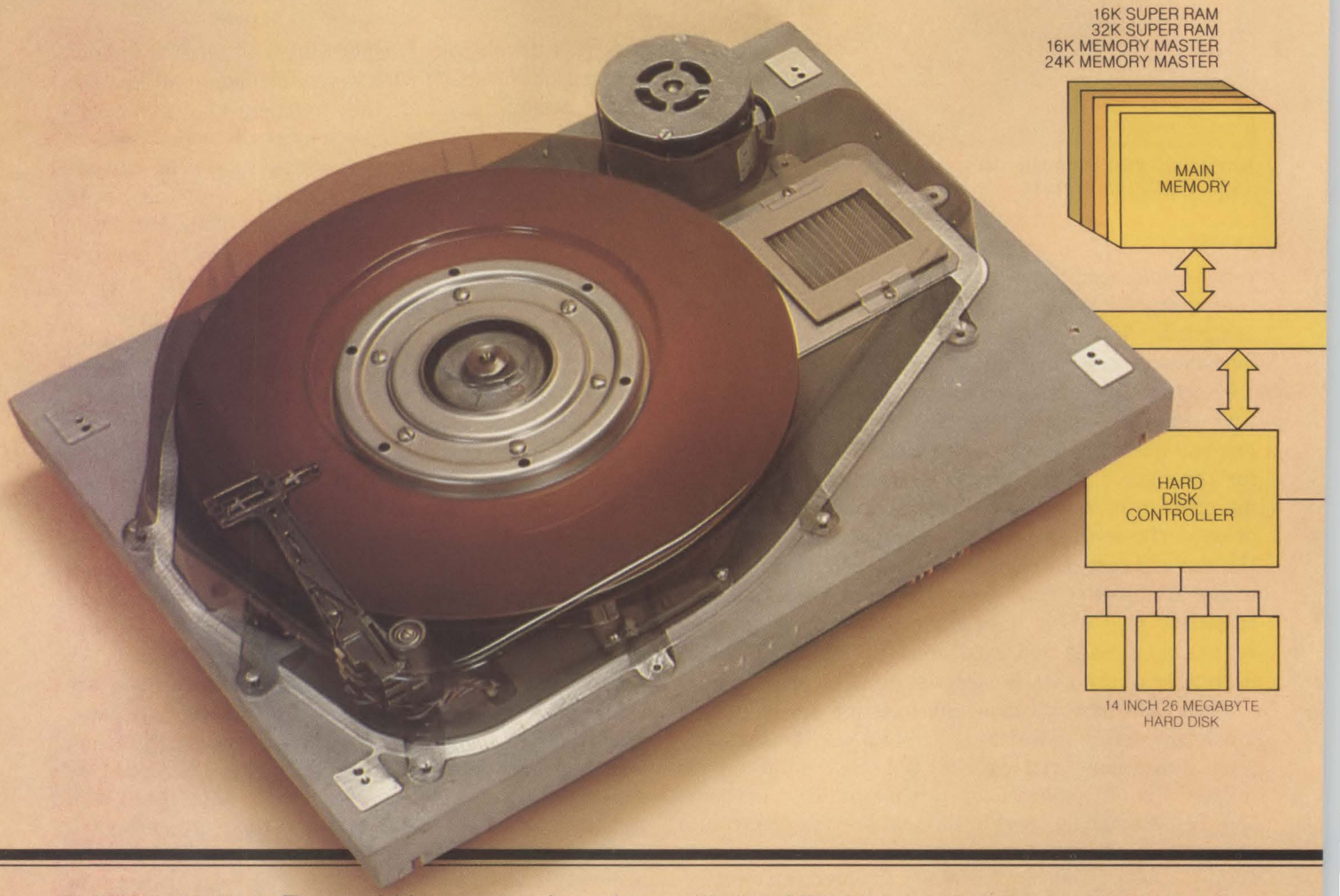
If the price of these high-powered machines were directly proportional to the increase in capability, their future might not be so bright. But such is the nature of the semiconductor business that relatively high introductory prices soon dwindle to a very competitive level as production experience traverses the familiar learning curve. So predictable is this phenomenon that semiconductor manufacturers often project product prices a year or two down the road, and semiconductor users base their design plans on these predictions. Since both old and new products traverse the same learning curve, the simpler products will always be less expensive. Nevertheless, the price differential will shrink to a level that often converts the more expensive *product* into a less expensive *system*—that is, the price/performance ratio greatly decreases in favor of the more complex components.

For example, the price range of Motorola's 8-bit Micromodule Monoboard line is from $250 to $500, in large OEM quantities, depending on the features of the module. The introductory price of the Monoboard microcomputer in the 16-bit VERSAmodule line is less than $1300 for similar large quantities, less than three times higher than the top-of-the-line Micromodule. However, total capability of the VERSAmodule Monoboard microcomputer is greater by a factor of 10 to 25, depending on the specific application. That's semiconductors. ■

Next: Examining Motorola's VERSAmodule system features in detail.

Jeff Gorin is manager, product applications, and **Lothar Stern** is manager, technical communications, for Motorola Semiconductor Products, Inc., Phoenix.

While they were thinking hardware and software, we were thinking



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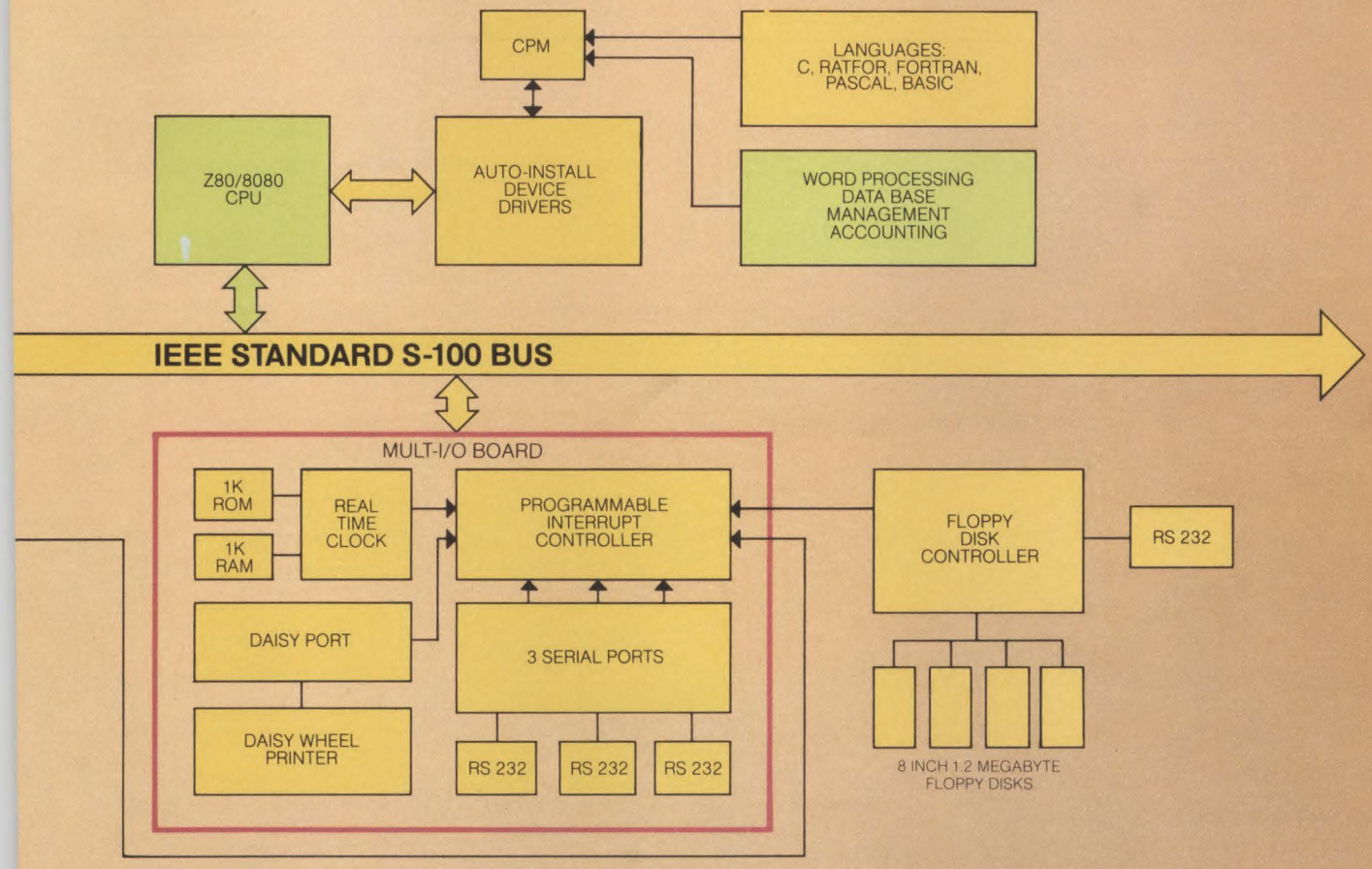

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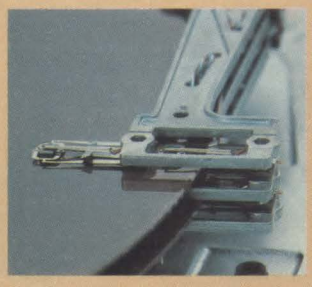

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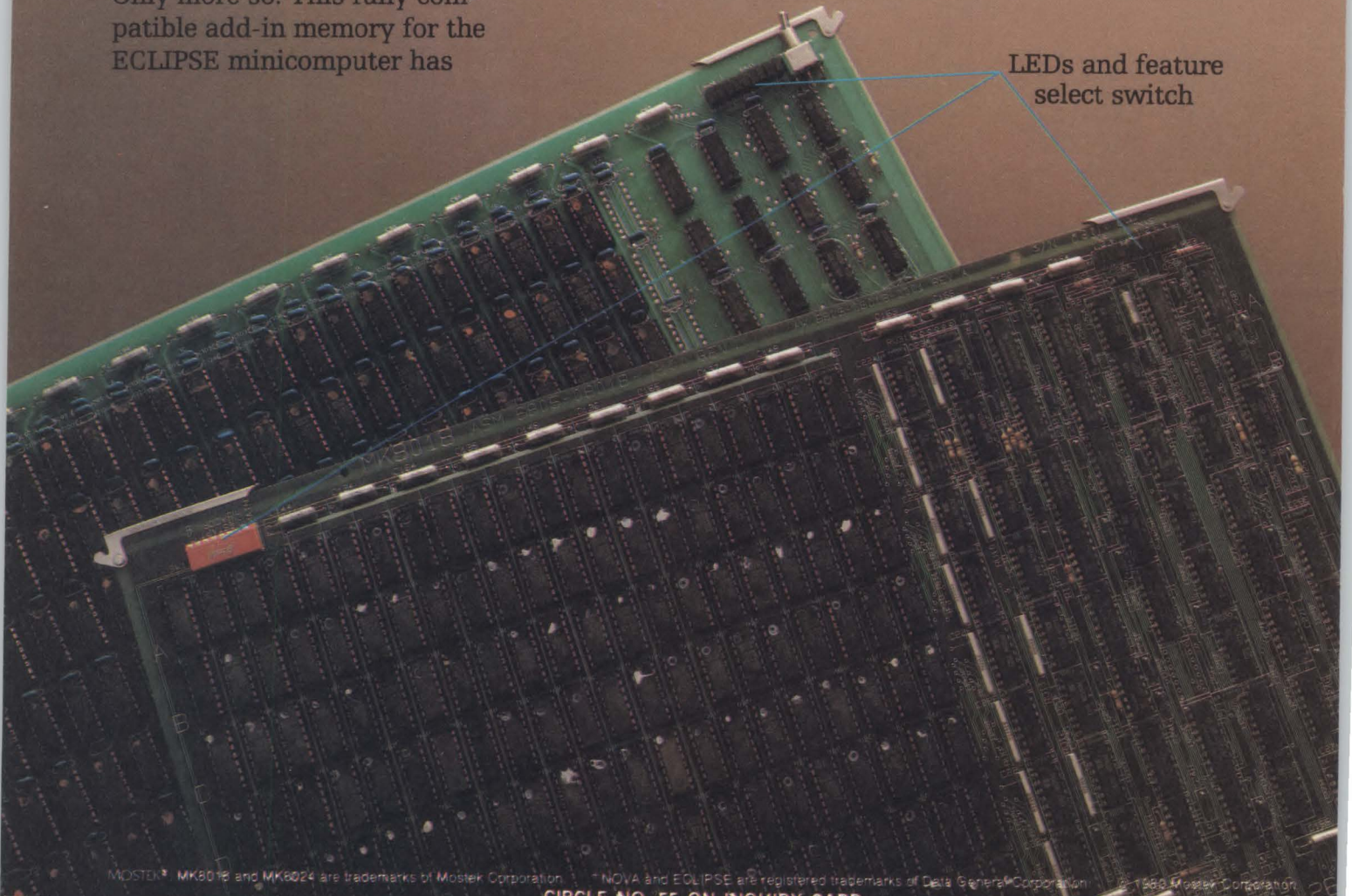

CIRCLE NO. 55 ON INQUIRY CARD

Intelligent terminals shift to 16-bit microprocessors

MALCOLM L. STIEFEL, Contributing Editor

Intelligent terminals are maintaining their traditional roles while growing in power and sophistication

If you thought 16-bit processors would be the next big thing in intelligent terminals, you were right. A few 16-bit terminals are already available, and more are on the way. But if you thought this shift would be accompanied by a move to small hard disks as the principal mass-storage medium, you were wrong (or, at least, ahead of your time). Convenient and inexpensive, floppies will maintain their primacy for the foreseeable future. For, although "intelligent terminals" are increasingly being sold and used as desk-top microcomputers, their basic role has not changed. They are used mostly in applications that require a mixture of on- and off-line operation or that depend on terminals to reduce the processing load on a host at a reasonable cost. A CRT terminal with a built-in floppy-disk drive, along with a small amount of user RAM, a microprocessor and one or more interpreters or compilers, is adequate for such tasks.

The inclusion of a compiler or interpreter is what distinguishes an intelligent terminal from a smart terminal, which, although less flexible, has functions a user can tailor to a specific purpose. For example, a

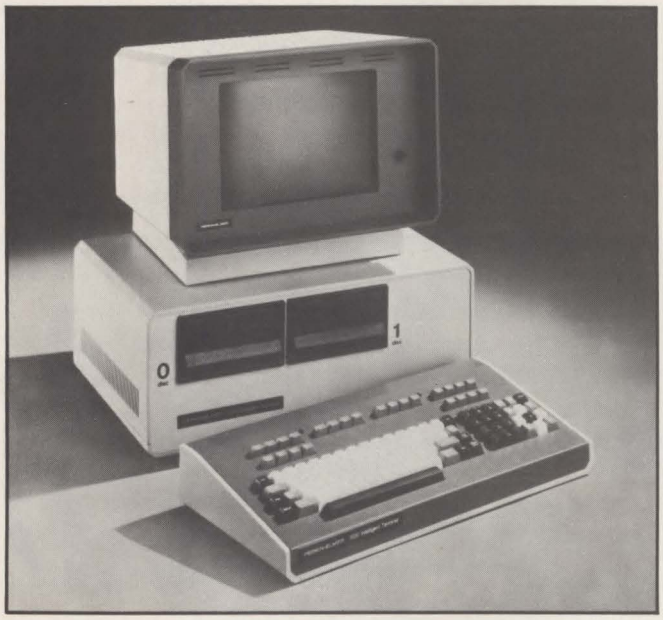

Fig. 1. The Perkin-Elmer model 3500 *intelligent terminal with detached keyboard and dual floppy-disk drives.*

Fig. 2. A Sperry Univac UTS-400 *clustered terminal system with floppy-disk drives and printer.*

Just now beginning to appear, terminals based on 16-bit microprocessors will eventually dominate the market.

smart terminal might enable a user to define fixed character strings (command sequences, most often) to be transmitted to a host computer when particular function keys are pressed. But the user does not have any control of the terminal's internal logic. An intelligent terminal can be programmed in a high-level language; the terminal's user can alter its behavior, or even create new programs, to suit a particular application. The device is as much a computer as a terminal—something that cannot be said of smart terminals, which depend far more heavily on their hosts.

Some might consider our definition of "intelligence" too severe. For example, the Datamedia Elite 4000, which appears in the product table, does not, strictly speaking, meet our standard, because it is programmable only in assembly language. Its manufacturer expects that systems houses will supply the terminal preprogrammed to end users, who will treat it as a turnkey system. End users could still do their own programming, but it would be far less convenient than if the unit supported a high-level language, such as BASIC or COBOL.

A typical intelligent terminal (Fig. 1) has an alphanumeric keyboard, usually accompanied by a separate numeric keypad to facilitate data entry and function keys to simplify communication with a host computer; an alphanumeric display screen, usually with 24 lines of 80 dot-matrix characters each; an RS232 port for communicating with the host, usually at 110 to 9600 baud; a floppy-disk drive for local mass storage; internal RAM; and a microprocessor to control the unit and put it through its paces. Prices for terminals with these features begin at $3000 to $5000. When extra peripherals are added, prices can climb to more than $50,000 per terminal, although the more expensive units tend not to be used exclusively as terminals, but also as stand-alone microcomputers. Most of the terminals in the product table are based on 8-bit microprocessors, although a few 16-bit machines are beginning to surface—units such as the Texas Instruments 771 and the Delta Data Systems 7000 Series, which use the TI 9900 microprocessor, and the Comark QB-11-12, which uses the DEC LSI-11.

Applications

Some users select intelligent terminals when smart or dumb terminals will do, just to convey a "state-of-the-art" image. There are some users who have a compelling need to be first, biggest or best, but for most, cash comes before flash. An intelligent terminal must earn its way by increasing productivity or meeting functional requirements that cannot otherwise be easily satisfied.

For example, a bank's customer-information data base is usually centralized in a host mainframe for security and reliability. Therefore, teller-terminal transactions rely on interaction with the host. On the other hand, the bank cannot afford to have all its teller operations disrupted if the host goes down. So it provides its tellers with intelligent terminals that can automatically switch to off-line operation if communications with the host are disrupted, keeping business moving until the host returns to operation. The off-line transactions are captured on tape or diskette at the terminal and loaded into the host when it returns to operation to update the central data base. Olivetti's TC800 terminal, for example, operates this way in insurance, banking and accounting applications.

An intelligent terminal can also pay significant dividends in remote transaction-processing applications, in which judicious use of the terminal can cut phone-line costs. For example, if thorough data-validation logic is loaded into the terminal, an operator can be sure that each transaction captured locally is logically correct and consistent. Data can be stored during the day and down-loaded to the host at night, when line costs are lower. Without the validation software in the terminal, many transactions would be rejected by the host, and an expensive editing cycle would ensue to correct the errors. With an intelligent terminal, the incidence of rejections by the host is reduced by an order of magnitude, with a concomitant saving in labor costs. Used to best advantage, an intelligent terminal also reduces its host's processing load. In some cases, a user might add several intelligent

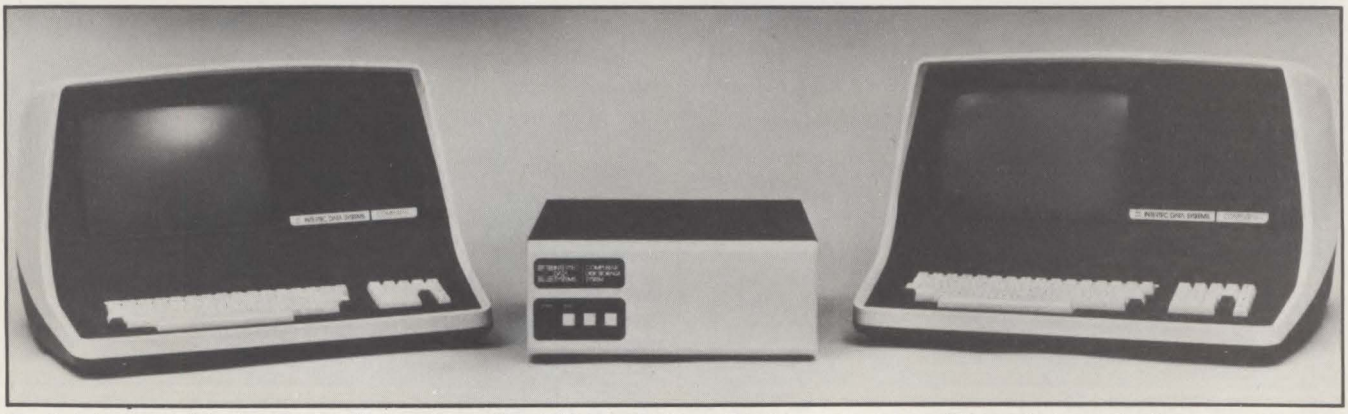

Fig. 3. A two-user Intertec Compustar system *with a 10M-byte tabletop disk drive. As many as 255 terminals can be tied to the subsystem.*

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TABLE OF INTELLIGENT CRT TERMINAL SUPPLIERS

The following table is provided as a guide to evaluating vendors of intelligent CRT terminals. *Mini-Micro Systems*' staff prepared the table from its own sources and from information supplied by GML Corp., Lexington, Mass.

Manufacturer	Model No.; Configuration	Processor; Memory (bytes)	Display; Keyboard
Applied Digital Data Systems, Inc.	System 70	16K	80 x 24, 12-in. screen; numeric pad, function keys
Applied Systems Corp.	ASC Terminal	8085; 2K to 32K	80 x 24, 12-in. screen; numeric pad, function keys
Artel	Series 1000	8086; 64K to 832K	96 x 39, 15-in. screen; numeric pad
Burroughs Corp.	MT 600, MT 700, MT 900	20K to 96K	80 x 25 or 80 x 48, 5-, 9- or 12-in. screen; numeric pad
Codex Corp.	CDX-68	8K to 42K	80 x 24, 12-in. screen; numeric pad, function keys
Comark Corp.	QB-11-12	LSI-11; 32K to 128K	64 x 16 or 80 x 24, 9-in. screen; numeric pad, function keys
Computek, Inc.	116, 200, 216/30; stand-alone or two- and four-terminal cluster	GA 16/110; 8K to 128K	80 x 24 or 80 x 25, 12- or 15-in. screen; numeric pad, function keys
Data Terminals & Communications	model 382	8K to 56K	80 x 24, 12-in. screen; function keys
Datamedia Corp.	Elite 4000A	8080A; 4K to 32K	80 x 24, 12-in. screen; numeric pad, function keys
Delta Data Systems Corp.	7000 Series; stand-alone	TI 9900; 32K to 128K	80 x 28, 15-in. screen; numeric pad, function keys
Digi-Log Systems, Inc.	Microterm II; stand-alone	dual Z80As; 48K to 64K	80 x 24, 12-in. screen; numeric pad
Digital Equipment Corp.	PDT-11 Series; as many as four terminals per cluster	LSI-11; 32K to 60K	66 x 7, 80 x 14 or 132 x 24, 12-in. screen; numeric pad, function keys
ECD Corp.	Smart ASCII; stand-alone	6512A; 32K to 1M	16 x 10 to 132 x 40, 15-in. screen; numeric pad
ECS Microsystems	model 4500	Z80; 64K to 80K	80 x 25
Hewlett-Packard Co.	model 2647A; stand-alone	32K	80 x 24, 12-in. screen; numeric pad, function keys
Honeywell Information Systems, Inc.	SPD 20 Series, SPD 300 Series, SPD 820/2; stand-alone or clusters of eight, 16 or 32 terminals	4K to 128K	80 x 24 or 40 x 12, 12-in. screen; numeric pad, function keys
Intelligent Systems Corp.	3600 Series, 8000 Series; stand-alone	8080A; 6K to 64K	64 x 32 or 80 x 48, 13- or 19-in. screen; numeric pad, function keys
International Entry Systems, Inc.	Datacorder II; stand-alone	Z80; 64K to 80K	40 x 1

Other Peripherals	Communications	Software	Price
serial printer, floppy-disk drive	as high as 9600 baud, parallel or synchronous or asynchronous serial	BASIC, FORTRAN, assembler	$4895
600K-byte floppy-disk drive, printer	as high as 9600 baud, parallel or synchronous or asynchronous serial	BASIC, assembler	$1690 and up
serial printer, floppy-disk drive	as high as 1200 baud, parallel or synchronous or asynchronous serial	Pascal, BASIC, word processng	$15,600
cassette drive, floppy-disk drive, serial printer	serial asynchronous, 1200 to 38,400 baud	IPL, APL, FPL	$2625 and up
disk drive, serial printer	serial asynchronous, as high as 9600 baud	COBOL, BASIC, FORTRAN, MPL; Macro, editor	$8000
floppy-disk drive, serial printer	serial asynchronous or synchronous, as high as 9600 baud, parallel	Macro, BASIC, FORTRAN, APL, RPG-II	$9535 and up
floppy-disk drive, serial printer, line printer	synchronous or asynchronous serial, as high as 9600 baud, parallel	BASIC, TAGS; Pascal; COBOL, FORTRAN	$4995 to more than $27,000
floppy-disk drive, serial printer	serial asynchronous, as high as 9600 baud	BASIC, assembler	$3875 to $9395
serial printer	serial asynchronous, as high as 9600 baud	assembler	$2895
floppy-disk drive, serial printer	serial asynchronous or synchronous, as high as 19,200 baud	BASIC, assembler	
floppy-disk drive, serial printer	asynchronous or synchronous serial, as high as 9600 baud	BASIC, Wordform, assembler	$8400 and up
tape cartridge drive, floppy-disk drive, serial printer	asynchronous or synchronous serial, as high as 9600 baud	BASIC, FORTRAN, Macro, FMS-11	$4800 and up
floppy-disk drive, serial printer	asynchronous or synchronous serial, as high as 19,200 baud, parallel	BASIC, Translex	$8000 to $10,950
serial printer, floppy-disk drive	asynchronous or synchronous serial, as high as 19,200 baud, parallel	COBOL, BASIC, editor, assembler	$6100 and up
tape cartridge drive, serial printer, plotter	synchronous or asynchronous serial, as high as 9600 baud, parallel	BASIC	$8950 to $12,550
tape cassette drive, floppy-disk drive, serial printer	asynchronous or synchronous serial, as high as 9600 baud, parallel	assembler, BASIC	$6122 to more than $30,670
disk drive, printer	asynchronous or synchronous serial, as high as 9600 baud, parallel	BASIC, FORTRAN	$1895 to $15,000
tape cassette drive, floppy-disk drive, serial printer	asynchronous or synchronous serial, as high as 9600 baud, parallel	Quick, BASIC	$3895 and up

Manufacturer	Model No.; Configuration	Processor; Memory (bytes)	Display; Keyboard
Intertec Data Systems Corp.	Compustar, Superbrain; stand-alone or as many as 15 terminals per cluster	dual Z80As; 32K to 64K	80 x 24 or 80 x 25, 12-in. screen; numeric pad, function keys
Logicon-Intercomp, Inc.	EE/80; as many as four terminals per cluster	16K to 32K	80 x 24, 15-in. screen; numeric pad, function keys
Mohawk Data Sciences Corp.	Series 21; as many as four terminals per cluster	48K to 256K	40 x 12 or 80 x 24, 15-in. screen; numeric pad, function keys
NCR Corp.	model 2950	8085; 48K to 60K	80 x 24, 12-in. screen; numeric pad, function keys
Northern Telecom Systems Corp.	NTSC 405, 435, 440, 445; as many as two or eight terminals per cluster	48K to 256K	64 x 8 or 80 x 25, 12- or 15-in. screen; numeric pad, function keys
Olivetti Corp. of America	TC800; as many as 16 terminals per cluster	16K to 48K	26 x 10, 40 x 12 or 80 x 24, 6- or 15-in. screen; numeric pad, function keys
Ontel Corp.	OP-1 Series; as many as 16 terminals per cluster	8085; 16K to 64K	80 x 24, 14-in. screen; numeric pad, function keys
Perkin-Elmer Data Systems Corp.	model 3500; stand-alone	6800; 16K to 48K	80 x 25, 12-in. screen; numeric pad, function keys
Ramtek Corp.	model 8410, model 8450	8080A; 6K to 64K	80 x 24, 15-in. screen; numeric pad, function keys
RCA	ZMS-50; stand-alone	8085	80 x 25, 12-in. screen; numeric pad, function keys
R2E of America	Micral C; stand-alone	Z80; 24K to 64K	80 x 24, 12-in. screen; numeric pad
Shasta General	model 3360; as many as eight terminals per cluster	8085; 32K to 64K	80 x 25, 12-in. screen; numeric pad
Solid State Technology, Inc.	Series 8100; as many as four terminals per cluster	2K to 64K	80 x 25, 12-in. screen; numeric pad
Sperry Univac	UTS 20, UTS 40, UTS 400; stand-alone or clusters of 12 or 16 terminals	8080, Z80A, AMD 2900; 32K to 64K	80 x 24 or 80 x 25, 12- or 15-in. screen; numeric pad, function keys
Systematics General	T5145	64K to 128K	80 x 24, 11-in. screen; numeric pad
Tano Corp.	Outpost 11; stand-alone	MC6800; 32K to 64K	80 x 24, 12-in. screen; numeric pad, function keys
Tektronix, Inc.	model 4051; stand-alone	6800; 8K to 32K	74 x 35, 9-in. screen; numeric pad, function keys
Telcon Industries, Inc.	VCS-300	16K	80 x 24 or 40 x 24, 12-in. screen; numeric pad
Texas Instruments Inc.	model 770, 771; stand-alone	TMS 9900 (16-bit); 32K to 64K	80 x 24, 12-in. screen; numeric pad, function keys
Wang Laboratories, Inc.	PCS II, WCS-15; stand-alone	8K to 32K	64 x 16 or 80 x 24, 9- or 12-in. screen; numeric pad
Wordplex	Wordplex/1; stand-alone	Z80; 48K to 56K	80 x 24, 12-in. screen; numeric pad
Zentec Corp.	ZMS-70, ZMS-90; stand-alone	4K to 64K	80 x 24 or 80 x 25, 15-in. screen; numeric pad, function keys

Other Peripherals	Communications	Software	Price
serial printer, disk drive	asynchronous or synchronous serial, as high as 9600 baud, parallel	BASIC, FORTRAN, CP/M operating system	$2995 and up
serial printer, floppy-disk drive	asynchronous or synchronous serial, as high as 38,400 baud, parallel	FORTH	$4800 and up
printer, tape drive, disk drive	asynchronous or synchronous serial, as high as 9600 baud, parallel	Mohawk Business Language	$7035 and up
serial printer, cassette drive	asynchronous or synchronous serial, as high as 4800 baud	BASIC	$3630 and up
serial printer, line printer, disk drive, tape drive	asynchronous or synchronous serial, as high as 9600 baud	BASIC, COBOL, TAL-2000	$2160 to more than $20,500
serial printer, floppy-disk drive, cassette drive	asynchronous or synchronous serial, as high as 9600 baud, parallel	PL/1, RPG, assembler, DMS	$12,000 and up
serial printer, line printer, disk drive, tape drive	asynchronous or synchronous serial, as high as 50K baud, parallel	FORTRAN, BASIC, COBOL, Pascal, word processing, editor	$1650 to $4195 in quantities of 100
serial printer, floppy-disk drive	asynchronous or synchronous serial, as high as 9600 baud	BASIC, assembler	$5833 and up
serial printer, floppy-disk drive	synchronous or asynchronous serial, as high as 9600 baud	BASIC, PL/M, assembler, CP/M operating system	$2400 to $8200
serial printer, floppy-disk drive	asynchronous or synchronous serial, as high as 9600 baud	BASIC	$2425
serial printer, floppy-disk drive	serial synchronous	BASIC	$8995
printer, floppy-disk drive	asynchronous or synchronous serial, as high as 19,200 baud	assembler, DACL	$3995 and up
serial printer, disk drive	asynchronous or synchronous serial, as high as 9600 baud, parallel	BASIC, COBOL, FORTRAN, Pascal, APL, Macro	$3500 and up
tape cassette drive, floppy-disk drive, printer	asynchronous or synchronous serial, as high as 19,200 baud, parallel	MAC/80, PL/M, COBOL	$4160 to more than $11,640 per terminal
tape cassette drive, serial printer	serial asynchronous as high as 9600 baud	BASIC	$12,000
serial printer, floppy-disk drive	serial asynchronous, as high as 9600 baud	BASIC, assembler	$4995 and up
tape cartridge drive, line printer, graphic tablet, plotter	asynchronous serial, as high as 2400 baud	BASIC	$5995 and up
cassette tape drive	asynchronous serial, as high as 9600 baud	assembler	$2895 to $3395
printer, floppy-disk drive, tape drive	asynchronous or synchronous serial, as high as 4800 baud	TPL, BASIC	$5995 to $9695
line printer, floppy-disk drive	asynchronous or synchronous serial, as high as 4800 baud, parallel	BASIC	$4800 to $11,400
serial printer, floppy-disk drive	asynchronous or synchronous serial, as high as 9600 baud, parallel	BASIC	$12,500 and up
printer, floppy-disk drive	asynchronous or synchronous serial, as high as 19,200 baud, parallel	BASIC, assembler	$3900 and up

Intelligent terminals can reduce phone-line costs in remote transaction-processing applications.

terminals for, say, $100,000, instead of spending $1 million to upgrade his mainframe. This approach does not actually reduce the load on the host, but it avoids an expensive increase in the host's workload, which is just as good.

In addition to data entry, prime applications are in business—payroll, order entry, inventory-keeping, general ledger and accounts receivable and payable—and word processing. Intelligent Systems Corp. also claims process-control applications for its 8000 Series terminals, and Perkin-Elmer cites laboratory-instrument control as an application for its model 3500. Virtually all vendors claim "distributed processing" as an application, but no one attempts to define what that means. In a sense, any activity at an intelligent terminal that makes use of on-board user- or vendor-written programs might be regarded as distributed processing; the term does not connote anything more specific.

Intelligent terminals come in two versions: stand-alone and clustered. The stand-alone type incorporates a display screen, a keyboard, mass storage, a processor and communications hardware in a single package. As the name implies, such units can operate off-line by themselves or on-line, connected to a host. Most vendors offer stand-alone systems.

The advantage of a stand-alone system is that its processing power is focused on the needs of a single user. It has a relatively elementary operating system and excellent response time in situations that do not require host communications. In fact, many units are sold primarily as desk-top computers and only secondarily as intelligent terminals. The Tektronix 4051, for example, is in this category.

A stand-alone terminal connects to a host directly or via phone lines and modems. A cluster, on the other hand, is almost always used in remote locations with modem interfaces. In these systems, a cluster controller connects directly to a group of terminals and concentrates messages for transmission to the host over a

WHEN A CRT IS NOT THE ANSWER

Applications involving low volumes of data entry/control display information may not require a CRT. Indeed, a CRT may be the *wrong* approach when size and environmental considerations also enter the picture.

Enter Burr-Brown Research with its new TM71 "Microterminal," shown for the first time at the Instrument Society of America show in Houston last month (October). A miniature (8.5- × 4.5- × .6-in.) keyboard/LED display, the TM71 is an enhanced version of the company's TM25 Microterminal introduced one year ago.

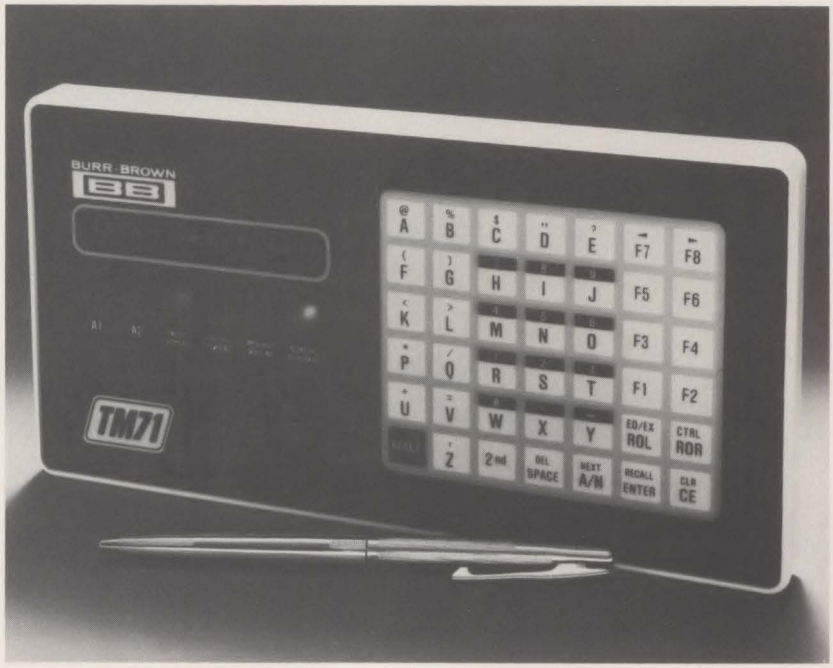
The Microterminal concept is simple: Pre-defined functioi keys and indicators guide even unsophisticated operators through an unambiguous sequence of operations, and a 42-key alphanumeric keyboard and 16-character (scrollable) alphanumeric display handle variable communications with the host computer. In addition, six LED indicators provide status and mode information.

The Microterminal's simplicity of operation belies its design. The TM71 is watertight, ruggedized and human-engineered. Baud rates (serial ASCII) range from 110 to 19,200 over RS232C or optically isolated 20 MA current loop, and as many as 15 Microterminals can be connected on the same serial interface. The Microterminal requires only a +5 VDC supply.

A typical application is for factory data acquisition. The computer, using the function indicators, leads the operator through various data gathering steps. Illuminating the first function indicator with its pre-labeled message panel instructs the operator to start the sequence by entering "employee number" through the keyboard. Illumination of the next function indicator instructs the operator to enter "log number." The third function indicator requests that "number of units" be entered, and so on as the process requires. Other applications include machine control, inventory/materials handling, production testing and management data input.

The company's previous Microterminal product, the TM25, has been described as "perhaps its most successful product," with hundreds now in use. The new TM71, at $595, expands on the $249 earlier model by providing double 80-character buffering on both the input and output sides to enable extended scrolling and message-handling, and the TM71 is a full alphanumeric terminal.

Circle No 416



Burr-Brown's TM71 *Microterminal is a replacement for CRT and printing terminals in low-data-volume applications where size considerations are paramount.*

single high-speed line. A typical cluster, such as the Computek Series 216/30, includes as many as four terminals.

Sperry Univac's UTS 400 (Fig. 2) supports as many as six terminals clustered through a common controller, while Intertec Data Systems' Compustar (Fig. 3) enables as many as 255 terminals to be daisy-chained to a shared-disk subsystem. The Sperry arrangement is much more common. Sperry also supplies a clustering arrangement in which as many as 16 master terminals—each with one or two slave terminals—can interact with a host computer through a multiplexor. Each slave shares interfaces, a microprocessor and working storage with its master.

Clustering facilities give the user enormous flexibility in choosing a terminal arrangement that properly reflects the intelligence, priority-of-operation and response-time requirements at each location. When memory, CPUs, peripherals or communications lines are shared, the resulting contention for resources can cause response times to lengthen. For low-priority users—such as those at the end of a daisy chain—the system may become unacceptably slow during peak traffic periods. The solutions are many: limit the number of terminals connected in this fashion, increase the bandwidth of the shared resources or increase the amount of local processing done at each terminal to reduce traffic to the shared units. The user must plan his clustered system carefully and diligently monitor its performance to achieve and maintain optimum performance.

With almost 30 years of experience in the use of computer terminals behind them, users now have fully developed notions of which terminal functions are necessary and which are superfluous. The design of the modern intelligent terminal reflects these ideas. It is taken for granted that the standard display medium is a monochromatic CRT (color is important only in graphics applications) with 64 to 80 dot-matrix characters on each of 16 to 28 lines. Most displays have 24 or 25 lines (in 25-line units, one line is devoted to system messages to the operator). The console contains not only a standard typewriter or Teletype keyboard, but also a separate numeric pad and function, message-control and cursor-control keys. (Cursor control, which also is taken for granted, enables the operator to move the cursor to almost any position on the screen in one or two keystrokes.) And an "N-key rollover" feature is included to prevent the user from operating two or more character keys simultaneously.

Characters are formed from a ROM-resident character generator, which holds multiple character sets in English and several foreign languages. A typical intelligent terminal's display memory can hold several full screens of information, enabling the operator to roll or page the display forward or backward at will. The user can also store display formats in local memory for later recall. These formats can contain both protected fields, such as titles, and unprotected fields, in which variable data is to be entered by the operator or displayed by the computer. Normally, the display can also perform highlighting tricks, such as blinking characters and reverse video, to draw an operator's attention to a particular field on the screen.

Contemporary intelligent terminals usually provide several switch-selectable baud rates for host communi-

REFERENCE LITERATURE

For more information on the intelligent terminals surveyed in this article, use the reader circle numbers below.

Company	Circle No.
Applied Digital Data Systems, Inc., Hauppauge, N.Y.	376
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Wordplex, Westlake Village, Calif.	414
Zentec Corp., Santa Clara, Calif.	415

Over the next 10 years, the intelligent terminal and its alter ego, the desk-top computer, will become important elements of data-processing systems.

cations and enable the operator to invoke a specific communication protocol, such as SDLC or Bisynch, through command entries. Similarly, the operator can load routines that cause the unit to emulate some other terminal, such as the Burroughs TD820, Honeywell VIP 7700, IBM 3780 or DEC VT52A.

Most intelligent terminals come with a built-in floppy-disk drive that can store as much as 300K bytes of data on a single-sided, single-density diskette. And they usually will accept certain add-on devices. For example, the Ontel OP-1 Series (Fig. 4) can be augmented with a 96M-byte hard-disk drive, serial and line printers and tape drives. The Tektronix 4051 supports a plotter, and the Olivetti TC800 works with a badge reader. Serial printers and floppy-disk drives

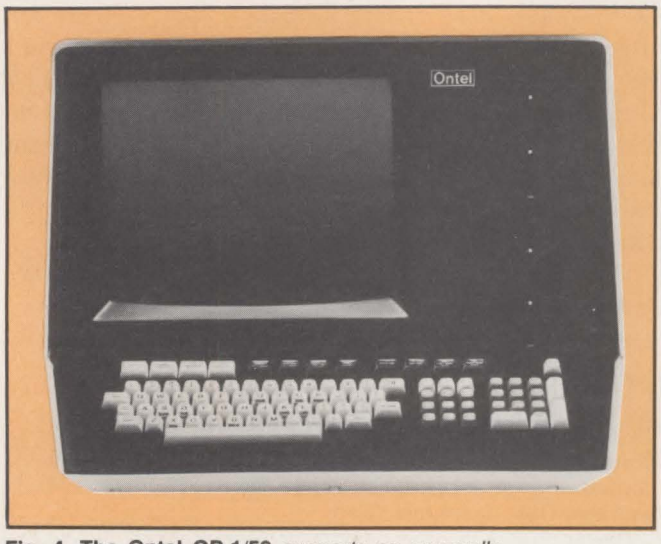

Fig. 4. The Ontel OP-1/50 *supports an unusually wide variety of peripherals.*

are available with many intelligent terminals, but only a few support line printers, hard-disk drives or other peripherals.

Software

All of the popular high-level languages—BASIC, COBOL, FORTRAN, FORTH, Pascal, PL/1—are available to intelligent terminal users, as are some rather obscure languages, such as Mohawk Data Sciences' MOBOL and Texas Instruments' TPL. Some vendors offer assembler for programs with tight storage requirements or for time-critical routines, but it is intended for use by systems houses rather than end users, for whom versions of BASIC and COBOL predominate.

Every intelligent terminal comes with an operating system, and therein lies a possible trap for the unwary buyer. If the operating system is ROM-resident, all is well, but a RAM-resident OS might cause trouble. If it occupies too much RAM, the sizes of user programs must be reduced accordingly, or the user must compensate by acquiring additional memory. Memory-size limitations also prevent full implementation of complex languages, such as COBOL and PL/1. What a user gets are subsets lacking some of the features that simplify programming. This economy can make software development something less than pleasurable.

Vendors try to ease the pain as much as possible by supplying utilities and debugging software, such as linkage editors, text editors, disassemblers, PROM burners and diagnostics. Some circumvent on-board memory restrictions by providing cross-development software that runs on a host, but can be down-loaded for test or execution on the terminal. As long as debugging (single-stepping, breakpoint insertion, memory and register examination and the like) can be performed on the terminal, this may be a convenient mode of operation. The user should also be able to load programs into the terminal from disk or tape without disturbing the host. Otherwise, he will be unable to change programs when the host is not available.

The future

W.M. Stanger, marketing director for Perkin-Elmer's Terminals Division, says manufacturers are "energetically investigating" 16-bit processors for use in intelligent terminals. In time, they will become the norm. Meanwhile, vendors will either continue to support their 8-bit systems or, as Jose Torres of Ontel Corp. suggests, convert customers' software from the old 8-bitters to the shiny new 16s.

Floppy disks will remain the mass-storage medium of choice indefinitely, because their capacity, access time and reliability will continue to meet the needs of intelligent-terminal users. However, the floppy is sure to take a battering in large systems, where small hard-disk drives will take over.

In most applications, peak communication rates will stay at 9600 baud, until fiber optics and other high-speed media become widely available. Users may then find it cost-effective to tie several dumb terminals over an ultra-high-speed line to a fast central computer—probably a 32-bit microcomputer—rather than bury a little intelligence in each terminal. But don't hold your breath. For the next 10 years, the intelligent terminal and its alter ego, the desk-top computer, will become increasingly important elements in data-processing systems. ■

Malcolm L. Stiefel, now a group leader at Mitre Corp., has worked as a systems analyst, systems engineer and programmer on military command-and-control, hospital administration, investment securities and municipal information systems.

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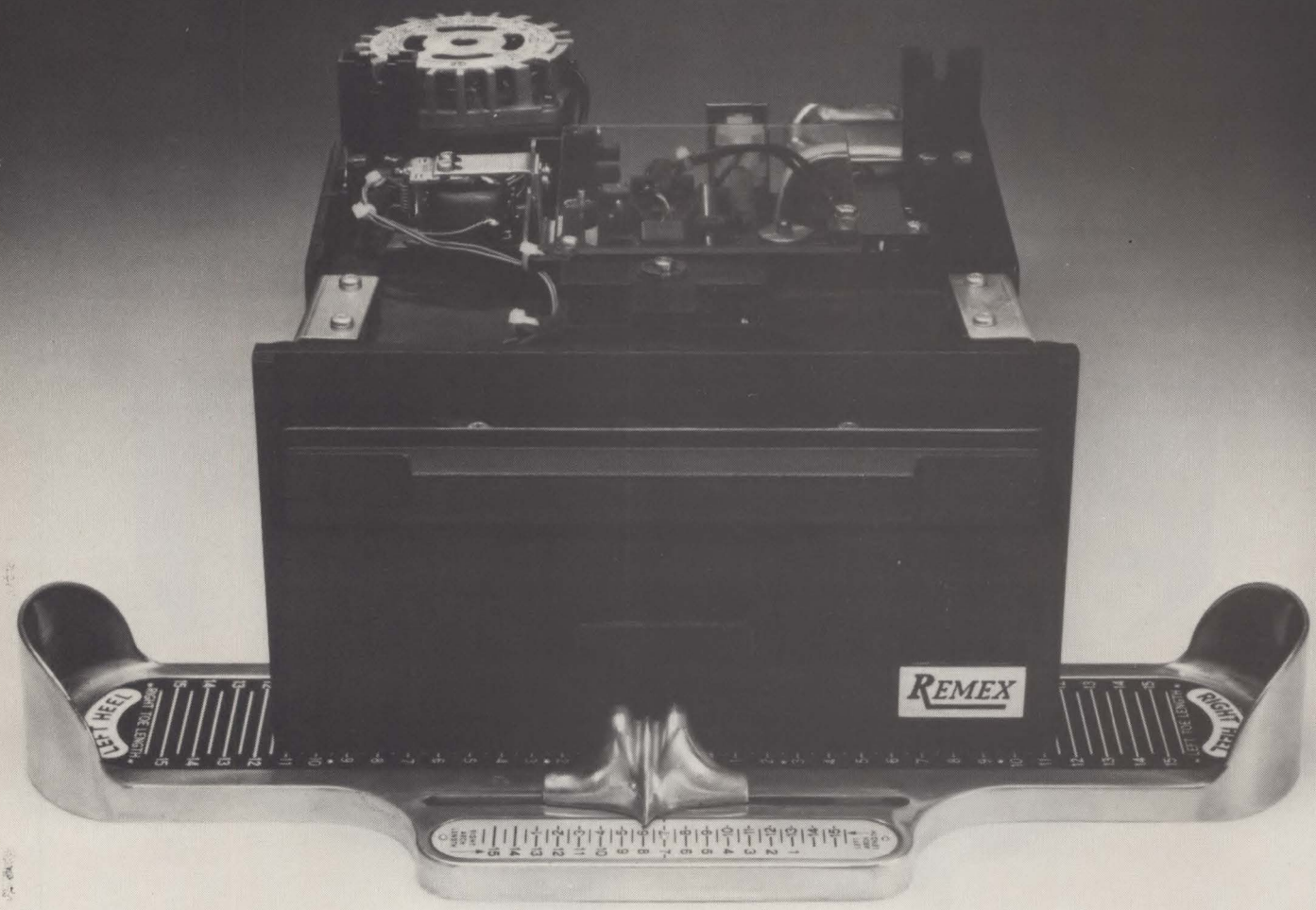

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DATA WAREHOUSE

CIRCLE NO. 26 ON INQUIRY CARD

CRT TERMINALS

Alphanumeric CRT growth is slowing

LEWIS I. SOLOMON, Venture Development Corp.

Nothing is new, but everything is changing

Manufacturers of alphanumeric CRT terminals can expect to face new challenges in the years to come. The rate of product innovation has slowed, and it will become increasingly difficult for vendors to produce more powerful and less expensive terminals than their competitors. The growth rate for shipments of alphanumeric CRT terminals will drop to single-digit figures. Most industry participants will face the difficult task of maintaining market share. Given the large number of competitors, only the most skilled management teams will be able to increase their company's share of the market.

A recent Venture Development study shows that the alphanumeric CRT terminal industry will not be growing at the rapid rates experienced in the past. Nor will it continue to grow at the 15 to 50 percent rates predicted by other industry sources. From 1980 to 1984, aggregate shipments of alphanumeric CRT terminals by U.S. manufacturers will grow by only 8.7 percent a year, from 510,000 terminals in 1980 to 712,000 in 1984 (Table 1). In terms of current dollars, shipments will grow from $1.8 billion to $2.6 billion. When the industry was younger, it grew at double-digit rates, and it was relatively easy for new companies to enter and for existing participants to grow. But in the future it will not be so easy.

CRTs were adopted nearly 20 years ago to serve as visual displays on computer terminals, which then were teleprinter terminals. CRTs have not replaced teleprinters, but CRTs have been continually improved to the point that nearly every computer system contains at least one. Venture Development Corp.'s recent research indicates that by the end of this year, the installed base of alphanumeric CRT terminals will be 2.2 million units with shipment value of $9.5 billion.

The capabilities of CRT terminals range from conversational to editing to processing, from single-station to clustered to remote and from alphanumeric to graphic. Despite the large number of available models, CRT terminals rarely differ significantly from others in their class. All such terminals use essentially the same kind of CRTs, monitors, keyboards, microprocessors and, hence, controllers and communications interfaces. Manufacturers purchase components and subassemblies from the same sources. All alphanumeric CRT terminals are raster-scan devices. Screens typically measure 10 to 12 in. and contain 20 to 25 rows and 80 columns that can be filled with 96 characters. Data transmission is typically in full-duplex synchronous

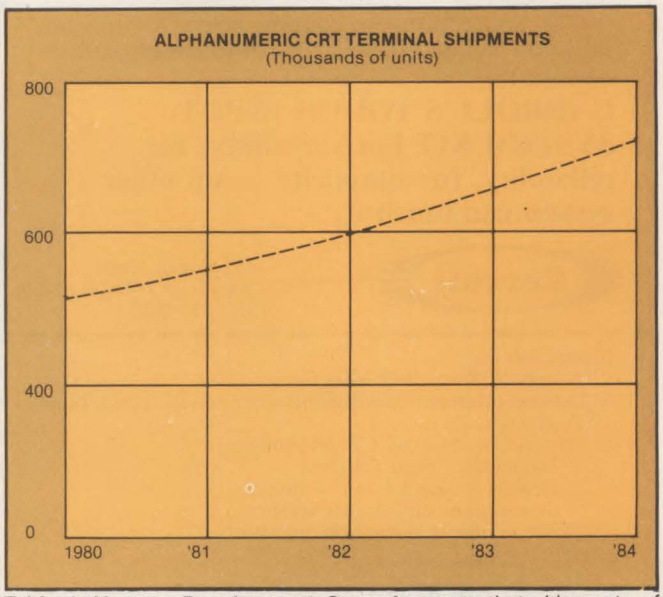

Table 1. Venture Development Corp. *forecasts that shipments of alphanumeric CRT terminals will grow only 8.7 percent a year.*

With a market that is expected to grow 28 percent a year, inexpensive graphics terminals pose the biggest threat to companies that manufacture only alphanumeric CRT terminals.

and/or asynchronous modes using ASCII or EBCDIC character codes.

The industry is maturing; users needs are satisfied. De facto standards have evolved, and the rate of innovation has slowed. As a result, it has become difficult for vendors to differentiate their alphanumeric CRT terminals on the basis of technical specifications and price. Other ways exist, however, and companies that hope to be leaders in 1990 will have to use them. Marketing techniques can distinguish a product. After all, we're told that Chiquita bananas are better than other bananas, that sewing an alligator on a shirt makes it more desirable and that Frank Perdue "manufactures" the best chickens. Marketing will become increasingly important.

Advent of graphics

The biggest threat to a company that considers itself solely an alphanumeric terminal manufacturer is the advent of inexpensive graphics terminals. The graphics industry is in its infancy, and Venture Development's research into this market indicates that it will grow at a 28.7-percent rate from $273 million in 1980 to $750 million in 1984. Users will increasingly expect their terminals to provide information in both alphanumeric and graphic forms.

If some technological innovation occurred, users would consider their present alphanumeric CRT terminals obsolete. The industry would then reenter a growth phase, and the entire installed base, estimated at 2.2 million units now and more than 4.5 million units in 1984, would represent a market opportunity.

The logical candidate for this innovation is the display. A great deal of research money already has been spent on developing a display to replace the CRT, which consumes considerable power, generates a lot of heat, requires high voltages, is bulky, promotes operator eyestrain and lacks a flat screen, thus distorting images.

Of all the alternative technologies considered, gas plasma panels seem to be the most promising. IBM and Burroughs already offer terminal products with plasma displays, but the market for them is negligible because they are too costly. Plasma panels won't be produced in volume economically until at least the mid-1980s.

Clearly, manufacturers of alphanumeric CRT terminals will find life more difficult in the 1980s than it was in the 1970s. Only innovative strategists will succeed. ■

Lewis I. Solomon is president of Venture Development Corp., a consulting firm in Wellesley, Mass.

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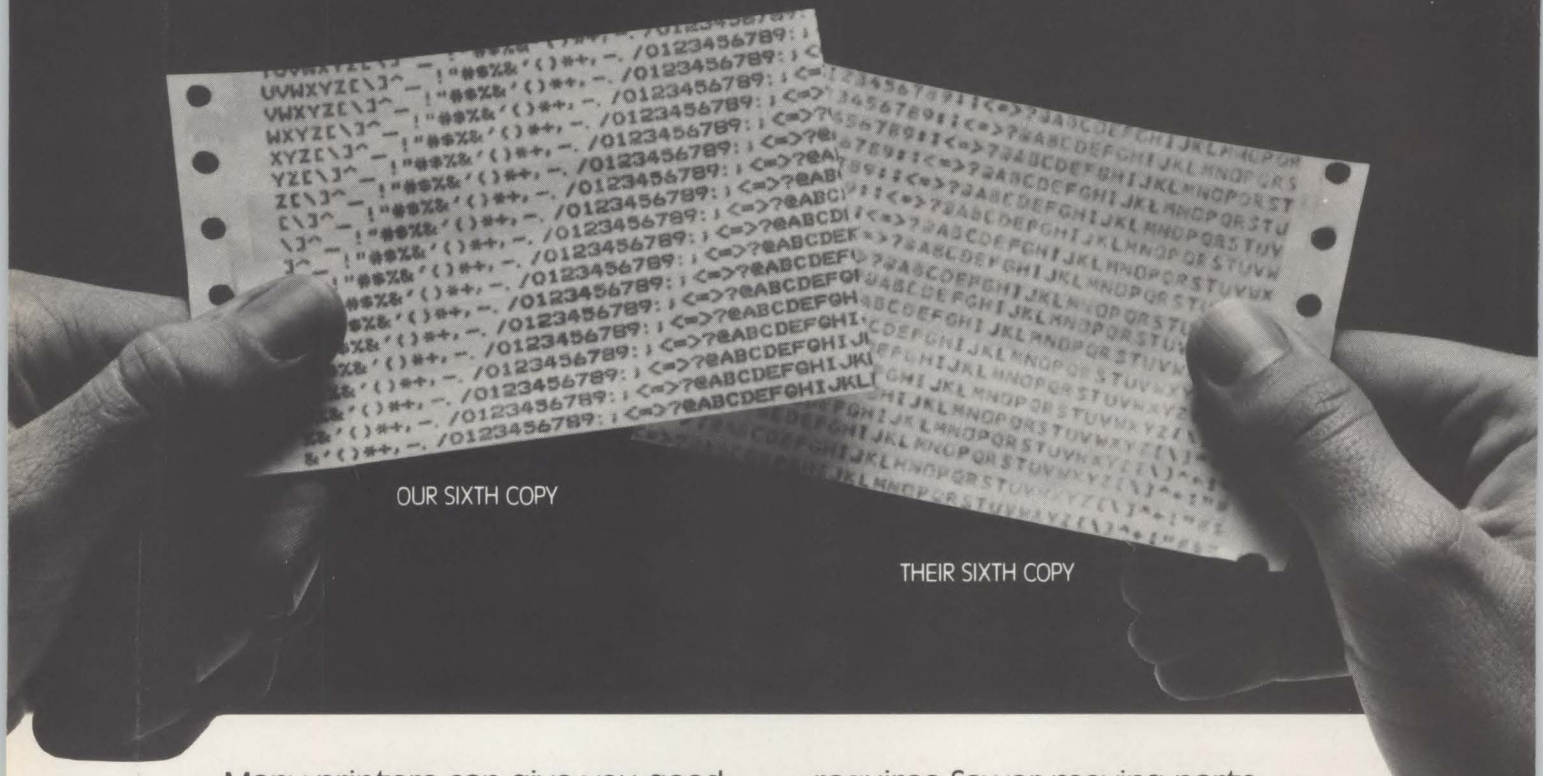

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CIRCLE NO. 61 ON INQUIRY CARD

Major challenge to CRTs from flat-panel displays

MARGARET DeJACKMO,
International Resource Development, Inc.

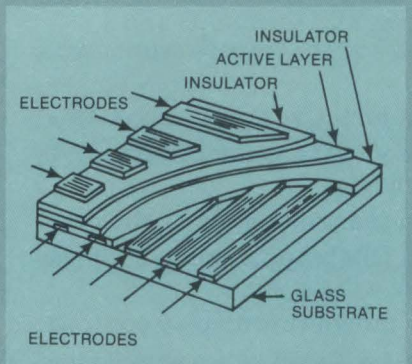
Moving toward the 'electronic briefcase'

More than 2 million CRT terminals are installed in the U.S., and CRT shipments—buoyed by rapid growth in the microcomputer, distributed-processing and word-processing markets—are continuing strong through the recession. Surveys by Booz Allen and others suggest that by the end of the 1980s, as many as 10 million of the 40 million white-collar clerical and professional employees in the U.S. will have keyboard/display terminals on their desks. This would imply that annual shipments of keyboard/display terminals may pass the million-unit level by the mid-1980s. But many of those terminals will not be CRTs.

CRTs have been accepted reasonably well. There has been some concern about the possibility of operators getting cataracts and eyestrain from continued heavy use, but these fears have been largely unfounded. Users are increasingly drawn from a generation raised on television. They find the appearance and function of a typical CRT reassuring and familiar. Nevertheless, CRTs have some big disadvantages. For example, they are bulky and occupy substantial valuable desk space. Further, the thin glass envelopes of the displays can be easily broken, and their surfaces reflect light, which can distract or annoy a user.

SOME ILLUMINATION ABOUT ELECTROLUMINESCENT DISPLAYS

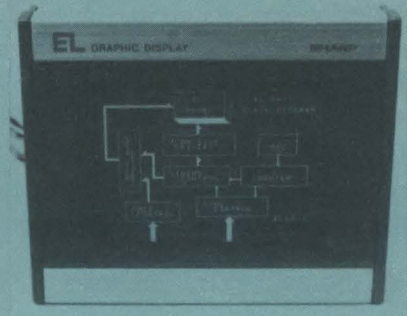
Hycom's thin-film electroluminescent (TFEL) displays consist of glass substrates on which a solid-state EL structure is fabricated. View direction is through the glass substrate (bottom of diagram), and the total thickness of the active structure deposited (above) it is about 1.3 microns.



Hycom's TFEL displays *consist of glass substrates on which a solid-state EL structure is fabricated.*

A TFEL panel picture element (pixel) is activated by applying AC voltage pulses across the appropriate pair of electrodes, the pulses normally being symmetric positive and negative waves of a certain pulse width and repetition frequency. The typical addressing pulse width is 100 micro-μsec. applied at a refresh frequency of about 80 Hz. The display is activated using x-y matrix techniques in a line-at-a-time sequence.

The photo is of a complete production model panel display, the Hycom ED-6240, available this month (November). The display has a diagonal size of 6 in. on which 76,800 points are addressable (240 by 320 EL lines). Alpha capacity is 24 lines of 53 characters in 5 × 7 font, or 20 lines of 40 characters in 7 × 9 font.



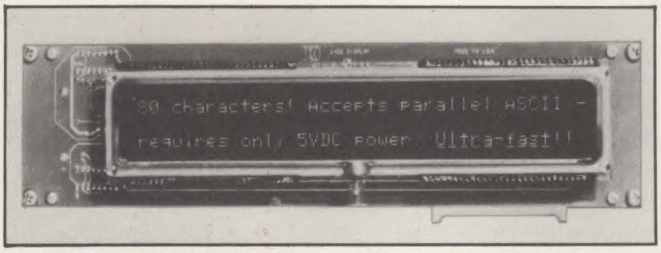
A complete *production model panel display of the Hycom ED-6240.*

Flat-panel displays are still too expensive to replace CRTs, but not for long.

To solve some of these problems, more than a dozen manufacturers have been working for several years to develop "flat-panel" displays, and there are now several types in production. The most successful flat-panel technologies are AC plasma and DC plasma, but there is increasing interest in liquid-crystal display (LCD) and electroluminescent (EL) panels. The problem with these techniques is that production costs are significantly higher than those of CRTs with comparable resolution.

Exxon vs. Sharp

Japanese firms have been particularly active in flat-panel research, along with Burroughs Corp. in the U.S., a leading supplier of today's flat displays. Fujitsu, Hitachi, Matsushita and Seiko Denki Co. have all



Digital Electronics' *M2400 features 80-character display.*

produced prototype TV-type displays using plasma or LCD techniques. U.S.-based Hycom Corp., a subsidiary of Japan's Sharp, is developing flat-panel displays for the "electronic desk" of the future, and perhaps even for the "electronic briefcase." Hycom has developed a thin-film electroluminescent panel for the U.S. Army's digital-message device (DMD), a portable battlefield terminal. The panel costs thousands of dollars, compared with a manufacturing cost of $200 or less for a comparable CRT. But the DMD requires considerably less electrical power than a CRT and has a longer life. Hycom expects manufacturing costs in quantity production to drop to CRT levels within two years.

Exxon Corp. has also been active in flat-panel display research. Kylex, Mountain View, Calif., an Exxon Enterprises subsidiary, has an LCD flat-panel display for applications in which no more than eight lines of characters are required, but industry sources are speculating that the Kylex displays will soon be expanded to CRT capacities. Another Exxon operation, Exxon Enterprises' Electophoretic Information Display (EPID) Division, Sunnyvale, Calif., is also researching flat-panel display technology.

Path to the 'electronic briefcase'

During the next 20 years, flat-panel display technology may eventually displace CRTs, even in the consumer TV market. But well before then, flat-panel displays will be competitive in applications requiring low power consumption, high daylight visibility, shock resistance and other factors. A likely application is in portable terminals. There are more than 250,000 portable printing terminals without displays—mostly made by Texas Instruments—in use and portable CRT terminals are beginning to appear in substantial numbers from Digi-Log Systems, Informer, Telcon and others. Announcements of portable microcomputer products are expected soon from Sony and Matsushita. These products will fit into a briefcase and provide access to electronic mail; to corporate data bases of sales statistics and inventories; and to public data bases of stock prices, news and other information. Electronic briefcases will constitute a major market for future flat-panel products, and may spawn production quantities the flat-panel makers need to challenge CRTs in nonportable office-of-the-future applications.

Estimated flat-panel display market* 1980-90

(U.S. shipments, $ million)	Military	Word/data processing	Consumer
1980	15	—	
1982	80	—	
1985	130	45	
1990	320	130	

*Displays with more than 200 characters, or equivalent

Table 1. International Resource Development's *forecast for flat-panel display shipments is based on current technology and pricing trends.*

Table 1 presents the IRD estimate of flat-panel display shipments in the U.S. over the next several years, based on current technology and pricing trends. The table indicates that by 1985, flat panels will be mounting a serious challenge to CRTs in military, commercial and consumer applications. ■

Margaret DeJackmo is a researcher with International Resource Development, Inc., a market consulting firm in Norwalk, Conn.

NEXT MONTH IN MMS

The December issue of Mini-Micro Systems will focus on graphics terminals and systems. Articles in the feature section will include:

- A survey of interactive graphics systems
- A look at a product that combines vector/raster technologies
- An update on the raster state-of-the-art
- A briefing on IBM's approach to business graphics
- A tutorial on monolithic display controllers

Also scheduled for December: a comparison of the three leading 16-bit microprocessors.

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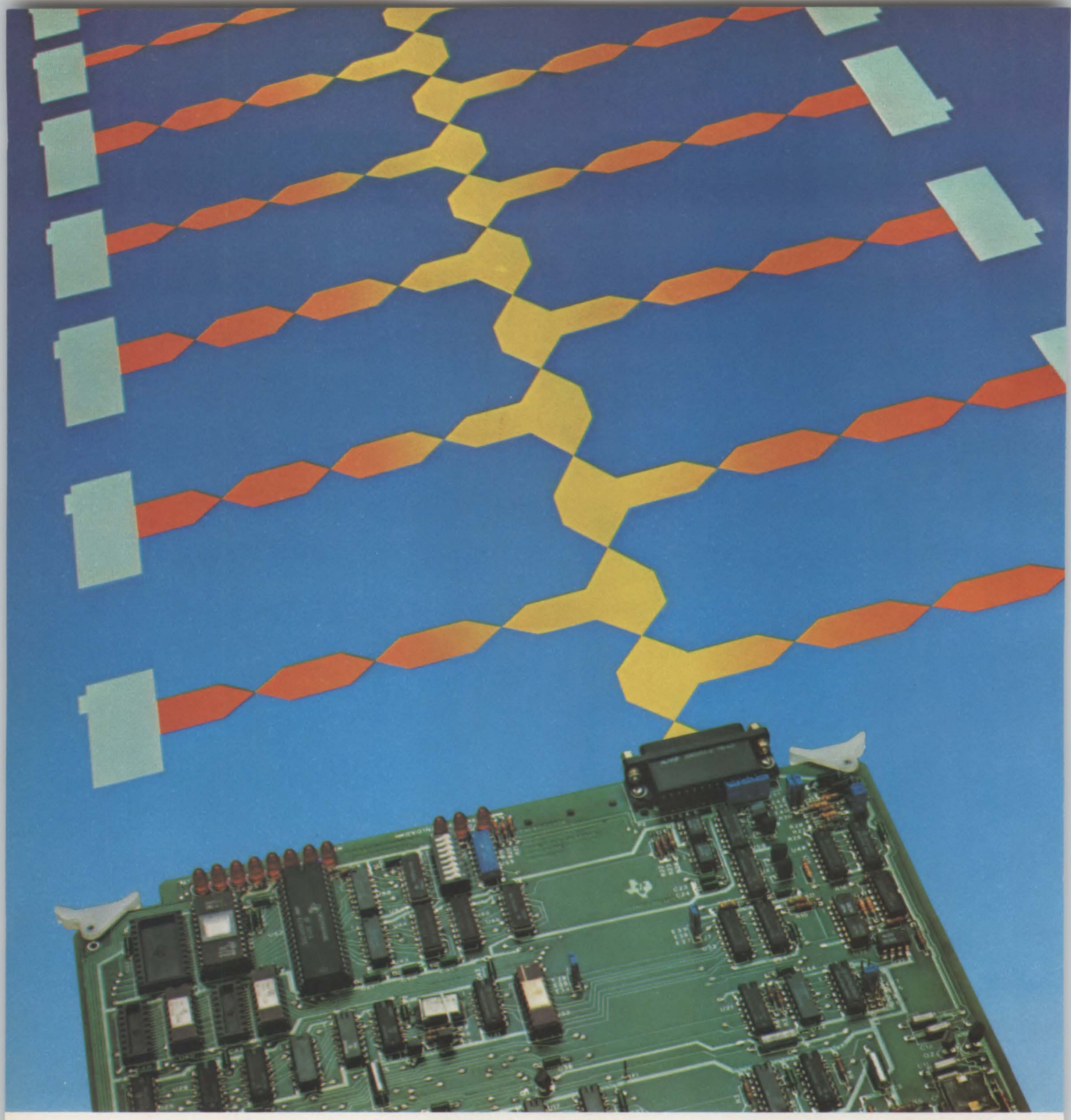

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A new development from TI extends industrial communication to more points. Over greater distances. At less cost.

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pair lines which substantially simplify interconnects and reduce installation costs. The interface is optically isolated (1500 V RMS).

Point-to-point communication over an even longer distance is achieved using Bell 208 type synchronous modems.

Either way, the 308 module is an intelligent interface, with processing handled by an on-board TMS9980 microprocessor. Firmware supports address decode, down-load command decoding, and other primitive functions.

New Communication Expander Module

A second new TI module — the TM990/307 — allows communication with up to four devices such as terminals or modems (see diagram at right). It provides four RS232C EIA ports using standard RS232 connectors, and one port can be RS422. A Bell 801 automatic calling unit interface is on board. Optionally, four channels of synchronous communication are possible by changing on-board devices to synchronous controllers. A loopback permits self-testing.

Demonstration Software

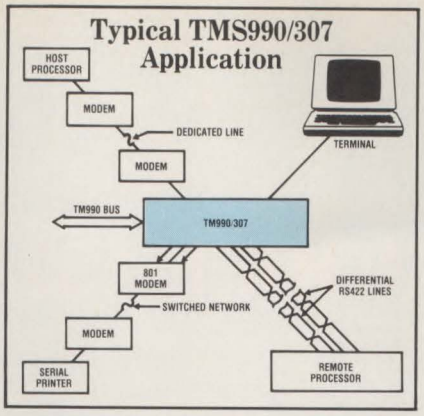
Demonstration software for either of the new communication modules will enable the user to check for proper operation quickly and easily. The software listing will also facilitate application programming.

Software Support

Coming soon for the new TM990/308 module: a Data Communication Software package. One of TI's new Component Software Series, it supports point-to-point and multi-point communications. Operating with TI's Realtime Executive, the DCS package will reduce software costs substantially by providing a library of statements common to most programs.

The HDLC Data Communication Software package provides networking capabilities by interprocess communication. TM990 systems, 990 minicomputers, and PM550 controller systems may be interconnected.

The HDLC package offers programmable features like character width, parity, start stop bits, and baud rate. Each port can be programmed independently to a particular priority level, special control character set, etc.



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TM990/211 Bubble Memory
TM990/303A Floppy Disk Controller

Digital I/O Modules:
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TM990/310

Analog I/O Modules:
TM990/1240
TM990/1241
TM990/1243

Communication Modules:
TM990/307
TM990/308

Speech Module:
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TM990 Modules: The efficient, economical solution

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Faster design: The modules come off the shelf from distributor stocks ready to use. Bringing with them the precision performance of TI's 16-bit 9900 Family microprocessors.

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All modules interface directly to the versatile, flexible TM990 bus which helps simplify system integration.

Faster software development: Support includes complete assembler, editor, linker and PROM programming utilities, as well as the TIBUG* interactive debug monitor, TI Microprocessor Pascal and Power Basic* high-level languages. Hardware development tools range from a software development module to the multi-user AMPL* prototyping lab.

Fast fit: The modules are based on the memory-to-memory architecture common throughout TI's pioneering 16-bit 9900 Family. This advanced architecture, in combination with the rich 9900 instruction set, is particularly well-suited to industrial control applications, simplifying both hardware and software.

Fast help: Demonstrations of the TM990 modules can be arranged at local TI distributor Systems Centers.

In-depth instruction courses on the modules and the 9900 Family are available at TI Regional Technology Centers. TI distributors and TI field sales offices can tell you dates, locations and course fees.

From a standpoint of time and money saved, reliability and performance gained, TI's TM990 Series modules are an extremely efficient and economical solution to design problems. For full particulars, get a copy of the TM990 Series brochure. Call your TI distributor, or write Texas Instruments, P. O. Box 1443, M/S 6404, Houston, Texas 77001.

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132 columns	blink	8 function keys	current loop	half & full dplx
132 COLUMNS	BLINK	8 FUNCTION KEYS	CURRENT LOOP	HALF & FULL DPLX
24 LINES				AUTO REPEAT
24 lines				auto repeat
24 LINES				AUTO REPEAT
24 lines	dual intensity	numeric pad	menu set-up	auto repeat
24 LINES	DUAL INTENSITY	NUMERIC PAD	MENU SET-UP	AUTO REPEAT
	dual intensity		menu set-up	
STATUS LINE	DUAL INTENSITY	CURSOR CTRL	MENU SET-UP	VT-100 OPTION
status line	dual intensity	cursor ctrl	menu set-up	vt-100 option
STATUS LINE		CURSOR CTRL		VT-100 OPTION
status line	underline	cursor ctrl	row & col cntr	vt-100 option
STATUS LINE	UNDERLINE	CURSOR CTRL	ROW & COL CNTR	VT-100 OPTION
	underline		row & col cntr	
132 COLUMNS	UNDERLINE	8 FUNCTION KEYS	ROW & COL CNTR	HALF & FULL DPLX
132 columns	underline	8 function keys	row & col cntr	half & full dplx
132 COLUMNS		8 FUNCTION KEYS		HALF & FULL DPLX
132 columns	blink	8 function keys	current loop	half & full dplx
132 COLUMNS	BLINK	8 FUNCTION KEYS	CURRENT LOOP	HALF & FULL DPLX
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CIRCLE NO. 64 ON INQUIRY CARD

Ergonomics: a growing concern in CRT design

LIONEL MARTIN, Zentec Corp.

The industry faces an increasing demand for designs aimed at operator comfort

CRT terminal manufacturers are facing a situation reminiscent of that encountered by automobile manufacturers a half century ago, when economic and mechanical concerns took precedence over those of comfort. The situation centers around the issue of human engineering, or ergonomics, and is a subject of growing concern. With CRTs gaining prominence in virtually every sector of the business world, there is increasing demand that terminals be specifically engineered to address the problems of operator ease and comfort.

While CRTs provide high performance and improved efficiency in a wide range of applications, they may also cause varying degrees of operator distress—especially for those who use them eight hours a day, five days a week. Many terminals are awkward to use and uncomfortable to operate. Some screens are difficult to read, resulting in operator stress and eyestrain. And certain functions may require more dexterity than the average operator possesses.

Many manufacturers are receiving ergonomic feedback from their European markets, where clerical workers, particularly in Scandinavia, are heavily unionized. There, workers' demands for improved working conditions directly address the variety of machines they are required to use, including terminals and peripherals. In Sweden, various unions and trade guilds have published specifications on which types of CRTs their members will use or will not use. These specifications carry a great deal of weight.

While European governments have stopped short of formulating their own requirements for human factoring in CRT design, many, such as Finland, have made strong endorsements of the union mandates. It is a good bet that some sort of legislation on CRT specifications is not far behind. Moreover, it is probably safe to assume that such incentives on the control of CRT design will, in the near future, make their way to the U.S.

Ergonomic considerations *in this Zentec Zephyr include a non-glare CRT screen and video features that include half intensity, reverse video, blink, blank and underscore.*

Responding to criticism

Most criticism of CRT design centers around those components in the CRT with which operators have the most direct interface—the keyboard input and the display-screen output. Suggestions about keyboard

Glare reduction can be achieved by using either bonded faceplates covering the CRT or etched CRTs, but these have been found to reduce clarity.

pitch or slant, for example, are quite common. Most users agree that keyboards with a pitch of 11 degrees or less are the easiest to operate. However, this depends upon the environment. Some investigation has revealed that the lower the keyboard relative to the position of the elbows, the flatter the keyboard should be. To solve this problem, at least one European manufacturer recently developed a keyboard with a variable pitch between five and 12 degrees. Therefore, depending upon whether the operator is sitting or standing, he can adjust the pitch accordingly.

A consensus among operators also appears to favor keyboards that are laid out in standard typewriter fashion. This can greatly minimize an operator's need to acclimate himself to each CRT model. Similarly, sculptured keys, such as those found on the IBM Selectric typewriter and a number of CRTs, are thought to have numerous advantages over regular or flat keys.

Zentec's ZMS-50 *(center) incorporates a conventional attached keyboard with a 12-in. non-glare screen. The ZMS-90 (left) and ZMS-70 feature detachable keyboards and 15-in. non-glare screens. White phosphors are standard on all models, and green phosphors are available as options.*

However, these are significant concerns only to those operators trained on or currently using typewriters. People who are accustomed to typewriters and who are required to use a CRT many hours a day, such as newspaper reporters, editors, technical writers and secretaries, strongly prefer sculptured keys and a standard typewriter layout. People not previously trained on keyboards or those who have only casual or occasional use of a CRT, such as airline ticket agents, bank tellers or high-level executives, might not particularly care about layout or key style.

Operator ease and speed can depend greatly on the depth a depressed key must travel to register, especially if the operator is typing 300 characters per min. Moreover, an operator should have feedback to alert him when a key is "down" and when it is "released." Some CRTs incorporate an audible click to alert the operator, but this is not satisfactory in many environments. One popular approach is the tactile click method, which employs a spring or copper dish beneath each key to cause a slight buildup of pressure as the key reaches full depression, with a complete loss of pressure once the key makes contact.

Dissatisfaction with the display screen—particularly with its color, transmissivity and glare—is another major concern. Until now, most CRT terminals have been predominantly data-processing-oriented. Because a data-processing operator is merely punching in alphanumeric data from a source document, he has no real need to refer to the screen. Ergonomic concerns in the design of CRT display screens have, therefore, been kept to a minimum.

Growing concern for legibility

But the advent of CRT systems that combine word-processing and data-processing functions has changed that. Suggestions about screen clarity and legibility have become more widespread because word processing requires a screen that is as sharp, clear and readable as possible. An operator refers more and more to the display screen as he inputs data; moves text; and inserts words, sentences and paragraphs.

How can manufacturers provide the best display possible? There are a variety of solutions and many are purely subjective, depending on application and personal preference. Which screen phosphor provides greatest readability, for instance, is still a subject of conjecture. White or green phosphors typically are used. In Europe, however, there have been requests for amber or orange phosphors, which certain studies have shown to be easier on eyes and to produce the least amount of eyestrain. A number of well-established European terminal manufacturers, including Siemens and Saab, have amber phosphors in their units.

The size of characters is another consideration. Many operators feel that a 0.2-in.-high character is ideal, with a specific number of characters per line. But manufacturers may find that character size will vary from application to application.

Transmissivity is another issue, but there are trade-offs between clarity and glare. Manufacturers can achieve glare reduction by using either bonded faceplates covering the CRT or etched CRTs, but these have been found to reduce clarity. The desire for sharper character resolution is taking precedence over the problem of glare, but some manufacturers are attempting to combat glare by designing units with CRTs that tilt or swivel. Manufacturers hope that these techniques will cause light to be reflected away from an operator's eyes without sacrificing any clarity.

The comforts of full color

Similarly, there is the issue of color video display. Most CRT displays are available in just white or black on a colored phosphor. Full-color display is a feature that can contribute greatly to operator ease and comfort. Color can also be used to handle a variety of functions.

The stepped typewriter-style *keyboard on the Zentec Zephyr (left) incorporates the standard 96 ASCII keys, a 14-key numeric pad, 12 special-purpose function keys and 16 programmable function keys. The ZMS-70 (right) has a similar keyboard, but it is detachable. The ZMS-70 also features a 15-in. non-glare CRT screen and dual, double-density, floppy-disk storage.*

In systems with a formatted or protected forms mode, in which variable data is constantly being introduced, color can distinguish between the new variable data and that which is already on the page.

Color can also highlight certain data that needs to be brought immediately to an operator's attention. In medical systems, for instance, patient charts are logged into a CRT for fast reference by staff members. Using a color CRT, an operator may simply glance at the chart of a patient and find that a certain prescription was supposed to be administered at a certain time. If the prescription hasn't been administered, that fact can be called out in vivid red or yellow so the operator can immediately bring it to the staff's attention.

This method is used in a variety of process-control situations. Operators who monitor crucial system changes can be alerted to deviations in pressure, water level and temperature, and correct them.

While prices have dropped in the past several years, color tubes are still expensive. Color as a means of reducing operator eyestrain is a very real possibility, but each manufacturer must determine whether that advantage can be justified by increased cost.

Light-pen input is another feature that can contribute to operator ease. Already used in applications that use menu selection, light-pen input is a simple method by which operators can respond to data on a screen. It eliminates the need to use the keyboard. When data from which an operator wants to select certain items appears on the screen, a light pen directed to the choice will register that data into the system. The operator simply points the pen, receives an acknowledgement, presses a button and the entry is made. Touch-sensitive systems, using a finger or a pen, are also possible, although these methods leave a rather wide margin for operator error.

Many ergonomic changes may be implemented without great cost to the manufacturer and buyer, but others may not. There are trade-offs. Options such as pan scrolling, tilting, swiveling and color are attractive features that will definitely contribute to operator ease, but are they worth the cost? For now, some manufacturers may not think so because they haven't felt any demand for such features. But as the features start to become industry standards, volume and availability will increase and prices will drop, making implementation easier.

Ergonomic concerns will have an increasing impact on the future design of CRTs. So far, the U.S. government has set standards dealing only with CRT safety. The Department of Health and Human Services has a list of specifications regarding protective measures against tube explosion and implosion; there are other regulations for fire and electrical-shock safety. Recently, NIOSH, an agency in the Occupational Safety and Health Administration, has been asked to produce a report of CRT radiation emission. Additional safety regulations can be expected to follow in this country.

The assumption that a CRT will be used only in a sedentary, desk-top environment is no longer valid. Terminals are used for almost every type of business application, so it is necessary for manufacturers to design units flexible enough to function well in a variety of environments—from composition rooms to nurses stations and customer service counters. Only by realizing this and by taking an offensive tack will manufacturers be able to establish and maintain strong positions in the burgeoning CRT market. ■

Lionel Martin is director of product marketing for Zentec Corp., a Santa Clara, Calif., manufacturer of CRT terminals.

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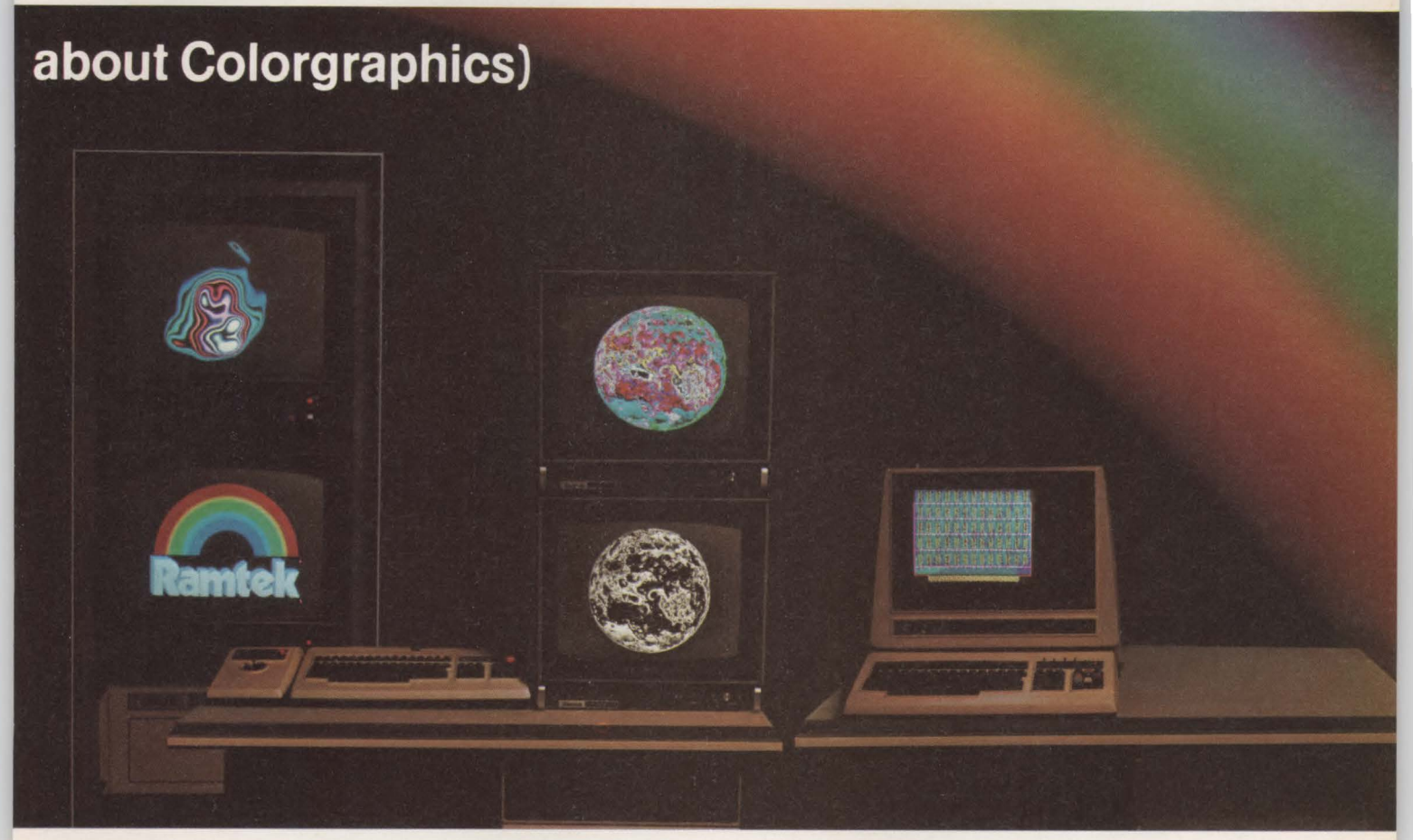

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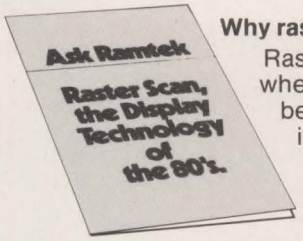

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- Automatic alternate sector assignment makes disc defects transparent to the host processor.
- Overlapped-command and implied-operations capability improves system throughput in multiple-drive systems.

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Meet The Elite! PRIAM's High-Capacity, Cost-Effective 14-Inch Disc Drives

PRIAM's high-technology 14-inch Winchester disc drives are available with capacities of 34 and 68 megabytes, with a 158-megabyte version on the way. And they all fit in the same 7" x 17" x 20" package, including optional power supply. Fully servoed linear-voice-coil head positioning provides fast, precise and reliable data retrieval. Average positioning time is only 45 milliseconds, and track-to-track is a fast 8 milliseconds for high throughput.

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From the same technical family tree as their bigger brothers, PRIAM 8-inch drives use linear-voice-coil positioning and brushless DC motors. In the next generation, they will permit database expansion to 70 megabytes, in the same small, interface-compatible package.

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Is SMART too smart? PRIAM also offers a lower-cost serial-bit NRZ data interface for the OEM who wishes to design the complete controller or to purchase one. This interface, similar to the evolving ANSI standard, has an 8-bit bidirectional microprocessor interface for all spindle motor and head positioning controls.

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INTERNATIONAL

France launches mini-CRT campaign

STEPHEN A. CASWELL, Bell Canada

A plan to give mini-CRTs to every home and business would also give French citizens on-line directories

The French government is preparing to launch one of the boldest campaigns yet seen in the miniperipherals market. It plans to give mini-CRTs to every home and business in the country so that French citizens can have on-line directories instead of letting their fingers do the walking or calling directory assistance. The mini-CRTs will have 7- or 8-in. diagonal screens that display 24 lines of 40 characters, solid-state keyboards, integrated modems that send data at 75 bps and receive it at 1200 bps, and OEM prices of $75 to $100 each.

The French Postal Telephone and Telegraph Authority (PTT) has already chosen four manufacturers for the mini CRTs and expects to procure 30 million units over the next 10 years. The manufacturers, who will produce different models, are French firms: Thomson CSF, Matra, Telic Division of CIT-Alcatel and TRT Radiotechnique.

The escalating costs of print directories and salaries of directory-assistance operators justify the procurement, says project director J.P. Maury. In the long run, these costs will be higher than the costs of giving away mini-CRTs. This makes the project one of the largest high-technology cost-displacement programs in history—more than $3 billion from 1982 to 1992. Maury says the terminals will first be used to access the white pages only, but he expects they will eventually be used for the yellow pages and for the French videotext system, Teletel.

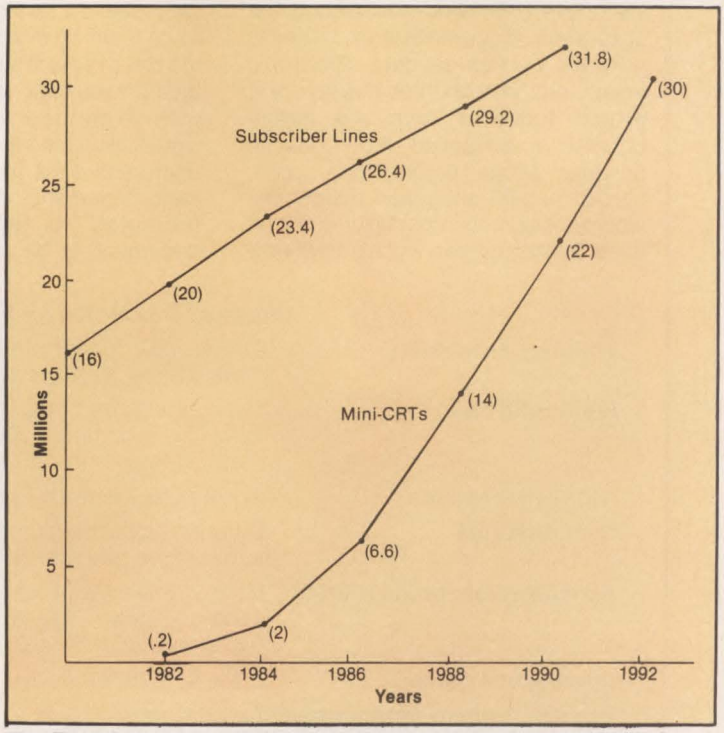
Maury anticipates that the PTT will pay $100 per terminal when production levels reach 800,000 in 1983. Beginning in 1982, the terminals will be field-tested by 270,000 users in Ille-et-Vilaine, southwest of Paris.

Should the PTT succeed in its plan, it will have spawned a new type of device, the mini-CRT, with profound implications for mini-micro-based systems. While there are hordes of doubters, the plan is on schedule, and it appears the price goals can be met, based on projected costs of memory and microprocessor chips.

The mini-CRT prototypes have several distinguishing features. The Thomson CSF model has an integrated telephone, which Maury expects to be available in the versions produced in 1982. Keyboards do not use the well-known QWERTY found in alphanumeric terminals worldwide, but an ABC . . . Z format. While its designers believe more people can relate to this alphabetic style, they admit the keyboard layout is controversial and will study it closely in field tests. QWERTY will probably be available if users prefer it.

The terminals also can be used to access videotext systems. According to the Viewdata Research Unit of the consulting firm Link, the program "represents a complete break from the concept of an adapted television set as the primary terminal device."

By giving away the terminal, the PTT will create a base of users for Teletel. While converting home color televisions to videotext terminals is expected to cost consumers less than $200 by the mid-1980s, the French think that the development of a user base can be



The French government *plans to sharply increase its shipments of mini-CRTs from 1982 to 1992.*

If the French succeed, they will have developed a strategy for building a critical mass of users.

augmented by black-and-white mini-CRTs.

"Color is preferable," says Alain Serra of French Telecom, Inc., the PTT's U.S. marketing arm, "but there is also need for black-and-white units." While stressing that mini-CRTs are cost-justified for the directory-assistance program alone, the large base of users created by the mini-CRTs will encourage information providers to develop more data bases, which will cycle to encourage further use, says Serra. "It solves the chicken-and-egg problem (of developing a user base) that exists in Britain and other countries," according to Link.

Ken Bosomworth, publisher of *Videoprint* newsletter and president of International Resource Development, a Norwalk, Conn., consulting firm, says, "If the French succeed, they will have made the breakthrough that most videotext services are awaiting—a strategy for building a critical mass of users. They also will create spin-off applications for mini-CRTs as telephones (see "The mini-CRT and the PBX," p.126) and as low-cost terminals for mini-micro systems."

Other countries beginning mini-CRT programs

Although the French have announced the boldest plan for mini-CRTs, they are not the only country with such products under development. In the U.S., AT&T recently tested its Electronic Information Service (EIS) program, which allows access to both white and yellow pages. EIS was tested in Albany, N.Y., from Aug. 24, 1979, to Jan. 30, 1980, using 15 normal-sized terminals rotated in 75 homes and eight businesses for two weeks at a time.

THE MINI-CRT AND PBX

Regardless of whether the French spark a mini-CRT boom, there seems to be a strong need for mini-CRTs in business systems, particularly computerized private branch exchanges (PBXs). It is not uncommon for companies to spend $1000 per user to provide advanced PBX functions, only to find them unused.

Today, special functions such as call forwarding, camp-on, automatic redialing, speed dialing, data entry, paging and extension hunting are implemented by entering numeric codes on the telephone. Users have problems remembering the codes and also have difficulties deciphering the crammed documentation sheets provided by PBX vendors. Electronic telephones with one-line displays and preset function keys are highly popular in advanced PBXs despite handset prices higher than $600. Mini-CRTs with integrated telephones would expand the capability of a PBX even further by serving as a window into the network's operation.

The accompanying table lists some of the functions that can be provided with CRT/Telephones, as they are called in the Diebold Automated Office Program report, "Telecommunication Systems." These features take advantage of the mini-CRT's self-training nature. Users currently must be trained to operate a complex PBX by other people, which is expensive and inefficient. With mini-CRTs, the PBX could do much of the training itself.

Expanded least-cost routing is another benefit. PBXs today automatically select the most efficient line to route a call by first attempting to route the call over WATS lines, then FX lines, then private lines, etc. Mini-CRTs used with expanded least-cost routing would allow the PBX itself to instruct its users about the most efficient way to send documents. The user would be prompted to input the type of document to be delivered, the time frame for delivery, and the destination. The PBX would respond with the delivery alternatives as preprogrammed by the telecommunications manager. In this way, users would automatically know the latest configuration of communication devices on the network.

Another major advantage of mini-CRT/PBXs is their ability to deliver electronic mail. Corporate departments could save paper and time by using the inherent electronic mail capabilities of the PBX with mini-CRTs for each user. Personal messaging could also be integrated into the system. If an internal call were unsuccessful, the caller could press a button and go into message mode.

Features such as expanded least-cost routing or integrated voice/text personal messaging are not available on PBXs because users have no way of accessing them. One role of mini-CRTs is to provide that capability.

Advanced PBX Software Features Requiring CRT/Phone

Training instruction	Allows user to learn features of PBX. Has two parts. One helps user known instructions. The second describes each function's benefits.
Electronic mail	Each extension has a mailbox address to leave messages. Can be used while traveling or at home. Eliminates problems in communicating to people not in their office.
Data entry/access	Allows easy access to data bases of information, either internal of external
User directory	Eliminates problems keeping directory up-to-date. Saves the company substantial printing costs.
Expanded least-cost routing	User queries transmission needs and the system responds with best way to send document. Will greatly expand use of little-known, but cost-effective, transmission media procured by telecom department for users.
Intelligent calendar	Lists scheduled events and notifies user of upcoming event.

Source: Diebold Automated Office Program

Use averaged 20 accesses per day. This probably includes some novelty use, but it also indicates that the system is easy to use. AT&T will not comment on the development of mini-CRTs or on the concept of not charging for them, but it is a safe bet that a prototype exists somewhere in Western Electric. It is too attractive a product not to be under consideration.

Unfortunately, however, product development is not AT&T's most serious problem. The U.S. House of Representatives recently added an amendment to the Communications Act of 1980 forbidding AT&T from publishing electronic yellow pages. The amendment is backed by the powerful American Newspaper Publishers Association and will be bitterly contested as the act moves through Congress. At stake is AT&T's position in a market of billions of dollars.

Undoubtedly, other telephone companies are also looking at the feasibility of mini-CRTs. Should the French succeed, a rush to copy the program can be expected, with equipment manufacturers dreaming of $100 items shipped in million-unit levels. In the U.S., annual shipments of more than 10 million mini-CRTs with a market value of $1 billion are conceivable.

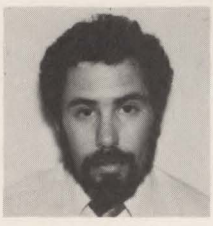
'Friendly' systems

Mini-micro systems can also benefit from mini-CRTs. Microcomputers can often be less expensive than the terminals required to run them, especially in such market segments as process control. Mini-CRTs can lower the cost of a terminal to control small systems, and can make them "friendlier" to users.

In laboratories and on process control lines, mini-CRTs with integrated phones would enable users to hold conversations with colleagues or with a central control facility. Versions could be produced for alternate voice/data operation.

Mini-CRTs do have limitations, however. They are unsuitable for small-business systems because their keyboards are not designed for word-processing or data-entry applications with heavy duty cycles.

On the whole, the mini-CRT seems to be one of the most interesting products to appear in a long time. But before manufacturers rush off to crank up the production lines, there are still a few questions. Whether or not the French can succeed as planned is one. There is no proven demand for mini-CRTs, although there seems to be enough applications. The mini-CRT is a promising prototype product. But if the French succeed in their bold plan, there could soon be a flood of them. ■



Stephen A. Caswell, a market planner with Bell Canada, is the principal author of eight multiclient research reports on computer/communications topics. He is also a consultant and former newsletter editor.

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DISTRIBUTED PROCESSING

Multiprocessing networks vs. mainframes

MICHAEL ROBERTS, ECS Microsystems, Inc.

Second of two parts

Multiterminal systems hold their greatest promise in the spectrum between powerful, special-purpose processors and low-end, control-oriented tasks

The first part of this article (MMS, October, p. 121) described the advantages of multiprocessing networks versus single mainframes and outlined the problems that had to be overcome to make the networks commercially viable. The conclusion of the article describes various methods to couple multi-microprocessor systems to overcome those problems.

Since mid-1975, considerable effort has been devoted to resolving the problems that limited the practicality of multi-microprocessor systems. These problems include system inefficiencies, complex interprocessor defects, interconnection structures, software system structures and others. The answers have been sought in the context of closely coupled multi-microprocessor schemes, such as Carnegie-Mellon University's Cm* modular multi-microprocessor system, Digital Equipment Corp.'s modular minicomputer using microprocessors and the University of Texas's investigation of cooperative loosely coupled microprocessor architecture in an interactive data-base task.

Coupling involves the degree of interaction between processors. In a loosely coupled system, each processor has some dedicated complement of program and data memory, and possibly some I/O devices. Each such unit, which can function independently, communicates with another using either data transfers over a common bus or point-to-point communication lines or coordinated signals maintained in a commonly accessible store. A tightly coupled system involves multiple processors sharing common program and data memory and I/O facilities. All processors access common buses to perform memory and I/O transfers.

Detailed hardware design of Cm* began in mid-1975 to explore ways in which LSI could be applied to a modular computer structure. The Cm* architecture (Fig. 4.) allows close cooperation among large numbers of inexpensive processors. All processors share access to a single virtual memory address space. The processor is a DEC LSI-11 microprocessor. Fig. 6 shows a cluster of Cm*s sharing a single map bus and mapping processor (K.map). There are no fundamental limits to the size of such a system. Cm*s and K.maps can be added incrementally to increase processing power, memory size and communications bandwidth. A

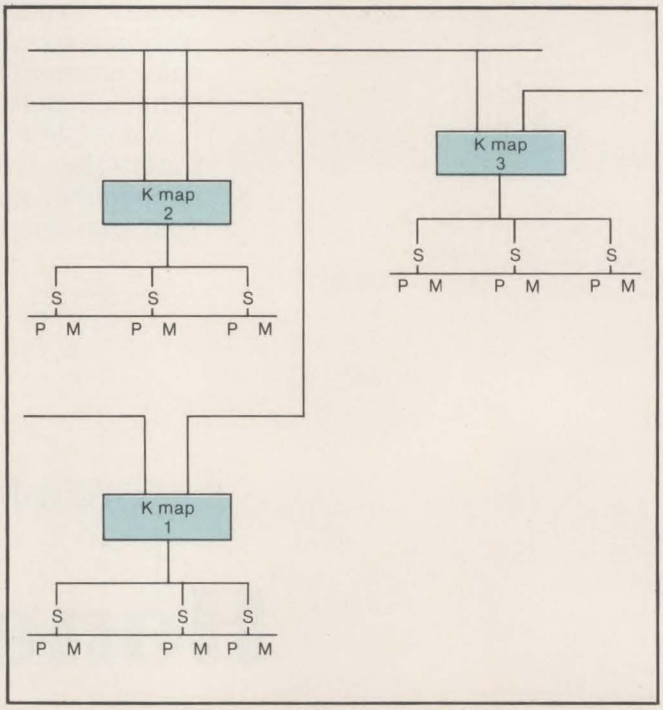

Fig. 4. Carnegie-Mellon University's CM* modular multi-microprocessor system *allows close cooperation among large numbers of inexpensive processors.*

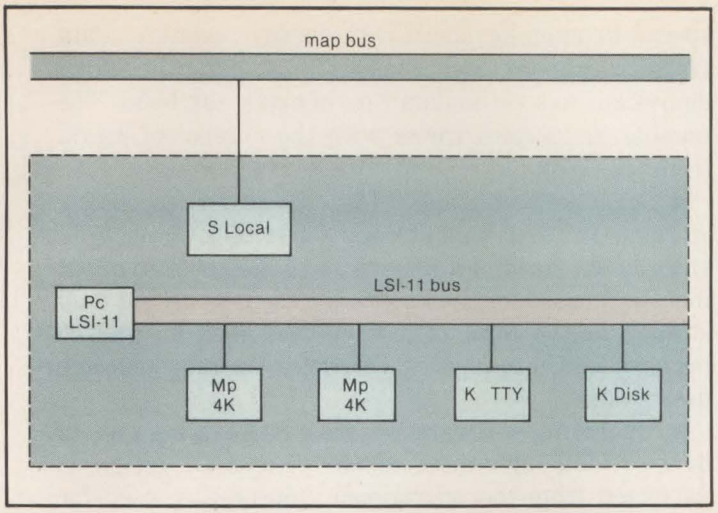

Fig. 5. Details of CM*'s computer module *show that LSI can be applied to a modular computer structure, using an LSI-11.*

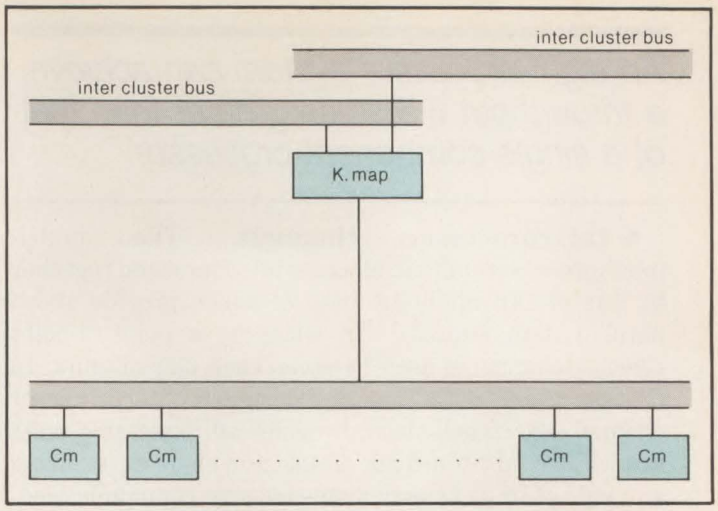

Fig. 6. A cluster of CM*s *shares a single map bus and mapping processor. (K. map).*

10-processor system was in operation by mid-1977 and expanded to a 50-processor system at the end of 1978.

The major accomplishment of the Cm* project has been to bring an experimental multi-microprocessor scheme into operation and to demonstrate that almost-linear speedup can be achieved. Moreover, there have been no serious bottlenecks or deficiencies in the processor/memory bus structure that preclude configurations with 100 or more processors.

In the DEC multi-microprocessor project, LSI-11 microprocessors again form the basic building block and their performance was compared against the performance of the PDP-11/70 minicomputer, the top of the 16-bit PDP-11 line. Fig. 7 is a block diagram of the breadboard hardware system, which consists of as many as 16 identical LSI-11 microprocessors, tightly coupled to a common memory management mechanism, cache, memory, I/O bus and I/O interrupt mechanism by a shared synchronous high-speed bus.

Measurements have shown that in suitable batch-processing environments, an eight-processor system could achieve a throughput 6.5 times greater than that of a single component processor.

Loosely coupled systems

The multi-microprocessor system that most closely parallels a multiterminal environment is the loosely coupled configuration. Such schemes have been much investigated, most recently by researchers at the University of Texas.

Using a specially developed discrete simulation tool called system-state-modeling (SSM), four different classes of system architecture (Fig. 8) were analyzed:

- **Class 1,** fully connected, in which each processor is connected to every other processor by a dedicated link;
- **Class 2,** bused with a private primary store, in which all processors share a single common link that allows any two to establish direct transfers;
- **Class 3,** also bused, but with both public and private primary store; and
- **Class 4,** a uniprocessor, for comparison purposes with the multi-microprocessor schemes.

All four classes possessed common features in the configuration of their basic processors, interprocessor channels, user consoles, secondary storage, operating software, application software and task loads.

- **Basic processor.** Architectural features of the basic processor include: 1) 15 generic operations; 2) one address, three-field instruction format; 3) a single internal data bus comprising separate address and data lines; 4) all registers, data paths and primary store locations 16 bits wide; 5) primary store read/restore cycle of 1 μsec.; 6) 16 general-purpose registers; 7) average instruction time of 2 μsec.; 8) primary store organized in blocks of 256 words; 9) addressing modes of indexed indirect and segmented; 10) a vectored interrupt mechanism; 11) a multiplexor channel; 12) a direct-to-primary store selector channel capable of operating in block or word mode.

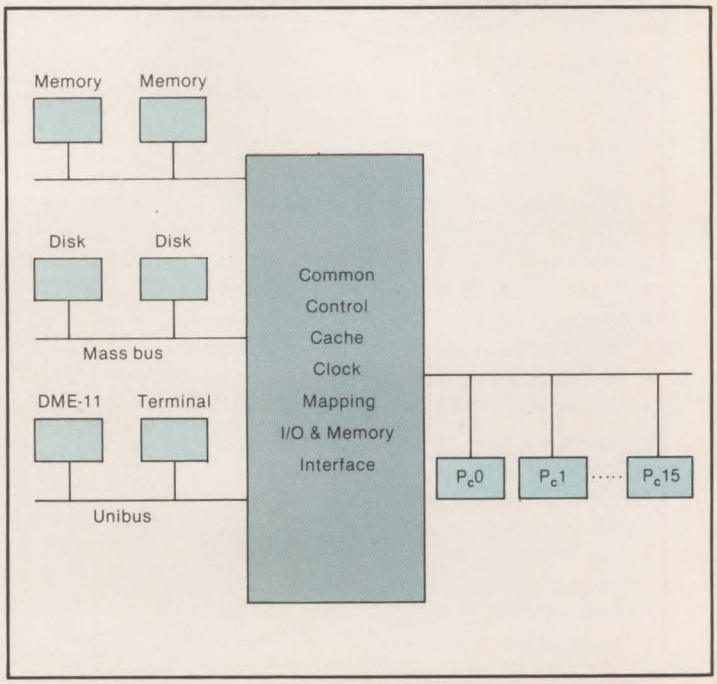

Fig. 7. Digital Equipment Corp.'s multi-microprocessor project *uses as many as 16 LSI-11 microprocessors, tightly coupled to a common memory management mechanism cache, memory, I/O bus and I/O interrupt mechanism by a shared, synchronous bus.*

An eight-processor system can achieve a throughput 6.5 times greater than that of a single-component processor.

• **Interprocessor channels.** The multi-microprocessor units in all cases are connected together by one of two methods, both of which provide 16-bit parallel data transfer. In Class 1, a point-to-point selector channel is used between each pair of units. In Classes 2 and 3, a specially designed interprocessor channel (IPC) bus is used, to which all processing units are connected by a form of selector channel, allowing any pair of units to establish exclusive communication. The channel transfer rate was set at 2M bytes per sec. to match the primary access cycle.

• **User consoles.** Features of the use consoles include a CRT display, a alphanumeric keyboard and a special function keyboard with display registers. Data transfer rate for each console is 2K bytes per sec., equivalent to a serial data rate of about 19K baud. The number of consoles varies with the number of users, from one to 32.

CPU
- Z80 microprocessor
- As much as 4MHz clock frequency
- 158 instructions
- 64K Memory Addressability with bank switching capacity to 256K
- 16K Buffer for Display and I/O

Display
- 80 Columns × 25 Lines
- 256 Programmable character set
- 8 × 7 matrix in 10 × 9 field
- 60 Hz refresh

Keyboard
- Typewriter Keys with editing, numeric and special-function keys
- Nonreflective, molded, matt key caps
- Auto repeat after half-second delay
- Programmable key locations

Communications
- RS232C Synchronous or asynchronous
- 75-19200 baud selectable
- Full modem controls
- Parallel interface options
- Protocol options for IBM, Honeywell, Burroughs, NCR, ICL, DEC, HP and others

Environment
- Power: less than 2A 110V 60 Hz nominal
- Temperature: 0° – 40° C
- Humidity: 90 percent without condensation
- Packaging: 20 × 12 × 17 in. plus keyboard 20 × 3 × 8 in.
- Weight: less than 30 lb.

Software
- Operating Systems
- Communications Protocols
- Printer Drivers
- Text Preparation
- Macro-Assembler, Editor, Debugger
- BASIC, COBOL, etc.
- Diagnostics

Disks
- 2 Drives with 983K-byte Storage

Table 3. General specifications *of the ECS Series 4500 loosely coupled multi-microprocessor configuration.*

• **Secondary storage.** Two forms of secondary storage are used: bulk store and fast bulk store. Bulk store in the form of a moving head disk or equivalent memory is used for the knowledge base, while fast bulk storage in the form of a fixed-head disk is used to perform logical-to-physical reference mapping and save user states.

• **Operating software.** No master operating system is used, although most of the functional design is extracted from the operational uniprocessor used for comparison purposes. All processors are task driven, using a simple system of ranked input and output queues to schedule and coordinate activity.

The results of the study completely rule out the Class 1 fully connected multi-microprocessor scheme. For one thing, the specialized capability of each processor to communicate directly with any other processor over a dedicated link is not justified for two of the three intercomputer links. Furthermore, the configuration doesn't provide an easy or inexpensive way to add computing units.

For a basic task load and a modest number of users—eight or less—the two multi-microprocessor configurations (2 and 3) showed responsiveness comparable to the uniprocessor (4). However, internal activity and use are sometimes quite different. For example, if widely varied dynamic task loading were used, Class 2 might be the best alternative. If exclusive tasking were to be included, a public store would not be an advantage, and Class 2 would also be preferred.

For heavy task loads and a larger number of users (16 to 32), Class 3 gives significantly better performance than the others and uses public store effectively. Class 3 would be the next configuration for cooperative tasking.

Multi-microprocessors and multiterminals

Many of the processor, data storage and user console features of the loosely coupled multi-microprocessor configurations have direct parallels in the structure of many of today's intelligent terminals/information stations (Table 3). Several design improvements, however, should be made if a loosely coupled/multiterminal local network is to be a cost-effective replacement for a mainframe CPU.

• **Processor architecture upgrading.** Present terminal configurations are based on 8-bit CPUs, such as the Z80, 8085 and 6800, and will require upgrading to match the specifications outlined earlier. But recent developments in 16-bit microprocessor design are approaching the basic functional features assumed here, although interprocessor-channel bus IPC-like capability is not yet available. Zilog's Z8000, along with its support chips, incorporates all other necessary features. With the exception of general-purpose

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5. Dual Intensity Display Character Selectable
6. Split Screen
7. Reverse Video Screen Format Character Selectable
8. Detachable Keyboard
9. Selective Character Blinking
10. Optional/Alternate Character Set
11. Optional APL Model
12. Underlining Character Selectable
13. Blinking/Underlining Cursor Style
14. Double-High and Double-Wide Characters
15. Addressable/Readable Cursor
16. Save and Restore Cursor
17. Line Drawing Set
18. Complete Set of Clear Commands
19. Non-Volatile Set-Up Mode with Answer-Back Message
20. Non-Glare Screen
21. Typewriter Style Keyboard
22. Accounting Type Numeric Keyboard Pad
23. Cursor Control Keys
24. General Purpose Function Keys
25. Auto Character Repeat
26. Columnar Tab Keys
27. 20 ma Current Loop Option
28. Buffered Printer Interface
29. Selectable Parity Check
30. Composite Video Input/Output
31. Self Test
32. Status Indicators
33. Local Mode
34. Audible Alarm
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36. Smooth Scroll
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39. **ANSI Standard/DEC VT100* Compatability**

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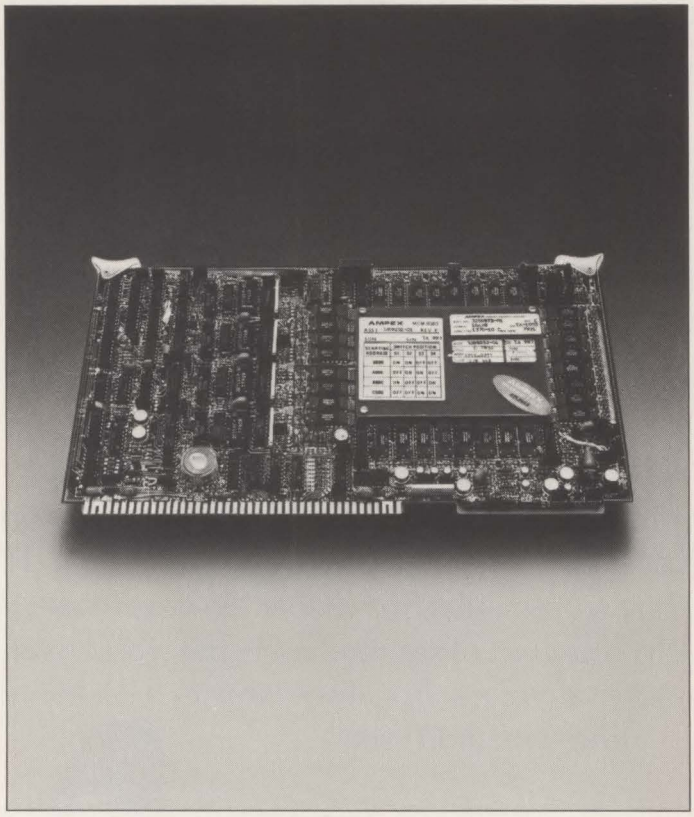

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As with multi-microprocessor systems, significant software development is needed to build a multiterminal equivalent of a mainframe CPU.

registers, the Motorola 68000, with its support chips, also qualifies. Another candidate is the NS16000 family from National Semiconductor.

• **Software development.** As with multi-microprocessor systems, significant software development is needed to build a multiterminal equivalent of a mainframe CPU. A multiterminal operating system, which allows tasks residing with different terminals to communicate with each other, is especially important. Depending on the hardware chosen, there may be little or no existing multiterminal software available. Some of it may be adapted from the operating software used in various clustered-terminal networks, or from the work already done with multi-microprocessor configurations. Even if some is available, extensive error-checking routines may have have to be written. Additionally, software must be developed to allow terminals to be checked individually before they are integrated into a total system.

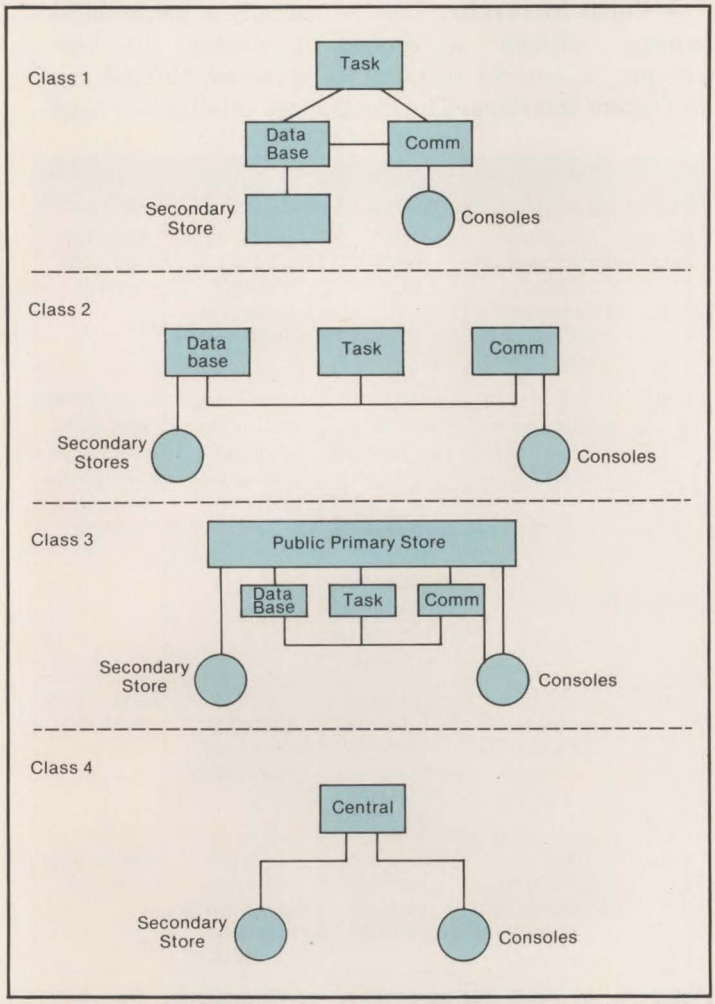


Fig. 8. The University of Texas researched *a loosely coupled multi-microprocessor system using a tool called System-State-Modeling to analyze four classes of system architecture.*

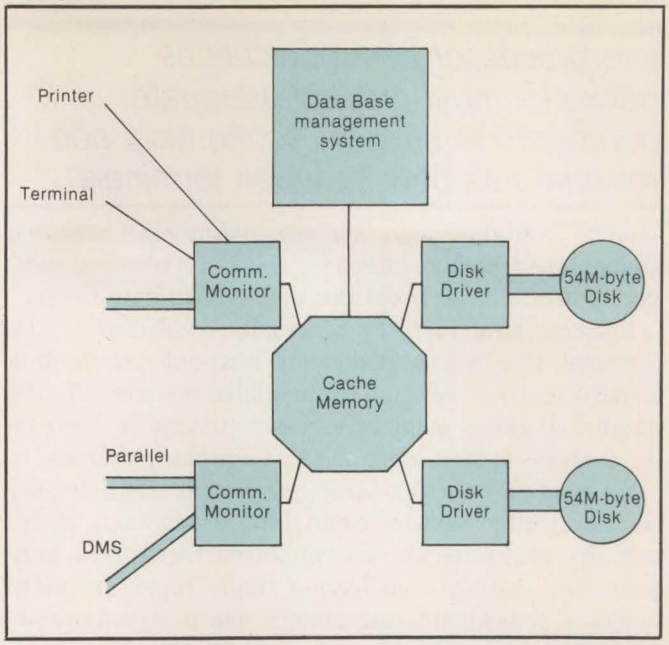


Fig. 9. An intelligent disk storage system, *such as the IMSAI 108, contains interacting microprocessors sharing cached memories, and handles all data-access work.*

• **Programming simplification.** While programming for multiterminal and multi-microprocessor systems is not an insurmountable problem, it must be made simpler if such alternatives to the mainframe CPU are to be successful. Fortunately, work toward that end is beginning. For one thing, a Massachusetts Institute of Technology research group has proposed ways to support distributed programs.

In this new approach, logical sub-parts of a single program reside in and are executed by different computers within a network. Each sub-part is under the control of the organizational entity responsible for the node in which it resides. Work is focused on language primitives to support modularity and communications between the sub-parts.

The advantages are impressive. By distributing the program, contention for any one part of it is reduced. Access speed is increased because the entity most likely to use a part of the program will be located close to it, and each division has greater control over its part of the program.

To keep the distributed program modular, a construct called a "guardian" has been proposed. It is a local address space—located at a node—that contains objects (data) and processes (execution of one or more sequential program parts). The guardian controls access to the node resources, including data, devices and computation results. It can survive node crashes, keeping the history of a computation prior to a crash in a stable, accessible environment.

• **Relieving memory contention.** Because memory partioning in the multiprocessor and multiterminal alternatives to the mainframe involves both local and global memories, there is the problem of memory contention. Local memory is used to store frequently used subroutines, tables and buffers and to provide diagnostic and restart procedures. Global memory

Interprocessor communications networks must provide adequate bandwidth to support economical and reliable data flow between terminals.

usually contains the system executive, resource queues, task queues, interprocessor/interterminal message buffers, large programs and system data bases.

Because local memory is usually connected to the terminal CPU via a dedicated bus link, contention usually occurs in relation to the global memory. As the number of global memory accesses (terminals) increases, contention increases, and throughput decreases.

As memory prices drop, and new high-density semiconductor devices come into production, global memory programs can be replicated throughout local memories, rather than having single copies in global memory, thus eliminating a major source of contention.

Until then, however, several other remedies can be used. The first is to divide the global memory into smaller modular blocks, which aids in distributing the requests and lowering contention. The second is to use additional local memory to reduce the number of accesses to global memory. And third, a local cache buffer can be used to store repetitive references to areas of global memory. The problem, however, is that individual terminal or processor caches will contain different data for what is supposed to be common memory. The problem of contention also arises when multiple simultaneous requests are made on data in a multiterminal network. The current technique of locking out a user from common records can cause requests to back up in a large system, which, in turn, reduces response times to unsatisfactory levels. This becomes more than a trivial problem when a dispersed multiterminal network has 50 to several hundred terminals.

By analyzing the type of request, an algorithm can maintain a smooth information flow throughout the network. An example of such an algorithm could be one in which not all data must be current, in which case the interrogator is informed that other processing is in progress. The algorithm, however, must be smart enough to identify and prioritize the request. Further, it must know the nature of the request and must be able to resolve all conflicts which can arise from these requests.

Several major factors govern the design of the interprocessor communications network, which must provide adequate bandwidth to support economical and reliable data flow between terminals. In multimicroprocessor configurations, in which the various nodes are close to each other, the most commonly used media for interconnecting processors are shared memory, serial data communication channels, parallel data buses and shared peripherals, such as drums and disks (Table 4).

In terminals, these media can be used as point-to-point connections in dedicated link networks, or as the basis for shared-network architectures. The choice of which medium to use is a function of bandwidth needs, distance between terminals, cost, flexibility requirements and availability of off-the shelf components.

For multiterminals, configurations being used as alternatives to mainframe systems in which various nodes are separated considerably, another alterantive may be off-the-shelf fiber-optic links. There are three bandwidth/distance target ranges suitable for such links. One range, corresponding to the lowest data rate multiplied by distance product is for links shorter than 20 ft., with rates as high as 1M bit/sec., NRZ. A second intermediate plateau covers 500-to 5000-ft. links with data rates as high as 10M bits/sec., NRZ. The most telling impact of fiber-optic links is the 50-to 500-ft. range handling data rates of 40M bits/sec. and greater. With fiber optics, such serial links can achieve data-transfer rates of more than 4M bytes/sec. between processors/terminals and auxiliary main memory and high-speed devices, such as disk drives.

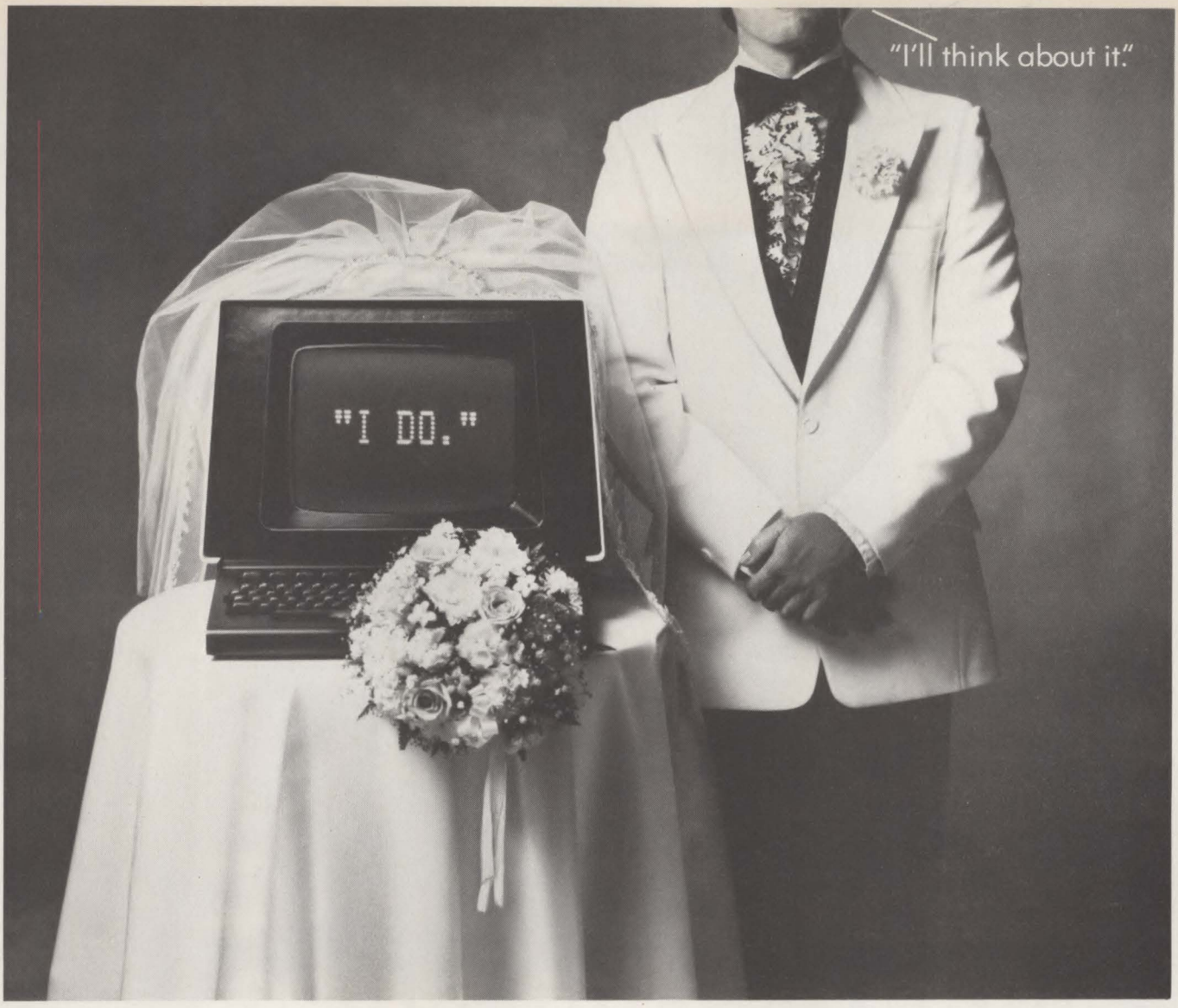
Multiterminal alternatives to mainframes

With the proper features, several multiterminal configurations can be considered as alternatives to a mainframe CPU in a local data-processing environment, including:

- **Local hierarchy.** This is basically a hierarchical scheme without a central processor. In this scheme, a central memory is accessed through an intelligent interface. This centralized intelligence need

Media	Description	Advantages	Disadvantages	Availability
Shared Memory	Dual-port main memory address space available to both computers	High bandwidth	Must be close to both processors; usually is limited to two CPUs	Available for most minis
Cable	2- or 4-wire cable capable of supporting bit-by-bit serial transmission	Low cost for low speeds; can be used for long distances (thousands of feet); allows complete conectivity in shared systems	Lower bandwidth than shared memory or bus	Low speed very common; high speed from only a few sources
Bus	Parallel wires; 8, 16, 32 bits plus control signals	High bandwidth allows complete connectivity in shared systems	Limited distance; more costly than serial	Reasonably available
Disk	Disk with access from either of two computers	Low cost, given that disk is needed	Limited distance; slow access times; contention	Reasonably available

Table 4. In multi-microprocessor configurations, *the most commonly used media for interconnecting processors are shared memory, serial data-communication channels, parallel data buses and shared peripherals, such as drums and disks.*



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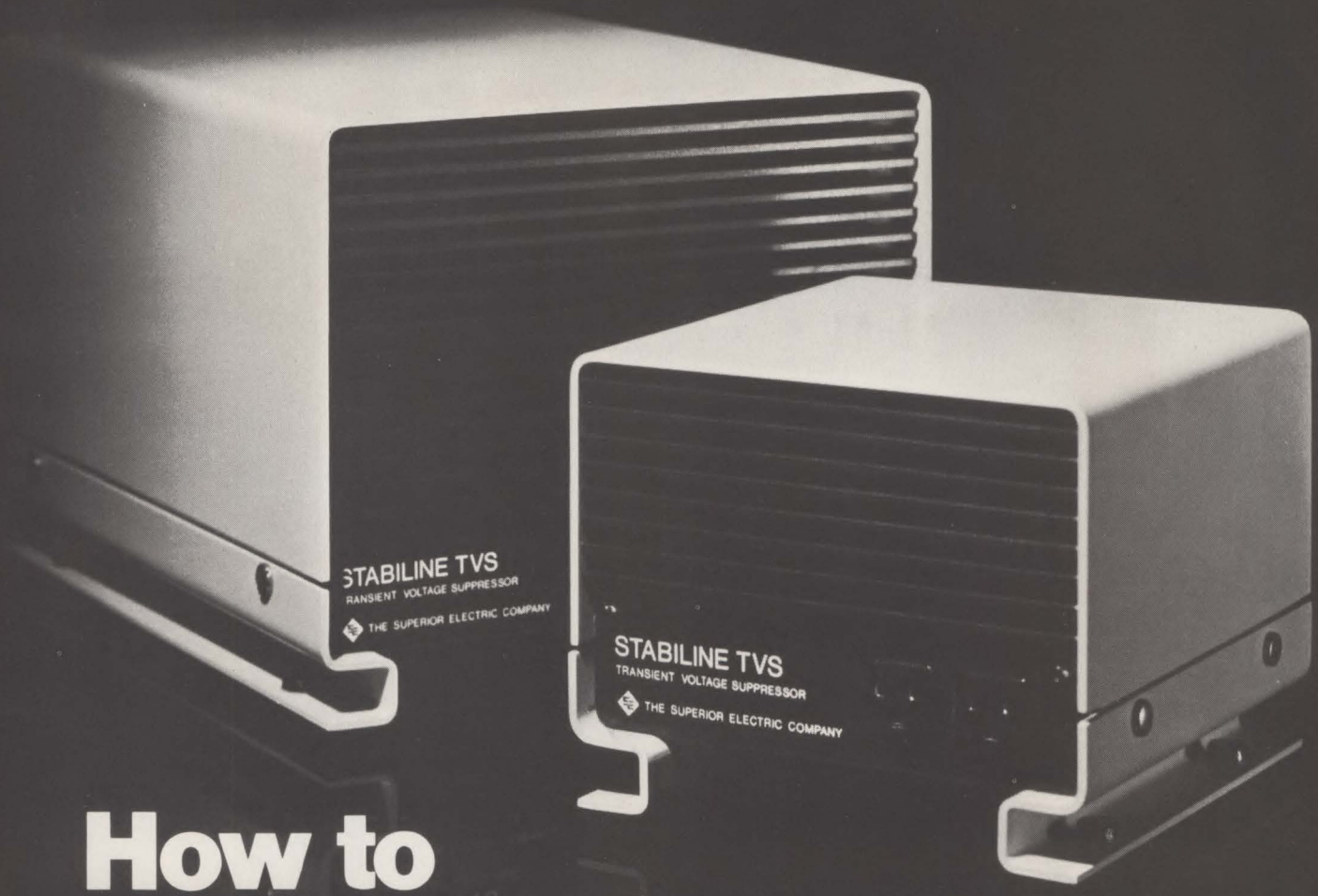

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An advantage of the crossbar-switch is its ability to support simultaneous transfers between all terminals and memory units.

be nothing more than one of the terminals in the local multiprocessor scheme that has an additional function as a repository for extra memory. An ordinary terminal with soft-disk capability can be adapted easily to hard disk to handle such a job.

A more sophisticated solution would be to use an intelligent-disk storage system, such as the IMSAI 108, designed for use as a stand-alone data base management system accessible by one or more CPUs and/or terminals. This field-expandable disk controller, containing interacting microprocessors sharing cache memories, handles all data access work, including indexing, searching, buffering, de-blocking, storage management and error-recovery. Data transfer consists only of the requested discrete item, record or file, making it possible to use only RS232 interfaces between the disk subsystem and the various terminals. The system can handle 54M bytes of data, but is expandable to 16 drives or 864M bytes (Fig. 9).

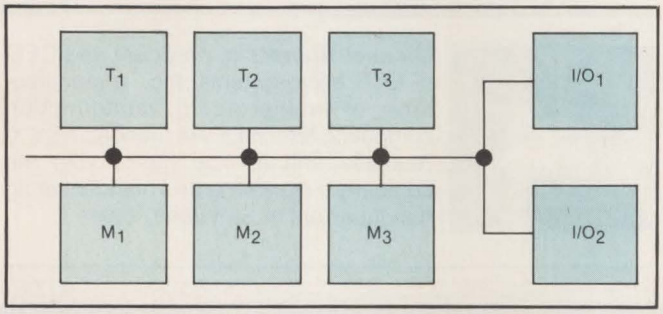

Fig. 10. A time-shared/common bus, shared memory interconnection scheme, *potentially the simplest for a multiterminal network, incorporates a common communication path connecting all functional units.*

This type of hierarchical system offers high throughput, providing common memory hardware is fast. Implementation and development of such a system initially would require only an intelligent terminal, a common memory and an interrupt network. The common memory can be loaded with dummy parameters and variables, and as additional terminals are added, these variables, as well as the corresponding system state vector entries, become active.

- **Time shared/common bus, shared memory.** This potentially simplest of interconnection schemes for a multiterminal network incorporates a common communication path connecting all functional units (Fig. 10). It has the lowest overall system cost for hardware, and is easily modified by adding or removing functional units. Expansion of the system, however, by adding terminals may degrade system performance.

And because the common bus is a shared resource, a way must be provided to resolve contention using such schemes as fixed priorities first-in, first-out queues, and daisy chaining. The most serious limitations of this organization are reliability and interference between processors requesting the bus. Because there is just one path for all transfers, the total system transfer rate is limited by the bandwidth and speed of this single path. For this reason, private memory and private I/O are highly advantageous, since the failure of the common path could cause complete system failure.

- **Crossbar switch shared memory.** If the number of buses in the first organization were increased to the point where there is an available path for each memory unit and I/O unit, the result would be a crossbar switch-based multiterminal system (Fig. 11).

In an M × N crossbar switch, there are M active elements—in this case terminals and I/O units—and N passive memory elements. Functional units in such a system need minimal bus interface logic because they perform neither conflict resolution nor recognition of

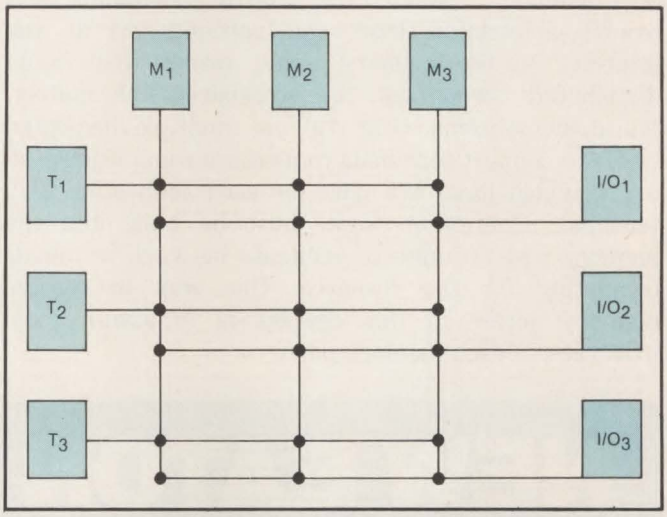

Fig. 11. A crossbar switch-based multiterminal system *can support simultaneous transfers between terminals and memory units.*

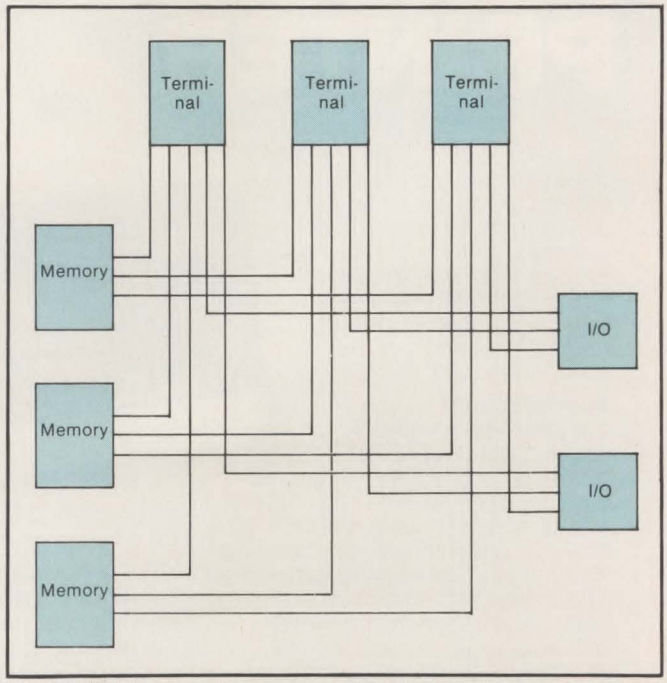

Fig. 12. Multiport systems *use multiple dedicated buses to connect terminals to memories and shared I/O units, which have one port for each connection to a terminal.*

In a multiport memory system, the control swtiching and priority-arbitration logic is concentrated at the interface to the memory units.

data intended for them. Instead, these functions are performed by the switch matrix, which is necessarily complex, costly to control and physically large.

One line of the crossbar carries address, data and control-bus signals that might correspond to as many as 32 to 64 wires. The complexity grows exponentially as M and N become large. A major advantage of the crossbar-switch approach is its ability to support simultaneous transfers between all terminals and memory units.

- **Multibus/multiport shared memory.** In a multiport memory system, the control, switching and priority-arbitration logic and concentrated at the interface to the memory units, rather than being distributed throughout the crossbar-switch matrix. Multiport systems (Fig. 12) use multiple dedicated buses to connect terminals to memories and shared I/O units, which have one port for each connection to a terminal. Contention logic must be built into the memory and I/O units to arbitrate between terminals competing for the resource. One way to resolve memory access in this context is to assign fixed priorities to each memory port.

The chief advantage of this approach is the very high total transfer rates, but this is offset by the fact that this approach requires the most expensive memory units because most of the control and switching circuitry is included in the memory units.

- **Dispersed multiterminal network.** The best approach for multiterminal network alternatives to the mainframe CPU will be a dispersed-processing multiterminal configuration with shared virtual memory and some sort of central indexing scheme. Such a scheme will be possible with the development of higher-density memory components.

Except for number-crunching jobs, in which very large amount of computing is required in a very short time, mainframes use high processing speed to process many independent jobs in as short a time as possible. But, if a minimum acceptable response or turnaround time is maintained, less-powerful multimicroprocessors or multiterminals concurrently operating on independent jobs could provide the same processing power. ■

Michael Roberts is president and CEO of ECS Microsystems, Inc., a manufacturer of multiprotocol, multifunction computing terminals. He founded ECS in Australia and is now based with the company's marketing and manufacturing headquarters in San Jose, Calif.

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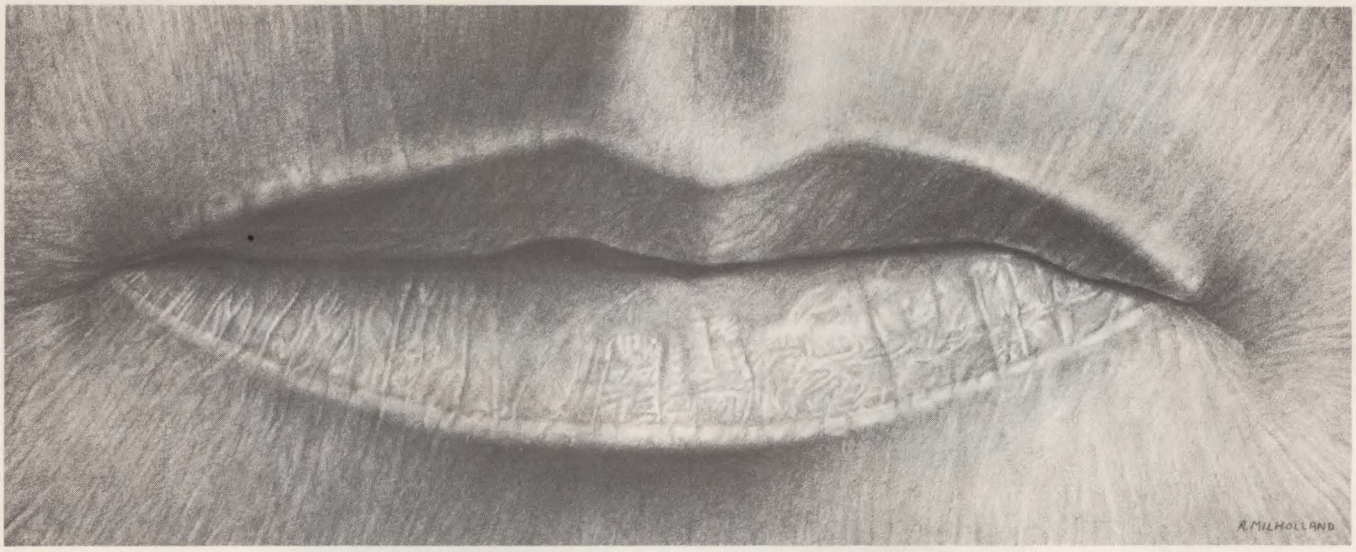

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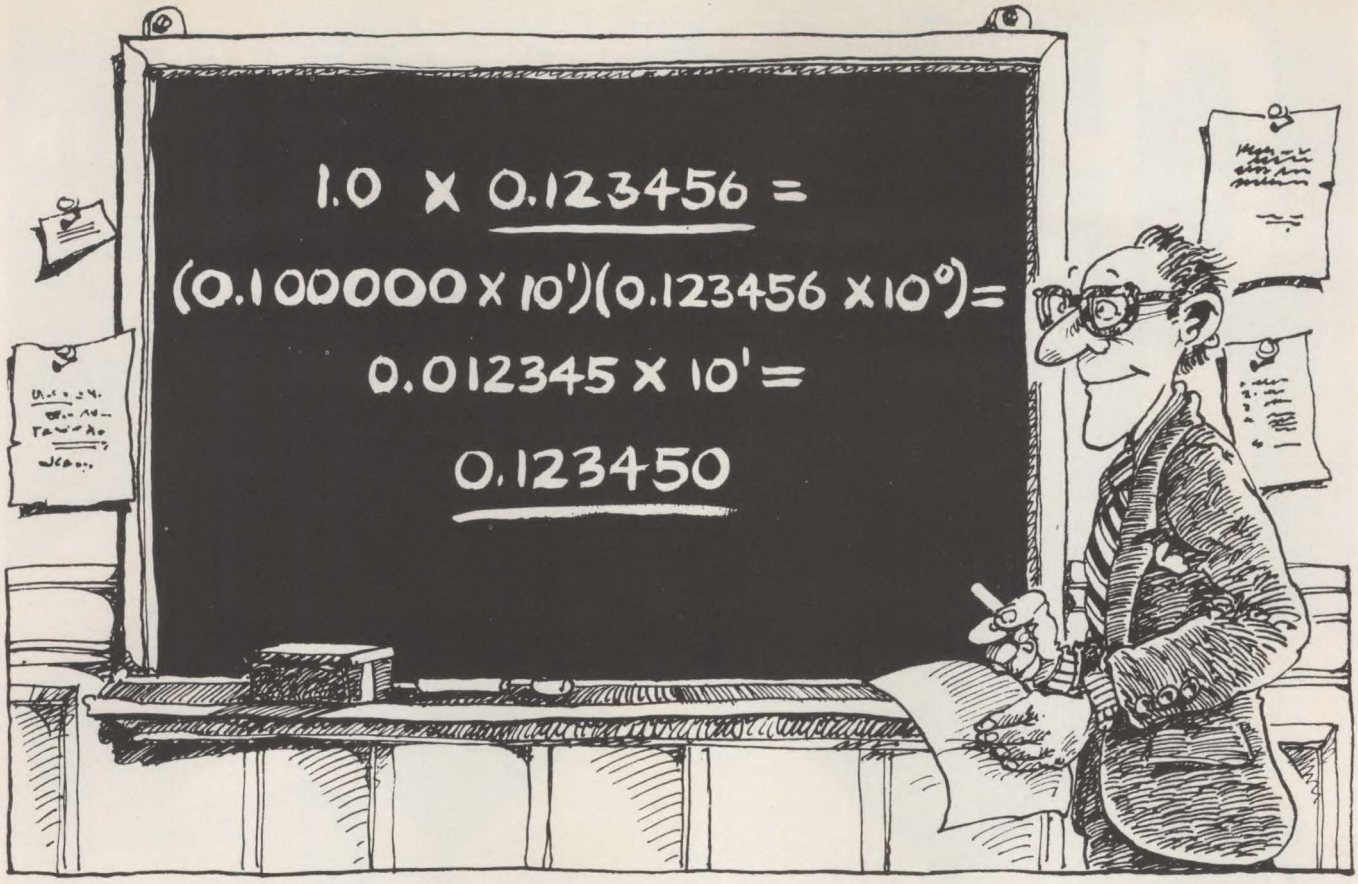

SOFTWARE

Floating-point arithmetic: can it be trusted?

CHRISTOPHER J. HENRICH, Perkin-Elmer Corp.

Making this mathematical convenience reliable requires careful design

Technical and scientific applications of computers often depend on floating-point numbers to represent physical quantities. They have the advantage of being able to represent small fractions or very large numbers equally well, and they relieve the programmer of the trouble of scaling them. Some might think, however, that there is a price to be paid for this convenience—that there is something fuzzy and untrustworthy about computation in floating point.

This should not be so. Floating-point arithmetic can be accurate, and its limitations can be understood and allowed for. But there are many different kinds of floating-point arithmetic, and the differences are important.

Floating-point numbers

The domain of a floating-point arithmetic system certainly is not fuzzy. In a computer, a floating-point number is a pattern of bits, just as discrete, finite and hard-edged as an integer. The bits represent a sign, an exponent, and something that is variously called a fraction, a mantissa or a significand. (The third name, though not beautiful, is best, because it does not also mean something else similar enough to be confusing.)

Illustration: Jon C. McIntosh

One important feature about floating-point numbers: In contrast to ordinary real numbers, floating-point numbers are inherently grainy.

The sign is +1 or −1, the exponent is an integer in some range, and the significand is some fractional number. In addition, every floating-point system uses some base, usually either 2 or 16. If the base is called B, then the significand is a fraction less than 1 but not less than 1/B; its value is given by the equation

$$SF = D_1/B + D_2/B^2 + \ldots + D_N/B^N$$

where N is the number of digits in the significand and D is the value of a digit in the significand (e.g., if SF = 0.baaca, N = 5, D_1 = b and D_N = D_5 = a). If the sign is called SGN and the exponent is called EX, then the number being represented is SGN × SF × B^{EX}. In Perkin-Elmer and IBM computers, B is 16, EX is between −64 and +63, and N is 6 for single precision and 14 for double precision.

These equations reveal some important features of floating-point systems. Whereas ordinary real numbers are perfectly continuous, floating-point numbers are inherently grainy. The smallest step between two floating-point numbers with exponent EX is B^{EX}/B^N, or B^{ex-n}. This step size is the system's "granularity," and an error or difference of a certain multiple of this size can be described as being so many granules. (Some say "bits" instead of "granules," leaving themselves open to serious misunderstanding. An error of 24 granules in a single-precision number would be tolerably small—about 12 parts in a million—but an error of 24 bits would imply that the whole significand were doubtful and the number totally useless.)

An error measured in granules is not quite the same as a relative error, because the granularity of a floating-point representation remains constant over an entire interval on which the exponent does not change. When the exponent changes, the granularity also changes—abruptly. For instance, suppose B = 16 and N = 6. For a number just greater than 1.0/16.0, the granularity is $1/16^6$, or approximately 0.6E-07 (0.6×10^{-7}) in decimal notation; the relative error corresponding to one granule is about 1.0E-06. Let the number

```
                D D D D D D (r, r)
                1 0 0 0 0 0 (0, 0)
             (−)0 0 0 6 6 6 (0, 1)
      Add
                0 F F 9 9 9 (1, 1)
Round up
                0 F F 9 9 A
 Which is
                EX = 1, SF = 0.0FF99A
  Realign
                EX = 0, SF = 0.FF99A0
```

Fig. 1. Addition of two numbers *in base 16, using two rounding bits.*

```
                D D D D D D G (r, r)
                1 0 0 0 0 0 0 (0, 0)
             (−)0 0 0 6 6 6 7 (0, 1)
      Add
                0 F F 9 9 9 8 (1, 1)
Round up
                0 F F 9 9 9 9
 Which is
                EX = 1, SF = 0.0FF9999
  Realign
                EX = 0, SF = 0.FF9999
```

Fig. 2. Another solution *to the problem introduced in Fig. 1, but this time using a guard digit as well as two rounding bits. The guard digit significantly improves the accuracy of the result.*

grow to be near, but less than, 1.0, and the granularity remains the same, but the relative error decreases to 0.6E-07. Let the number become larger than 1.0, and suddenly both the granularity and the relative error become 16 times larger. The moral is that if you have base-16 floating-point arithmetic and are willing to take the trouble, it may be worthwhile to scale numbers to be just less than 1.0 rather than just greater.

Another characteristic of floating-point systems is that zero is a very exceptional number. For numbers other than zero, the significand must be normalized so that the leading digit is not zero. If EMIN is the minimum value of the exponent, then the smallest nonzero floating-point number is B^{EMIN-1}. Just above that threshold, the granularity is B^{EMIN-N}; between it and zero there is a gap. In practice, however, a gap of B^{EMIN-1} is usually too small to be bothersome.

Arithmetic . . .

Because every floating-point number is an exactly known rational number, there is always an unambiguously correct result for any floating-point arithmetic operation. Unfortunately, it usually is not exactly one of the numbers that the floating-point system can represent. If it is out of range (i.e., too large or too small), it is an overflow or underflow. Overflow is usually an arithmetic fault, signifying that a computation has gone astray; underflow is quietly replaced by zero. But for most operations, the result is in the gap between two representable numbers. What distinguishes high- from medium-quality arithmetics is how they handle that problem.

. . . And good arithmetic

If in all cases we know the endpoints of the gap in which the true result lies, our arithmetic should return one endpoint or the other in place of the value it cannot express. Of all the ways of choosing, the crudest is just to pick the smaller number. This policy is called truncation, or chopping, because it resembles taking a longer, more accurate result and chopping off the low-order bits. Its great drawback is that the average error is half a granule, always in the same direction.

R-STAR rounding is not the end to all difficulties with floating-point arithmetic. To ensure that every addition or subtraction gets a correct R-STAR rounding, it is sufficient to use one guard digit, one ordinary rounding bit, one sticky bit.

Another easy way out is to choose the endpoint for which the lowest digit is odd. Called jamming, this method puts a "1" in the lowest bit position whether a "1" was there already or not. Jamming is less biased than chopping, because there is equal probability of the error being positive or negative, but the absolute value of the error still averages half a granule.

To get closer results, it is necessary to know where in the gap the true result falls, enabling the system to choose the closer of the two representable values. This policy is called rounding. At first glance, it has the advantage of jamming, in that it is not biased in either direction, and the absolute value of the error averages only a quarter granule. Although this improvement seems worth the extra effort, rounding can be inferior to chopping in some cases. Rounding does choose the representable number that is closer to the true result, but if the true result is exactly halfway between the two endpoints, rounding is biased toward the larger number.

Rounding can be cured of its bias by means of a technique similar to jamming. When a true result is midway between two representable numbers, the system picks the larger number or the smaller number equally often. Called R-STAR rounding, this method is implemented by setting the lowest bit of the significand to "1." R-STAR rounding is better than chopping by a factor of 2 and is usually the best arithmetic policy.

Guard digits

But R-STAR rounding is not the end to all difficulties with floating-point arithmetic. Even addition and subtraction have traps for the unwary. For example, suppose the base of the floating-point representation is 16, so that the digits are hexadecimal; they run from "0" through "9" and then from "A" through "F." To make a floating-point adder that uses R-STAR rounding, it is necessary to extend each significand by two rounding bits. (If there were only one rounding bit, R-STAR rounding would be mere jamming.) Along come two numbers to be added; the first has

SGN = +1, EX = +1, SF + 0.100000,

and the second has

SGN = −1, EX = −2, SF = 0.666755.

Before adding, the exponents must be equalized by shifting the second significand three digits downward. The 5s get shifted through the rounding bits and disappear. Of the 7, which is bit pattern "0111," the top two bits remain. Fig. 1 shows the pattern of digits and rounding bits. The rounding bits for the result are clearly more than halfway to the larger number, so the significand is rounded up to 0 F F 9 9 A, which is

EX = 1, SF = 0.0FF99A

The first digit of the significand must not be zero, so the system shifts the significand upward and reduces the exponent to compensate:

EX = 0, SF = 0.FF99A0

This is the finished result, and it is of poor quality. A digit has been lost from the end of it; it ought to be

EX = 0, SF = 0.FF9999

The damage occurred because the answer had to be realigned after subtraction, and the system failed to prepare for the realignment by keeping another full digit on hand. An extra "guard digit" is needed for each significand.

Fig. 2 shows another solution to the same problem, but this time using guard digits. The result is the one desired and certainly a great improvement. But for the very highest accuracy, there is yet more to be done.

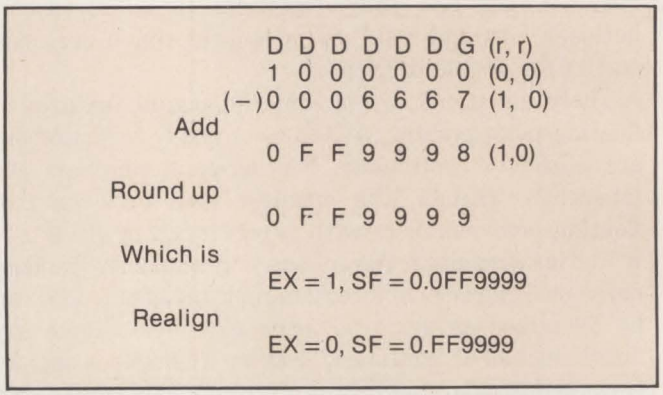

Fig. 3. This addition *gives a result midway between two representable numbers. Using R-STAR rounding, the system rounds up, which turns out to be the wrong way. Making the second rounding digit "sticky" would make the system round correctly in such cases.*

Suppose the numbers to be added are these:

SGN = +1, EX = 1, SF = 0.100000

and SGN = −1, EX = −2, SF = 0.6667BF

Fig. 3 shows the addition. The remaining question is whether to round up or down. The two rounding bits say that the result is midway between two representable numbers. Following the R-STAR rounding policy, the system puts a "1" in the lowest bit of the significand, which, after realignment, yields

EX = 0, SF = 0.FF9999

After all that trouble, the system still rounded the wrong way. If it had carried along an arbitrary number of digits, it would have found 0.FF999841, and the best rounding would have been 0.FF9998.

The error occurred when the smaller number's significand was shifted downward. The last two digits, which were "BF," disappeared altogether except for the two highest bits in the "B." The system should have somehow remembered the rest of these digits. One easy and effective way to achieve that is to make the second rounding bit "sticky." During a shift, it becomes "1" when a "1" is shifted into it, and it stays "1" from then on. If the last bit had been sticky, the example in Fig. 3 would have been rounded correctly. In fact, to ensure

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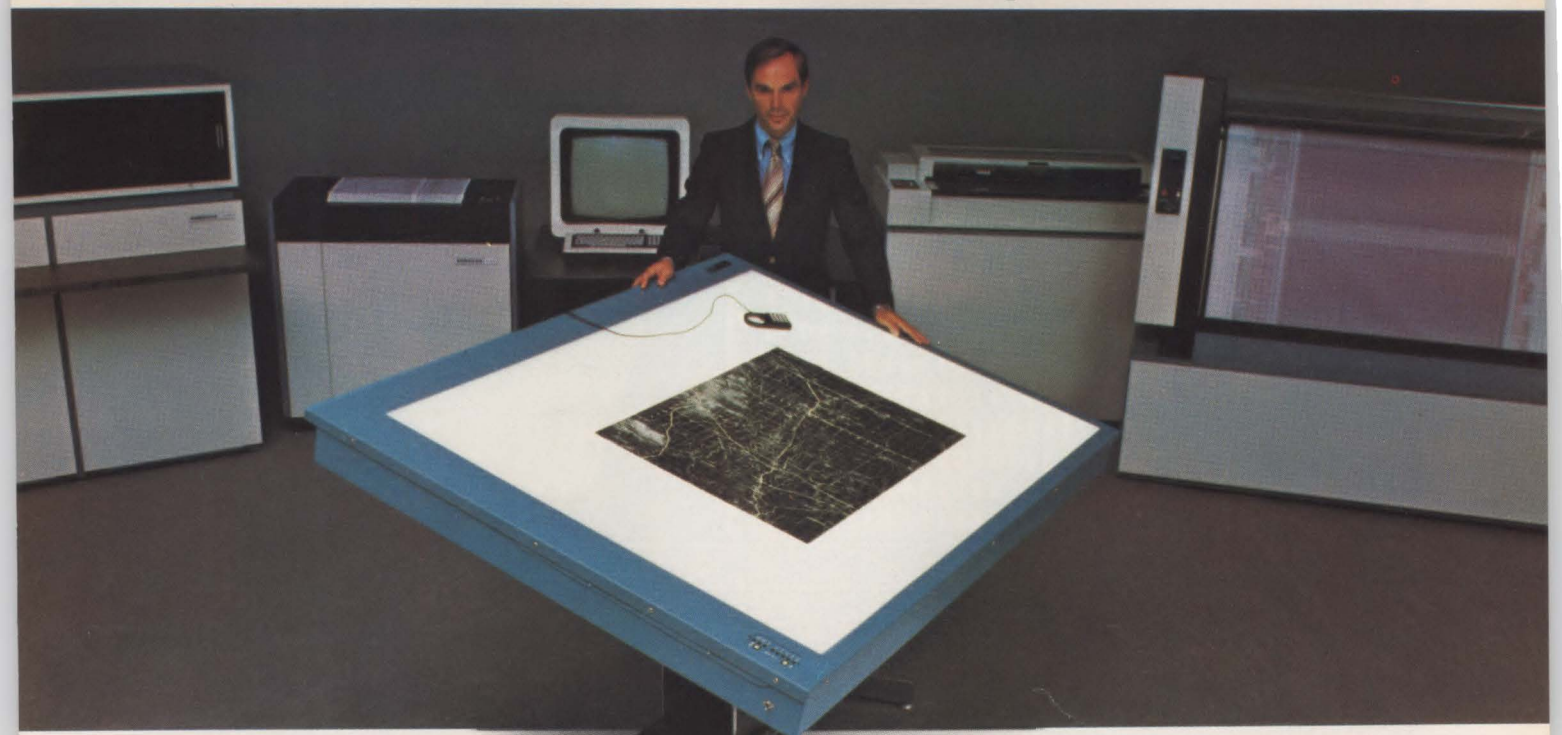

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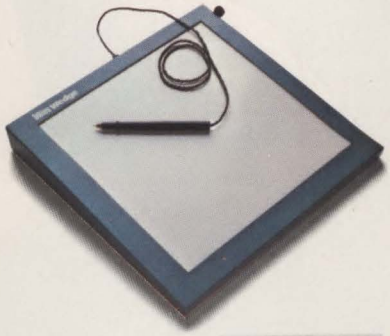

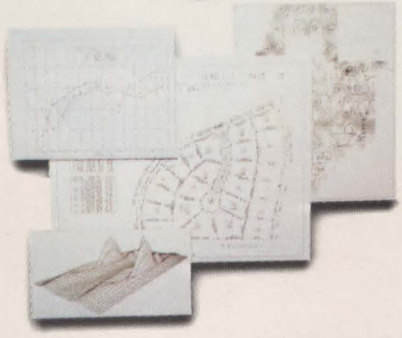

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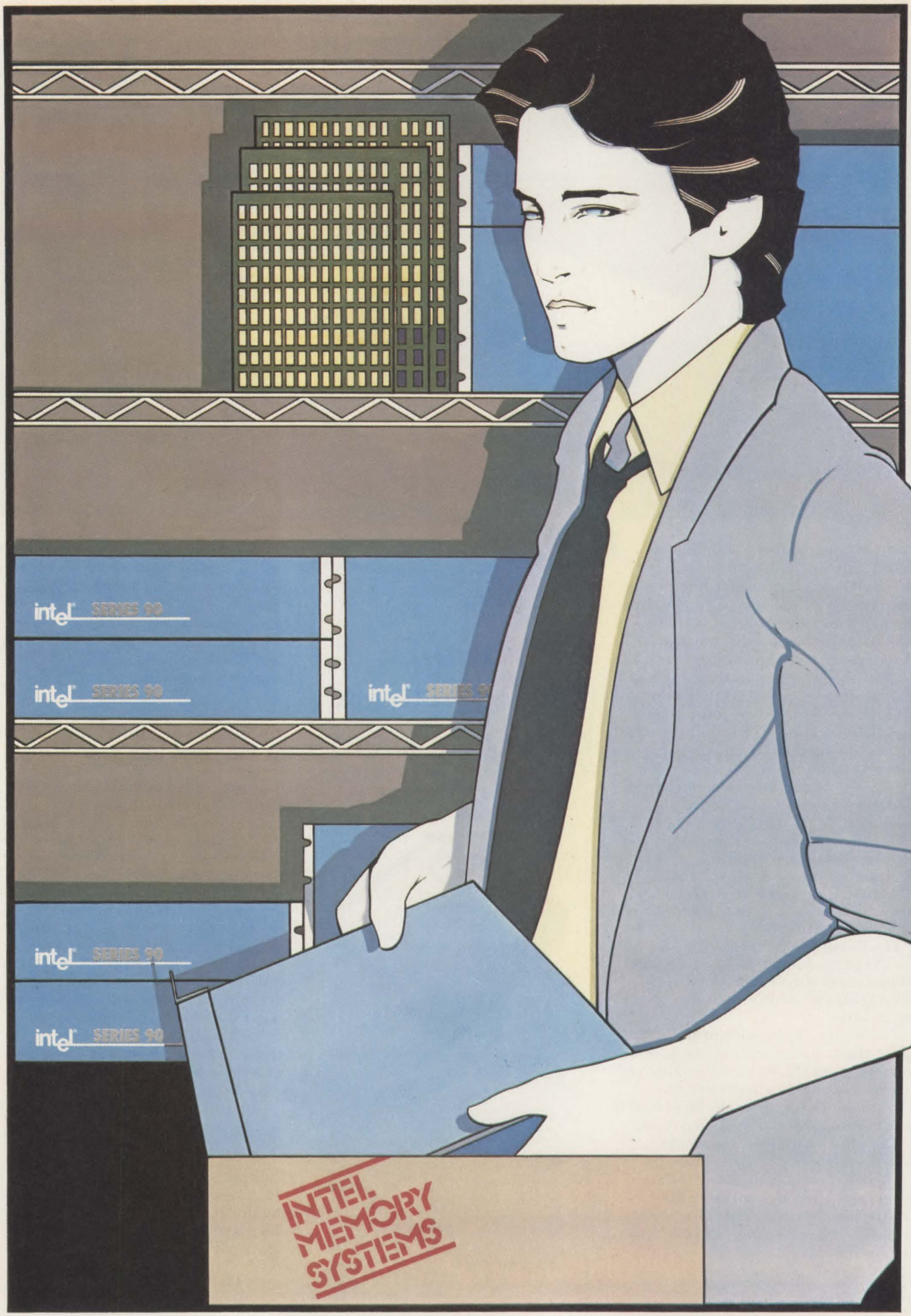
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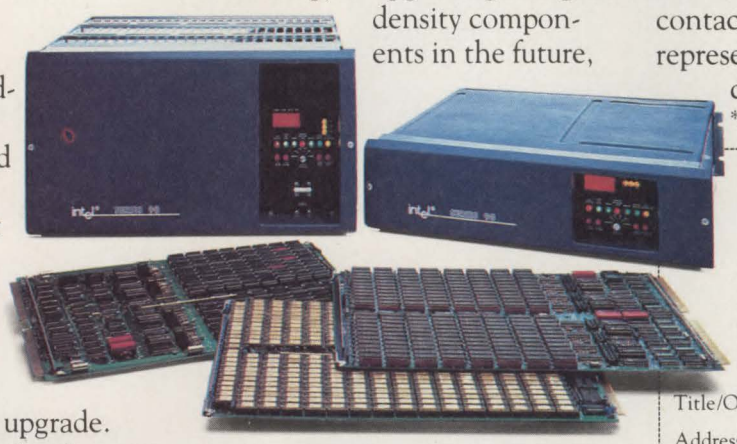

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If an adder without a guard digit is not very good, a multiplier without a guard digit is downright bad. It has the alarming property that A × 1.0 is slightly different from A.

that every addition or subtraction gets a correct R-STAR rounding, it is sufficient to use one guard digit, one ordinary rounding bit and one sticky bit.

Happily, the problems of accuracy in multiplication and division are not very tricky, once we get this far. The product of two N-digit significands has 2^n digits. The significant digits for the result are either the first through the Nth or the second through the (N + 1)st. The system must keep the (N + 1)st as a guard digit until the algorithm knows whether it will be needed. If an adder without a guard digit is not very good, a multiplier without a guard digit is downright bad. It has the alarming property that A × 1.0 is slightly different from A. For rounding, a bit below the guard digit is necessary, and for perfect R-STAR rounding, a second bit, which should be sticky, is both necessary and sufficient.

Division is the most difficult of the four basic operations, but the difference between a barely usable algorithm and an excellent one is comparatively small. The most common algorithms boil down to repeated shifts and subtractions. At the end, the remainder is available for inspection. Rather than compute a rounding bit, the algorithm can multiply the remainder by 2 (a shift will do it) and compare the result with the divisor. If the first number is smaller, the system rounds down. If it is larger, the system rounds up. And if the two are equal, then R-STAR rounding says to set the lowest bit of the quotient to 1.

The ideal of trustworthy floating-point arithmetic might have seemed an infinitely receding goal, or at best one that demanded unreasonable luxuries of implementation—quadruple-precision internal registers, for example. It is a relief to discover how little, comparatively, is sufficient. If the base is two, three extra bits are needed; if it is 16, six are needed. Either way, one of the bits is peculiar, for the purposes of shift operations, in a way that is not hard to understand and implement. Some prefer chopping to rounding, because they know in advance which way the errors will lean. But whichever is used, a guard digit is important, especially in base 16. ■

Christopher J. Henrich is with Perkin-Elmer Corp.'s Computer Systems Division, where he works on the development of systems software, including mathematical functions, real-arithmetic architecture and high-level language compilers.

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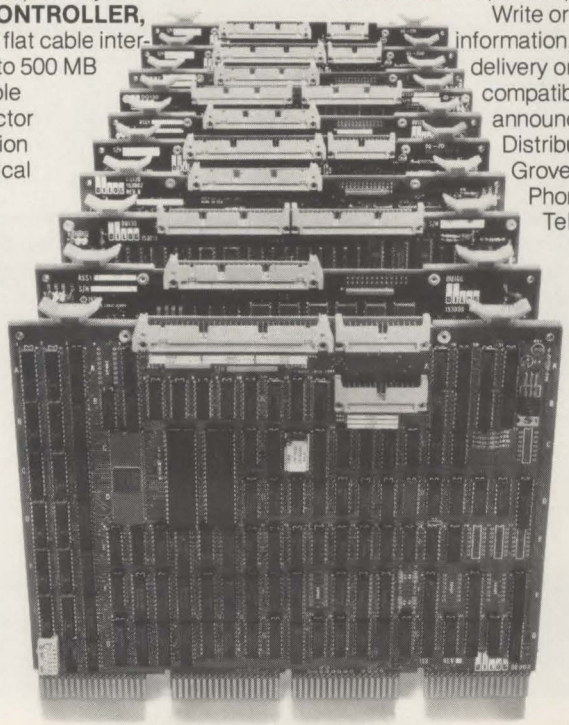

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Applying automatic speech-recognition to data entry

MICHAEL ROTHBERG, Chase Manhattan Bank

This emerging technology can make data entry faster and more accurate

Over the last decade, automatic speech-recognition (ASR) has emerged from the laboratory to become a promising and useful data-entry technology. Speech recognition's key advantage over traditional methods, such as keyboard entry, is its directness (Fig. 1). A user no longer has to learn to operate a terminal—only to speak so that a computer can understand. By eliminating the need for eye-to-hand coordination, ASR frees the operator to concentrate on his primary task. Training time goes down, while productivity goes up. And entry errors such as transposition of digits, which are caused by eye movement or other distractions, almost disappear.

Most speech-recognition terminals have several functional modules (Fig. 2). The heart of the terminal is an acoustic-pattern classifier that transforms user utterances into digital code. The classifier itself consists of a spectrum analyzer, an analog multiplexor and A/D converter, a programmed digital processor, a reference-pattern retention facility and an output interface. The spectrum analyzer divides speech signals from input microphones into 16 frequency bands. The coding compressor compensates for changes in rate of articulation (time alignment) and reduces the spectral data generated by each utterance to a fixed-length bit string. Because of technological limitations, most

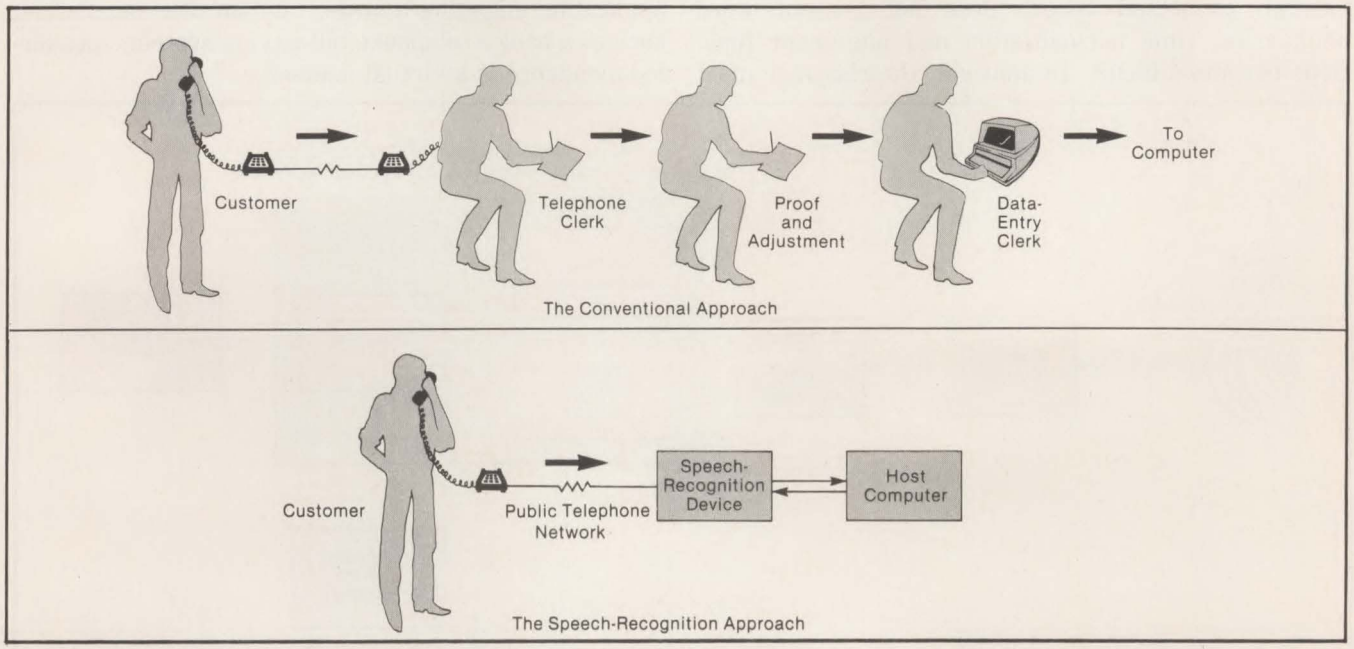

Fig. 1. The benefits of automatic speech-recognition *for data entry include reduced costs (labor displacement), improved accuracy (no intermediate human errors) and higher speed (immediate and timely data capture).*

Most commercial speech-recognition systems are discrete-word recognizers.

available systems are isolated, or discrete, word recognizers, which detect word boundaries by "listening" for a minimum period of silence between utterances. After establishing this word-boundary gap, the classifier compares the digitally represented utterances to previously captured reference patterns from a speaker or group of speakers. The resulting "best match" is taken as recognition of the utterance.

Discrete-word and connected-speech systems

The principal drawback of discrete-word recognizers is the slightly unnatural speaking style required of the user. Depending upon the specific piece of equipment and the proficiency of the speaker, the necessary word-boundary pause ranges from 25 to 200 msec. An experienced speaker can speak two to three utterances per sec. with 25-msec. gaps, provided the utterances are short and preferably monosyllabic, but it is unlikely that anyone can sustain that rate over a long period. Furthermore, with a 25-msec. gap, misclassifications and rejects will probably occur because of the natural gap created by the closure of stop consonants in some polysyllabic and multiple-word utterances. With a longer gap (more than 100 msec.), proficient speakers develop a punctuated, staccato manner of addressing the machine, which, although somewhat artificial, yields data-entry speeds competitive with those of more conventional methods.

Much research is under way on connected-speech recognition. Connected speech is a continuous stream of acoustic signals, segments of which must be recognized and syntactically evaluated within the stream to facilitate complete recognition. Because natural, connected speech does not present word boundaries, time normalization and alignment functions become difficult. In addition, the classifier must use the system's own request for data to predict the most likely next word in the user's response based on its recognition of the preceding segment.

As a result, the processing power required to decipher connected speech is very expensive. In some laboratory systems, the recognition process can take as much as 200 times as long as the utterance itself—i.e., it may take 100 min. to decode a 30-sec. utterance. Commercial connected-speech devices are available, but they have serious price and performance limitations. Significant advances will be necessary for connected speech to become a competitive data-entry alternative.

Speaker-independent systems

Most speech-recognition systems use reference patterns specific to a particular speaker. Speaker-independent systems base their classification techniques on the principle that there are common denominators in the acoustic signals produced by most people making the same utterance. The support for this theory is that if several hundred people in an auditorium all say "one" in unison, a listener in the front of the room will understand the blended voices to be saying "one."

In a speaker-independent system, reference patterns would be gathered reflecting a wide variety of ethnic and regional voice characteristics. In use, the system might employ a form of adaptive training, which would update the general patterns with samples from the current speaker as recognition of his utterances was confirmed. This would yield increasing recognition accuracy over the course of a conversation. At the end of the session, the general patterns would be restored for the next speaker.

The need for a speaker-independent system usually arises when the operators are occasional users whose identities do not have to be validated. For any application engaging a large, random user population, such as a bank's telephone bill-paying system, speaker-independence is a virtual necessity.

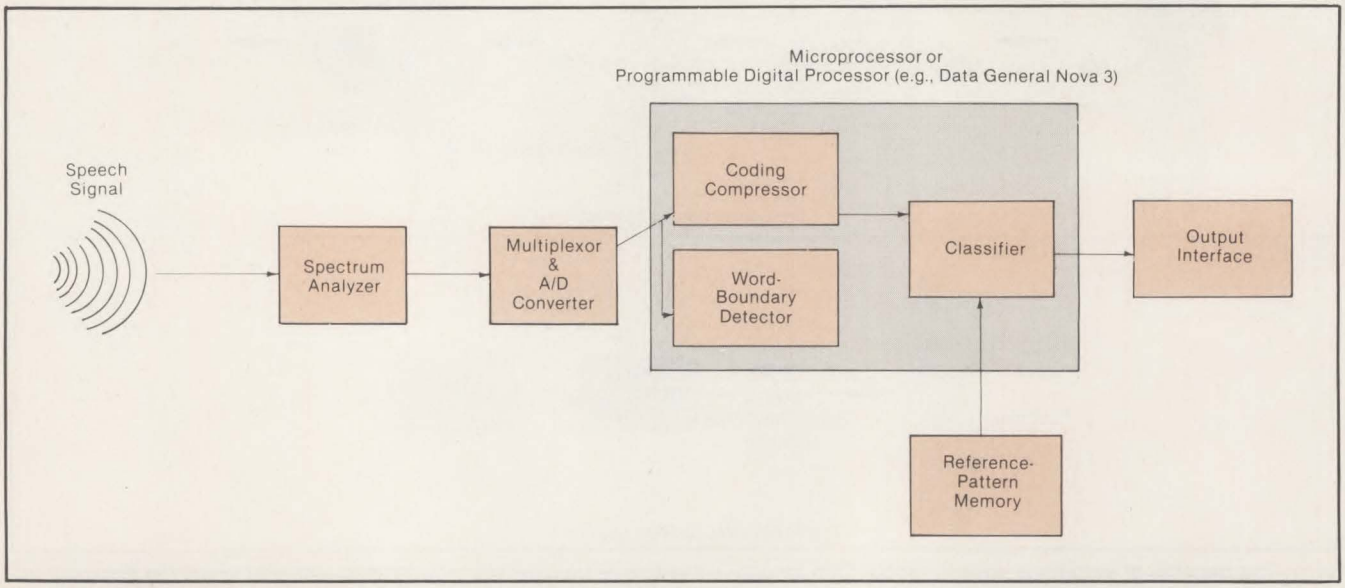

Fig. 2. Basic functional components *of a speech-recognition device.*

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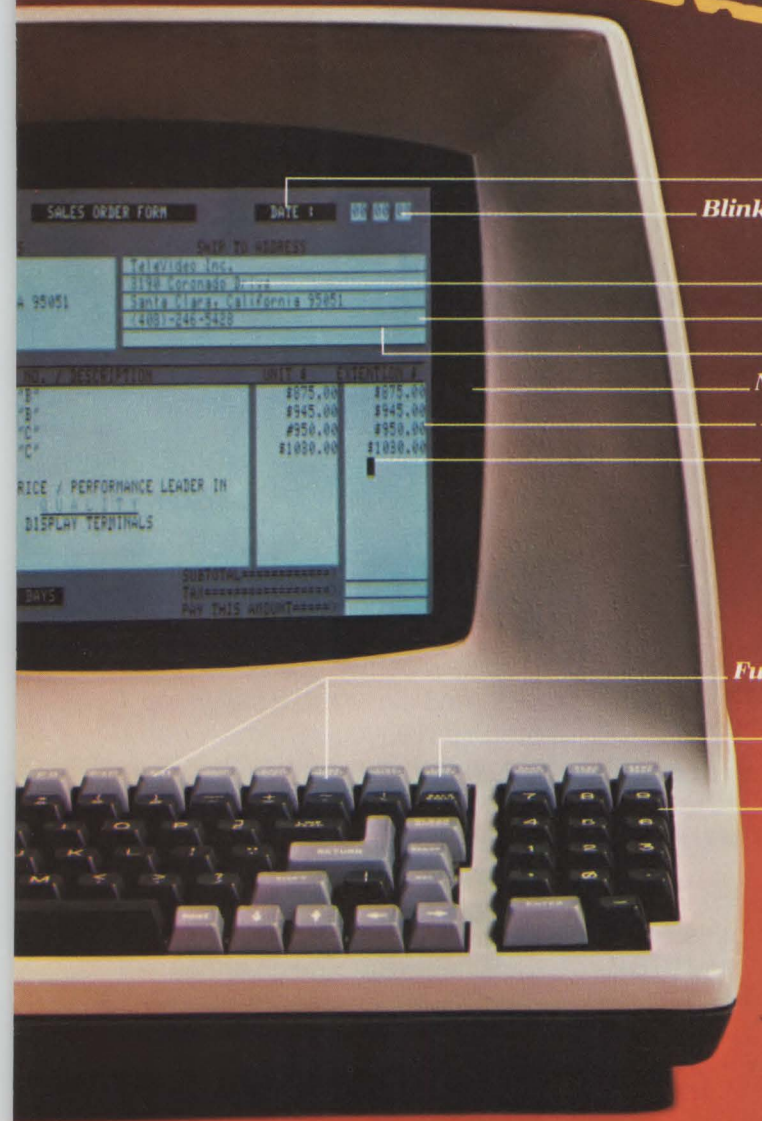

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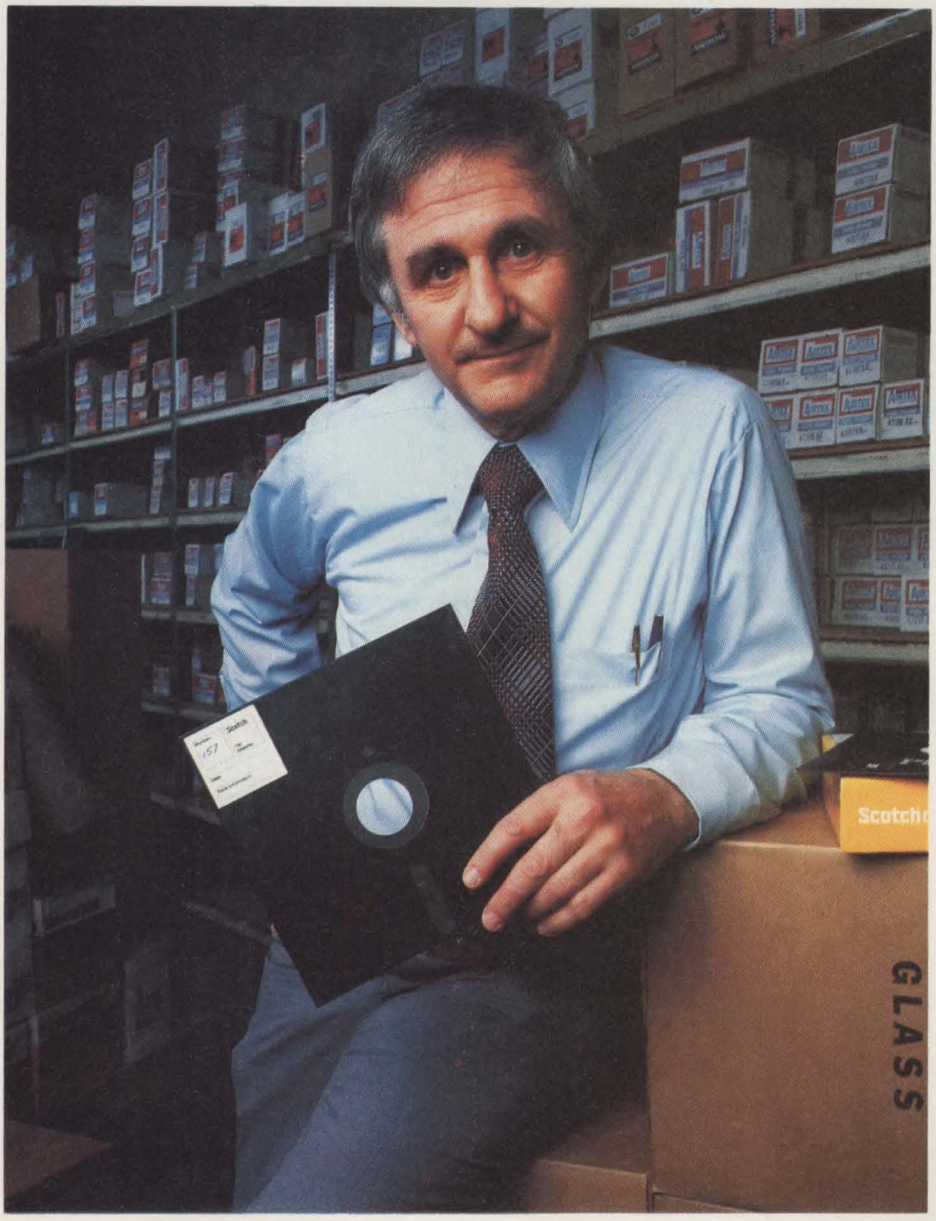

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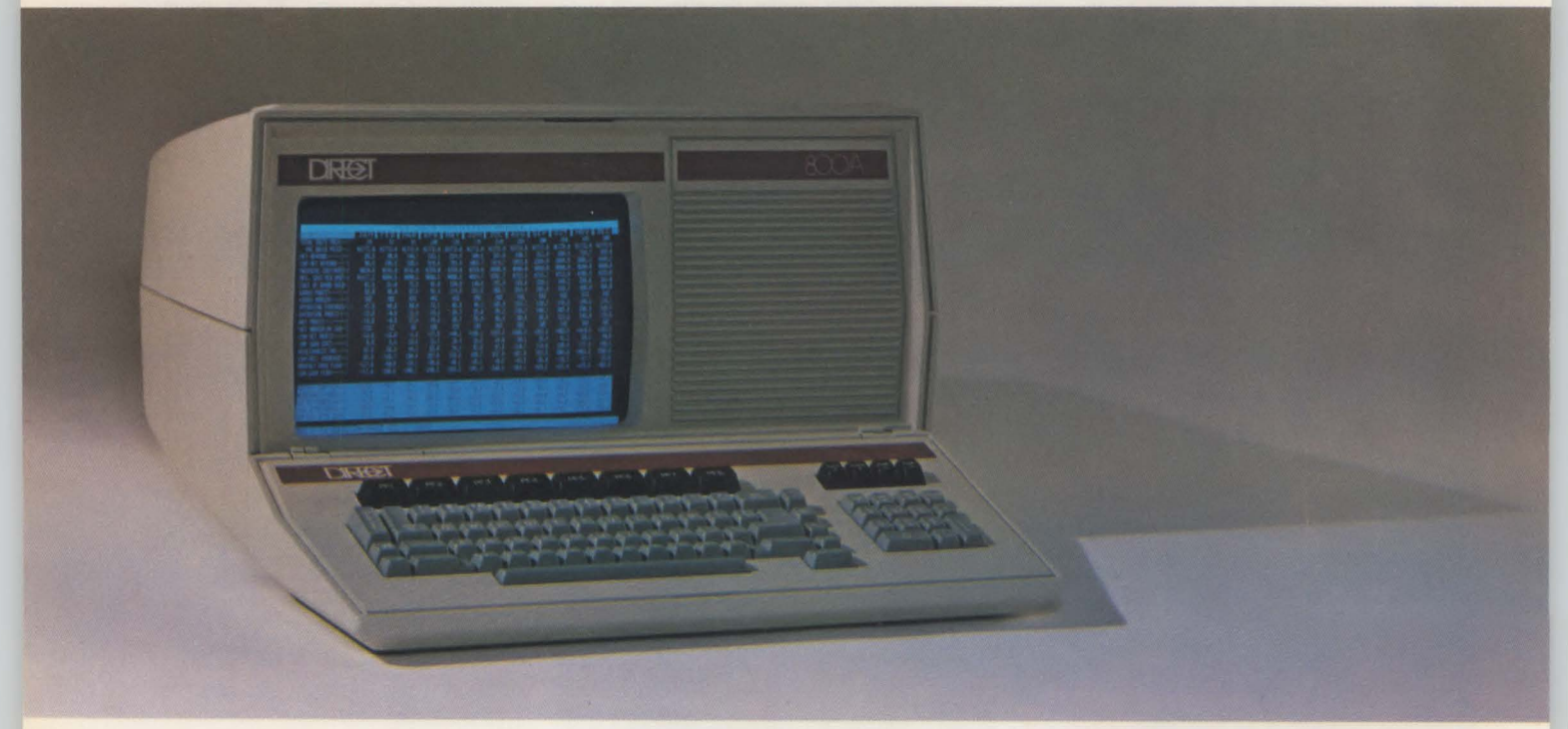

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CIRCLE NO. 82 ON INQUIRY CARD

Speaker-independent systems base their classification techniques on the notion that there are common denominators in the acoustic signal produced by most people making the same utterance.

As with connected-speech devices, the development of effective speaker-independent systems is a subject of continuing research, but the majority of available systems are discrete-word and speaker-dependent.

The most important factor affecting the success of a speech-recognition system is recognition performance. If it frequently rejects or misclassifies utterances, the resulting burden on the operator will cause hostility, impatience and tension in his voice, which will further degrade recognition accuracy. A minimum recognition accuracy of 98 percent is required to maintain adequate operator satisfaction.

An important aspect of the customization of a speech-recognition system is the choice of vocabulary, which should be natural for the speaker in the context of the task. Codification should be avoided in favor of natural language unless the number of variables involved makes it necessary. For example, a transaction name might be used instead of a transaction code, leaving the computer to translate.

The vocabulary should also be sufficiently flexible and should include commands for verification of entered data, for correction of errors and for instructions to the computer to repeat a prompt or verification. In case of interruptions or distractions, there should be a voice command to deactivate the recognition process until a reactivation command is given.

The system can also be programmed to identify utterances that are logically correct in response to a given prompt. For example, the words "oh" (alternative zero) and "no" might sound very much alike to a speech-recognition device, but is unlikely that both would be logically correct responses to the same data request. "Oh" would be accepted only where a digit was expected, while "no" would be accepted only in response to a binary question. This method, called syntax partitioning, can also be effective for data validation, in that the recognition and correlation process can be restricted to reference patterns associated with a valid response.

One of the products of the correlation process is a correlation, or recognition, score, which indicates how well the input utterance matches the reference patterns. The system recognizes the utterance as the reference pattern that gives the highest score.

The system can also be programmed to accept a minimum score, known as the recognition threshold. If the recognition threshold is set high enough, it is unlikely that misclassification will occur. However, this will inveriably cause false rejects where the system claims the utterance does not adequately match any of the allowable reference patterns. Normal variations in an individual's voice must be considered in determining the threshold if rejects are to be minimized. Conversely, if the threshold is set too low, unintentional noise, coughs and other distractions could result in misclassifi-

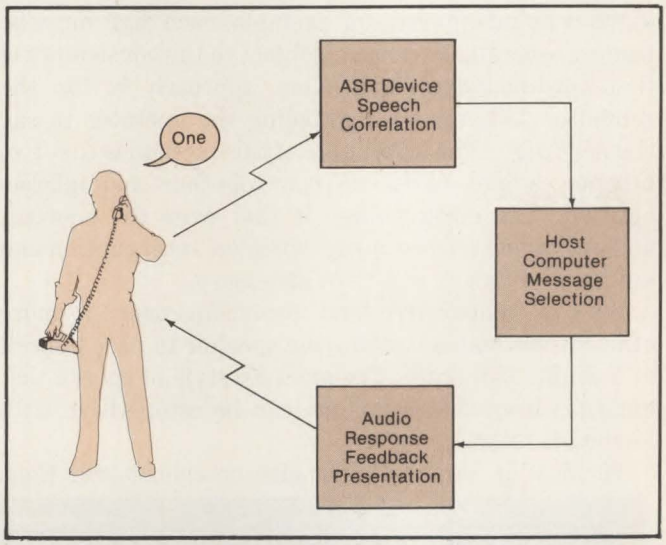

Fig. 3. The response-time loop *starts at the end of the user's spoken entry and ends at the beginning of the system's feedback presentation.*

IS SPEECH-RECOGNITION THE RIGHT SOLUTION?

There are many operator functions and application characteristics that can be used as criteria for determining whether automatic speech recognition is the correct solution for a given data-entry problem. If some of the following are true, you probably have a good candidate:

- You have a computer-based reporting system.
- Your data-entry protocol can be structured.
- Your user population is of a limited or defined size.
- A reasonably sized vocabulary can be used for data entry.
- You want to capture data at its source.
- The operator is in a "hands- or eyes-busy" situation.
- The operator must move around during data entry.
- You want to avoid mental encoding.
- You want to access your computer by phone.

If the data entry system is telephone-based, Touch-Tone keyboard entry may be a workable alternative, but it has the following drawbacks:

- Touch-Tone phones are not universally available. Only 36 percent of the installed telephones in the U.S. are Touch-Tone, and in some cities the percentage is lower. Touch-Tone mouthpiece adaptors are available for $15 to $100, but they are cumbersome.
- Touch-Tone requires condification of data, and so precludes the use of natural language.
- Eye-to-hand coordination is necessary, increasing the probability of entry error.

Speech recognition is not a panacea, but at its current state of development, it warrants evaluation. Most vendors of speech equipment will assist in evaluating and developing the vocabulary and population constraints for an application.

The most important factor affecting the success of any speech-recognition system is recognition performance.

cations. The threshold is also an important consideration in speaker identification. The higher the setting, the greater the number of rejects. In a speaker-identification process, however, this may be desirable.

In an interactive data-entry environment, speed is a critical factor in operator acceptance. The speed at which an operator can enter data depends mostly on proficiency and the application protocol, and there are some situations in which speech recognition will not be competitive with key data entry. However, if specially designed source documents and data preparation and transcription procedures can be eliminated, speech can be significantly more efficient. Also, operator accuracy is usually much better, so that the research and adjustment activities associated with error detection and correction can be almost eliminated.

Accuracy aside, there are several entry techniques that can substantially affect speed. When a string of digits is being entered, for example, each digit must be made a separate utternace, subject to the constraints of the word-boundary gap. One approach is for the computer to beep, thus signaling the operator to say the next digit. The advantage of this method is that two utterances will never be run together and misrecognized. The disadvantage is that even the shortest audible signal creates a psychological interruption and will force a longer gap than necessary.

With a cooperative and proficient user, a more efficient method is to allow the speaker to pace himself at a comfortable rate. The staccato style of speech that emerges from this technique can be competitive with keyboard rates.

Verification protocol must also be considered. Each utterance can be confirmed before the next is spoken. This procedure is relatively slow, but affords the advantage of forcing a word-boundary gap. Verification by string or field is much faster and can also be used with natural translation functions. For example, a speaker says, "2-2-6," in response to a date prompt, and the system replies, "February 26."

The other factor that influences data-entry speed is response time, which is the delay between the end of a spoken utterance and the operator's perception of the start of feedback. This can be called the response-time loop (Fig. 3). If the operator perceives a delay, his satisfaction with the system will be low. A response time greater than 400 msec. is easily perceptible and should be avoided.

Response time is the sum of the word-boundary gap length, the correlation (pattern-matching) time, the verification-message selection time and the communication time required to cause the feedback device to begin presentation of the message. Because the correlation time is a function of the number of reference patterns that must be compared to the input utterance, syntax partitioning can play an important role in cutting response time. The characteristics of the host computer and the process by which it selects a response are also important considerations.

Some user inquiries may require the host to retrieve data from mass storage, which could cause considerable response delays. In such cases, user anxiety can be avoided by having the system advise that it has received the request. The system should always give the speaker clear and prompt positive feedback whenever appropriate. It cannot be assumed that a user will understand vague requests or messages or wait patiently for slow responses. Depending on the application and the size and nature of the user population, feedback can be conveyed by video displays, speech-synthesis units or recorded audio response.

Vendor Location	Model No.	Vocab. Words Per Speaker	Vendor Accuracy Quotations (percent)	Basic Unit Cost	Comments
Auricle Inc. Cupertino, Calif.	AUR-1	32	97	1995	Subsidiary of Threshold Technology
Centigram Corp. Sunnyvale, Calif.	MIKE	32	97	2750	
Dialog Systems, Belmont, Mass.	1800	12	98	62,500	Subsidiary of Exxon Enterprises; Speaker Independent
Heuristics Sunnyvale, Calif.	H2000	64	95	259	
Interstate Electronics Corp., Anaheim, Calif.	VDES	to 800	99.4	22,500	Subsidiary of A-T-O
	VRM	40	99.4	1550	Single-board processor
Nippon Electric Co., Ltd. Tokyo, Japan	DP100	1000	99.3	67,000	Limited connected speech
Threshold Technology, Inc. Delran, N.J.	580	256	99	13,800	

Primary vendors *of commercial speech-recognition equipment.*

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- It conforms fully to the ANSI '74 standard, so programs are portable upwards and downwards to minis or mainframes.
- Its interactive features enable mainframe programmers to get results fast... working on inexpensive microcomputers.

Forms

The FORMS utility lets you build a screen layout online at the CRT. Then it automatically generates COBOL record descriptions for inclusion in your program.

Forms-2

A superset of FORMS, it eliminates the need to write simple data entry and inquiry programs, because the programs can be automatically generated from screen definitions.

Environment

CIS COBOL products run on the 8080 or Z80 microprocessors under the CP/M* operating system, and on the LSI-11 or PDP-11 processors under RT-11. They are distributed in a variety of disk formats and come with a utility that enables you to use any make of CRT.

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Intel has adopted CIS COBOL and offers it (as iCIS-COBOL) for their Intellec and Intellec II systems. Ideal for OEM's or private label, CIS COBOL was developed entirely by Micro Focus. Send inquiries for CIS COBOL object packs and application vendor terms to MICRO FOCUS or its licensed distributors. Distributor terms also available from MICRO FOCUS.

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Speech-recognition systems can be programmed to identify utterances that are logically correct in response to a given prompt.

The manner in which a user is enrolled on a speaker-dependent system may be one of the most important factors in its success. Occasional entry errors can be easily corrected, but poorly generated reference patterns will seriously degrade recognition performance. Most new users will never before have spoken to a computer, and some may never have been involved in any data-entry function. Consequently, there will be some initial anxiety in their voices.

It follows that the training and enrollment process must accomplish two goals: it must facilitate collection of accurate reference-pattern data, and it must enable users to become familiar with the system. By separating the enrollment process from data entry, it is possible to give a first-time user some experience talking to a machine without introducing the complexities of the application protocol. The enrollment program should be designed so that the speaker can be prompted through several passes of the vocabulary. It also may be desirable to segment the vocabulary into numeric, command or utility and application-specific utterances. On completion of these initial passes, the user could be given the option of testing the system's recognition performance. The system would prompt the user to say each word in the vocabulary and then go through its correlation process. Based on the correlation score, it would give the user an appraisal, such as: "very good," "OK" or "I may need more samples." Such a procedure will quickly acclimate the trainee to the system.

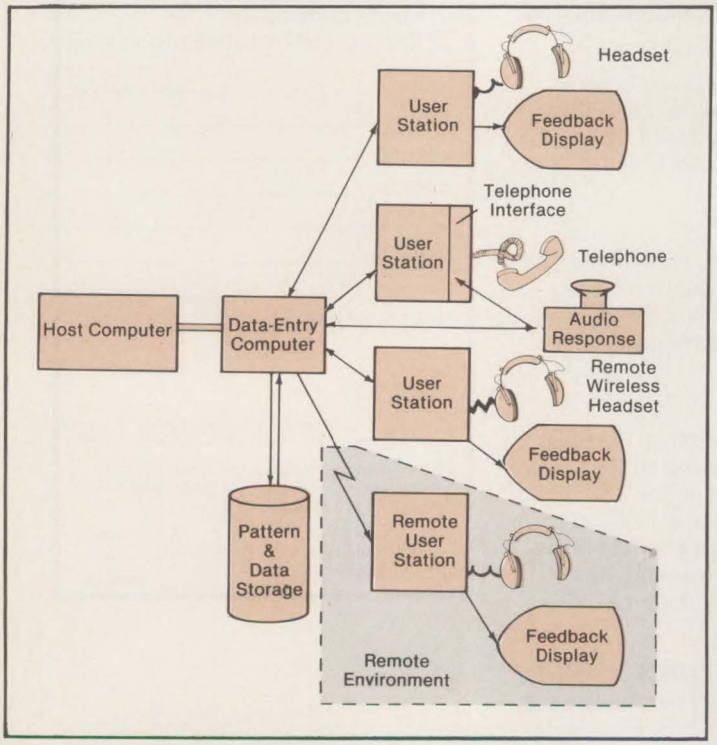


Fig. 4. Automatic speech-recognition *lends itself to a variety of configurations.*

The configuration of a speech-recognition system is strongly application-dependent, and there are many options available (Fig. 4). The primary concerns are transmission media, feedback mechanisms, reference-pattern storage and interface to the host computer.

There are essentially two data-capture options: a microphone/headset (either cabled or wireless) or a telephone. The choice will depend on the location of the users and the practicality of providing terminal equipment for each speaker. The physical environment of the speaker must also be considered when choosing microphone equipment. Several lightweight headsets with noise-canceling microphones are available for use in noisy environments, and there are adaptors that replace telephone mouthpieces to screen out unwanted background noise.

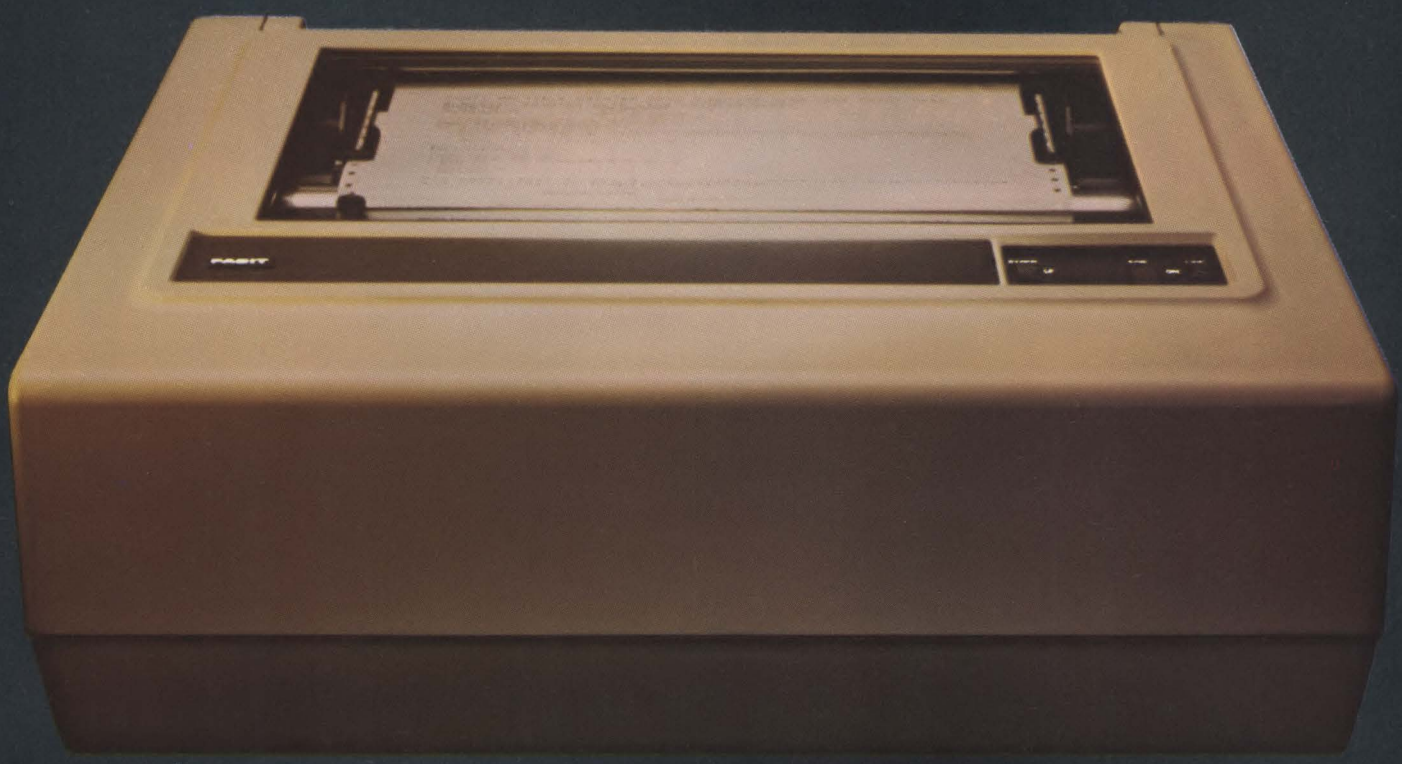
Regardless of which option is chosen, it is imperative that the user train on the system using the same device that will be used for data entry. If possible, the training environment should also approximate the conditions of the workplace. A user who trains in an office will have poor recognition results entering data from a railroad station.

Another issue that must be faced in telephone-based system is variable line quality. Noise and static on a telephone line will wreak havoc on recognition results. The speaker must be able to identify unacceptable conditions and call back if necessary.

Bandwidth is also an important consideration in selecting a transmission medium. The telephone bandwidth is relatively narrow (typically 100 to 3200 Hz) compared to that of a coaxial microphone cable. This difference can significantly affect recognition performance, so anyone planning a telephone-based system should have his vendor demonstrate telephone capabilities before buying. The most common difficulty is misclassification of the words "five" and "nine," which have very similar acoustics. In some cases, the speaker may opt to train "nine" as "niner." The addition of the second short syllable creates a more discrete sample for comparison.

The basic distinction between feedback options is whether they are audible or visual. Again, the application and user population determine the choice. In a local environment with few users, CRTs will probably be more effective. Their faster response can increase throughput and improve operator productivity. Audio response, whether synthesized or recorded, is the only feasible option for a large, remote, telephone-based configuration. ■

Michael Rothberg, now a second vice president and technology consultant at Chase Manhattan Bank, has worked in the computer industry for 18 years.



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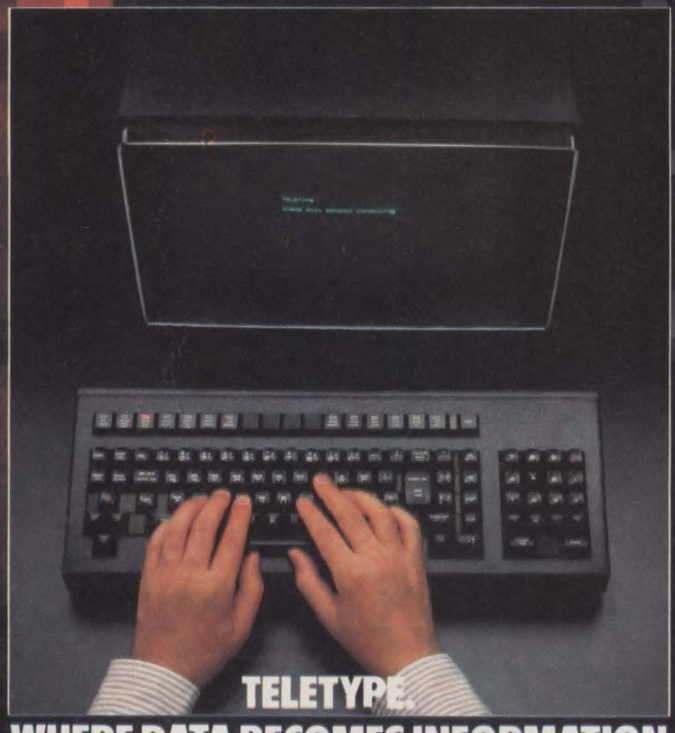

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DATA COMMUNICATIONS

Newspaper takes to the airwaves

Digital broadcasting provides low-cost tie-in for computer, 225 remote terminals

More than 800,000 subscribers take the *Los Angeles Times* with their morning coffee every day. They probably would be surprised to learn that a plastic-wrapped paper on a rainy day doesn't necessarily mean their paper boy is exceptionally considerate (or looking for a generous tip).

Instead, the plastic wrapping is there because the *Times* recently installed the Local Area Data Distribution (LADD) system, a one-way message transmitting system that carries critical information, such as missed deliveries and whether to wrap papers for rain, to circulation agents throughout the Los Angeles area.

The job of delivering the 800,000 papers on weekdays—and even more than that on Sundays—is performed by some 3000 carriers. It is usually accomplished by 6 a.m. daily and 7 on Sundays, according to Robert D. Hynes, the *Times'* telecommunications manager.

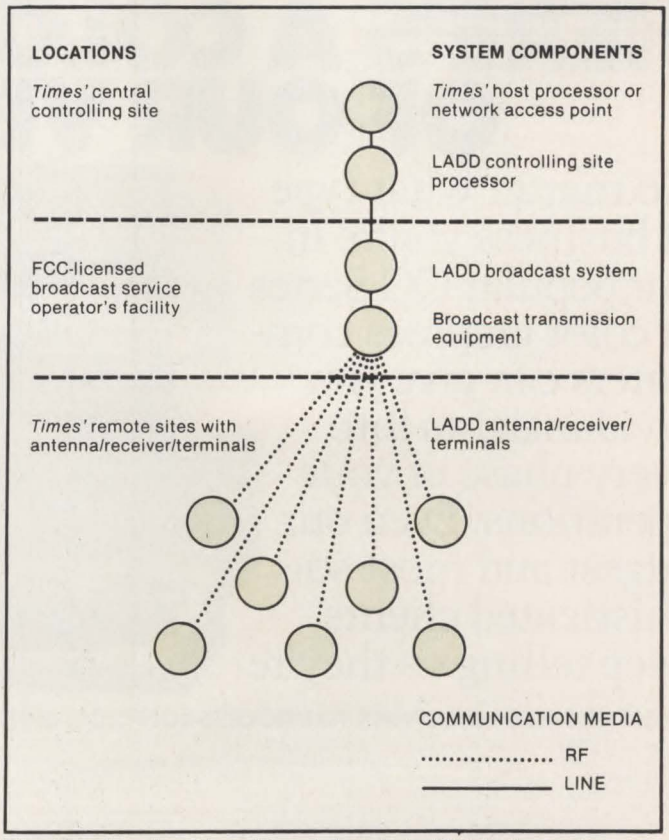
"Then the phones start to ring, because inevitably there are missed deliveries, damaged papers and an assortment of other major and minor problems," he says. "Our objective is to clear every complaint within four hours."

To help circulation agents get replacement papers out faster and more efficiently, the *Times* recently began installing LADD.

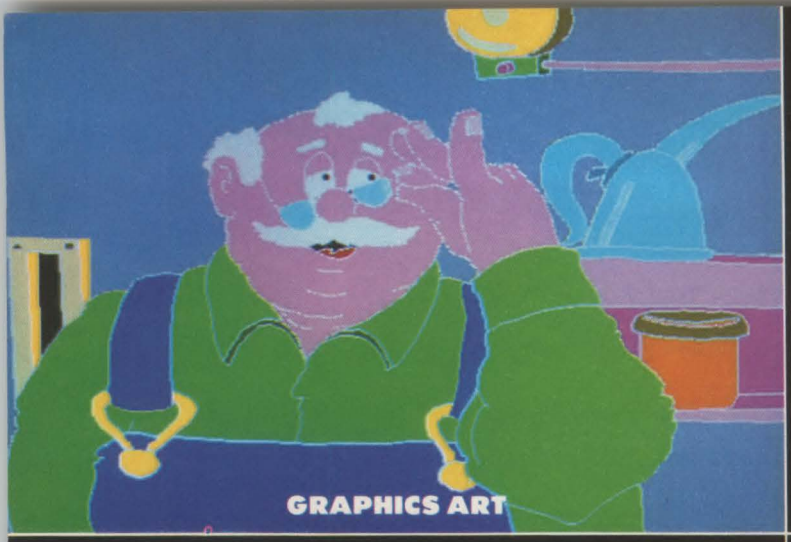
The LADD is a radio frequency data communications system designed and manufactured by Printer Terminal Communications Corp., Ramona, Calif. In developing LADD, the company combined existing broadcast radio techniques and digital modulation-demodulation to achieve digital broadcasting. The resulting low-cost, data communications system operates in voice-grade to wideband channel widths in either broadcast or point-to-point mode.

At the *Times*, the LADD system will tie the downtown subscriber service center to a network that sprawls from Santa Barbara to Mexico and from the Pacific Ocean to Palm Springs. This network of more than 225 circulation agents communicates with receiver-equipped print-only terminals at agents' distribution points.

The LADD system will be interfaced directly into the subscriber service center's central computer (an IBM 3032 mainframe), where messages are stored by agent identification codes. Polling the computer periodically, the LADD system automatically transmits customer



***The Los Angeles Times'** Local Area Data Distribution system is a computer-based radio network that speeds communications between the newspaper and 225 circulation agents.*



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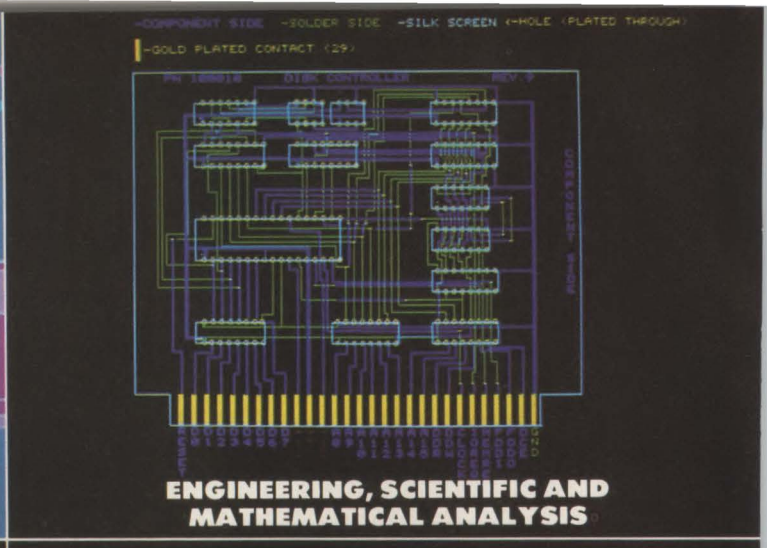
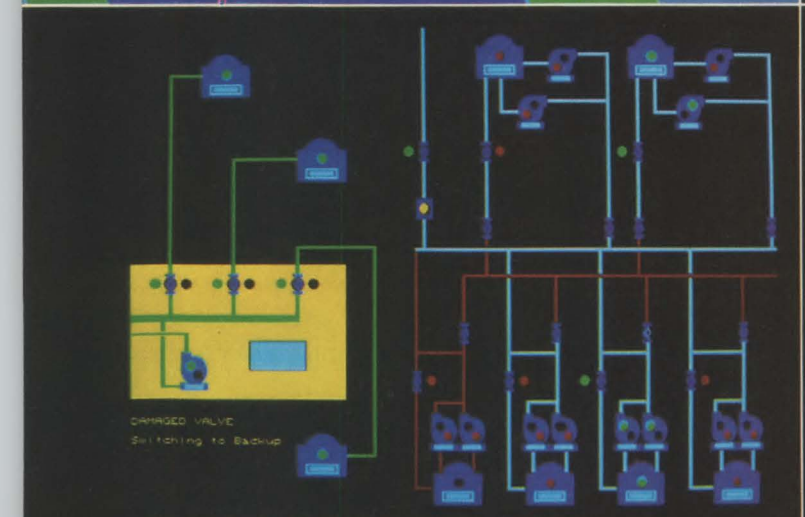
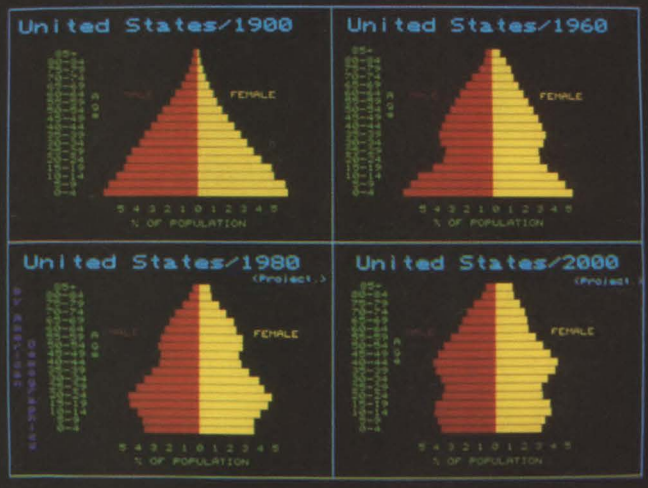


ENGINEERING, SCIENTIFIC AND MATHEMATICAL ANALYSIS



PROCESS CONTROL AND MONITORING



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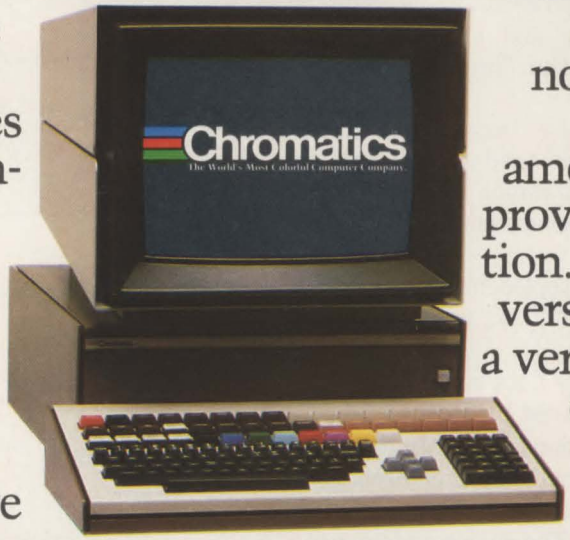

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The Times invested an estimated $400,000 in the LADD system, including all hardware and installation costs.

complaints, other time-sensitive messages and nonpriority information.

The LADD installation complements the *Times'* Circulation Home Delivery System—a computerized subscriber service operation that has been in development and implementation for nearly three years.

Messages sent over the LADD system travel from computer storage or directly from the LADD controlling terminal over leased lines to the transmitter location. There, information is stored as necessary, encoded for broadcast, assigned priority and processed for radio frequency transmission.

Special antenna/receivers at each reception point pick their specific signals out of the air; the 120-character-per-second radio printers process and format the data for printout. The system supports a transmission rate of 110 to 9600 baud.

According to Hynes, the LADD system offers many advantages over other systems that were considered for linking the circulation computer to agents in the field. These advantages include leased lines and portable mobile radio systems. "Our investigations placed the improvement of customer service in the priority spot among our selection criteria," he says. "A radio system communicating with a fixed printer terminal was rated best for the majority of our agents."

In terms of cost, outlays slightly favored the LADD system over leased lines, Hynes adds. He estimates that the *Times* invested $400,000 in the system, including all hardware and installation costs. In addition, the hardware will be the property of the Times-Mirror Co. "We prefer to be responsible for our maintenance so we can assure ourselves that it is carried on just as we want it," he says.

"Further, the nature of a radio system precludes most possibilities of an out-of-service situation, which is a risk when using leased lines. As we implement other transmitting options, including our own industrial radio service installation, our control will be even greater." Savings will also be realized in personnel costs both downtown and in the field, Hynes adds.

One-way system

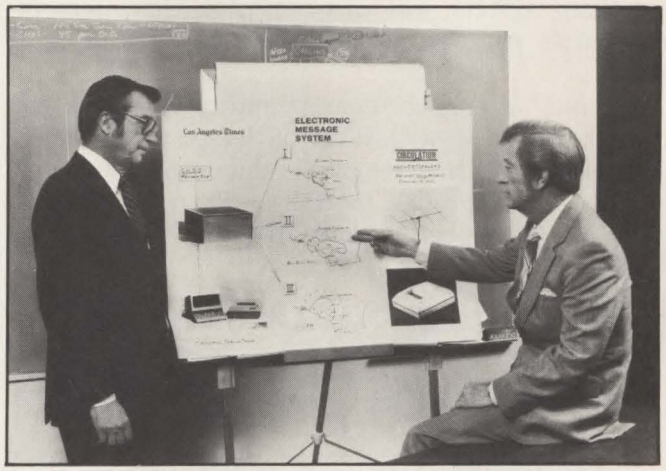
Noncritical messages take a variety of forms, and virtually all necessary communications to agents not requiring response will ultimately be dispatched via LADD, which is designed to be a one-way system. Such transmissions include stuffing notices, start-stop notices, transfers, service requests, special market coverage instructions such as samplings and test areas, and many more—previously delivered by pouch.

Critical messages include not only replacement paper notifications, but also instructions such as whether to wrap papers in plastic when it rains.

"This is a $6000 to $8000 decision, and it's made downtown," Hynes says. "With LADD, we can be highly selective on an up-to-the-minute basis, contacting agents individually in specific geographical areas with instructions unique to their locations.

"For example, we use multiple weather information resources. Because the terminals are discriminating, we are able to transmit once, with designated terminals receiving rain-wrap instructions even when most agencies are dry. The new facility makes it possible for us to notify them instantly on their radio terminals as weather information is updated."

The computerized home-delivery system hardware that supplies information for transmission over the LADD network consists of a battery of intelligent CRT terminals tied into a host IBM 3032 computer dedicated to subscriber service activities. Terminal operators receive customer calls by telephone, format their messages on the CRTs and input the information to the host computer, which can be polled automatically or given "send" instructions. Noncritical messages are input as necessary and transmitted at managers' options.



The *Times'* electronic message service is reviewed by telecommunications manager Robert Hynes, left, and David Stevens.

Until now, field agents have been phoning in for messages to the battery of subscriber service representatives downtown. With messages coming automatically, agents simply check their terminals periodically and carry out the instructions they receive.

Eliminating paperwork

"We now have more than 1,000,000 subscriber records in our delivery service data base," notes Robert L. Hernandez, assistant manager of subscriber service. "Currently our operators do many handwriting chores, filling out a dozen or more forms which go into the pouch for delivery to agents. As they are able to transfer these tasks to the electronic delivery capability of the LADD system, paperwork will diminish and productive work will increase. We'll realize better and faster distribution, and virtually foolproof accuracy.

"What we will have is immediate access to such information as the active and paid status of each

When the system is fully implemented, it will carry 750,000 characters of information a day, transmitting at a data rate of 1200 baud.

account as well as the service history record," he says. "In the past we have been at the mercy of the subscriber. If he had a complaint, we had to assume it was legitimate. Sometimes there are reasons for nondelivery, such as stopped accounts, temporary stops or Sunday-only subscribers calling on weekdays."

The new service "gives us the capability to view complaint activity on each subscriber account before notifying our delivery agents, something we could not do until now. In all cases we can be in a better position to identify field problems as they occur and immediately dispatch complaint activity where necessary using the LADD system."

Hernandez estimates that when fully implemented, the LADD system will carry 750,000 characters of information per day, transmitting at a rate of 1200 baud.

Accuracy of transmissions is anticipated to be far greater than that achievable on leased lines, which historically have an error rate in the range of 5×10^{-5} to 5×10^{-6}, according to Hynes. The error rate is expected to be significantly reduced using LADD: perhaps 10^{-8} or $^{-9}$

The *Times'* *LADD system is designed to operate automatically, but it can be activated at will from the control center, using a Hewlett-Packard 2649-A intelligent terminal.*

The reason: There is no noise intrinsic to FM as there is with switched or leased line services, explains Thomas G. Albright, vice president of Printer Terminal.

"Further, the LADD system has been designed to emphasize signal level and quality, as well as transmission range. Several factors, rather than simply power, contribute to the maintenance of high quality signals at each phase of the data communications process, and ultimately at the antenna/receiver and printer," Albright says. ■

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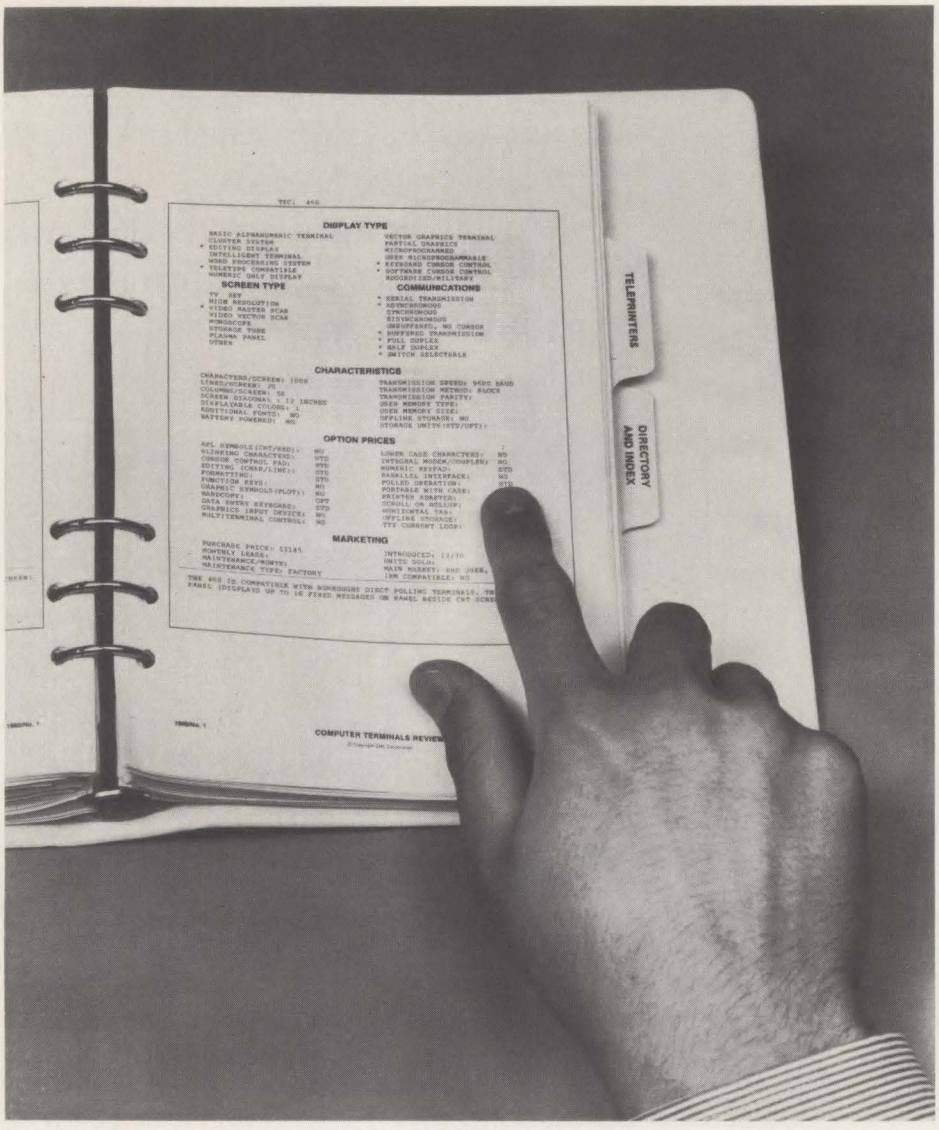

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CIRCLE NO. 90 ON INQUIRY CARD

TECHNICAL COMPUTER SYSTEM. The HP100 Performance/45 incorporates an F-Series CPU, 512K to 1.8M bytes of fault-control main memory, 19.6M to 960M bytes of disk storage, a graphics terminal, a FORTRAN 4X compiler, EDIT/1000 screen-editing software and the ACCEL/1000 program-profiler and microprogram-development package. All system configurations also include at least 256K bytes of main memory, plus one of the following: a PASCAL/1000 compiler, an IMAGE/1000 data base management package, DATACAP/1000 factory data-collection software, an RTE-IVB multi-user real-time operating system, an HPIB fiber-optic link or an L-Series CPU with distributed-intelligence architecture. Price is $64,000. **Hewlett-Packard Co.,** Palo Alto, Calif. **Circle No 201**

MICROCOMPUTER SYSTEM. The model 6300 multi-user computer system consists of as many as 128 user consoles and a service processor, which routes communications from the user processors to a shared disk data base and a system printer. Each console and the service processor includes its own Z80 CPU, 64K bytes of RAM and I/O and runs on its own CP/M 2.2 disk operating system, ensuring that response time will not deteriorate as consoles are added to the system. Communication between user and service CPUs is via a special 16-bit channel. The model 6300 comes with two 8-in. double-density floppy-disk drives, and as much as 128M bytes of optional hard-disk storage is available. Price is $5195 in single-unit quantities. **OSM Computer Corp.,** Santa Clara, Calif. **Circle No 202**

LSI-11-BASED DESK-TOP COMPUTER. Based on Digital Equipment Corp.'s LSI-11 microcomputer, the RD-11C computer system includes a dual-drive, double-sided, double-density minifloppy subsystem providing 700K bytes of storage, as much as 256K bytes of RAM, four serial I/O ports and a switching power supply in a 12½- × 8½- × 16¾-in. enclosure. A Winchester-disk drive, a magnetic-tape drive, paper-tape equipment, punched-card hardware and printers are also available. An RD-11C with 64K bytes of RAM, four serial ports and floppies costs $6950. **RDA, Inc.,** Beltsville, Md. **Circle No 203**

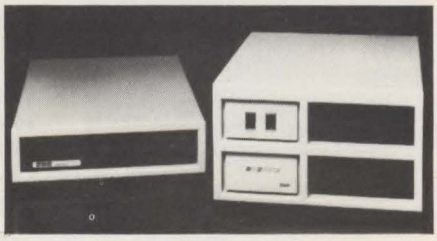
32-LANGUAGE WORD-PROCESSING SYSTEM. The ML-32 and the color CML-32 word-processing systems enable users to select via soft keys from among 32 languages and to display these languages simultaneously on a CRT. The systems, which are designed to interface with any host computer system, can perform full graphics in color or black and white. The screen displays 34 80-character lines on a high-resolution raster display, and the keyboard includes 80 programmable function keys. Telecommunications is via RS232, GPIB and IBM 3270 ports. Price is $17,500 for the ML-32, $26,000 for the CML-32. **Computer Systems Consultants, Inc.,** Chelmsford, Mass. **Circle No 204**

COMPUTER-AIDED DRAFTING SYSTEM. The COMDRAW IV two-dimensional computer-aided drafting system eliminates repetitive drawing tasks, reduces errors and provides convenient standardized formats. Users can construct circles, arcs, ellipses, splines, rectangles and polygons. Individual lines and text can be erased selectively, without waiting for the drawing to be redisplayed. Included are a minicomputer with a moving-head disk drive, a 500-line graphics video-display system, an alphanumeric video-display terminal and keyboard and a 12-× 12-in. resolution digitizer for graphics input. Price is less than $60,000, including a perpetual license for the MDSI COMDRAW IV applications software. **Manufacturing Data Systems, Inc.,** Ann Arbor, Mich. **Circle No 205**

PDP11/23 SYSTEM WITH TIMESHARING. The Q610 and Q620 systems, based on the DEC PDP11/23, include the RSTS/E time-sharing operating system, which supports concurrent, interactive and batch processing, BASIC-plus, BASIC-plus II, COBOL, FORTRAN, Pascal, APL, RPGII, PL/1, assembler and other programming languages, as many as 63 independent user jobs and connections to 127 terminals. A basic configuration includes 192K bytes of MOS memory, a four-port multiplexor, two removable-disk drives, BASIC-plus and the QDMS data-management system with report generator. The Q610 with two 5M-byte RL01 disk drives costs $33,100; the Q620 with two 10M-byte RL02 disk drives costs $36,900. **Quodata Corp.,** Hartford, Conn. **Circle No 206**

GRAPHICS SYSTEM. The WHIZZARD 7290 dual-output computer graphics system, intended for computer-aided design and manufacturing applications, combines support for both vector-refresh and color-raster displays on a single controller. Based on the WHIZZARD 7200 Graphics Engine, which comprises a host-computer interface, a graphics processor, vector memory and optional two- and three-dimensional transformation modules, the WHIZZARD 7290 can be interfaced to a variety of minicomputers and mainframes. Dual multidirectional buses are integral to the 7290's architecture, and data transfers for vector calculations and refresh are handled by a 32-bit, tri-state graphics bus. Each vector memory module contains 16K words of 32-bit RAM and can accept 2K 32-bit words of PROM. Price is approximately $35,000. **Megatek Corp.,** San Diego, Calif. **Circle No 207**

DESK-TOP PROCESSOR FOR FINANCIAL DATA. The model 7530 desk-top processor helps banks and businesses reduce the number of paper checks written and processed and reduces use of courier services required to transport magnetic tapes of financial data between businesses, banks and the Federal Reserve-operated ACH (automated clearing house) communication network. The 7530 can receive or transmit data without an operator and can be automatically dialed up by another system. The system also aids in detecting and correcting data errors and can operate as a sophisticated data-entry device, a general-purpose processor or a media-conversion system. A typical 7530 system, including processor, keyboard, CRT, cassette-tape unit, magnetic-tape drive and communications adaptor, costs approximately $16,000. **NCR Corp.,** Dayton, Ohio. **Circle No 208**



ENTRY-LEVEL BUSINESS SYSTEM. The SYSTEM 50 business system is geared to first-time computer users, or companies that have been using accounting or ledger-card billing machines. It includes a NOVA-compatible minicomputer with 64K bytes of memory; a 10M-byte removable-cartridge hard-disk drive; a 24-line CRT; and a bidirectional, 150-cps, 132-column matrix printer. The SYSTEM 50 runs all applications developed for the SYSTEM 200, 300, 400 and other IRIS-based computer systems. Available applications software includes medical/dental, a business-management system for parts distributors, CPAs and attorneys and a BOMP/MRP system for manufacturers. Price is $14,500. **Microtech Business Systems, Inc.,** Costa Mesa, Calif. **Circle No 209**

New Systems

ENTRY-LEVEL SYSTEM. The VIP (vector intelligent partner) entry-level computer system, which performs word-processing and list-management functions can be upgraded to one of the vendor's higher-level systems by adding disk capacity. The VIP includes a Vector 3 integrated video console with built-in S-100 electronics and a separately housed 315K-byte minifloppy-disk drive. As many as three more such drives can be added, or they can be replaced by a single 2M-byte diskette or 30M-byte Winchester drive. Price is $3695. **Vector Graphic, Inc.**, Westlake Village, Calif. **Circle No 210**

LSI-11/23 COMPUTER. The Disk System 11X computer system includes a DEC LSI-11/23 CPU, 128K bytes of RAM, four RS232C serial ports and as much as 2M bytes of floppy-disk storage in a single 10½-in. tabletop enclosure. Storage can be expanded by adding a 26.4M-byte 14-in. Winchester drive. Disk System 11X is compatible with the RT-11 and RSX-11M operating systems, and its dual-headed floppy drives are said to provide twice as much storage and 40 percent faster disk access compared to DEC single-headed floppy-disk drives. The system includes extensive test and diagnostic support. Prices start at $7400. **Scientific Micro Systems, Inc.**, Mountain View, Calif. **Circle No 211**

MULTIPROCESSOR. The Discovery Multiprocessor, a multi-user microcomputer system based on the S-100 bus, includes independent Z80/8080 CPUs and as much as 64K bytes of memory for each user. A service processor running the vendor's distributed-processing operating system (DPOS) manages system disks and printers and communicates with as many as 100 user processors. Users can concurrently update the same file record without encountering the problems of "interleaved update" or "fatal embrace sequences." The system is intended for business applications that require simultaneous access and update of company records by different departments. Price including a 32K-byte service processor, two 64K-byte user processors, dual floppy-disk drives and two CRT terminals is less than $12,000; a 26M-byte Winchester disk is available for $4995. **Action Computer Enterprise, Inc.**, Pasadena, Calif. **Circle No 212**

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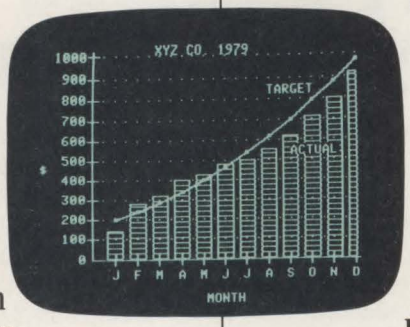

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Numeric Key Pad	Accessory	Built-in
Input/Output	8 expansion slots	4 expansion slots plus built-in: disk interface RS-232 interface Silentype™ printer interface clock/calendar
Disk Drives	Add-on one to six drives	One drive built-in, plus interface to support three more drives
Languages	BASIC Fortran 77 Pascal Assembly Pilot	Enhanced BASIC Fortran 77 Pascal Assembly
Typical Configuration Pricing	CPU, 48K RAM, single disk drive, B&W Monitor (9"), Silentype™ printer, and BASIC. **$2875.00***	CPU, 96K RAM, integrated disk drive, B&W Monitor (12"), Silentype™ printer, SOS, Enhanced BASIC. **$4865.00***

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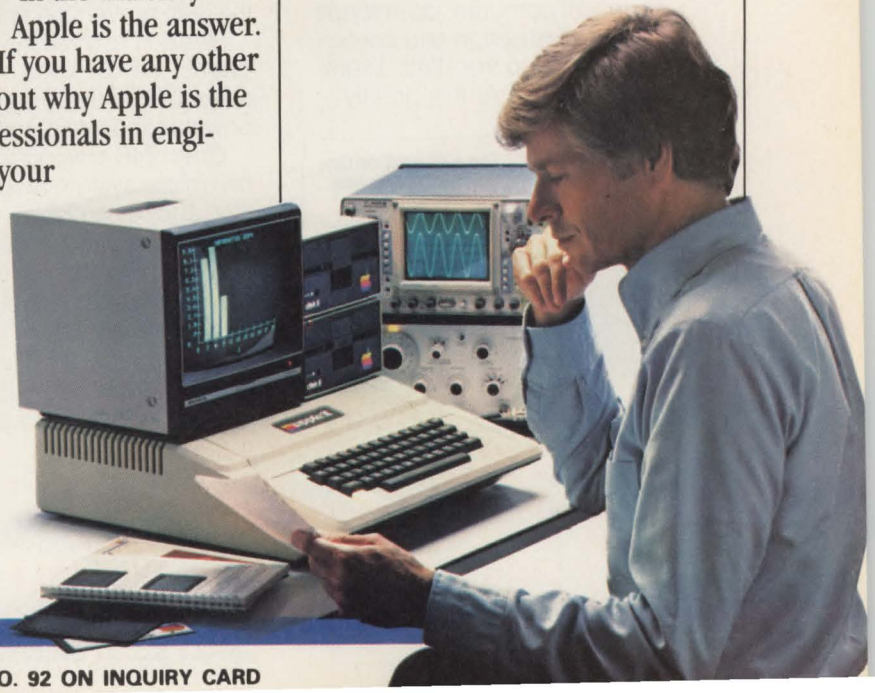

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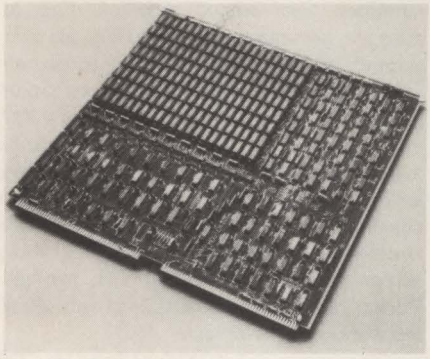


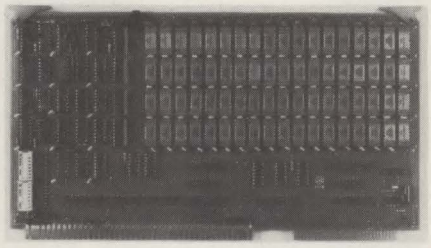
NOVA PCM. The MK8018 add-in memory card for the Data General NOVA 4 computer has both on-board error correction and an eight-LED error log for on-board RAM-level troubleshooting. The 15- × 15- × 0.56-in. board has a capacity of 128K 16- or 21-bit words, a write-access time of 200 nsec. and a read cycle of 400 nsec. It uses four-way interleaved timing compatible with the NOVA 4/X or 4/S and can be used alone or with other memory cards in either five- or 16-slot chassis. Price is $5700, with OEM, educational and government discounts available. **Mostek Corp.,** Carrollton, Texas. **Circle No 213**

SINGLE-BOARD BUBBLE SYSTEMS. The RMS family of single-board bubble-memory systems, which include controllers and all electronics, comprises four modules with capacities ranging from 32K to 256K bytes. Designed to interface with the Rockwell AIM 65 microcomputer and System 65 development systems and with the Motorola EXORciser and Micromodules, the 6- × 9¾-in. RMS modules use a 100-kHz field rate and are electrically compatible with the 6500 and 6800 bus. Host systems communicate with the RMS boards via programmed I/O at a rate determined by the number of RBM256 256K-bit bubble-memory devices used. For the two-device 64K-byte RMS122, the average data rate for a block, once it has been accessed, is 22K bytes per sec. and the maximum data rate is 25K bytes per sec. Access time ranges from 20 μsec. to 20 msec., depending on block location. Single-unit prices range from $1800 for the 32K-byte RMS121 to $5300 for the 256K-byte RMS142. **Rockwell International,** Anaheim, Calif. **Circle No 214**

11/70 "SEMI DISK." The Maxiram-11/70HS, a solid-state equivalent of DEC RS04/RS03 fixed-head disk drives, can be attached directly to the cache bus of a PDP-11/70. The system consists of a high-speed controller located in one of the RH70 locations in the processor plus a 19-in. rack-mount chassis containing 256K to 8M bytes of semiconductor RAM. The unit can be used as a swapping device for program overlay storage, for scratch files, for remote user storage and in any situation requiring frequent access to large blocks of data. **Imperial Technology, Inc.,** El Segundo, Calif. **Circle No 215**

INTEL PCM. The CI-8086 single-board memory, which plugs directly into the backplanes of Multibus-based microcomputers, is available in 32K- to 512K-byte capacities. The CI-8086 generates and checks even parity with selectable interrupt on parity error, uses on-board refresh control logic, has a data-access time of 250 nsec. and a cycle time of 375 nsec. and is addressable in 16K-byte increments to as much as 16M bytes. The board measures 6¾ × 12 in. and consumes less than 8W of power. In single quantities, price is $1500 for a 128K × 9-bit board and $8700 for a 512K × 9-bit board. **Chrislin Industries, Inc.,** Westlake Village, Calif. **Circle No 216**

PLOTTER MEMORY EXPANSION. The expanded memory option for the vendor's model 4662 interactive digital plotter increases plotter efficiency as much as four times by reducing the CPU time required for data transfer. The enlarged buffer provides a memory capacity of as much as 8K bytes, compared to 2K bytes for the standard plotter. The option is available either factory-installed for $495 or as a kit for field installation for $575. **Tektronix, Inc.,** Beaverton, Ore. **Circle No 217**

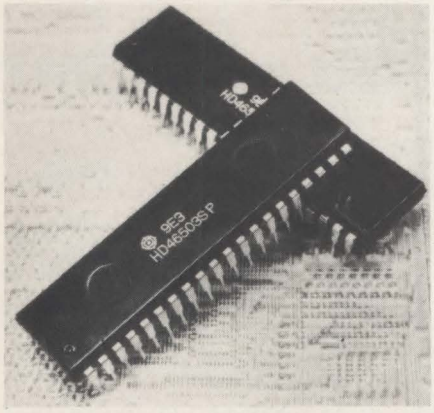


S-100 BOARDS. The Superam 4-Z family of S-100 boards provides 64K bytes of dynamic RAM for Z80A, 8080A and 8085 processors. All Superam 4-Z boards are organized in four blocks of 16K bytes, each of which can be enabled or disabled via simple switch settings. The Superam 4-Z B includes bank selection, which is made on 16K-byte boundaries, and the Superam 4-Z BP adds a parity-bit option for error detection. Operating speed is 4 MHz with no wait states, memory access time is 220 nsec., and cycle time is 400 nsec. Single-board price is $750 for the Superam 4-Z, $800 for the 4-Z B and $850 for the 4-Z BP. **Pliceon, Inc.,** San Jose, Calif. **Circle No 218**

New Products

components

BIDIRECTIONAL BUS EXTENDER. Signetics Asynchronous Bidirectional Bus Extender and Repeater (SABER) 8 × 4 can physically extend a common bus between close-coupled or remote digital data-processing or communications equipment and repeat and retransmit signals without signal degradation. The eight-channel device can transfer data between as many as eight pairs of elements in a system without external logic. The 8 × 41 has a maximum delay time of 30 nsec., is TTL compatible, has open-collector outputs and operates from a single 5V power source. In a 24-pin plastic DIP, the 8 × 41 SABER costs $25 in quantities of 100. **Signetics Corp.,** Sunnyvale, Calif. **Circle No 219**



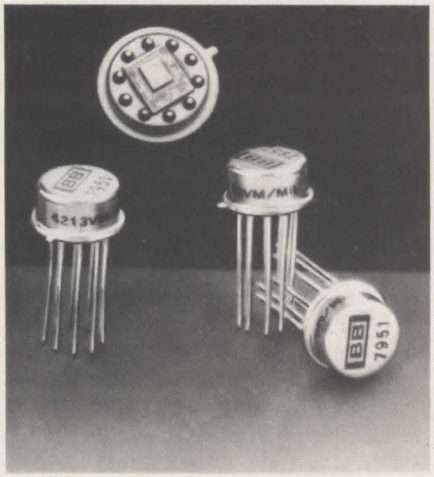
3740-COMPATIBLE CONTROLLER CHIP. The HD46503/MC6843 IBM 3740-compatible floppy-disk controller for microprocessor-based systems uses 10 macro-commands to control all head movements and read/write functions. Features include programmable seek and settling times, read/write operation on consecutive sectors and both program-controlled and DMA data transfer modes. The HD46503/MC6843 FDC costs $11.85 in quantities of 100. **Hitachi America, Ltd.,** Arlington Heights, Ill. **Circle No 220**

VERTICAL RACKS. The 331 Class is a family of full- and half-size racks. The full-size racks will hold as many as 13 15.85- × 14.90-in. wire-wrapping panels or as many as 26 printed circuit boards on .600-in. centers. Optional data bus and I/O bus backplanes are also available. The I/O bus backplane has one 72-pin I/O connector associated with each 108-pin wire-wrapping connector. Appropriate side plates enable mounting in a 19-in. cabinet or bench-top enclosure. Prices in quantities of one to nine, including connector backplanes, is $979.97 for the full-size racks, $526.09 for the half-size. **Mupac Corp.,** Brockton, Mass. **Circle No 221**

MIL/AEROSPACE DAS. The MN7140 12-bit hybrid data-acquisition system (DAS), designed for military and aerospace applications, has an eight-channel input multiplexor, a track-and-hold amplifier, a 12-bit A/D converter and all the timing and control logic necessary to operate the system from a single trigger pulse. The MN7140 meets MIL-STD-883, Method 5008. Prices start at $309 in quantities of 100. **Micro Networks Co.,** Worcester, Mass. **Circle No 222**

8-BIT HYBRID A/D CONVERTER. The ADC-825 8-bit A/D converter has a 1.0-μsec. conversion time and six pin-programmable input voltage ranges: 0 to +5V, 0 to +10V, 0 to ±20V, ±2.5V, ±5V and ±10V. A logic input switches the converter from unipolar to bipolar operation. Output coding is straight binary, offset binary or two's complement. The converter also has a serial data output, a clock output and a status output. Price is $165 in quantities of one to 24. **Datel Intersil,** Mansfield, Mass. **Circle No 223**

8K-BIT PROM. The HM-7681A bipolar PROM has a 50-nsec. access time, a 1024 × 8-bit format and tri-state outputs. The device comes in a 24-pin cerdip package. Prices are less than $36 each in quantities of 100 or more. **Harris Corp.,** Melbourne, Fla. **Circle No 224**



MIL-SPEC MULTIPLIER-DIVIDER. The 4213VM/MIL, a four-quadrant analog multiplier that can also function as a two-quadrant analog divider, meets the requirements of MIL-STD-883 Class B. Maximum total error is ±1 percent; maximum output offset is 50 mv and feed-through only 100 mv p-p at 25°C. The 4213VM/MIL can operate over the full MIL temperature range of −55°C to 125°C. Price is $45 in quantities of 100. **Burr-Brown,** Tucson, Ariz. **Circle No 225**

12-BIT D/A CONVERTER. The MN3348, a 12-bit voltage-output D/A converter with reference and output amplifier, has an absolute accuracy error, including all error sources and specified without optional gain and offset adjustments, of less than ±0.05 percent FSR at 25°C and ±0.1 percent FSR from −55°C to +125°C. Other features include five user-selectable output ranges, an 8-μsec. settling time and 375-mW maximum power consumption. Packaged in a 24-pin DIP, the MN3348 is available with high-reliability screening to method 508 of MIL-STD-883. Prices start at $55 in quantities of 100. **Micro Networks, Co.,** Worcester, Mass. **Circle No 226**

MILITARY RAM. The M2118 16K-bit dynamic RAM, a MIL-STD-883 Class B device fabricated with the vendor's HMOS technology, uses the standard 16K × 1-bit, 16-pin configuration and operates on a single +5V power supply. The device's 120-nsec. maximum access time is guaranteed over a temperature range of −55°C to +85°C. A 150-nsec. version (M2118-7) is also available. In quantities of 100, price is $78.35 for the M2118-4, $60.30 for the M2118-7. **Intel Corp.,** Santa Clara, Calif. **Circle No 227**

micros

SINGLE-BOARD COMPUTER. The Am 96/4116, a MULTIBUS-compatible single-board computer based on the Am8002 16-bit microprocessor, has two serial and three parallel I/O ports, five high-speed programmable counter-timers and multiple-mode interrupt response capability. On-board memory consists of 32K bytes of dual-ported RAM, providing 4-MHz operation with the CPU and bus access via an arbitrated second port. Also included is 8K bytes of PROM space, interchangeable with RAM space, to increase the effective use of memory while enabling a user to control PROM-RAM mapping dynamically. Prices start at $2145 in single-unit quantities. **Advanced Micro Computers,** Santa Clara, Calif. **Circle No 228**

CPU BOARD. The model SCB-69 CPU board, intended for use as a microcontroller, business processor or single-board computer, provides 2-MHz operation, 1K byte of scratchpad RAM, 20-bit address generation to handle as much as 1M byte of main memory and space for as much as 20K bytes of EPROM. Other features include a field-programmable logic array (FPLA) to decode EPROM addresses, switches to select 2K- or 4K-byte EPROM and provision for an optional 9511/9512 floating-point processor. Prices start at $299. **Smoke Signal Broadcasting,** Westlake Village, Calif. **Circle No 229**

WHEN IT COMES TO PUTTING IT ALL ON DISPLAY, THE ORION-60/S4 STANDS ALONE.

Magnavox combines the superior display and control features of the plasma-panel-based Orion-60 terminals with the powerful S4 Micro-Computer System.

The result is a stand alone graphics system that allows you the freedom to develop a wide variety of graphics application and development programs—while maintaining complete control over program storage, program-generated data, library routines and other facilities.

The Orion-60 display terminal offers full graphics with floppy-disc storage, as well as optional rear-projection functions. It lets you create your own displays and enter data by simply touching the screen with your finger. So you can program your own character sets and generate vectors of any length to absolute coordinates. And because the Orion-60 is plasma-based, you'll get bright, high-contrast images free of jitter or distortion.

The S4 Micro-Computer has system software with development capabilities that are as good or better than those found in many larger computer systems.

Features include CP/M* 8080 system utilities, Fortran with 32K RAM, and a full range of graphic utility routines including window, zoom, sub-image movement and rotation. The Orion-60/S4.

For a demonstration, call or write Tyler Hunt at Magnavox Display Systems, 2131 South Coliseum Boulevard, Fort Wayne, Indiana 46803, (219) 482-4411.

Magnavox
DISPLAY SYSTEMS

*CP/M is a trademark of Digital Research.

CIRCLE NO. 96 ON INQUIRY CARD

interactive terminals

VOICE TERMINAL. The Total Talk terminal converts data into full-word synthetic speech for blind people. Based on the HP2621A terminal, it consists of a keyboard, two microprocessors, a CRT and a speech synthesizer. An operator can listen to all transmitted information, a page, a selected line or a single word. The terminal can be switched from full-word to spelled-speech (character-at-a-time) output, enabling any word or character to be verified. Speech rate (45 to 720 words per min.), tone and volume are adjustable. Price is $5995. A version with fewer features, called Speak Easy, costs $4000. **Maryland Computer Services, Inc.,** Bel Air, Md. **Circle No 230**

MULTIWINDOW TERMINAL. The HP 2626A data-entry CRT terminal, which can divide both display memory and screen into as many as four independent work areas, has dual ports for connection to multiple computers or to other RS232C peripherals. Other features include lines as wide as 160 columns, horizontal scrolling, screen-labeled user-definable soft keys and an optional integral thermal forms-copy printer. The line for the four work spaces can be set from 80 to 160 characters, and the total length of different work spaces can vary if the total number of lines is within the capacity of the terminal. Price is $3950, or $5100 with the integral forms-copy printer. **Hewlett-Packard Co.,** Palo Alto, Calif. **Circle No 231**

HAND-HELD RUGGEDIZED CONTROL/DISPLAY. The HT/20 hand-held control/display device for OEM applications has a membrane keyboard for operation in severe environments. The unit, which can also be panel- or desk-mounted, has a 16-element full alphanumeric LED "starburst" display and front-mounted shift keys. The entire 128 ASCII set can be generated and transmitted by the 24-key front panel. OEM prices begin at less than $200. **Termiflex Corp.,** Nashua, N.H. **Circle No 232**

ZOOM DISPLAY TERMINAL. The Ambassador terrninal has a zoom feature that enables the display format to be varied from the keyboard. The terminal is preset to a 30 × 80 display format. The zoom capability enables an operator to move as many as 60 additional lines into the window to view larger areas of text and to move 18 or more lines out of the window for greater viewing distance. Host-defined status areas and data in display memory remain unaffected by the zoom. The terminal, which implements the ANSI X3.64-1979 standard, has extensive editing and formatting capabilities, and full print and copy functions. The unit operates at keyboard-selectable data rates from 110 to 19,200 baud. Self-diagnostics and a data line monitor mode are also included. Prices start at $1300 in single-unit quantities. **Ann Arbor Terminals, Inc.,** Ann Arbor, Mich. **Circle No 233**

CRT WITH DETACHABLE KEYBOARD. The Series 610 Data-Screen terminals have detached keyboards. Other features include upper- and lower-case characters, protected data fields, forward and backward tab, five video attributes, X-Y cursor positioning, cursor sensing, page or roll-up mode and self-test. Baud-rate and parity switches and brightness controls are readily accessible. The Series 610 measures 16 × 13½ × 15½ in. and uses a 12-in. diagonal P-4 phosphor tube. The standard keyboard is 16 × 2⅝ × 6¾ in. Base end-user price is $1090 in single-unit quantities. **TEC, Inc.,** Tucson, Ariz. **Circle No 234**

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CIRCLE NO. 98 ON INQUIRY CARD

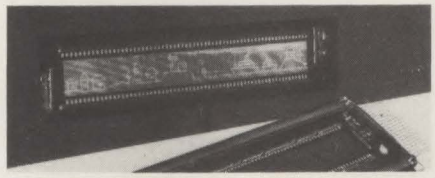
New Products

graphics

LASER FILM WRITER. The L-5500 Laserwriter is a HeNe laser film recorder that writes as many as 960 lines of data per min. Nominal resolution is 4800 pixels per line with pixel placement precise to 2 microns RMS/cm. Maximum resolution is 19,200 pixels per line. There are 256 steps of gray-scale modulation, with each step discrete and repeatable over the entire 10- × 10-in. (25- × 25-cm.) standard image format. Data is transferred at rates as high as 250,000 pixels per sec. The L-5500 Laserwriter costs approximately $100,000 built to customer specifications. **Optronics International, Inc.,** Chelmsford, Mass. **Circle No 235**

MULTI-IMAGE COLOR CAMERA. The model 633 multi-image color camera provides photographic hard copy for color computer graphics in user-selectable formats with one, two, four, six, nine, 12, 16, 25 or 36 images per photograph. Image size can be magnified to as large as 8- × 10-in. or reduced to microfiche size. Users can position images at any location on the film, rotate them and create a wide range of special effects. Control from a host computer of all camera operations, film types and exposure conditions is exercised via an RS232C interface. Film formats available are 8- × 10-in. transparencies or Polaroid prints, with options for 35-mm. slides, SX-70 Polaroid prints, 4- × 5-in. prints and transparencies and 16-mm. film. Prices start at $15,750. **Dunn-Instruments, Inc.,** San Francisco, Calif. **Circle No 236**

PLOTTING WORK STATION. The model 430 plotting work station sorts, rasterizes and controls electrostatic plotting from unsorted CalComp 921/925 magnetic tapes (nine-track, 800- or 1600-bpi), Versatec-ordered vector data and Versatec type 1 raster data (blocked or compressed). The system includes 64K bytes of internal memory, a 24.8M-byte Winchester-disk drive able to store plots containing as many as 2 million vectors, a CRT display, a dual-density tape drive with an embedded formatter and a bipolar algorithmic processor for sorting and vector-to-raster conversion. The system can generate multiple copies, select either of two of the vendor's electrostatic plotters and select files from disk or tape. Menus simplify creation of canned sequences and graphics manipulation, such as scaling, expansion or reduction, windowing, rotation in 1° increments and modification of multiple line widths and line masks. Price is $48,500. **Versatec,** Santa Clara, Calif. **Circle No 237**



FLAT FLUORESCENT MATRIX DISPLAY. The "itron" (DM256 x 26B) is a 256- × 26-dot matrix array, vacuum-fluorescent display panel that can display side-to-side scrolled messages, expanding or contracting dot-matrix graphics, symbols, hieroglyphics, multisized alphanumerics and varied pattern thicknesses and shapes. Each output dot is a 0.4-mm. square aligned between dots spaced on 0.65-mm. centers in both X and Y directions. The complete panel without terminals is 60-mm. wide, 226-mm. long and 12-mm. thick. **Noritake Electronics, Inc.,** Torrance, Calif. **Circle No 238**

At $795*, how tough can these new Tigers be?

Introducing the new Paper Tiger™ 445 with the most rugged printing mechanism ever put in a low-cost matrix printer.

The 445 comes with a reliable ballistic-type print head and an advanced cartridge ribbon that lasts four times longer than many cassette or spool ribbons. Two separate heavy duty motors drive the print head and advance the paper. Plus you get true tractor paper feed.

And the new 445 gives you the performance you expect from the Paper Tiger family of printers. You can software-select character sizes, print 80- and 132-column formats, adjust paper width and length, even generate six-part business forms. All at unidirectional print speeds to 198 characters per second.

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CIRCLE NO. 100 ON INQUIRY CARD

New Products

data entry

OPTICAL WAND FOR HP-41C CALCULATOR. The HP82153A optical wand for the HP-41C calculator enables entry of programs and data printed on paper in HP bar code. The wand can read as much as 30 in. of HP bar code per sec., scanning from either left to right or right to left. The HP82153A costs $125. **Hewlett-Packard Co.,** Palo Alto, Calif. **Circle No 239**

RECEIVING/INSPECTION SYSTEM. The System 7080 receiving-inspection system consists of a key-to-diskette data collection and retrieval terminal with built-in software for receiving and incoming inspection applications. Optional communications facilities are also available. Price is $12,925. **Tab Products Co.,** Palo Alto, Calif. **Circle No 240**

WIRELESS KEYBOARD INPUT FOR TRS-80. The RX-10 hand-held, ultrasonic remote keyboard for the Radio Shack TRS-80 can be used as an adjunct to the computer's standard keyboard for convenient data entry from across the room. The system also permits remote control via the AC power lines of devices located in a home of office. The RX-10 system includes all necessary cables and interfaces, a cordless controller, a command console appliance, control modules and a diskette with software for status display, security monitoring and scheduling. Price is $285. **Omni Automation,** Atlanta, Ga. **Circle No 241**

Dear Ma:

Racal-Vadic has the world's first Dual Acoustic Coupler... 1200 bps full duplex and 0-300 bps as well!

Another winner from Racal-Vadic, Ma. It's the world's first DUAL acoustic coupler.

The compact VA3413 is fully compatible with Racal-Vadic's VA3400 and your 103/113 type modems. Just think, Ma, a single portable coupler can now handle virtually all originate applications for full duplex 1200 bps and 0 to 300 bps data transmission over the dial-up telephone network.

This is great news for remote terminal users who can, if they wish, instantly step up to 1200 bps full duplex, using the same 103 type protocol, yet can operate at 0 to 300 bps as well. It's two couplers in one!

Great features, too. Under microprocessor control, the VA3413 employs a unique scheme for automatic detection of the called modem, making it unnecessary for the user to have to manually select the VA3400 or 103 mode. The unit also has automatic 9 or 10 bit character length recognition.

Where can you obtain the VA3413? Easy, just phone the nearest Racal-Vadic stocking rep or for more information dial **800-543-3000, OPERATOR 500.**

Your independent thinking son,

Alexander Graham Jr.

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New Products

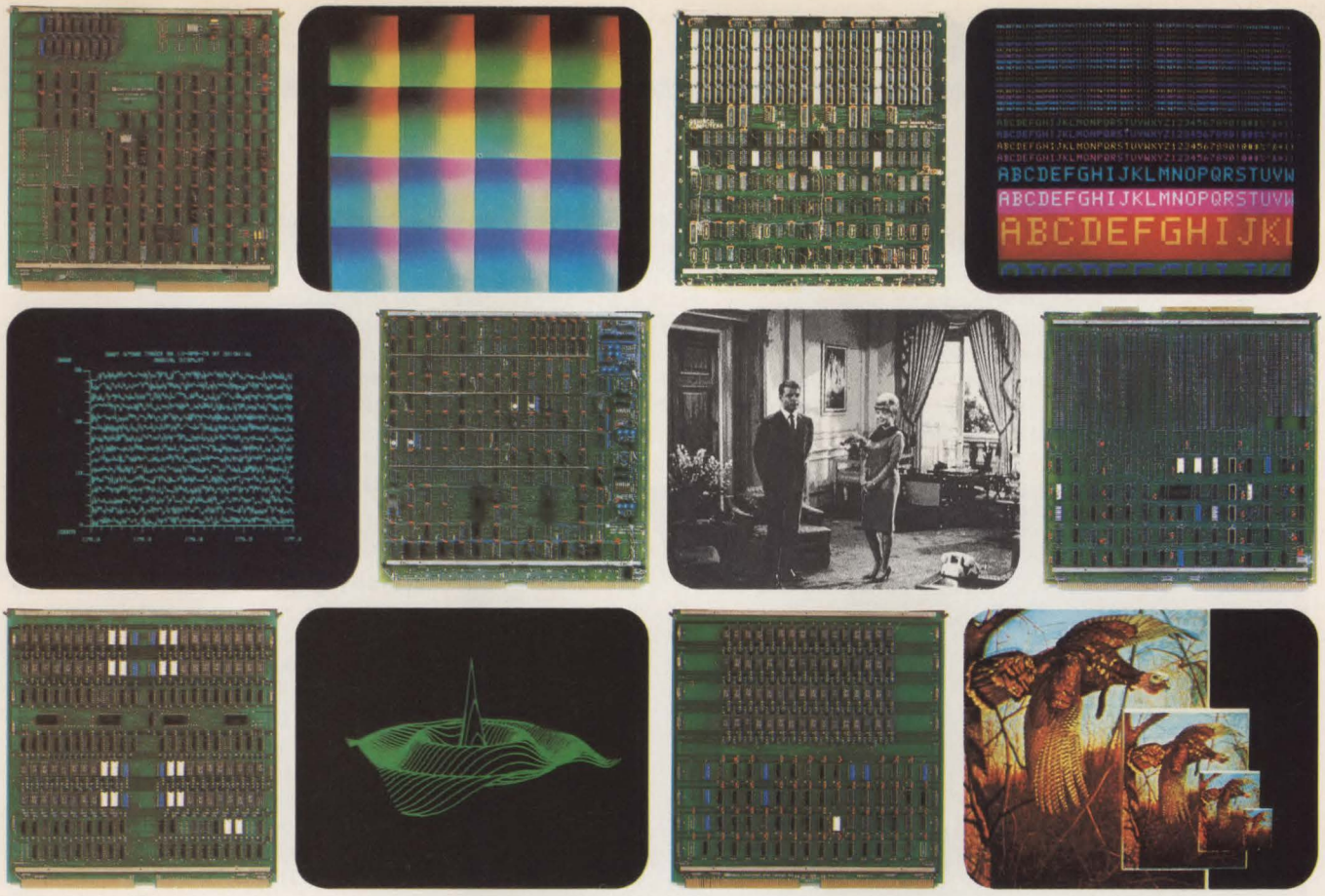
test equipment

PROGRAMMABLE DATACOMM TESTER. The model 834 programmable datacomm tester performs standard bit and block error rate tests, as well as the cyclical and longitudinal redundancy checks needed to confirm the accuracy of data transmission. The device uses a series of ROM packs containing preprogrammed, standard test routines for common protocols, synchronous, asynchronous or HDLC operation, transmission speeds as high as 19.2K bps, full- or half-duplex operation and ASCII, EBCDIC or user-defined codes. Prices start at $3700. **Tektronix, Inc.,** Beaverton, Ore. **Circle No 242**

MICROPROCESSOR EXERCISER. The model 5001A microprocessor exerciser runs test stimulus programs from its own ROM while an HP 5004A logic analyzer takes signatures at designated circuit points for each stimulus. The device provides 51 preprogrammed test stimuli for troubleshooting of ROM, RAM, I/O, buffers, decoders and bus lines, custom test stimulus programs stored in external ROMs, single signature tests and gating signal outputs for a signal analyzer. Prices start at $900 in single-unit quantities. **Hewlett-Packard Co.,** Palo Alto, Calif. **Circle No 243**

64-CHANNEL LOGIC ANALYZER. The model D132 logic analyzer provides 10-MHz sampling on as many as 64 channels and 400-MHz effective sampling on eight special channels. The unit is controlled from a fold-down keyboard. Three self-prompting menu displays are used to establish trigger, sample and display specifications. Eight setup procedures can be stored, each with eight levels of sequential triggering. The model D132 costs $10,000 to $15,000, depending on options selected. **Intech, Inc.,** Santa Clara, Calif. **Circle No 244**

MINIATURE DATACOMM TESTER. The model 65/60 comprises two pocket-sized units: a model 65 miniaturized modem test set, able to perform bit error rate tests on synchronous and asynchronous EIA data-communications channels, and a model 60 "Blue Box" EIA monitor and breakout panel. Together, they provide a hand-held, battery-powered unit for testing and monitoring data-communications systems at the RS232/CCITT V.24 modem-terminal interface. The transmitter on the model 65 continuously generates one of four switch-selectable data patterns. The receiver section generates a true replica of the selected data pattern and compares it to the received data pattern. Prices start at $850 per single transmitter/receiver unit; a battery charger costs $20. **International Data Sciences, Inc.,** Lincoln, R.I. **Circle No 245**



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GENISCO COMPUTERS

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CIRCLE NO. 104 ON INQUIRY CARD

New Products

test equipment

TAPE-FORMATTER EXERCISER. The TFX-500 tape-formatter exerciser provides 15 sections of test points and LED indicators for all signals from the formatter. It can be operated manually to test known problems or in a program mode to uncover intermittent ones. The 10-lb., 17- × 10- × 4¼-in. unit can test from one to eight linked drives and is compatible with all microstreamer-formatter interfaced drives and with dual-mode embedded formatters from Cipher, Pertec, Kennedy, Datum, Perkin-Elmer and others. Other features include an attaché case housing with a self-contained 5V power supply, tester-to-interface cables and a manual. Prices start at $995. **Wilson Laboratories, Inc.,** Orange, Calif. **Circle No 246**

DATACOMM TEST SET. The TE620 Infotester verifies proper operation of synchronous and asynchronous modems and time-division, frequency-division and statistical multiplexors. The compact test unit also measures, counts and displays bit, character and block error rates, distortion and overspeed variations. Other features of the RS232-compatible unit include selectable speeds from 50 to 19,200 bps and a choice of six formats. Prices start at $2495. **Infotron Systems Corp.,** Cherry Hill, N.J. **Circle No 247**

FLOPPY-DISK TESTER. The 3PX158 double-sided floppy-disk tester accommodates both 5¼- and 8-in. disks. The 8-in. drive tests both sides of a floppy disk in parallel, while the 5¼-in. double-sided drive tests consecutively. Other features include optional overwrite testing, modulation test on every track, peak jitter test, RAM and ROM. The unit can be used in automatic reject, automatic stop-on-error or continue-on-error operating modes. Prices start at $29,490 in single-unit quantities. **Three Phoenix Company,** Phoenix, Ariz. **Circle No 248**

design aids

SOFTWARE-DEVELOPMENT MODULE. The model 810 software-development module adds resident text entry, editing, assembly and debug facilities to systems based on the vendor's iSBC 8080/8085 single-board microcomputers. It enables software written in 8080/8085 assembly language to be developed and debugged completely in the target system. After use, the module can be removed from the target system to develop other products, or it can be shipped with the target system to serve as a resident programming subsystem and memory expansion unit. Price is $1500. **Intel Corp.,** Santa Clara, Calif. **Circle No 249**

STD-BUS DEVELOPMENT SYSTEM. Based on the STD-BUS interconnect system, the DS22 microcomputer development system supports 8080, 8085 and Z80 processors. The basic DS22 includes dual floppy-disk drives, 32K bytes of RAM and full assembly-language programming capabilities, including an editor, an assembler, utilities and a dynamic debugger. Optional software includes macro assemblers, BASIC, FORTRAN, Pascal, C and PL/1. STD-BUS cards can be plugged directly into the DS22, enabling software development, hardware debugging and system integration to be performed on the target system. A basic DS22 system costs $6150. **Micro/Sys, Inc.,** La Canada, Calif. **Circle No 250**

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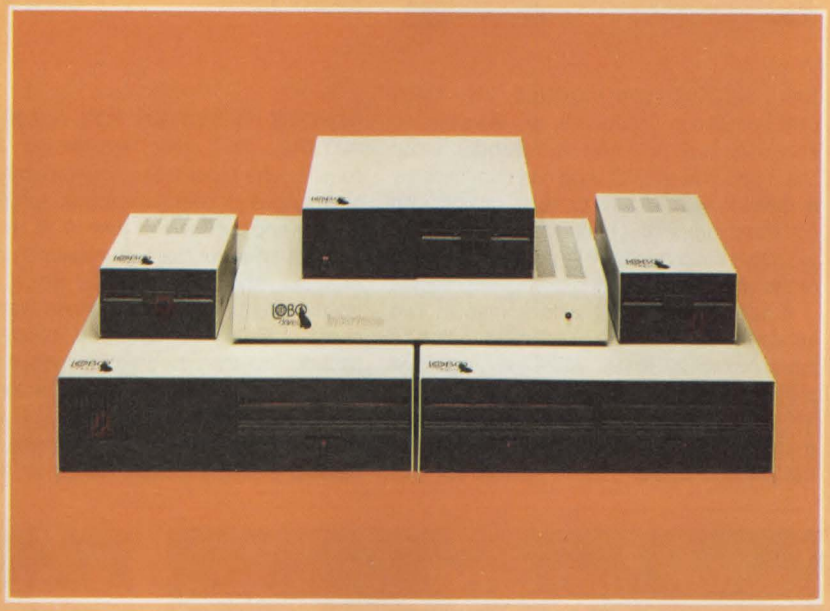
LOBO DRIVES manufactures a full line of S-100 computer compatible disk drives. All drives are software compatible with most S-100 disk operating systems and applications software programs. Only LOBO DRIVES offers you the variety and choice of floppy and fixed disk drives. Choose from 5¼ and 8-inch floppies, 5¼ and 8-inch Winchester technology fixed disk drives, and several Floppy/Fixed disk combinations. Each LOBO DRIVES system is thoroughly tested and burned-in and has the famous LOBO DRIVES One Year, 100% Parts/Labor Warranty.



MODEL 400 5¼-INCH FLOPPY DISK MEMORY SYSTEM

A high-speed (298) Msec Access), high-reliability (8000 hrs MTBF), low-cost floppy disk memory system. It is available in both soft and hard sector formats, and a choice of single or double density configurations.

- Up to 220 KBytes Capacity
- Single/Double Density
- Soft Sector Format
- Complete Software Compatibility

MODEL 800/850 DUAL FLOPPY DISK DRIVE MEMORY SYSTEM

LOBO DRIVES offers you a choice of single-sided, single or double density (Model 800) or double-sided, single or double density (Model 850) dual 8-inch memory subsystems. Each system comes complete with chassis and power supply, cables, controller and interface.

- Compatible with Most S-100 DOS Systems
- Up to 3.2 MByte Capacity

MODEL 1850 DUAL FLOPPY/FIXED DISK MEMORY SYSTEM

No more worries about back-up. LOBO DRIVES has combined the latest state-of-the-art Winchester technology with the proven reliability and dependability of its Model 850 8-inch floppy disk drive to bring you the ultimate in memory expansion for your S-100 computer. The Model 1850 is the ideal memory system for small business and word processing applications.

- 5 or 10 MByte Fixed Disk Capacity
- 1.6 MByte Floppy Disk Capacity
- Software Compatibility
- Sealed Environment
- Winchester Reliability
- 70 Msec Average Access Time

MODEL 950 DUAL FLOPPY/FIXED DISK MEMORY SYSTEM

All the advantages of Winchester technology fixed disk memory: large capacity (6.38 MBytes), high speed (170 Msec avg. access time), and extended reliability, combined with the convenience of a built-in floppy disk back-up in one cabinet. Only LOBO can bring you the storage capacity of 16 mini-floppies at a fraction of the price.

- The Storage Capacity of 16 Mini-Floppies
- Built-in Back-up
- 170 Msec Access (Avg)
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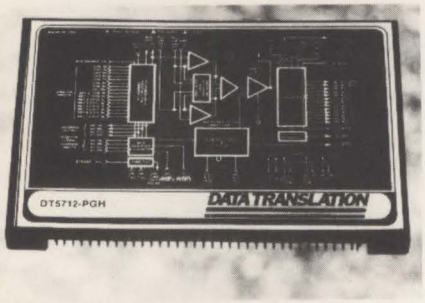
CIRCLE NO. 106 ON INQUIRY CARD

New Products

data acquisition



DATA ACQUISITION MODULE. This 12-bit data-acquisition module (DAM) accepts 16 single-ended or eight differential input channels. The DT5712's gain can be fixed by a resistor over a one to 1000 range with corresponding throughput rates of 40 kHz and 3.8 kHz, respectively. With no gain, the input range spans ±10 mV, and relative accuracy is ±½ LSB. The DT5712 also comes in two versions with computer-controlled gains. A basic DT5712 costs $275. A high-level programmable gain (eight maximum) option is an additional $50. A low-level (5000 maximum) option, $100. **Data Translation, Inc.,** Natick, Mass. **Circle No 251**

16-BIT D/A CONVERTER. The DAC73 16-bit digital-to-analog converter produces voltage or current output signals accurate within ±0.00075 percent of full-scale range. The 2 × 4 × 0.4-in package includes a ceramic hybrid IC containing critical components; potentiometers for gain, offset and linearity calibration; an output amplifier; and an input storage register. No external components are needed to achieve 16-bit accuracy. The DAC73 costs $228 in 100-unit quantities. **Burr-Brown,** Tucson, Ariz. **Circle No 252**

REMOTE I/O SYSTEM FOR TI MINICOMPUTERS. The IS990 remote I/O system consists of a processor module, 8K-byte RAM, operating and communications software in EPROM and a choice of analog I/O modules. The industrial HDLC communications package enables the IS990 and other Texas Instruments DS990 minicomputer systems to communicate via shielded twisted-pair cables. Together, the two products enable a user to configure multidropped factory data collection networks consisting of a host minicomputer system and as many as 32 satellite systems located as far as 9800 ft. from the host. A basic IS990 system consisting of a processor, three I/O modules, a four-slot chassis, a power supply, termination panels and cables costs $3775. The HDLC communications package sells for $1300 to $2500, depending on the storage media selected by the customer. **Texas Instruments Inc.,** Houston, Texas. **Circle No 253**

interfaces and controllers

PARALLEL I/O INTERFACE. The DRV11 general-purpose parallel I/O port for the DEC LSI-11 Q-Bus has switch-selectable device and vector-interrupt addresses. Other features include individual 16-bit input and output connectors with appropriate handshaking logic for ease of interface. Input lines are diode clamped, output lines are latched, and all inputs and outputs are TTL- or DTL-compatible. Maximum rate for program-controlled data transfers is 40K words per sec. The DRV11 costs $250 in single-unit quantities, $162.50 in quantities of 100. **General Robotics Corp.,** Hartford, Wis. **Circle No 254**

The Prime system builder's kit. Just add your software and sell.

Our small, 32 bit, 50 Series computers come packed with everything you need, including the same in-depth support and system installation that we provide with our most powerful systems. All you have to do is add your own application software.

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PRIME Computer

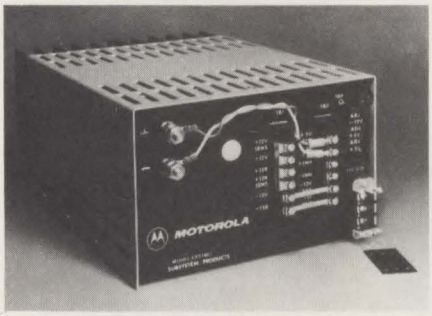
CIRCLE NO. 109 ON INQUIRY CARD

New Products

power supplies

DIGITALLY PROGRAMMABLE SWITCHER. The PM 2497 switching power supply—available in 200W to 750W versions—is digitally programmable when used with an RS232-compatible interface option. It can also be configured to accept an 8-bit parallel signal, enabling connection to most minicomputers and microcomputers. The supply can be programmed in 256 discrete steps of the rated output voltage. A tracking power-good signal option is available that indicates when the output is within ±4 percent of the selected voltage. A constant-current version is also available. The unit operates over an input range of 92 to 138 VDC or 184 to 250 VDC. A 750W unit costs $670. **Pioneer Magnetics, Inc.,** Santa Monica, Calif. **Circle No 255**

ISOLATION TRANSFORMERS. These extreme isolation transformers provide as much as 160 dB of common-mode noise rejection. The devices have an effective coupling capacitance of 0.1 femtofarad (0.0001 pF) between windings. Models are available with 1, 2.5 and 5 KVA ratings. Prices begin at less than $200. **Xentek, Inc.,** San Marcos, Calif. **Circle No 256**



400W SWITCHING POWER SUPPLIES. The EPS1901, 2 and 3 and the EPS1901F, 2F and 3F are 400W switching power supplies. The F-Series units have built-in electromagnetic interference (EMI) filters designed to meet the requirements of the new VDE 0871/6.78 curve A specification. A front-mounted terminal block allows the addition of the EMI filter without increasing case dimensions. Prices range from $450 for an EPS1901 single-output supply to $630 for an EPS1903F triple-output supply with filter. Motorola Semiconductor Products, Inc., Phoenix, Ariz. **Circle No 257**

AUTORANGING SWITCHER. The HP 6024A autoranging switch-mode power supply provides maximum output power over a wide, continuous range of voltage and current combinations without requiring manual selection of the proper output range. Other features include mode and status indicators, adjustable overvoltage protection, two 10-turn potentiometers for high-resolution control, amplified current-monitor terminals and voltage and current meters. A barrier strip at the back of the supply provides the necessary terminals for current monitoring, remote programming and remote sensing. The 6024A costs $895. **Hewlett Packard Co.,** Palo Alto, Calif. **Circle No 258**

SWITCH-MODE REGULATED DC/DC CONVERTER. The UM and UMC series of switch-mode regulated DC/DC converters have input ranges of 9 to 18 VDC, 18 to 36 VDC and 35 to 70 VDC and can withstand 8-msec. surges of 25V, 40V and 100V, respectively, before converter shutdown. All units have input filters that hold reflected ripple to 40 mA peak to peak. The converters have single outputs of 5, 12 or 15 VDC at 800 mA to 3A. Prices start at $99.95 in single-unit quantities, with OEM discounts available. **Semiconductor Circuits, Inc.,** Haverhill, Mass. **Circle No 259**

30-WATT SWITCHING SUPPLY. The 1030 series of switching power supplies provide 6A outputs adjustable from 4.5 to 5.5 VDC. Full rated output is maintained over an ambient temperature range of 0° to 50°C, with a 2 percent derating to 71°C. The power supply input has pin-strappable voltage ranges of either 85 to 130 VAC or 170 to 260 VAC at 47 to 470 HZ. An RFI input line filter is standard. Model 1030-A (PC board) costs $74; model 1030-B (open frame) costs $79; and model 1030-C (enclosed unit) costs $83. **Power General,** Canton, Mass. **Circle No 260**

DUAL-OUTPUT SUPPLY FOR MICROS. The UPS14 dual-output power supply for microprocessors provides 6W on both outputs. Voltages can range from 5V to 15V at 0.8A to 0.25A. The unit is an open-frame supply with both outputs totally isolated for positive and negative operation. It is fully rated to 55°C and is supplied with a dual 115/230 VAC input. Price is $31 in quantities of 250. **Elpac Power Systems,** Santa Ana, Calif. **Circle No 261**

POWER-LINE FILTERS. These RFI power-line filters, designed for use with instrumentation, communications equipment, industrial controls, computers and peripherals, are available in 2A and 6A configurations. Both filters have integral CEE-22 connectors and provide at least 40 dB of attenuation from 1 to 100 MHZ. Price is $17.22 in quantities of one to 99. **Panel Components Corp.,** Santa Rosa, Calif. **Circle No 262**

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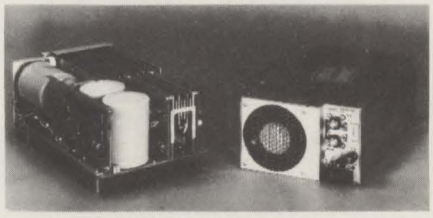
CIRCLE NO. 111 ON INQUIRY CARD

New Products

power supplies

BIDIRECTIONAL FILTER. The COMTRANS TM series of bidirectional power-line filters suppress both self-generated and external RFI/EMI and protect against induced lightning effects and inductive-load switching transients. The design uses a Pi filter with a common-core inductor for maximum common-mode rejection with minimum current leakage to the chassis. Insertion loss is greater than 40 dB to 10 GHz for protection against high-power radar and microwave radiation. **Pilgrim Electric Co.,** Plainview, N.Y. **Circle No 263**

OPEN-FRAME SUPPLY FOR MOTOROLA M4408. The D55-2.5 open-frame DC power supply is designed for use with the Motorola M4408 15-in. display module or any other display unit requiring a 55V supply. Voltage input range is 115 or 230 VAC, ±10 percent at 47 to 440 Hz. Output is 55 VDC at 2.5A, 0° to 50°C. Regulation is ±.02 percent for a 10-percent line change or a 50-percent load change. Maximum output ripple is .02 percent peak to peak. Transient response is 30 μsec. for a 50-percent load change. Automatic foldback current limiting and remote sensing are standard. Price is $84.95 in quantities of one to nine. **Condor, Inc.,** Camarillo, Calif. **Circle No 264**



1500W SUPPLY. The model HL 1500, a 1500W switching power supply designed for computers, test systems, industrial controls and other large digital systems, provides +5V at 300A. It controls output voltage within one percent over a 25-percent load change and recovers to "flat" output in 0.5 msec. Typical line regulation is 0.3 percent. The HL 1500 also provides 30-msec. holdup to mask AC line-power interruptions. Price is $1220. **Boschert, Inc.,** Sunnyvale, Calif. **Circle No 265**

SINGLE-OUTPUT SWITCHER. The five models in the SWS 150 series of single-output switching power supplies, which are rated at 150W, provide 5 VDC at 30A, 12 VDC at 12.5A, 15 VDC at 10A, 24 VDC at 6.5A or 28 VDC at 5.5A Other features of these open-frame supplies include continuous operation, 115/230 VAC single-phase inputs and 75 percent efficiency. **Standard Power, Inc.,** Santa Ana, Calif. **Circle No 266**

Guard your margins while you ring up sales.

Employees can press the right register keys and still end up with costly mistakes. That's because common electrical power disturbances can trick electronic cash registers into accepting false data, misunderstanding real data, or forgetting all data.

These problems result from momentary surges and dips in power line voltage, low-energy/high-frequency interference known as "noise", and the all-too-familiar brownout. Now they can be solved easily with Sola's Micro/Minicomputer Regulator ... a portable, plug-in, UL-approved device that stabilizes voltage, provides ultra-isolation to block out noise, and offers the near-pure AC sine wave that electronic cash registers and back-room data processors crave. A choice of sizes lets you match your power needs economically.

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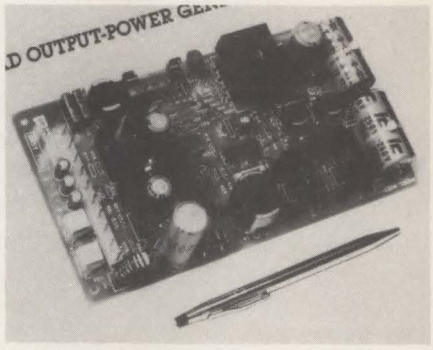
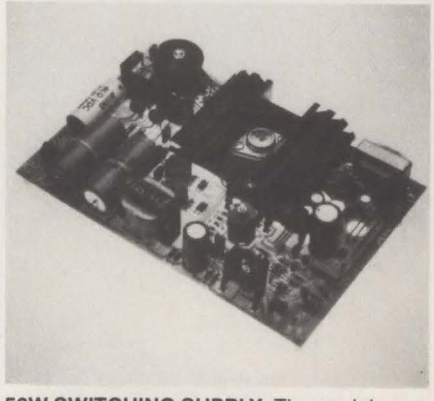
New Products

power supplies

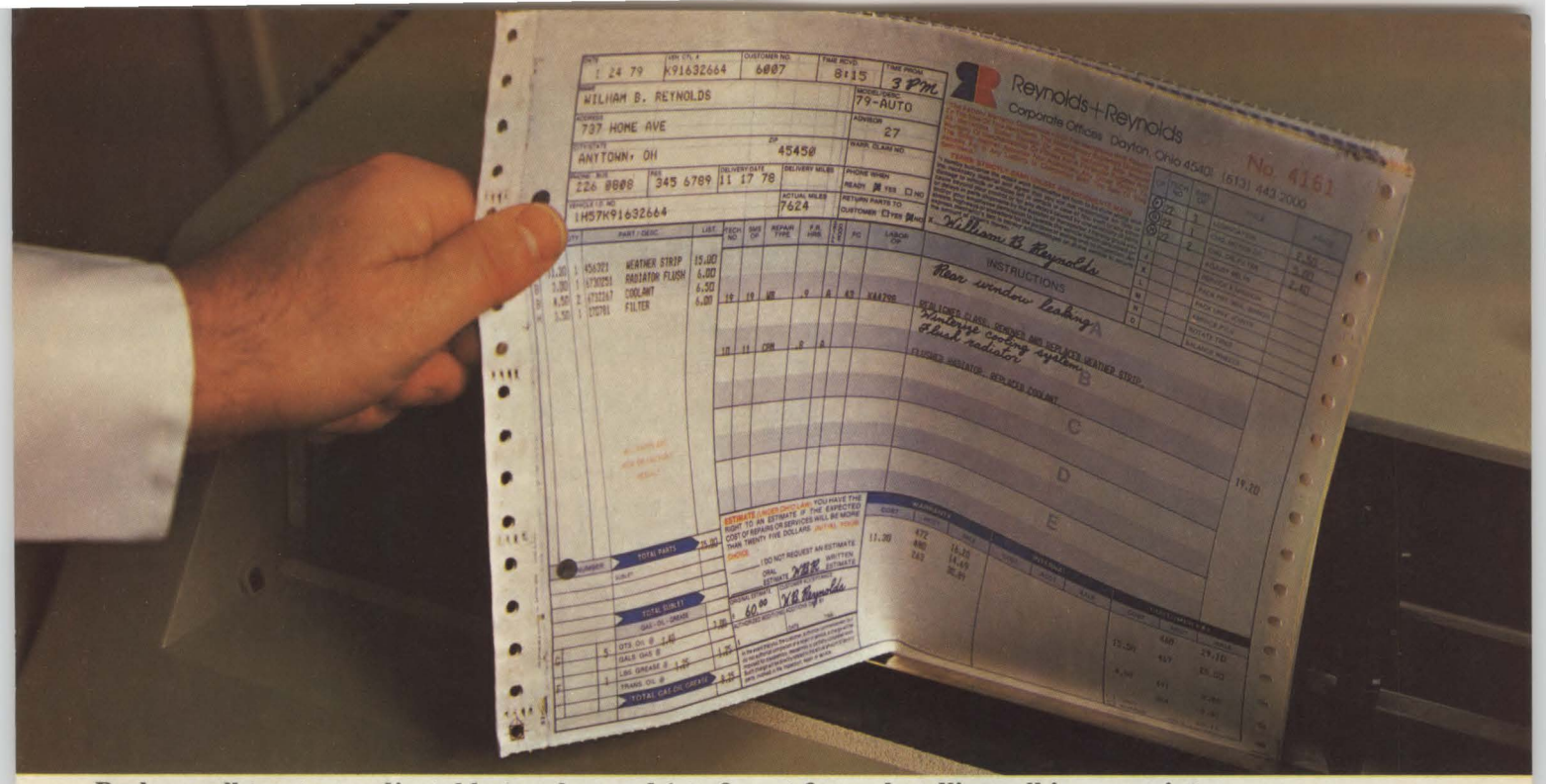


MULTIPLE-OUTPUT POWER SUPPLY. The Series 4027 power supplies are true-off-the-line switching power supplies with as many as four output voltages and efficiencies of 70 percent or better. The supplies' RFI-filtered inputs are pin-strappable to ranges of either 85 to 130 VAC or 170 to 260 VAC at 47 to 470 Hz. The main output is 5V at 4A; auxiliary outputs are custom selectable, including ±12V at 0.4A, −9V at 0.4A, −5V at 0.3A and −2A to −12V at 0.1A to 0.4A. Prices range from $75 to $99. **Power General,** Canton, Mass. **Circle No 267**

DUAL 10W SUPPLY. The μPS18 open-frame power supply has two 10W outputs, rated at ±12V at 0.7A and ±15V at 0.5A. The 4¾- × 4- × 2¼-in. unit is fully rated to 55°C and has a dual 115/230 VAC input. The μPS18 costs $32 in quantities of 250. **Elpac Power Systems,** Santa Ana, Calif. **Circle No 268**



56W SWITCHING SUPPLY. The model 7282, a 56W switching power supply designed for OEM use in data terminals, ATE and computers, provides outputs of +5V at 10A and ±12V at 250 mA with almost 70 percent efficiency. Ripple is less than 50 mv p-p, and the unit is protected against overvoltage, accidental overload and low line voltage. Price is $198 in quantities of one to nine. **Calex Mfg. Co., Inc.,** Pleasant Hill, Calif. **Circle No 269**



Push-n-pull tractors, adjustable tear bar and 1-to-9 part forms handling: all in one printer.

Finally, real-time forms access plus continuous forms output in one printer. Perfect for such applications as airline ticketing, invoicing, order preparation and more. And another example of the expanding TermiNet 200 printer family's application versatility.

No-waste, flexible forms control

One reason: an adjustable tear bar that lets you use standard forms with different header lengths. For precise alignment, no paper waste and clean paper tear. Every time.

More reasons: servo-driven tractors that allow infinite manual adjustment in both forward and reverse. A non-volatile electronic VFU that makes forms set-up easy and permits storage of up to 8 vertical formats. A down-line loading option enabling you to load formats directly from your data source. Plus straight-through paper path and push-n-pull tractors that give you perfect first-to-last-copy registration. As well as smoother paper handling for all types of forms, including single-part paper.

More features add up to more application versatility

With TermiNet 200 printers, you can also get a 9 x 9 printhead for exceptionally legible underlining and lowercase descenders. Two complete 96-character switchable print fonts for ASCII/APL use or your own special needs. A choice of Magnetic Tape or Edit Buffer Accessory. Plus a 100% duty cycle capability, excellent print quality at speeds up to 200 cps and low cost of ownership. All of which help make TermiNet 200 teleprinters and line printers the industry workhorses.

Immediate delivery instead of piecemeal allocation

Why wait months for other printers when TermiNet 200 printers are available now? When you need them. Mail the coupon today and find out how the expanding TermiNet 200 printer family can meet your range of application needs and generate real cost savings.

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Quality that will make a lasting impression

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CIRCLE NO. 117 ON INQUIRY CARD

New Products

datacomm

SURGE PROTECTOR. The COMGUARD surge protector guards a remote terminal or minicomputer and its associated modem against voltage surges. The device, which wraps around a data station's cable inputs, attenuates switching transients and other electromagnetic interference by 40dB. Custom designs, OEM packaging, rack-mounted and PC plug-in versions are available. Price ranges from $215 to $350, depending on model and quantity. **Kapusi Laboratories,** San Mateo, Calif. **Circle No 270**

FIBER-OPTIC TRANSMITTER/RECEIVER SETS. The 5100 series electro-optical transmitter-receiver modules support 150M bytes of digital data communications over standard fiber-optic cables as long as 5 km without repeaters, and longer at lower data rates. Bit error rate is higher than 10^{-9}. A complete transmitter/receiver set costs $2500. **Optical Information Systems,** Elmsford, N.Y. **Circle No 271**

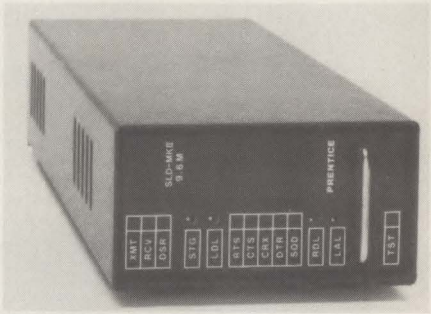
DATA LINKS. These data links for in-house and in-plant communications equipment employ RS232C-compatible short-haul modems, molded cable assemblies and metallic or fiber-optic interconnecting cable. Both metallic and optical versions support simplex and duplex asynchronous communications capabilities at data rates as high as 56K bps. Range is as much as 15,000 ft. for metallic links and 6000 ft. for optical links. Both versions include LED status indicators to aid system diagnosis. Prices are $195 and $280 for the metallic and optical modems, respectively. **Belden Corp.,** Richmond, Ind. **Circle No 272**

MODEM SHARER. The modem sharer, intended to replace multiple modems in polled networks, protects a network via a port-shutdown capability. Other features include signal regeneration, LED indicators for RTS and CTS and a loopback mode for testing. Single-unit price is $500, with quantity discounts available. **Xyquad Inc.,** St. Louis, Mo. **Circle No 273**

DIRECT-CONNECT MODEM. This answer/originate modem for handset jack connection with any modular phone is FCC-approved. Aimed at personal and small computer users, the Bell 103-compatible unit works with a single-line or 50-pin, six-line business phone. Other D-CAT features include full-duplex capability, a voice/data monitor, a hold function, a privacy button and a self-test mode. Price is $199. **Novation, Inc.,** Tarzana, Calif. **Circle No 274**

New Products

datacomm



LIMITED-DISTANCE MODEM. This multi-speed synchronous modem for private-line circuits supports transmission distances as long as 20 mi. The SLD-MKII operates in four-wire full-duplex, or two- or four-wire half-duplex modes in point-to-point or multipoint/polled networks. Other features include local and remote loopbacks, a psuedo-random self-test generator, front panel LED diagnostic indicators, internal/external clock or repeater timing modes, and solid state (CMOS) design and code transparency. The SLD-MKII is available in four models: 2400 to 9600 bps, 2400 to 14,400 bps, 2400 to 19,200 bps and 2400 to 28,800 bps. Unit prices range from $600 to $670 for the 9600-bps model to $880 to $950 for the 28,800-bps model. **Prentice Corp.,** Sunnyvale, Calif. **Circle No 275**

MODEM ELIMINATOR. The model 6100 modem eliminator is said to reduce the cost of terminal interconnection by eliminating the need for two back-to-back modems operating within 500 ft. of each other. Features include internal strap selections for primary and secondary RTS/CTS delays, RC controlled by DCD, switched-network or private-line operation, ring memory functions and clock source. The model 6100 costs $360. **International Data Sciences, Inc.,** Lincoln, R.I. **Circle No 276**

AUTO-ANSWER MODEM. The DL 212B auto-answer modem for central computer and remote multiplexor sites is compatible with call-originating Bell 103, 113 and 212 modems and may be directly connected to the switched network without requiring a data access arrangement. The dual-speed modem operates in full-duplex mode over two wires at speeds as high as 300 bps asynchronous and 1200 bps synchronous or asynchronous. It automatically identifies the calling modem and the speed of operation with no changes to existing protocols. The rack-mounted devices costs $750; an eight-modem rack, power supply and master test module costs $625. **Infotron Systems Corp.,** Cherry Hill, N.J. **Circle No 277**

The best in data base management for your micro-computer

Get the most out of your micro-computer. Use our advanced and progressive data management system.

HDBS is an extended hierarchical data base system offering
- fixed length records
- file-level read/write protection
- one-to-many set relationships

MDBS is a full network data base system offered as an upgrade from HDBS...or it may be ideal as your initial system. **Unique and versatile,** it adds these features:
- full network CODASYL-oriented data structures
- variable length records
- multiple levels of read/write protection
- one-to-one, many-to-one, and many-to-many sets
- non-redundancy of data, easy updating
- occurrences of a record type may own other occurrences of the same type
- a single set may have multiple owner and member record types

MDBS-DRS. As an add-on to MDBS, the DRS system offers extraordinary flexibility in data base restructuring to meet new needs.
- Item, record, and set types can be added, deleted, or renamed in an existing data base as well as other data base characteristics. You can redesign the data base after it is already on-line!

MDBS-RTL. As an add-on to MDBS, the RTL (Recovery Transaction Logging) logs all data base transactions, so that in the event of a system failure, the data base can be recovered with minimal loss of information.
- The recovery processor permits selective reloading of the data base from the transaction file. Users can log messages, indicate complex transaction sequences, and effect selective control over the recovery process.

MDBS-QRS. An interactive Report-Writer/Query-System for HDBS/MDBS data bases. Features...
- may be customized for non-technical users
- complex retrieval conditions may be specified
- detailed reports can be quickly generated
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HDBS and MDBS Packages Include:
- DDL data definition language analyzer/editor
- 260-page users manual
- DMS data management routines callable from host language
- Sample application program and DDL files
- Relocator to re-org all routines
- System specific manual for bringing up our software

54-page "primer" on data base systems for micro-computers — only $10.00 per copy.

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  - OASIS
  - TRSDOS and NEWDOS (Models I and II) with Disk BASIC
  - North Star DOS with North Star BASIC
  - Apple DOS and Applesoft BASIC
  - Machine Language Interface available on all above systems.
- Up to 254 record-types definable in the data base; each record-type may contain up to 255 item-types; each item-type may be up to 9,999 bytes in length.
- Names of data items, records, sets, and files are wholly user definable.
- Commands to add, delete, update, search, and traverse the data base.
- Straightforward use of ISAM-like structures.
- Records can be maintained in several sorted orders.
- Written in machine language for maximum execution efficiency and minimal memory usage.
- Independent of types and sizes of disk drives. Support data base spread over several disk drives (max.8); disks may be mini- or full-sized floppies or hard disks.
- Available versions: Z80 (requires approx. 18K), 6502 (approx. 30K), 8080 (approx. 22K) Total memory requirement must allow for buffer areas. For Apple users, a language card is recommended.
- 8086 version available. (Call or write for details and prices.)

Ordering information (applicable to Z80, 8080 and 6502 versions):

HDBS (Version 1.04)	$ 300.00
MDBS (Version 1.04)	900.00
DRS	300.00
RTL	300.00
QRS	300.00
HDBS upgrade to MDBS	650.00
MDBS with DRS, RTL, and QRS	1500.00
HDBS/MDBS Manual	35.00
DRS Manual	5.00
RTL Manual	5.00
QRS Manual	5.00
System Specific Manuals (each)	5.00

Within a given operating system, add $125.00 for each additional language selected.

For prices outside the U.S. and Canada, please ask for price lists.

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4. CP/M® - Microsoft BASIC 5.XX
5. CP/M® - Microsoft BASIC or FORTRAN Compiler
6. CP/M® - Microsoft COBOL-80
7. CP/M® - InterSystem PASCAL/Z
8. CP/M® - Sorcim PASCAL/M
9. CP/M® - Digital Research PL/I
10. CP/M® - Micro Focus CIS COBOL
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CIRCLE NO. 122 ON INQUIRY CARD

New Products

printers

MICROPROCESSOR-BASED PRINTER SYSTEMS. The HPI-33 printer system for use with Hewlett-Packard 300/3000 Series 30/33 minicomputers supports printing speeds as high as 1800 lpm. The controller includes a Z80 microprocessor and an Intel 8291 talker/listener for interfacing with the GPIB. Three modes of operation are available. In program-control mode, the Z80 handles all control, status and identification operations to the GPIB through the talker/listener. In transfer mode, the Z80 configures the 8291 to listen and perform DMA transfers directly from the bus to the printer. And in test mode, the HPI-33 can run several diagnostic routines. The HPI-33 controller costs $2500; prices of accompanying printers range from $8200 to $31,500, depending on speed and print technology. **BDS Computer Corp.,** Menlo Park, Calif. **Circle No 282**

UNIVERSAL INTERFACE PRINTER. The model 722UA line printer accepts 20-mA current-loop, RS232, ANS/IEEE 488 and BCD input and includes provisions for device selection via a single line or a BCD decoder. All interface lines are tri-state, but can be hard-wired active high or low. Solid characters are produced at speeds as high as 2400 lpm. Maximum line length is 22 characters. Average price is $2500. **Datadyne Corp.,** Norristown, Pa. **Circle No 283**

IBM PLUG-COMPATIBLE LABEL PRINTER. The LABEL/300, a 300-lpm, large-character printer that produces labels, forms, tickets and tags, is plug-compatible with the IBM 5256 printer. The microprocessor-controlled unit can be used as a standard line printer or as a special-character printer connected to an IBM System 34 or System 38, as well as to most other computers. The LABEL 1300's commands control variable size and aspect ratio, variable background, italics, overprint and compressed print. Also included are vertical print, line drawing, OCR-A, logos and more than 12 horizontal and vertical bar codes. Command overhead is typically less than 10 percent of the actual data printed. Price is $9850. **Technical Analysis Corp.,** Atlanta, Ga. **Circle No 284**

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New Software

UNIX FOR 16-BIT MICROS. The Xenix operating system for 16-bit microprocessors is an enhanced implementation of Bell Laboratories' Version 7 UNIX operating system. An interactive, multi-user, multitasking system, it runs on the Intel 8086, Zilog Z8000, Motorola M68000 and DEC PDP-11. The design incorporates a tree-structured directory hierarchy of files in mountable file systems. Files, directories and devices can be handled identically within the file system. A process can create offspring processes that can then run in parallel. Interprocess communication features in the form of pipes, multiplexed pipes and asynchronous software interrupts support multitasking. Files, devices and interprocess pipes are read and written using identical system calls; applications can use several small general-purpose tasks instead of one large special-purpose task. **Microsoft,** Bellevue, Wash. **Circle No 285**

FORTH FOR THE 6502. This FORTH programming system for the 6502-based KIM-1, SYM-1 and AIM 65 microcomputers contains a 6502 assembler, a text editor and a cassette file-management system. Information on interfacing FORTH to a floppy disk is provided. The package sells for $94, including a user manual, a source listing and a cassette containing the object code. **Eric C. Rehnke Tech Services,** Corona, Calif. **Circle No 286**

MANUFACTURING INFORMATION CONTROL. DMICS, a manufacturing information control system for Texas Instruments 990 series minicomputers, consists of 24 application modules, including bill-of-materials processing, production scheduling, routing, material requirements, customer order releases, engineering change, job costing, inventory control, purchase orders and order entry; payroll, general ledger, payables, receivables and sales analysis are also available. The system, supported by a data dictionary, has screen and report program generation utilities and a documentation package. A single-user license sells for $10,500 to $28,000. **Datatype Manufacturing Systems, Inc.,** Livonia, Mich. **Circle No 287**

DATA ENTRY. The EasyEntry system for DEC PDP-11 and VAX computers supports data entry on a variety of CRT terminals. An interactive screen editor enables a user to create and maintain his own library of forms. Range and validity checks can be applied and fields can default to values contingent on values in other fields. Split-screen forms and forms-chaining facilitate development of complex applications, and multiple forms libraries, each with many forms, enable applications to be developed and tested without disrupting existing production work. EasyEntry tasks are regular tasks under the RSX-11M, IAS, RSTS/E and VAX/VMS operating systems. A single-machine perpetual license sells for $4000, including one year of maintenance support. **Applied Information Systems, Inc.,** Chapel Hill, N.C. **Circle No 288**

PARTS INVENTORY. This parts-inventory system for the Radio Shack TRS-80 computer creates a master file for all parts to be held in inventory. For each one, it gives the part number, description, number on hand, cost for each, total cost, sales price for each and total sales dollars. A minimum stock amount can be entered to produce a reorder report showing the number on hand and how many to reorder to restore the minimum stock level. Price is $495. **Custom Tailored Software, Inc.,** Wayne, N.J. **Circle No 289**

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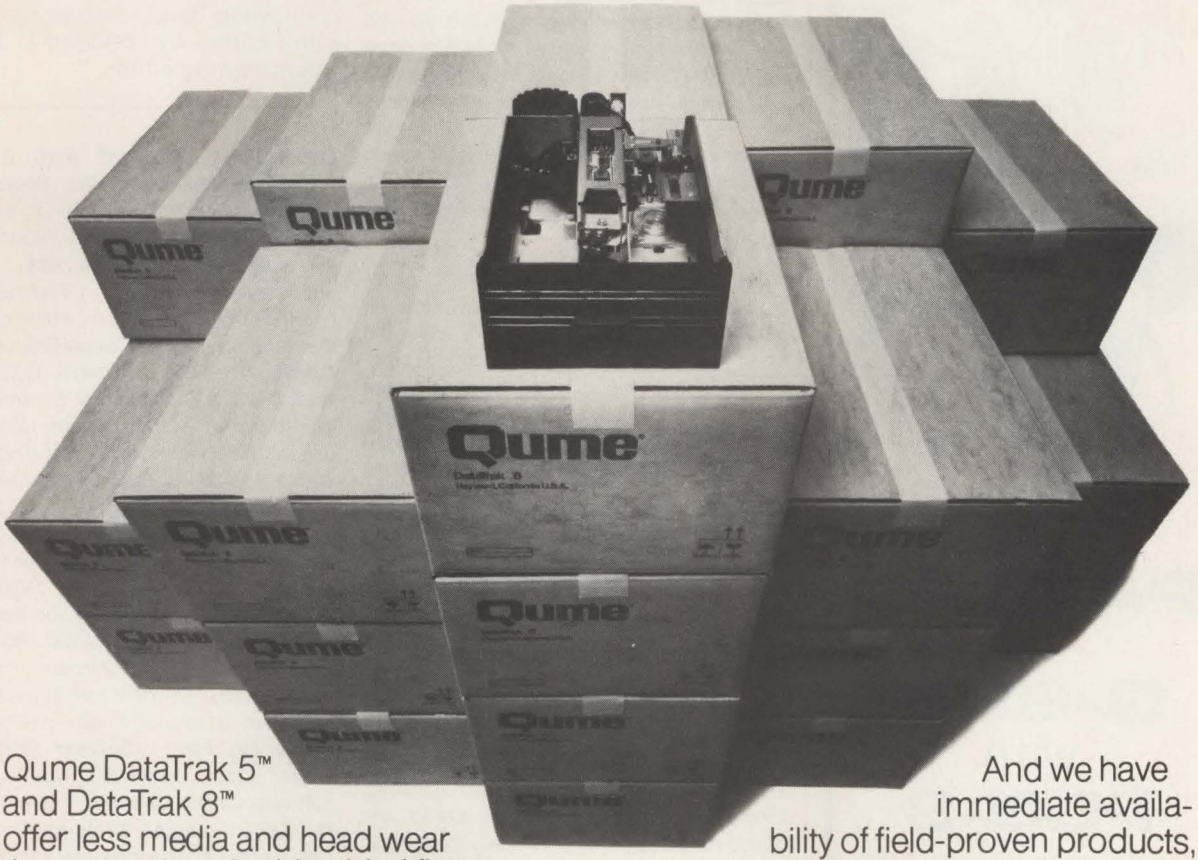

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CIRCLE NO. 128 ON INQUIRY CARD

New Software

UNIVERSAL GRAPHICS. Template, a set of general-purpose computer-graphics subroutines written in FORTRAN, incorporates the ACM Siggraph Core Standards. Features include 2D and 3D line drawing and text generation, user-definable viewing environments, structured archiving of graphic objects, general axis generation, color definition and selection, display of 21 character fonts and a virtual display-surface capability. The package runs on 24-bit or larger processors with vector refresh, storage tube or color raster displays, flatbed or drum pen plotters, COM recorders, alphanumeric line printers and interactive alphanumeric terminals. Template leases for $1000 per month, plus an installation charge of $4000 per computer system. **Megatek Corp.,** San Diego, Calif. **Circle No 290**

WORD PROCESSING. The PWS word-processing/list-processing system runs on DEC PDP-11 and LSI-11 computers under the RT-11 operating system. Formatting commands determine spacing, margins, page length, tabulation, indentation, justification and hyphenation. Formatting can be changed as often as necessary, as copy is being entered or after entry is completed. The system's list-processing feature enables it to sort and merge a list of names and addresses into a business letter to create individualized correspondence. A forms generator enables an authorized user with no programming experience to use user-defined input screens to create and maintain a data file. Other features include automatic outline formatting, multilevel superscripts and subscripts, table protection (no page breaks), automatic indexing and creation of tables of contents. Single-unit price is approximately $2300, with OEM discounts available. **Plessey Peripheral Systems,** Irvine, Calif. **Circle No 291**

MANUFACTURING PLANNING AND CONTROL. MAC-PAC/HP, a discrete manufacturing control package for HP 3000 computers, is intended for companies with annual sales of $20 million or more. A basic system includes design engineering, inventory control, material-requirements planning and on-line communications modules. This system can be augmented with a variety of additional modules. Implementation support includes documentation, customer training, assistance in organizational and procedural aspects of implementation and program modification for special customer requirements. The task-driven system is written in COBOL and operates in on-line and batch modes, using Hewlett-Packard's IMAGE data base manager. A single-CPU license for the basic system sells for $49,000, plus implementation support. **Far-West Data Systems, Inc.,** Irvine, Calif. **Circle No 292**

Mini-Micro Systems receives dozens of news releases each week about new software products that may not warrant the detail included in the foregoing New Software section. Nevertheless, we don't want to deny readers the opportunity to get more information about the latest software developments. Toward that end, we offer the following brief entries, compiled and edited by Malcolm L. Stiefel, contributing editor.

OPERATING SYSTEMS AND UTILITIES. Hemenway Associates, Inc., Boston, Mass., introduces a disk operating system . . . **Circle No 420** . . . and floating-point subroutines . . . **Circle No 421** . . . for the 68000 microprocessor . . . Information Engineering, Newmarket, N.H., enhances an OS that runs on Intertec's SuperBrain computer. **Circle No 422 . . . Heath Co.,** Benton Harbor, Mich., announces a screen editor, text formatter and file-transfer utility running under the Heath disk operating system. **Circle No 423 . . . International Mathematical & Statistical Libraries, Inc.,** updates its library of FORTRAN mathematical and statistical subroutines and its finite-element program. **Circle No 424 . . . Vydec, Inc.,** Florham Park, N.J., offers a sort option for its text-editing systems. **Circle No 425 . . . Quality Systems,** Chicago, offers an audit-trail routine that is said to track changes in source programs in any on-line system. **Circle No 426 . . . Selanar Corp.,** Santa Clara, Calif., unveils graphics-plotting software for the Decwriter II terminal. **Circle No 427 . . . Legler Systems Co.,** Orinda, Calif., announces a disk-record dump and a cross-reference dictionary for the IBM Series/1 computer. **Circle No 428 . . . Unique Automation Products, Inc.,** Irvine, Calif., releases its remote job-entry software for DEC PDP-11 computers running under the RSX-11M operating system. **Circle No 429**

LANGUAGES AND DEVELOPMENT TOOLS. Digital Research, Pacific Grove, Calif., updates its PL/1 compiler for 8080, 8085 and Z80 microprocessors running under the CP/M or MP/M operating system. **Circle No 430 . . . Digital Equipment Corp.,** Maynard, Mass., announces a PL/1 compiler for its VAX-11/780 computer. **Circle No 431 . . . Softronics,** Roosevelt, N.J., introduces an APL for microcomputers running under CP/M. **Circle No 432 . . . Hewlett-Packard Co.,** Palo Alto, Calif., has two offerings of interactive graphics software for the HP 3000 computer, **Circle No 433 . . .** and an enhanced FORTRAN for the HP 1000 computer, **Circle No 434**

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CIRCLE NO. 132 ON INQUIRY CARD

New Literature

MAGNETIC MEDIA. A line of floppy disks, data cassettes and magnetic cards are described in a brochure. The six-page pamphlet covers design, specifications and performance characteristics. **Dennison KYBE Corp.,** Waltham, Mass.

Circle No 293

LOGIC PROBES. A line of hand-held logic probes is detailed in a brochure. The four-page publication describes the 700 Series and LP-450 logic probes and the HL-480 universal pulser. The illustrated brochure includes technical specifications. **Kurz-Kasch, Inc.,** Dayton, Ohio.

Circle No 294

LABORATORY RECORDER. The Sabre IV all-band laboratory magnetic-tape recorder/reproducer is detailed in a brochure. The 14-page publication, which includes numerical charts and diagrams, describes tape transport, specifications, servicing and accessories. The illustrated brochure also examines the TC 14 digital-time base corrector. **Sangamo Data Recorders,** Sarasota, Fla. **Circle No 295**

KEYBOARD INTERFACE. Micromotion membrane keyboards, which provide switching, input and graphics display functions, are detailed in a booklet. The four-page publication lists applications for the keyboards, including programmable appliances, control devices, telecommunications, computer-peripheral equipment, calculators and games. The booklet also covers technology and manufacturing capabilities. **Rogers Corp.,** Chandler, Ariz.

Circle No 296

DUMB TERMINALS. A line of dumb video-display terminals is described in a brochure. The four-page publication examines the ADM-3A and the ADM-3A+ dumb-terminal consoles. The booklet also includes specifications, options and photographs. **Lear Siegler, Inc.,** Anaheim, Calif.

Circle No 297

DISK-STORAGE SYSTEMS. The DD 70 series disk-storage systems for PDP 11/70 processors are described in a brochure. The booklet details performance and system software compatibility. The brochure also includes a diagram of a typical system configuration and a table that provides specifications for the six-model series. **DIVA,** Eatontown, N.J. **Circle No 298**

SWITCHING POWER SUPPLIES. More than 120 models of switching power supplies are described in a catalog. The brochure includes AC-DC models and 115-VAC or 230-VAC inputs and DC-DC models with 12- to 125-VDC inputs. The catalog, which lists prices and specifications, also describes the Univerter switching circuit. **Etatech, Inc.,** Placentia, Calif. **Circle No 299**

MINICOMPUTER ACCESSORIES & SUPPLIES. A line of minicomputer accessories and supplies is described in a catalog. The 36-page booklet lists media and computer products, custom and DEC-compatible cables, muiltipoint paper shipping and BASF floppy and minifloppy disks. The catalog also includes a disk tote, screen cleaner and dust covers for terminals and printers. **Misco, Inc.,** Holmdel, N.J. **Circle No 300**

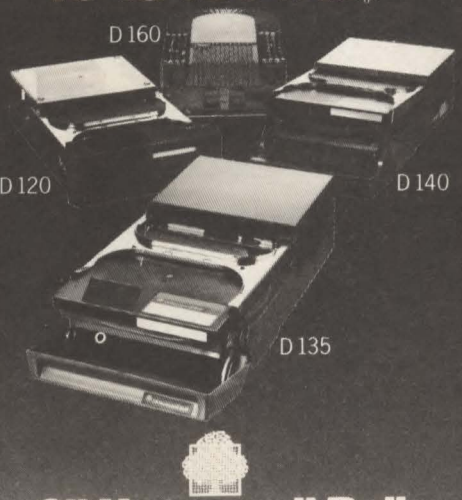
LOCAL DATA NETWORKS. A line of access network communications products for local data networks is described in a brochure. The pamphlet describes limited-distance modems, line drivers, coaxial cable modems, microwave modems, FM systems and

random-access carrier current modems. The brochure also provides application diagrams for digital and analog transmission, including FM-FDM multiplexing. **Data-Control Systems,** Danbury, Conn. **Circle No 301**

INDUSTRIAL MICROCOMPUTERS. A line of modules, desk-top systems, system software packages and support equipment is detailed in a catalog. The 40-page booklet describes more than 180 modules and industrial microcomputer multifunction modules, 8-bit microcomputers and floppy disk-based microprocessor systems. The catalog also lists chassis, power supplies, I/O modules, CRTs, printers, Industrial Pascal, FORTRAN compilers, BASIC interpreters and high-density EPROM programmers. **Xycom, Inc.,** Ann Arbor, Mich. **Circle No 302**

DATA COMMUNICATIONS. A line of data-communications products is described in a catalog. The eight-page publication includes the Micro400 local data set and Micro5000 intelligent modem series. The catalog also discusses line costs, transmission errors and computer port use. **Micom Systems, Inc.,** Chatsworth, Calif. **Circle No 303**

SWITCHES. A line of miniature and subminiature switches is described in a catalog. The 32-page pamphlet covers slide switches, rotary and pushbutton switches, panel indicator lights, toggle switches and lamp holders. The catalog also provides photos, line drawings, specifications and ordering information. **Chicago Switch, Inc.,** Chicago, Ill. **Circle No 304**



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MEASUREMENT-AND-CONTROL PRODUCTS. A line of measurement-and-control products is detailed in a catalog. The 40-page booklet describes standard data-conversion products, signal-conditioning products, temperature instrumentation, digital panel instruments, power supplies, computational circuits and monolithic integrated circuits. The catalog also lists specifications, prices, technical publications and subsystems. **Analog Devices,** Norwood, Mass. **Circle No 305**

LOCAL DATA SET. The Micro400 local data set series, designed for short-range transmission, is detailed in a brochure. The booklet describes the series, which includes asynchronous and synchronous versions of line drivers for use over customer-owned, twisted-pair cable and local data sets for private-line metallic circuits. **Micom Systems, Inc.,** Chatsworth, Calif. **Circle No 306**

MICROCOMPUTERS. A line of microcomputer products is detailed in a brochure. The 36-page book describes hardware, software and system configurations for Digital Equipment Corp.'s LSI-11 series, and systems from other manufacturers, including Apple, Commodore and Texas Instruments. The catalog also lists microcomputer books, supplies and peripherals, prices and technical information. **CompuMart Corp.,** Cambridge, Mass. **Circle No 307**

BACK PLANE SYSTEMS. A line of back plane systems is described in a catalog. The 20-page design guide details printed circuits, metal and SEM/NAFI panels and connectors. The catalog also includes technical data and suggestions for dimensioning procedures. **TRW Cinch Connectors,** Elk Grove Village, Ill. **Circle No 308**

New Literature

LITERATURE THAT COSTS

SMALL BUSINESS COMPUTERS. Information on purchasing small business computers is provided in "The Insider's Guide to Small Business Computers." The 70-page book discusses how to select computer hardware and software, the trade-offs between buying application software packages and developing customized applications, how to analyze a computer's cost-effectiveness and how to calculate the time it will take for the computer to pay for itself. The $6.95 guide also includes an audio cassette tape containing interviews with businessmen on how computers have benefitted their companies and a summary of the contents of the guide. **Data General Corp.,** Route 9, Westboro, Mass. 01581.

DATA COMMUNICATIONS. An introduction to data communications is presented in "Data Communications for Minicomputer Users." The 80-page booklet is intended for use with a one-day seminar offered in 49 cities. It explains how to connect terminals located at a distance from the computer. The $15 publication contains more than 35 illustrations, a data communications glossary and reference charts for standards such as the ASCII code set and the EIA interface circuit designation. **Micom Systems, Inc.,** 9551 Irondale Ave., Chatsworth, Calif. 91311.

DATA DICTIONARY USE. Information on data dictionary applications is provided in "The Data Dictionary in Systems Development." The 125-page, illustrated book outlines the relationship between the data dictionary and the phases of systems development. The $15 publication also covers the dictionary's uses in structured analysis, with business systems planning and as a development control tool in multinational, multisite environments. **MSP, Inc.,** 21 Worthen Road, Lexington, Mass. 02173.

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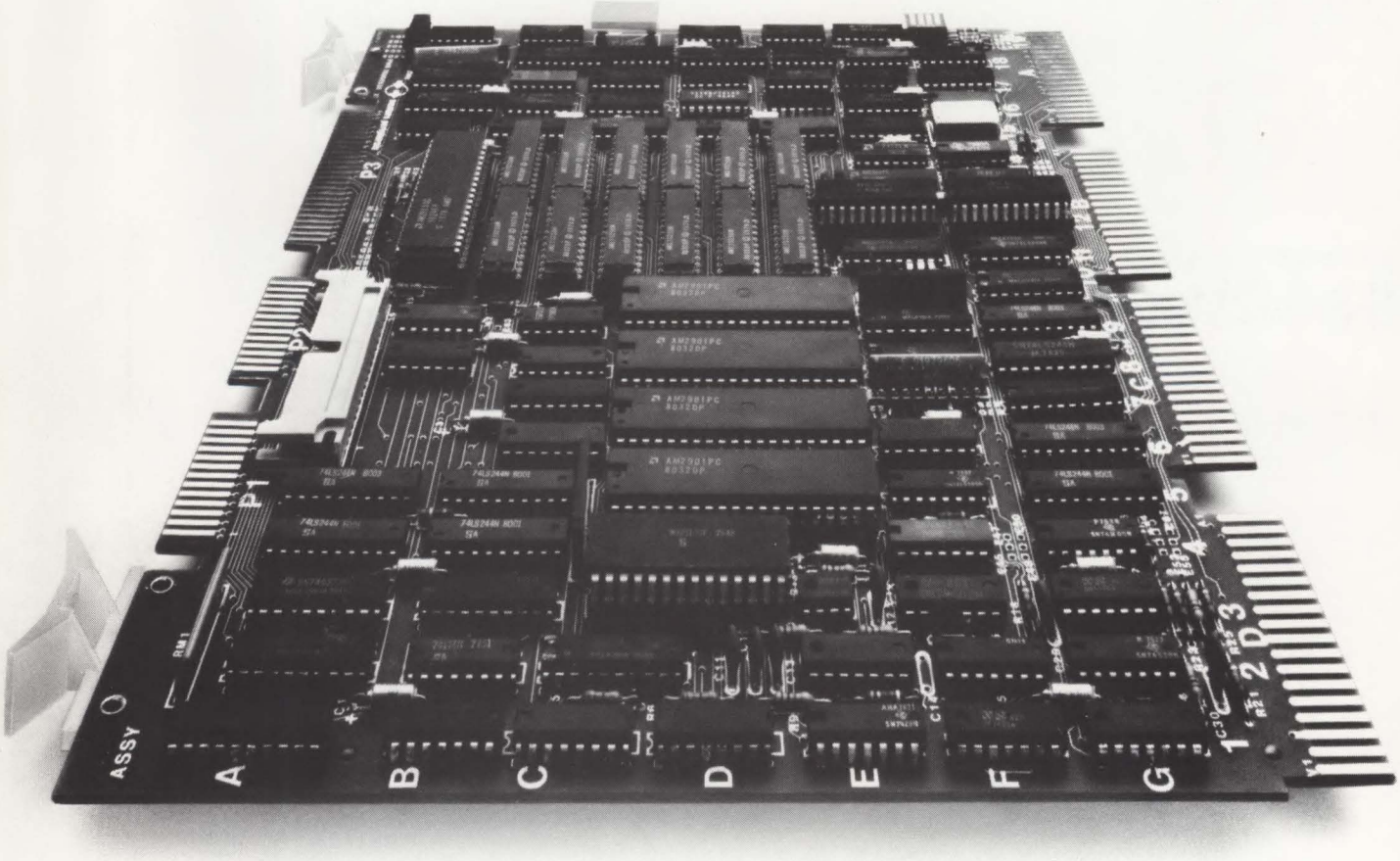

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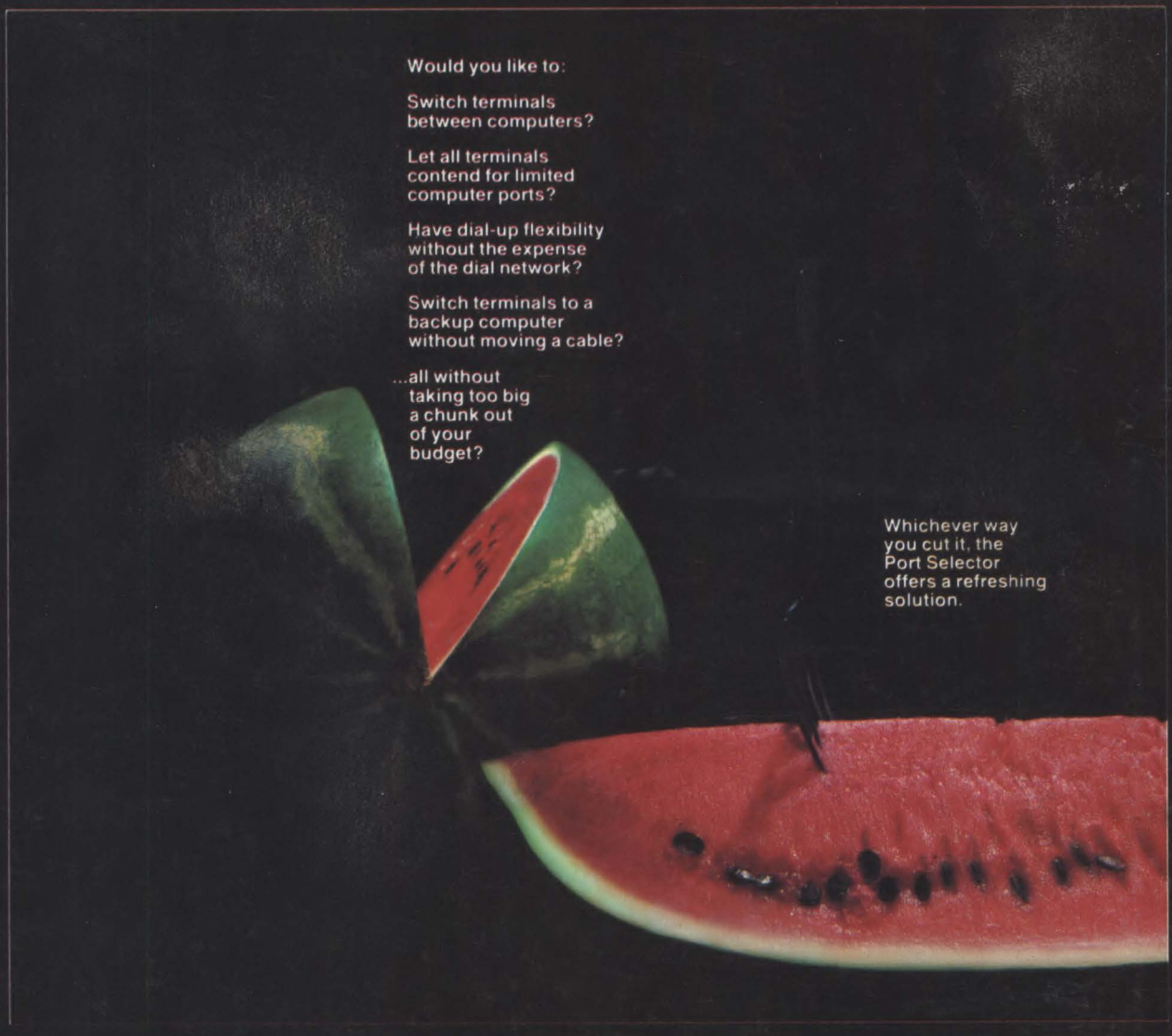

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