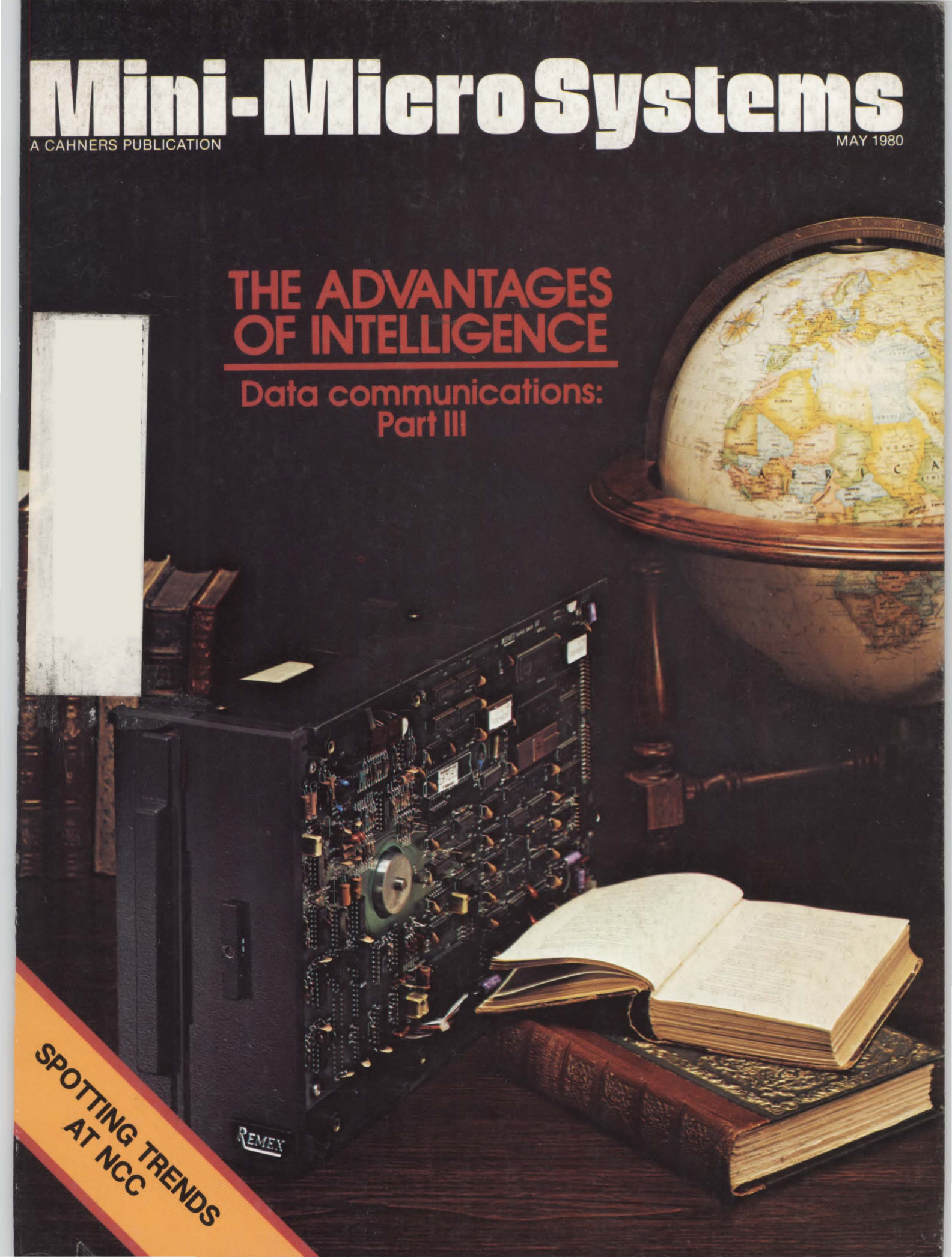
Mini-Micro Systems

A CAHNERS PUBLICATION

MAY 1980

THE ADVANTAGES OF INTELLIGENCE

Data communications: Part III



SPOTTING TRENDS AT NCC

Fastest Data On Two Reels

The winners—Model 9300 (125 ips) and 9100 (75 ips) Vacuum Column Tape Transports. They're the fastest—and most dependable in their circuit.

Speed isn't their only advantage—they handle beautifully. Data densities of 200/556 cpi or 556/800 on the 7-track unit and 800 cpi, 1600 cpi or 800/1600 cpi on the 9-track. The format is NRZ1/PE.

They're fully equipped, with features such as capacitive tape-location detectors for improved tape life, hard coated read-after-write heads to reduce tape wear, crystal controlled timing, front-accessible test panel—all the features that make Kennedy tape transports the industry standard.

Just one thing—don't expect a deep-throated roar when you start up. Models 9100/9300 have the lowest noise levels in their class. Typically Kennedy—fast, reliable and quiet.

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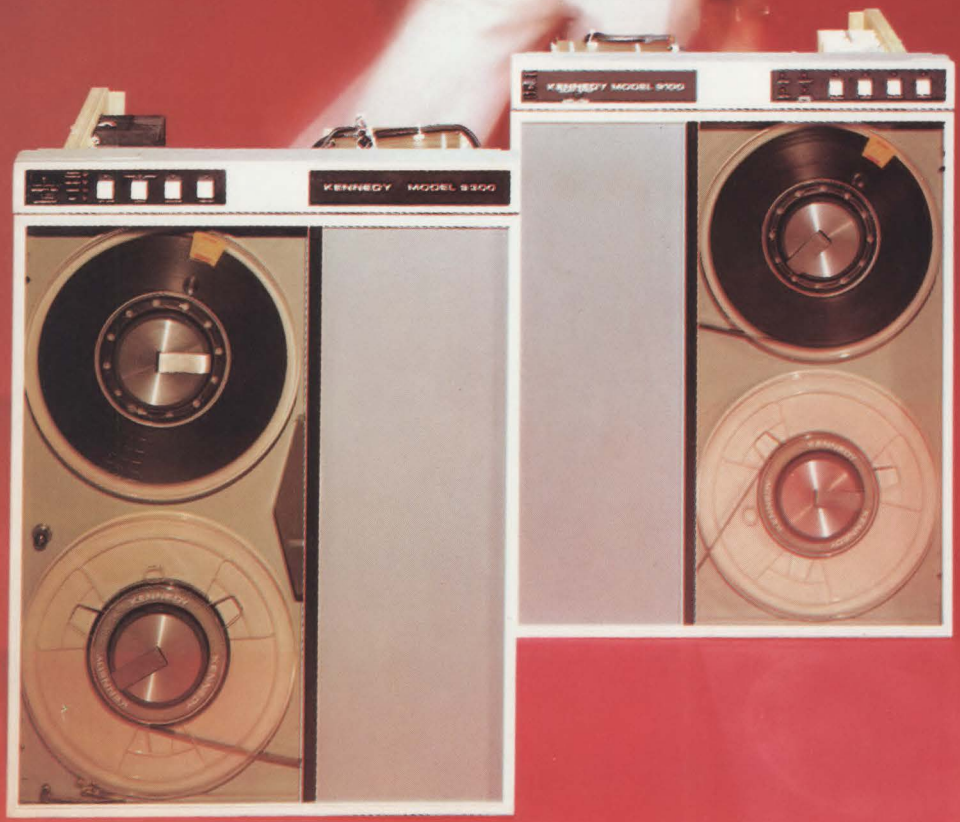
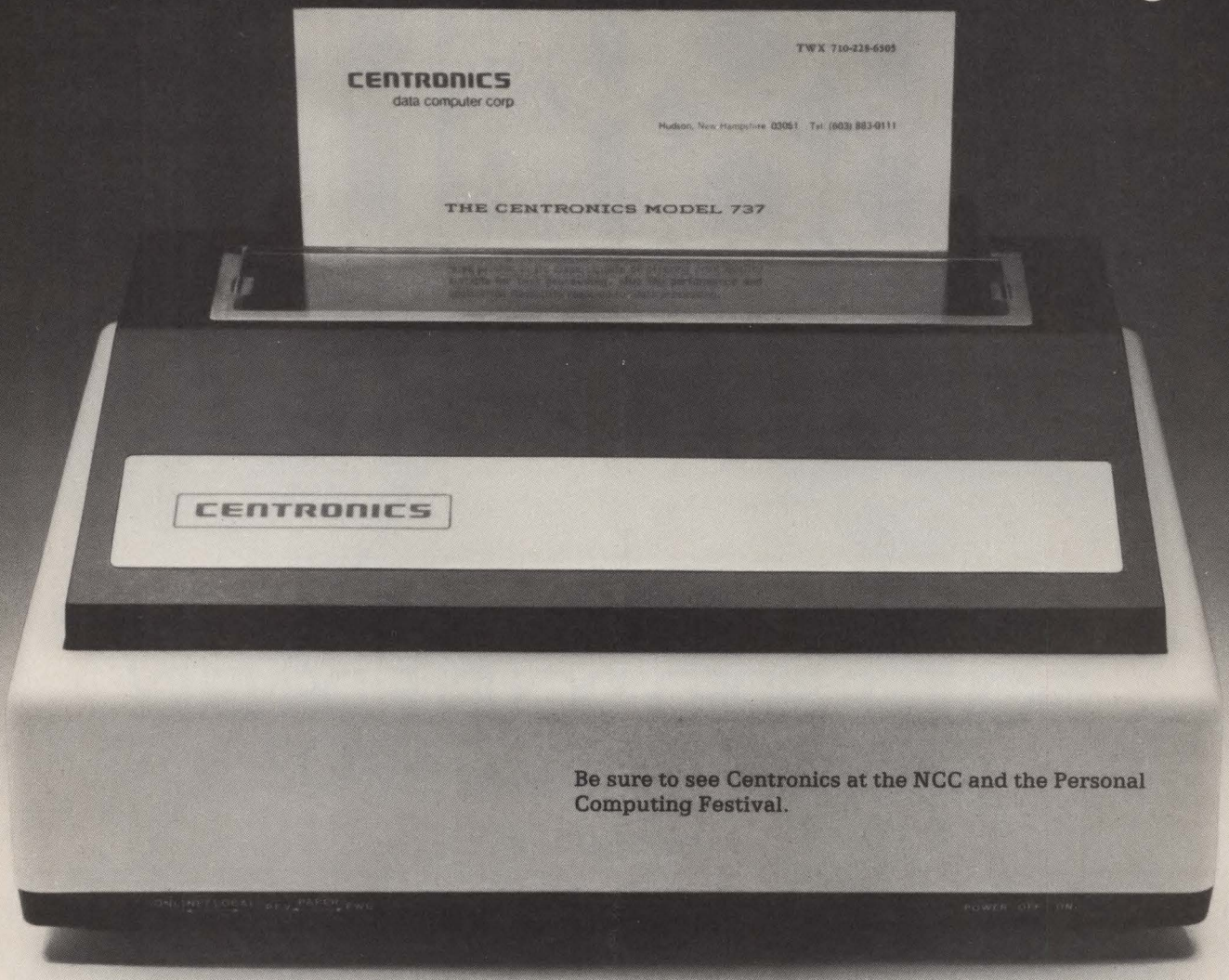


KENNEDY • QUALITY • COUNT ON IT

CIRCLE NO. 1 ON INQUIRY CARD

CENTRONICS MODEL 737: The Advantage for Low Cost Word and Data Processing



Be sure to see Centronics at the NCC and the Personal Computing Festival.

The flexibility and print quality OEMs need is here now. The new Model 737 is the small business printer versatile and reliable enough to meet almost any systems requirement. It's the first low-cost printer to offer print quality suitable for text processing plus the performance and applications flexibility required for data processing and electronic mail. And this latest Centronics breakthrough is priced under $1000 in the U.S.A.

Outstanding Print Quality

Model 737 is the first small business printer to offer correspondence quality printing. 18 x 9 dot matrix provides high-quality characters with true descenders as well as underlining. Proportional spacing, the ability to justify right margins and serif typeface makes the 737 ideal for text processing applications. Standard business data processing spacing of 10 and 16.7 characters per inch are also resident in the 737, allowing for applications ranging from letters to aged accounts receivable reports. The steel platen assures crisp, clean print impression.

Unexpected Features

Leave it to Centronics to have some surprises in the new Model 737. You get the ability to print subscripts and superscripts. Especially attractive to OEMs requiring superior print appearance and/or chemical or mathematical applications. Centronics gives you its field proven 700 Series printhead, stepper motor paper drive, fewer moving parts, microprocessor electronics and high volume production to achieve reliability that you wouldn't expect in a compact, low-cost printer.

The 737 is quiet. An optional acoustic cover makes it ideal for office environments.

Pick Your Paper

Run letterhead paper for correspondence, roll paper for general information, or fan-fold paper for standard data processing (payroll, billing, inventory, etc.). You can, with the 3-way paper handling ability of the Model 737.

The Printer of the Future... Today

Never before has one printer offered such high quality, reliability, and applications flexibility at such low cost.

Another workhorse in the Centronics 700 Series is the 730, if you don't need the correspondence quality of the 737. Delivers 100 c.p.s. at even greater savings.

Why Wait?

The new Model 737 is now available for delivery. Call Ance Thatcher, (603) 883-0111. Centronics Data Computer Corporation, Hudson, New Hampshire 03051, or any of our 15 U.S.A. or 9 international sales offices.

All Centronics products are supported by the largest worldwide service network of any independent printer company.

CENTRONICS® PRINTERS
...the advantage

CIRCLE NO. 2 ON INQUIRY CARD

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DOUBLE SIDED. DOUBLE DENSITY. DOUBLE THE DEC® RX02.

FULL RX02 COMPATIBILITY—HARDWARE, SOFTWARE, AND MEDIA.
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BUILT-IN BOOTSTRAP—CONFIGURE AN ENTIRE LSI SYSTEM IN A FOUR-SLOT BACKPLANE.

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MMS 5/80

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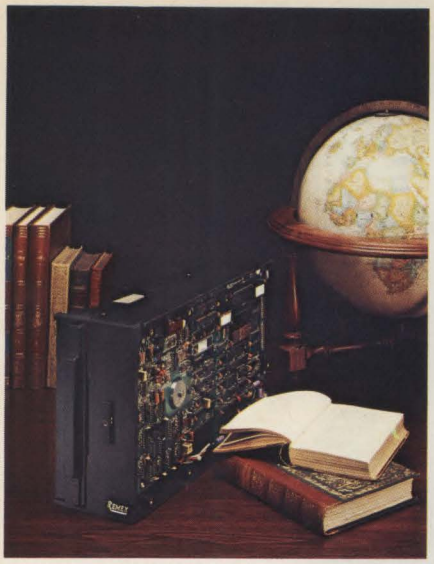
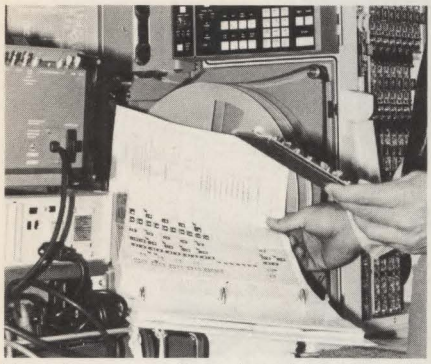
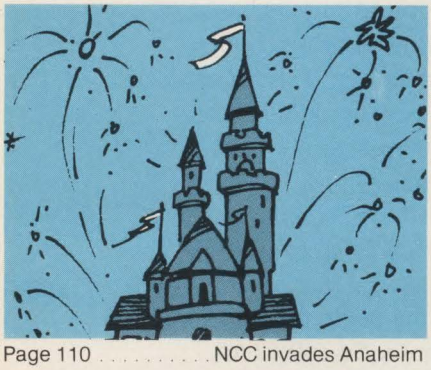
CIRCLE NO. 3 ON INQUIRY CARD



Small size and reduced cost are just two of the advantages of building intelligence into a floppy-disk drive. See p. 134. Photo courtesy of the Remex division of Ex-Cell-O Corp. Photo by Gary Ramsey; art direction by Gary Watson.



Page 47 . . . . . Boom in peripheral rentals



Page 110 . . . . . NCC invades Anaheim

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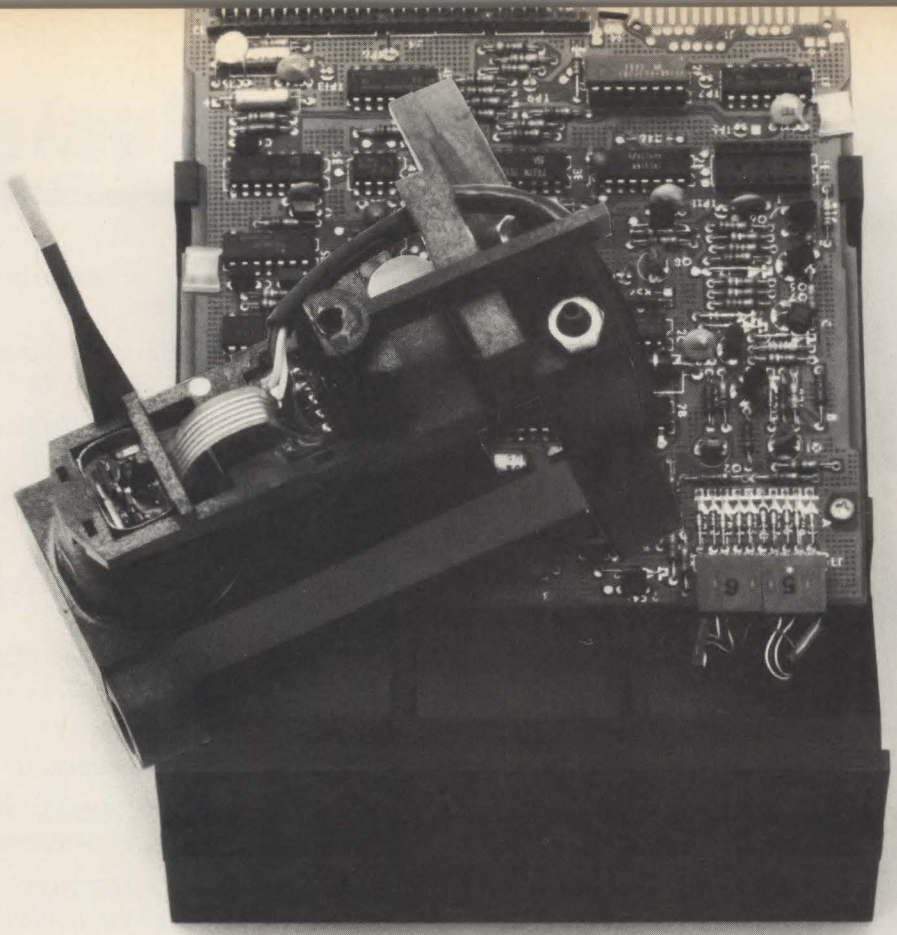
FEATURES

MINI-MICRO WORLD

DEPARTMENTS



Tandon Drives. Heads above the Rest

For years, Tandon Corporation has been designing and manufacturing read/write heads for most major flexible disk drive manufacturers. Their heads are currently in over 1,000,000 field operable units, and deliver a standard of reliability that is positively unmatched.

Tandon now introduces their own mini-floppy disk drive. The TM-100 family consists of four models, and offers the widest range and the highest storage capacities of any 5¼" mini-floppy. What's high? Try 250K to 1000K bytes of storage. With a track-to-track access time of 3 to 5 ms. And a price that is lower than any other comparable unit.

The TM-100 series design is based on Tandon's patented head design and superior head technology. This guarantees 20,000 hours of wear in media contact, and at least 4×10^6 passes per track. Tandon's unique head finish eliminates the need for a head load solenoid. The heads needn't be unloaded even if not reading or writing!

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Tandon

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Heads above the rest in disk technology.

CIRCLE NO. 4 ON INQUIRY CARD

SEL TO UNVEIL LOW-END SUPERMINI

Continuing an industry trend, Systems Engineering Laboratories this month will introduce its lowest-priced 32-bit machine to date, the model 32/27. Mike Coffee, model 32/27 product marketing manager, says that a basic configuration including the 32/27 CPU, two I/O channels and 256K bytes of memory will sell for $24,900 — about $6000 less than its previous low-end 32-bit minicomputer, the model 32/30A. However, the new machine has only about 85 percent of the 32/30A's speed, Coffee says, because it uses firmware instead of hardware to implement floating point instructions. The system fits between the DEC PDP-11/44 and low-end 32-bit machines like the Perkin-Elmer 3220. The 32/27 uses eight AMD 2901 bit-slice microprocessors, and can be squeezed into a single chassis slot. Other SEL processors, which use discrete logic, require four boards or more to implement the same functions, Coffee says. In addition to the new CPU, the 32/27 will also include a new 16-bit microprocessor-based I/O channel compatible with the IEEE-488 bus protocol.

BUY YOUR DISK BACKUP AT FOTOMAT

The first Winchester backup hardware to use video cassettes may make its appearance by the end of this year. Under development at Belmont, Mass.-based Pixel Corp. is a 270M-byte transport that company officials claim provides data transfer rates at speeds up to 20K bytes per second. Said to be priced at less than $2000 in OEM quantities, the new device, called the Back-up 270, runs on inexpensive consumer-grade VHF video tape and incorporates a high-speed helical-scan recording head. As a result, says Pixel president Bill Southworth, a given disk file can be quickly replicated on tape as many as 17 times, guaranteeing data integrity despite bit dropouts. The video cassette drive is aimed at what Pixel sees as a gap between lower-cost, lower-capacity tape cartridge drives, and high-speed (100K bytes/sec.) ½-in. "streaming" transports, says the head of the six-man Infoton spin-off. The drive may be followed by an as-yet-unnamed 1G-byte, 80K-byte-per-sec. device, and a Winchester-based module incorporating an 8-in. drive, once venture capital funding is firmed up.

LANIER SEEKS FACTORY DATA-COLLECTION MARKET

Lanier Business Products, Inc., manufacturer of stand-alone word processors and dictating equipment, with $180 million in revenues last year, is branching into the source data collection market. Its announcement on May 8 of the ALERT shop-floor control system enters Lanier into competition with Digital Equipment Corp., Texas Instruments and Hewlett-Packard. Company vice president George O'Leary says, "We think there is a lot of similarity between office and factory productivity," adding that ALERT is the first step by Lanier toward more of a push into distributed environments, communications and sophisticated data bases. ALERT can support more than 500 hand-held data entry terminals, each costing less than $100, on multidrop lines. The low cost per terminal means that each factory machine can be coupled with an associated terminal to measure conformance to standards, and to gauge machine and worker efficiency. A configuration with 250 terminals, one Computer Automation 16-bit Naked mini, two 80M-byte disks, a backup tape logger to 3.5M bytes and a printer will sell for $150,000

SHUGART SUPPORTS TAPE CARTRIDGE DRIVES

Shugart Associates has incorporated tape-cartridge backup into a newly announced SA1400 disk-drive controller that will tie the Sunnyvale, Calif., Xerox subsidiary's SA1000 (8-in.) and SA4000 (14-in.) Winchesters to the 10M- and 20M-byte ¼-in. drives announced earlier this year by Data Electronics, Inc. (DEI), San Diego (MMS, February, p. 26). Given Shugart's dominant position in the low end of the Winchester market, many feel that its decision to work with DEI to develop the controller may put an end to the lingering controversy over the use of tape-cartridge drives as low-end Winchester backup. "The market is finally coming to accept ¼-in. media," reports industry consultant Ray Freeman, Santa Barbara, Calif. "Shugart's decision is sure to hasten this trend."

Breakpoints

QUARK TO COMPETE AGAINST LARK

Watch for Memorex Corp.'s Santa Clara, Calif.-based Mini Disc Drive subsidiary to unveil its model 201 8-in. disk-cartridge Winchester this month at the National Computer Conference. Code named "Quark," the device will have 12.5M bytes of removable media and 12.5M bytes of fixed Winchester media, compared to the 8M bytes fixed, 8 removable found on Control Data Corp.'s "Lark" drive, also scheduled for an NCC debut (MMS, April, p. 69). Information related to the 201's cartridge technology is unavailable, however, as are the 201's bit and track densities, interface specifications, pricing and delivery schedule. It is known that the device will operate at a transfer rate of 1.2M bytes per second and an average access time of 20 msec. Data on the Memorex drive will be formatted at 19,968 bytes per track, compared to the SMD-compatible 20,672 specified on the Lark.

MEMOREX, FUJITSU CHART 8-INCH STRATEGY

Also look for Memorex Corp. to sign a new joint venture manufacturing and distribution agreement with Fujitsu. Covered under the arrangement, say industry sources, will be the Santa Clara, Calif.-based hardware vendor's model 101 8-in. Winchester-disk drive, with the 201 disk-cartridge drive (see above) also reportedly under consideration. Memorex's deal with Fujitsu will parallel the agreement announced earlier this quarter with Olivetti, with one exception — Fujitsu will not get a piece of Memorex' Mini Disc Drive R & D subsidiary. One obstacle to the agreement, however, concede company insiders, could be a previously negotiated joint venture between the two firms to manufacture Memorex 14-in. drives in Japan. Fujitsu owns a substantial piece of neighboring Amdahl Corp., which is in merger negotiations with Storage Technology Corp. — Memorex's arch rival in the plug-compatible disk drive market.

GOVERNMENT'S TEMPEST COULD BE WORD-PROCESSING BOON

Manufacturers of word-processing equipment are just beginning to tap what could be the fastest-growing segment of that market: word processors designed to conform to rigid federal standards for very low radio frequency interference (RFI). The government's so-called Tempest requirements for word processors stipulate that RFI levels be less than 10 microvolts/meter (a game connected to a TV transmits more than 100 microvolts/meter). That low level can be achieved by shielding against leakage. The government's concern, including that of major buyers in the Defense Intelligence Agency, Departments of Defense, Army and State, is that data leaking from work-processing hardware through RFI may be obtained by unauthorized users. That concern prompted establishment of the RFI requirement, and a subsequent scramble by vendors to have their equipment qualify, because the U.S. government — the largest single buyer of word-processing equipment in the world, according to one source — purchased $300 million in word-processing equipment last year.

Only one unnamed supplier's hardware has been formally qualified as a Tempest-approved product, but two of the latest entries designed for that market are competing to be listed on the government's preferred product list: CPT Corp. and Lexitron Corp. Wang Laboratories and Vydec, Inc., are already selling hardware that has not formally qualified, with NBI, Lanier and Xerox expected to enter. "We can feel the competition's hot breath," says a source at Wang.

PRIAM ADDS LOW-END 8-INCH WINCHESTER

Priam Corp., already offering a line of 33M- and 66M-byte 14-in. Winchester-disk drives as well as 20M- and 34M-byte 8-in. devices, has also moved into the low-end 8-in. Winchester market. Available in evaluation quantities by July, say company sources, will be 5M- and 10M-byte 8-in. (200mm) drives equipped with stepper motors. The new hardware is aimed squarely at the market now targeted by Shugart Associates, Memorex and Santa Clara, Calif., newcomer Quantum Corp.

The two drives, designated the Diskos 570 and the Diskos 1070, will be built for Priam under terms of an agreement recently negotiated with Hokushin Electric Works, Ltd., Tokyo, and will be shipping in quantity by the end of the year.

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Imagine a computer-aided graphics system that interfaces directly to the mind's eye, that takes a designer's visual perception of his design and does everything but weld it together.

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The visual interface that enables the designer to communicate directly with the computer is a Megatek vector refresh terminal. Dr. Patrick Hanratty, MCS president, tells why.

"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.

MEGATEK/WHIZZARD

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Learn about all of the protective features of Sola's Micro/Minicomputer Regulator. For free literature, contact Sola Electric, 1717 Busse Road, Elk Grove Village, IL 60007. Phone (312) 439-2800.

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CIRCLE NO. 6 ON INQUIRY CARD

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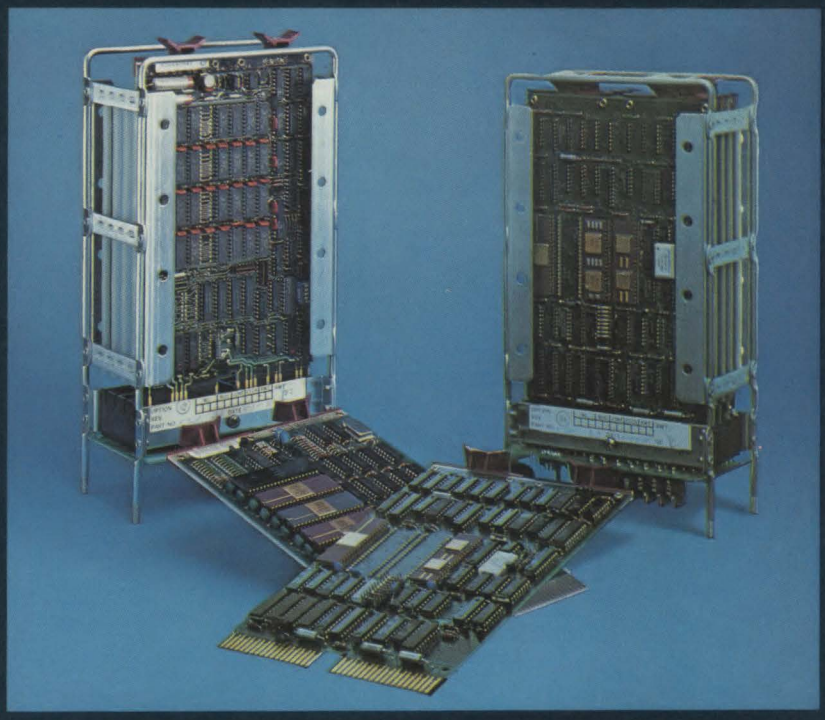

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CIRCLE NO. 8 ON INQUIRY CARD

Data General aims to be No. 2 in competitive 32-bit market

The long-awaited arrival late last month of Data General Corp.'s contender in the 32-bit minicomputer market (MMS, September, 1979, p. 19) brought ambitious plans and an attitude that the company isn't late with its entry, but "hitting the market with the right solution."

In the 32-bit market—which is expected to reach $4 billion by 1983—DG faces stiff competition from Digital Equipment Corp., Prime Computer, Systems Engineering Laboratories and Perkin-Elmer Corp., all of which have announced 32-bit systems over the past five years. But DG announced some "bigger and better" features that it expects will quickly establish the MV/8000 in second place, behind DEC's VAX 11/780.

"We don't feel we've missed out on the market or are late," explains DG's Ed Zander, manager of general systems marketing. The 32-bit mini market was small in revenues from 1975 to 1978 because of high component costs, including memory, he says, adding: "We're hitting the market at the right time, and the majority of growth is yet to come."

To be successful in the 32-bit arena—which is seen as the fastest growing sector of the mini market—William R. Becklean, vice president of Bache Halsey Stuart Shields, Inc., says a newcomer "would have to find a significant market niche that is not well-served by others." The key is developing a good market strategy, he says, in the same way that Tandem Computers, Inc., filled a high-reliability niche.

DG, however, initially aims to focus on the same market in which DEC's VAX 11/780 and 16-bit PDP-11 minis have flourished: scientific and engineering applications requiring high-volume number crunching.

Although Zander admits that "VAX is really doing a job in the market—they've got a really good machine," he expects that DG and DEC will share in the 32-bit mini market by offering a total systems approach.

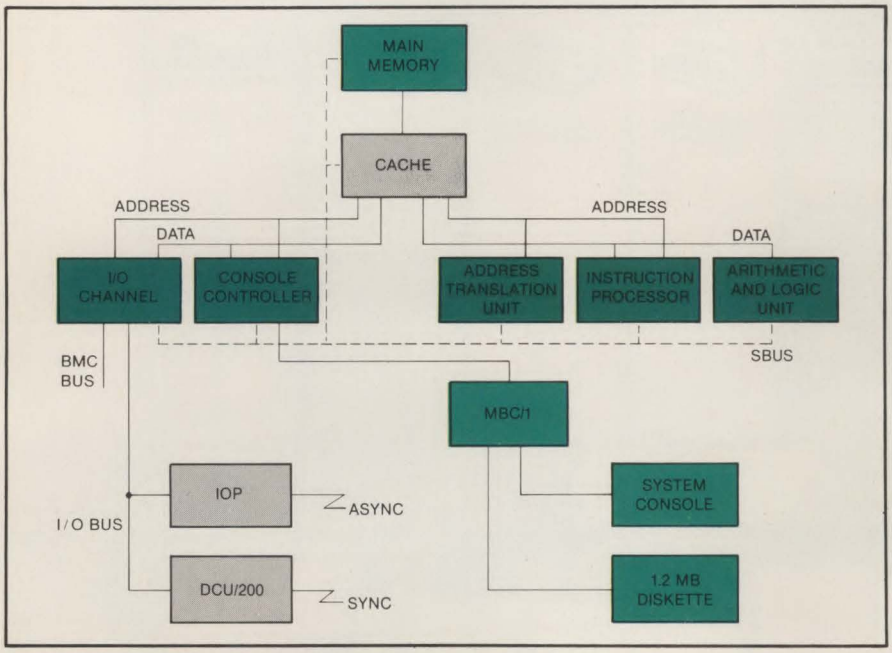
DG has overcome what it terms a "split personality" by not using the mode-bit approach to integrate hardware with the 16-bit instruction set used by DEC and others.

Jim Perry, marketing manager for ECLIPSE scientific/computational systems, says DG's approach to compatibility is to extend and define certain instructions in the 16-bit ECLIPSE, making them inseparable from the entire MV/8000 advanced AOS/VS instruction set. This means that all ECLIPSE AOS software can be run on the MV/8000 without recoding. Instead, only run-time libraries must be used. However, 16-bit COBOL will have to be recompiled, but this is a short-term restriction, according to Perry.

In comparison, VAX and 16-bit PDP-11 instruction sets are mutually exclusive. As a result, 16-bit instructions must be duplicated in 32-bit instructions because each operates in a different mode, explains Steve Wallach, manager of advanced development on ECLIPSE systems. And, he adds, VAX does not include PDP-11 floating-point instructions. There are two solutions to compatibility with VAX: recompile software or simulate it and run it as much as 10 times slower than intended.

DG's approach is said to include these benefits:

- total binary compatibility with ECLIPSE AOS programs
- AOS program development on the MV8000 for 16-bit ECLIPSEs
- concurrent execution of existing 16-bit programs with new 32-bit programs
- commingling of 16- and 32-bit instructions in the same program



Data General's *ECLIPSE MV/8000: a system overview.*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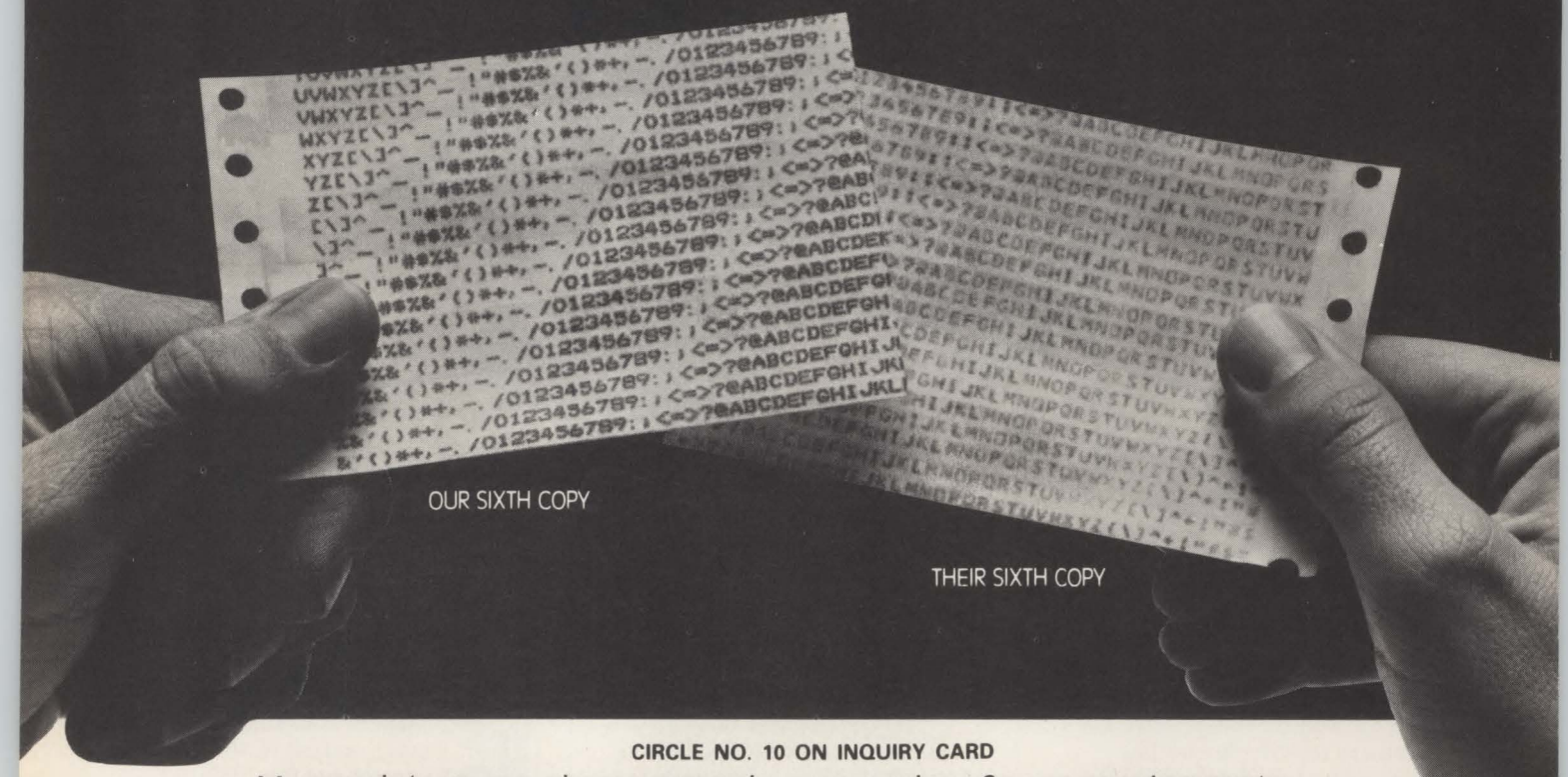

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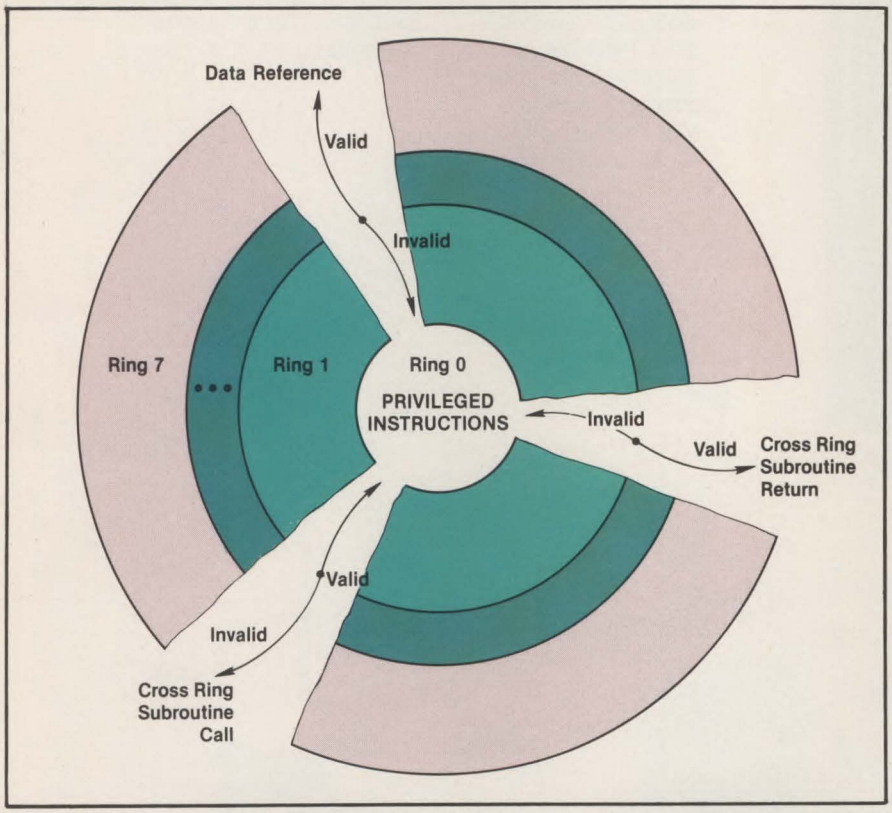
- execution of all peripheral diagnostics from the MV/8000.

As a proper superset of the 16-bit ECLIPSE instruction set, the MV/8000 CPU can run existing AOS, COBOL, INFOS II, DBMS, AZTEC and applications software. In addition to 16-bit instructions, it handles 250 other instructions for manipulating functions of the new 32-bit architecture, as well as three 32-bit languages: FORTRAN 77, PL/1 (ANSI general-purpose subset) and new BASIC. The MV/8000 has 400 instructions; VAX has only 254.

The 32-bit operating system, AOS/VS, will not be available in initial hardware shipments. First shipments of hardware with standard 16-bit ECLIPSE AOS are scheduled for October, with advanced AOS/VS software following in the first quarter of 1981. All software is licensed and priced separately from the minicomputer, which sells for $130,000 to $150,000.



The MV/8000's *hierarchical ring protection mechanism. Four rings are dedicated to system functions; four others are designated for users.*

Total virtual address space is 4.3 billion bytes (gigabytes), with eight address spaces, each with 512M bytes, a ring protector and gate function.

The 32-bit ECLIPSE CPU includes an advanced segmented virtual memory that permits user access to 512M bytes for program writing—that is 32 times larger than any single IBM 370 or IBM 4300 program, and 16 times larger than those of VAX. Perry admits that while 16M bytes are sufficient in most scientific applications, users will find new ways to extend programs to 512M bytes. In commercial applications, he adds, only 1M byte is needed.

The system control processor is run by a microNova MBC/1 with 4K bytes of PROM, 32K bytes of RAM, console interface, 1.2M-byte diskettes and a separate S-BUS for diagnostic access to CPU functional units. The processor supports single-bit error detection and correction during memory refresh operations through a "sniffing" process, in which every memory location is sniffed and corrected, if necessary, every 4 sec. DG claims sniffing is unique to its system and lowers mean-time between failure at each location.

An ECLIPSE input/output processor controls all asynchronous communications for as many as 128 terminals. With 64K bytes of local storage, it serves as a front end by

FEATURE/CPU	MV/8000	VAX-11/780	IBM 4341	PR1ME 750	PE 3240	SEL 32/77
LOGICAL ADDRESS SPACE	4GB	4GB	16MB	512MB	16MB	16MB
MAXIMUM PROGRAM SIZE	512MB	32MB	16MB	32MB	16MB	16MB
MEMORY BANDWIDTH (MB/S)	36.4	13.3	15	8	64	26.7
I/O BANDWIDTH (MB/S)	18.2	9.5	10	8	40	26.7
SYSTEM CACHE	16KB	8KB	8KB	16KB	8KB	4 bytes
INSTRUCTION CACHE	1024B	8B	??	1 CACHE BLK	16B	1 INSTR
NUMBER OF RINGS	8	4	0	4	0	0
INTERLEAVING	4-WAY	2-WAY	??	2-WAY	4-WAY	4-WAY
RAM-BASED CONTROL STORE	YES	NO	YES	NO	NO	NO
16/32 BIT COMPATIBILITY	YES	MODE BIT	-	MODE BIT	YES	-
NUMBER OF TERMINALS	128	96	??	64	32/128*	64

How the MV/8000 *stacks up against the competition. Source: Data General Corp.*

* 128 terminals in transaction processing mode only.

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More good news. The seven 1950 Series Drives models have a 90% plus parts commonality. The same is true of 1920 Series Drives. So training is simplified and spare parts headaches are a thing-of-the-past.

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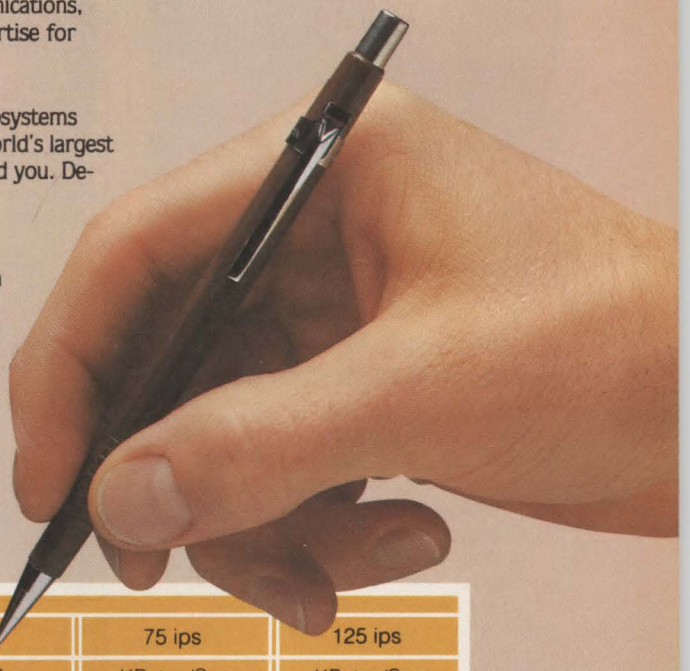
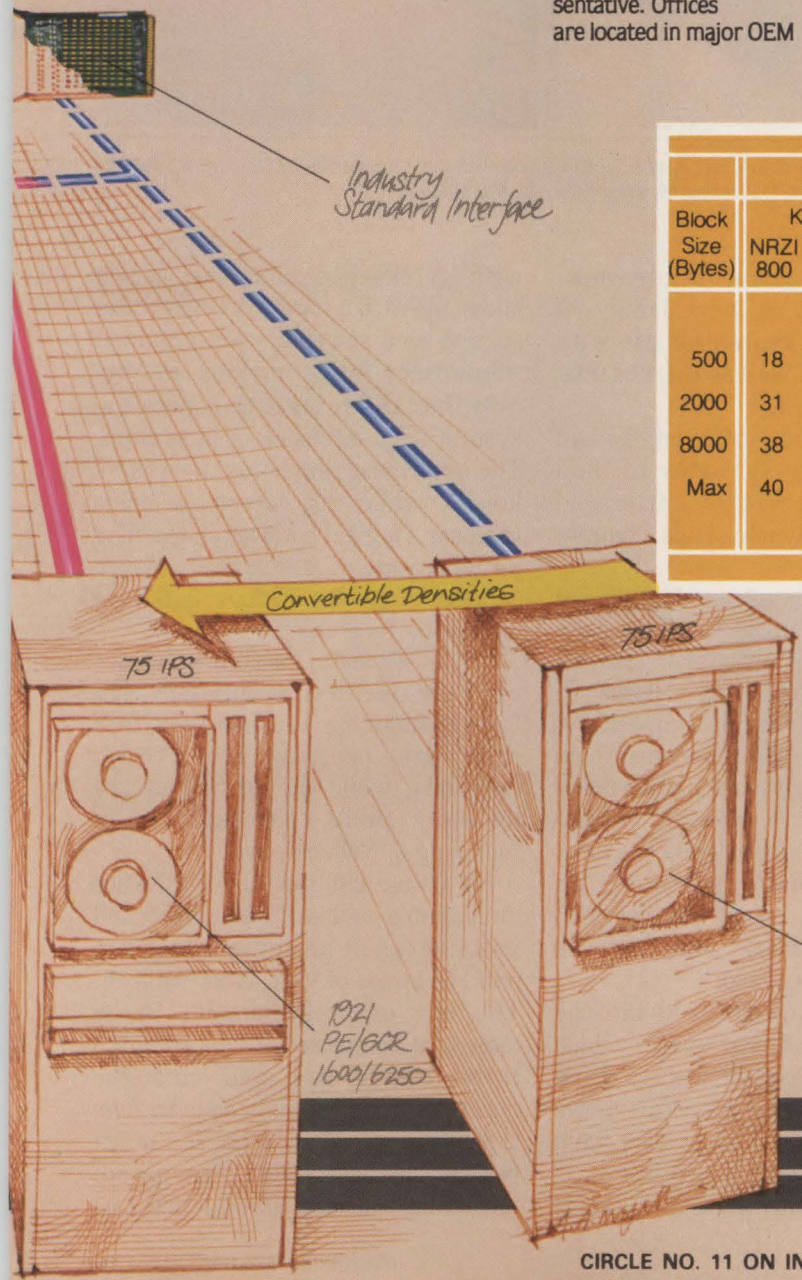


Block Size (Bytes)	50 ips KBytes/Sec NRZI 800	PE 1600	GCR 6250	75 ips KBytes/Sec NRZI 800	PE 1600	GCR 6250	125 ips KBytes/Sec NRZI 800	PE 1600	GCR 6250
500	18	27	62	28	42	94	47	70	156
2000	31	52	156	46	78	235	77	130	390
8000	38	71	249	57	107	379	96	178	624
Max	40	80	312	60	120	470	100	200	780



Channel throughput as a function of data block size.

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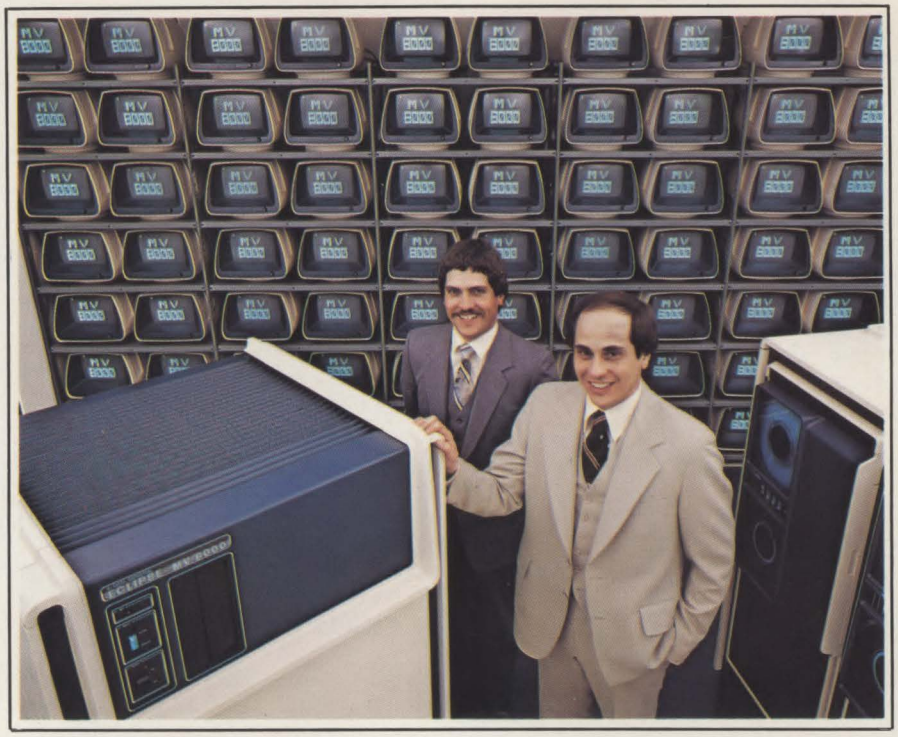

Data General's *Jim Perry, left, and Ed Zander show off the long-awaited ECLIPSE MV/8000, standing among the 128 terminals supported by the system.*

off-loading line character interrupts from the CPU. A new family of multiplexors is geared for use with the MV/8000, as well as the ECLIPSE S/140 and Nova 4.

The DCU/200, offered as an option, includes 8K bytes of local memory and serves as a front-end processor for synchronous communications.

A combination of four high-speed buses gives a total cache-to-main memory bandwidth of 36.4M bytes/sec., which DG claims is higher than DG's major competitors, DEC and Prime. Data is transferred over an 18.2M-byte/sec. CPORT bus via a 16K-byte system cache between main memory and the CPU. Data is transferred over an 18.2M-byte/sec. IPORT bus between the main memory and the I/O processor or DCU/200.

The integration of AOS/VS into the user's logical address space, which is said to increase software writing efficiency, requires protection of the operating system data base and programs. That protection is provided by eight hierarchical rings with gatekeeper functions, which allow users to view the operating system as a set of system-provided subroutines while making system calls, but still protect the operating system from intrusion or alteration. The innermost ring holds the AOS/VS kernel, while the outermost holds the user's logical address space. The initial release of AOS/VS will reserve certain rings for future software expansion (see chart).

With MV/8000, systems houses can have their own proprietary ring for applications, because only four rings are occupied by MV/8000 functions, while the other four are for users. DEC's VAX uses all of its four rings, Wallach says.

By using LSI devices that were unavailable when DEC designed VAX, DG can fit its entire MV/8000 in half the space of VAX, says Wallach. The use of programmable array logic (PAL) chips reduces chip counts from five to one and cuts the number of processor boards to five; the DEC equivalent is housed on 27 boards, Wallach says. The use of PALs and bit-slice architecture, he

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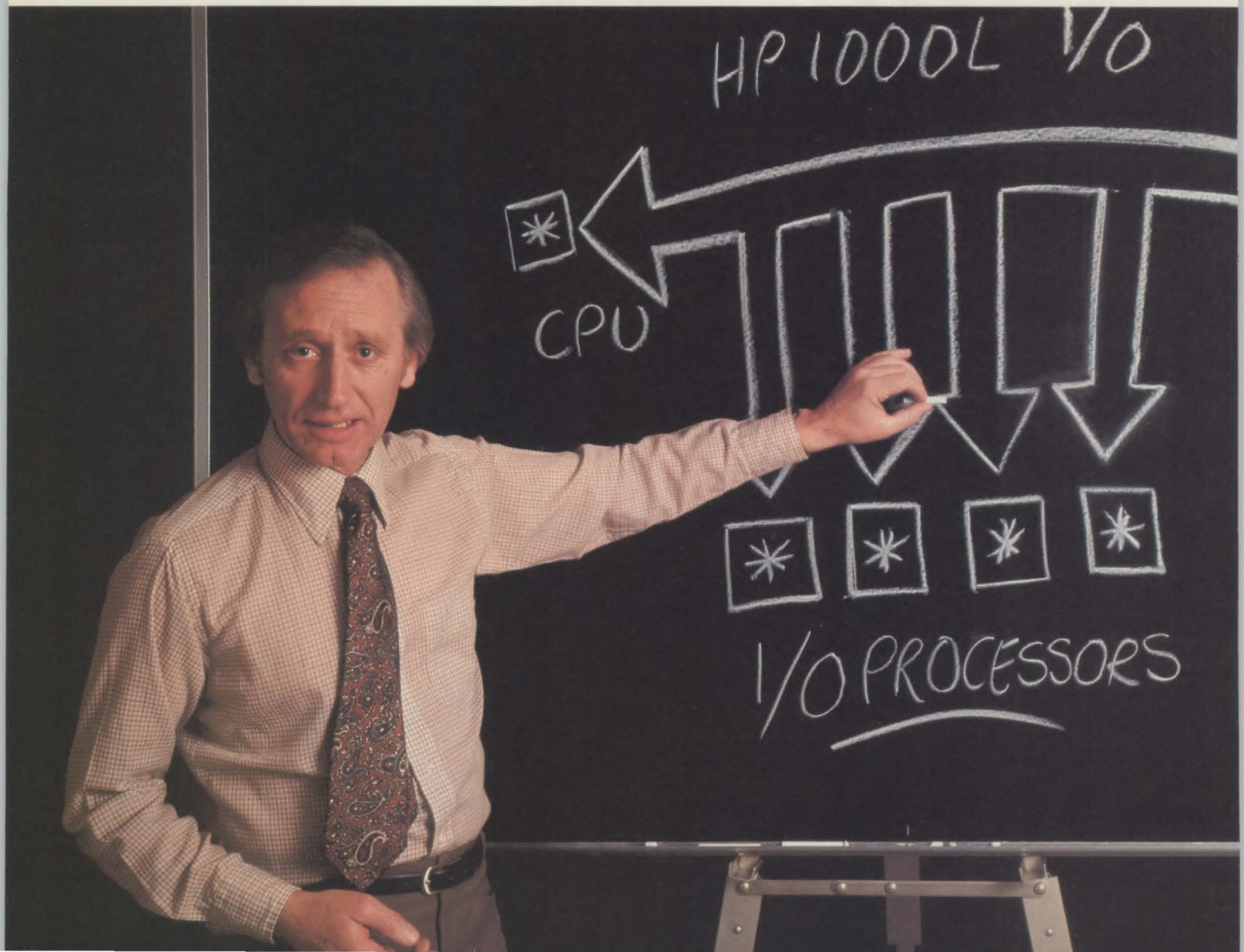

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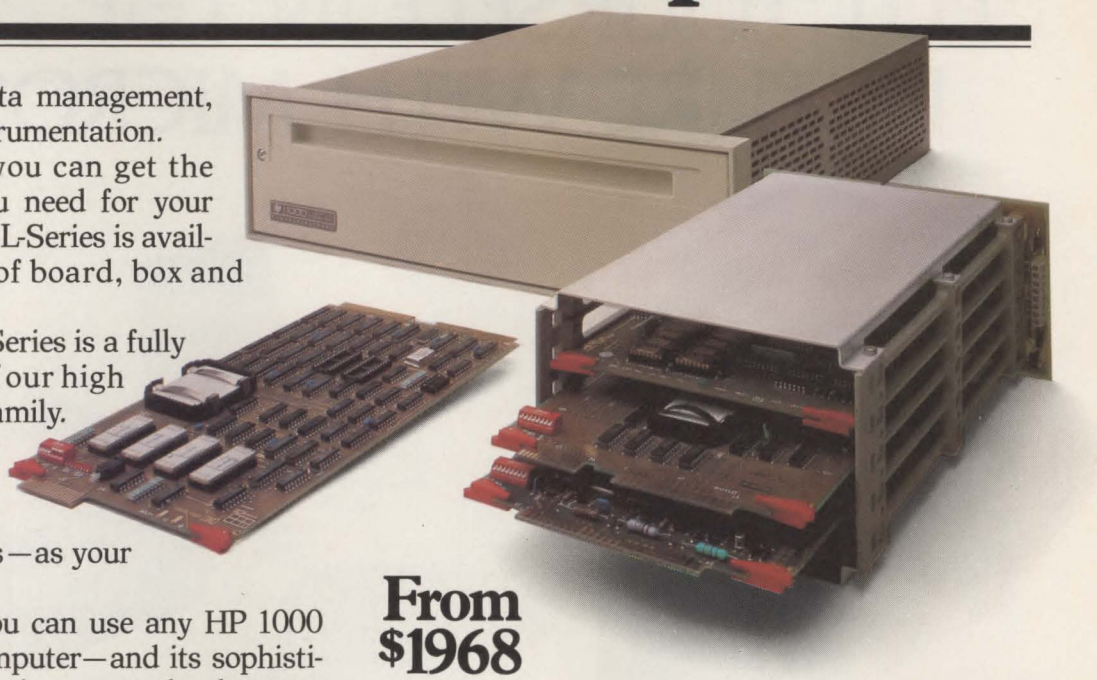

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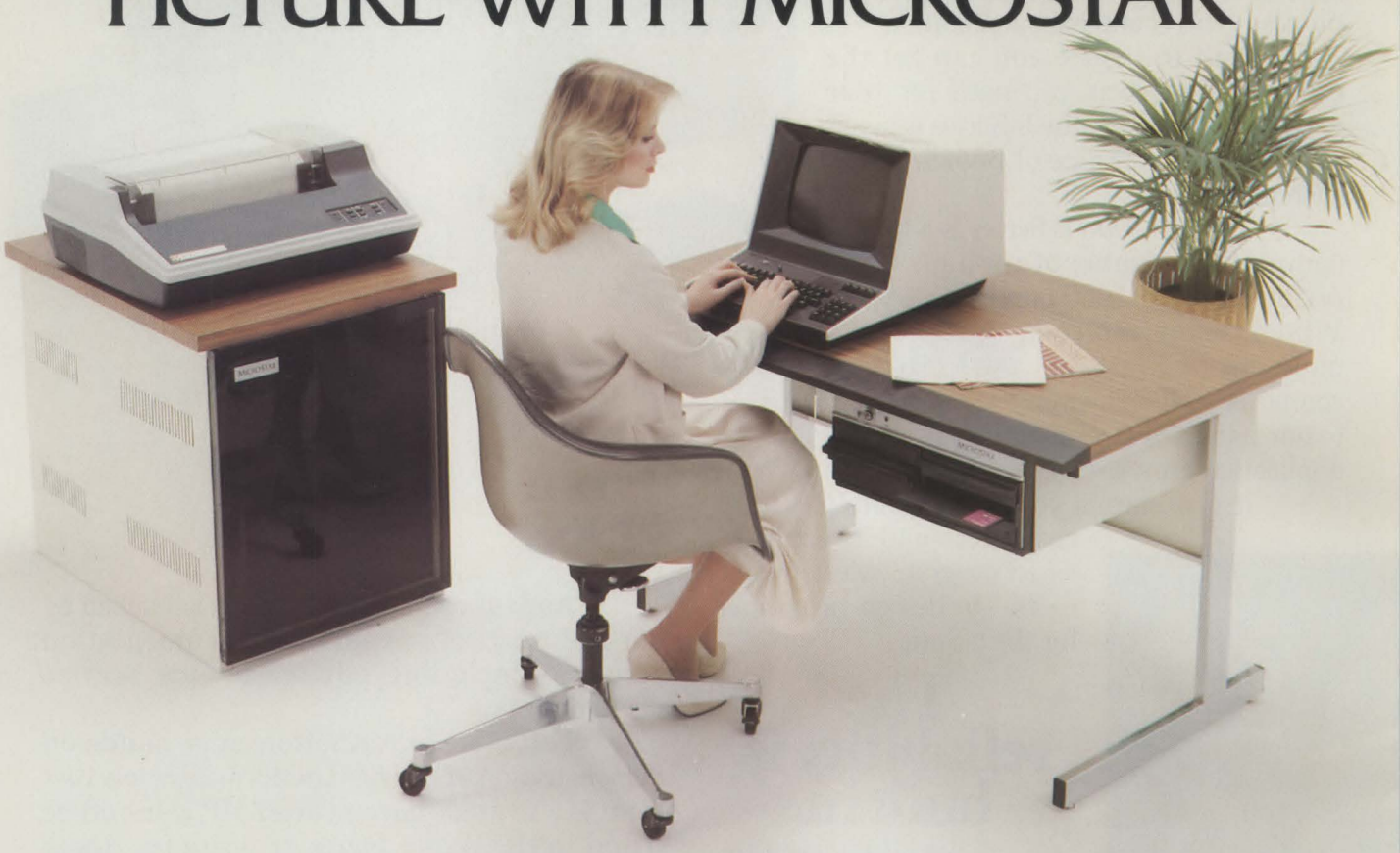

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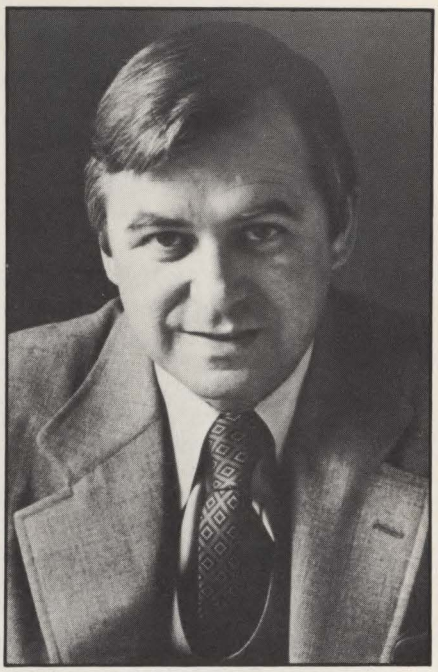
says, is "functional decomposition of the processor into major functional subsystems" that improve performance and are easier to debug. Wallach says this approach, unique to DG in the 32-bit market, puts the intelligence as close as possible to data manipulation tasks, thereby not cluttering the CPU with tasks like I/O processing. These features will help DG to meet system ARM (availability/reliability/maintenance) requirements, which it deems one of the MV/8000's "highest-priority design objectives."

However, the MV/8000 falls short in networking. DEC's network software includes DECnet/VAX. DG, however, is not announcing capabilities to work its XODIAC networking product. "We fully realize this is a missing link," Perry admits, "and we intend to be there. But we have not announced when."

Availability of the system may be a key point in DG's favor. DEC delivery times are about a year, but DG is hoping for initial hardware deliveries of about 150 days. The company will attempt to match the 90-day rate of other ECLIPSE models. —*Lori Valigra*

Tandon: *"Shugart's head is a copy of our design."*



Sanders: *"The Bi-Compliant head is definitely a Shugart design."*

Shugart, Tandon spar over head-license issue

Talks between Shugart Associates and Tandon Magnetics Corp. concerning manufacturing licenses for Tandon's double-sided read/write head assembly for floppy-disk drives remain at a stalemate. Despite the impasse, some industry observers feel strongly that the two companies may come to terms by mid-year.

Meanwhile, Shugart is distributing evaluation versions of a 5¼-in. double-sided minifloppy drive equipped with its newly announced "Bi-Compliant" head assembly—a move sparking rumblings from Tandon that Shugart's new design may be in direct violation of a year-old Tandon patent.

At issue is a head assembly that has proven to be both reliable and manufacturable in large quantities. It comprises a fixed "button" head that reads and writes data on one side of a floppy disk and a gimballed slider mounted onto a spring-loaded pivot arm that reads and writes data on the other side. The completed assembly, resembling a small desk-top stapler, is mounted onto a carriage way and tied to a lead screw or band positioner.

In most drives the assembly is driven across the diskette's data tracks by a stepper motor. The button head is mounted firmly to the carriage itself; the gimballed head reads and writes data on the upper surface of the diskette, while serving as a loading pad to push the diskette down onto the lower head.

Compounding the controversy between Shugart, the Xerox subsidiary in Sunnyvale, Calif., and Tandon, the Chatsworth, Calif., components and peripherals house, is the explosive demand for low-cost, high-capacity rotating memories, particularly by builders of microcomputer-based small-business and word-processing systems. In the face of this demand, however, many floppy-disk drive makers have been unable to follow through on promised deliveries of large quantities of reliable drives.

Problems with read/write heads have been the source of much of this difficulty, and Shugart's are no exception. The firm's first double-sided drives were originally designed using what some call the "clothespin" head assembly, a variation of an IBM design.

Shugart's SA450 (5¼-in.) and SA850 (8-in.) double-sided drives originally incorporated two gimballed heads—one fixed on the carriage, the other mounted on a pivot arm—similar to the Tandon design. Shugart found that building small quantities of these drives was painless. But when it came to filling the large-scale orders that followed the introduction of its double-sided hardware several years ago, manufacturing problems quickly arose. "We could easily put together 20 to 30 drives a day," recalls Ferrell Sanders, marketing vice president at Shugart. "It was something else, though, when we tried to ship thousands per day."

In addition to manufacturing

problems, Shugart's clothespin head posed its own operating constraints. "When the heads loaded, you had two pieces of ceramic banging together," Sanders recalls. "If we increased pressure to get better compliance between the heads and the media, diskette wear went up. If we reduced pressure to control wear, we ended up with data-handling problems."

Last summer, Sanders adds,

MINIBITS

DEC AND MEGATEK UNVEIL COLOR GRAPHICS SYSTEMS

Both Digital Equipment Corp., Maynard, Mass., and Megatek Corp., a San Diego, Calif., vector graphics display manufacturer, have announced high-performance raster display systems able to generate dynamic graphics in as many as 16 colors. But the Megatek 7250 is said to be more powerful than the DEC product. For example, the Megatek hardware can do three-dimensional rotations in real time—something beyond the capability of other raster systems. The 7250 is also more expensive, at $20,000 to $25,000, than DEC's VS11/VSV11 system, which sells for $5000 to $14,000. Megatek is aiming the 7250 at computer-aided design and simulation applications, while DEC is targeting the VS11/VSV11 system at more traditional raster display markets—general engineering, process control and image processing. Both systems are slated for fourth-quarter delivery.

DATA GENERAL ANNOUNCES PRICE HIKES OF 5 TO 10 PERCENT

Following Digital Equipment Corp.'s announcement of across-the-board price hikes of 5 to 15 percent, Data General also increased prices by 5 to 10 percent on Nova minicomputers and ECLIPSE scientific systems. DG also raised prices for maintenance services an average of 6 percent. Both companies cite inflationary pressures as the reason for the hikes, specifying the spiraling costs of labor, components and travel. Before the increases, a typical Nova 3D unit with 64K bytes of MOS memory sold for $16,275. It now sells for $17,085. A Nova 4/C with 32K bytes of MOS memory and a five-slot chassis, which previously sold for $2800, now costs $2950. And an ECLIPSE S250 with 64K bytes of core memory formerly sold for $30,000 and now costs $31,500. Peripherals were also affected by the increases: a Dasher D1 alphanumeric display printer with a detachable keyboard went up from $1990 to $2190.

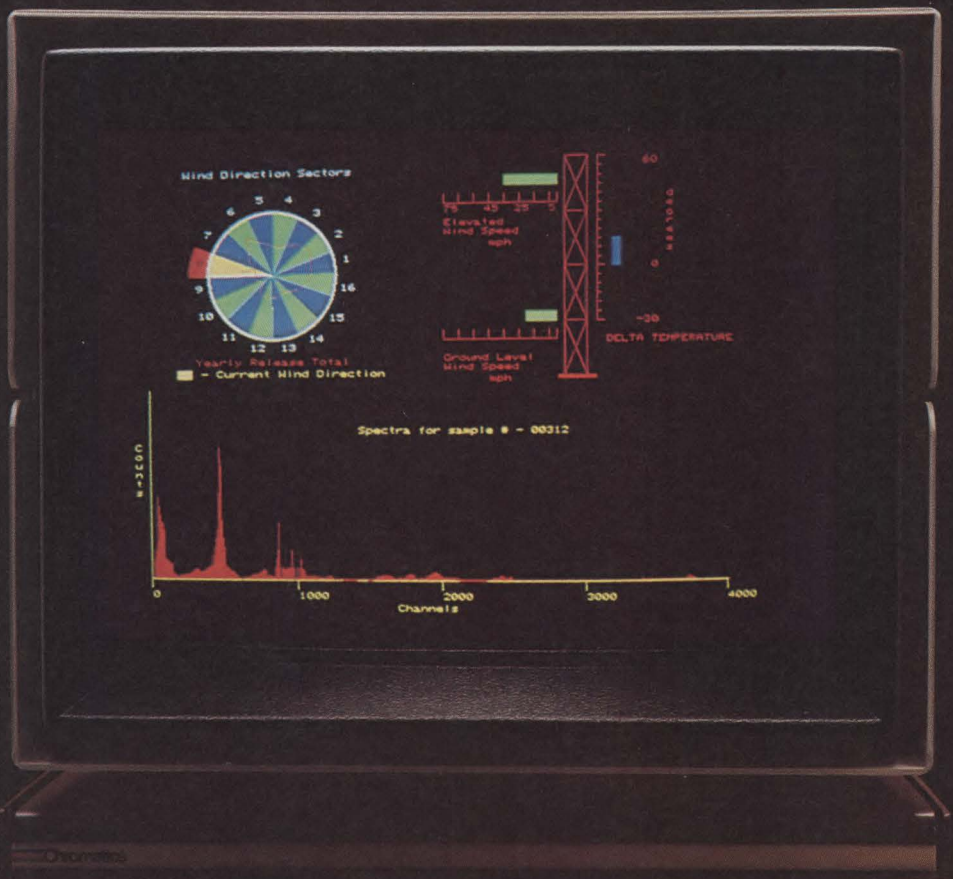
DASTEK PROVIDES SPECIFICATIONS FOR 4835 SERIES

More information has surfaced about Dastek Corp.'s recently announced 200M- to 400M-byte 4835 series of disk drives. The 14-in. drives will operate at bit densities of 12,772 bpi and track densities of 635 tpi, using thin-film read/write heads and 3350 oxide-coated Winchester media. More important is the 4835's 40,320 byte-per-track specification—twice that of Control Data Corp.'s 3330 storage module drives (SMD). These byte densities, plus the 4835's optional SMD interface, will ease the new drives into existing SMD-based high-level minicomputers and allow the older removable-media hardware to be used for 4835 file backup. Evaluation versions of the new drives are due this summer, with production models set for delivery during the second quarter of next year.

DISK CONTROLLER TIES WINCHESTERS, FLOPPIES

Shugart Associates plans to unveil a single-board controller this month at the National Computer Conference. Company sources say the controller will expedite the use of floppy-disk drives as backup for the firm's line of low-cost 8-in. Winchesters. Designated the SA1400, the microprocessor-based controller can handle a total of four 8-in. fixed-disk drives (or 14-in. SA4000 Winchesters) in conjunction with the firm's SA800 (single-sided) or SA850 (double-sided) 8-in. floppy-disk drives in any combination. Standard with the controller is a sector interleaving feature that compensates for the differing transfer rates of the company's floppy-disk drives. Also standard, says Tom Markmann, product line manager for the new controller, is an automatic copy feature that permits systems incorporating Winchester/floppy combinations to map data from the prime to the backup device without intervention of the host CPU. The SA1400 is available in quantity now, Markmann says, with an OEM price of $1125.

A COLORFUL MESSAGE TO COMPETITION: 512x512 FOR ONLY $5995*



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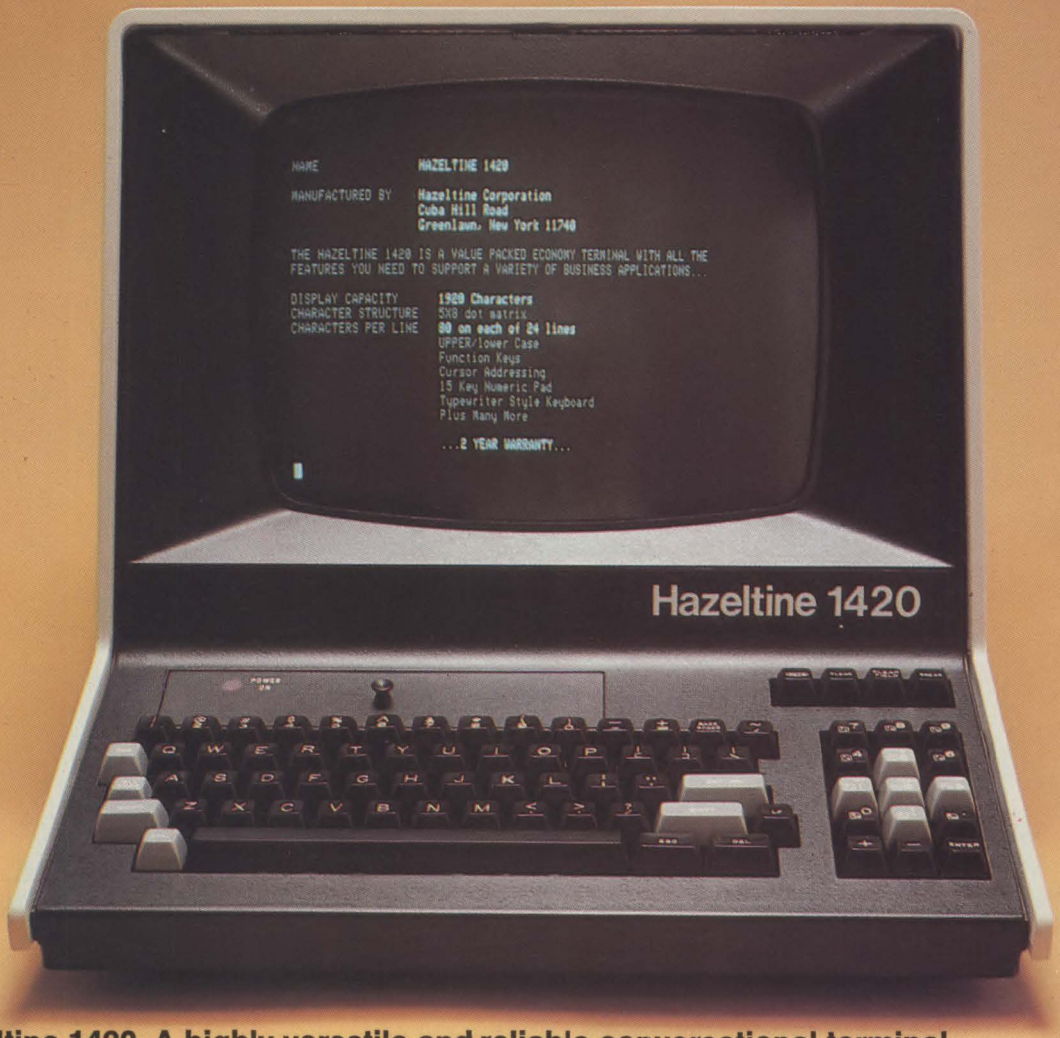
CIRCLE NO. 16 ON INQUIRY CARD

Hazeltine

builds more performance into a low cost terminal



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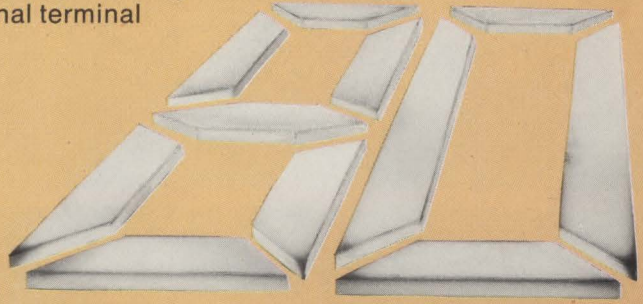
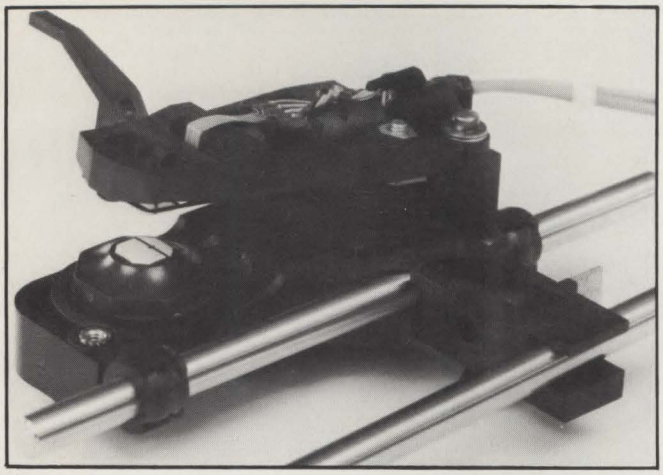
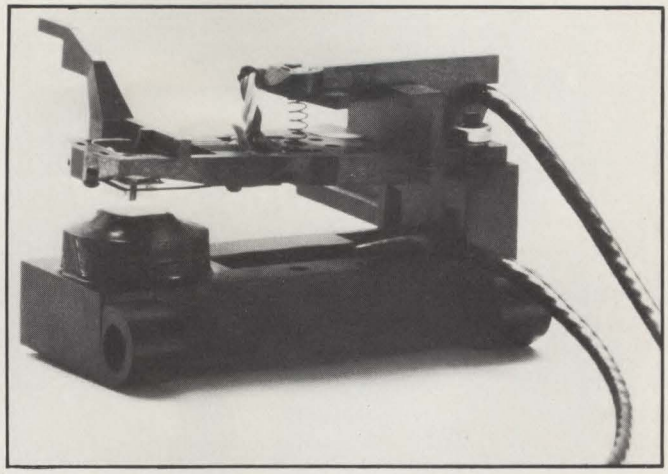


Hazeltine **Answers for the eighties**

CIRCLE NO. 17 ON INQUIRY CARD





At the center *of the controversy: Does Shugart Associates' "Bi-Compliant" head assembly, left, violate patents on Tandon Magnetics Corp.'s read/write head assembly, right, for floppy-disk drives?*

Shugart chose the Bi-Compliant design and moved to phase out earlier clothespin head assemblies. One of the first drives to incorporate the new head may have been the SA450 demonstrated at a computer exhibition in London. At the same time came word of talks between the two companies, aimed at negotiating for Shugart an agreement that would permit it to build Tandon's head in-house. [*Mini-Micro Systems* had erroneously reported that a licensing agreement between the two had already been signed (MMS, December, 1979, p. 19).]

According to a number of sources, these talks are now "dead in the water." Exactly why they broke down has not been made public. They appear tempered, however, by events associated with an abortive attempt by Shugart two years ago to buy out Sirjang Lal "Jugi" Tandon's company. At the time, Tandon's head patent was still pending, and as part of the negotiations, claims one source, Shugart engineers were given acces to Tandon's manufacturing technology.

Talks between the companies eventually sputtered out, only to be reopened in the summer of last year when Shugart sought a license for the now patented Tandon component. These discussions dragged through December, at which point Shugart demonstrated its Bi-Compliant head. That reportedly angered Tandon, who promptly suspended negotiations.

Other sources, however, blame Tandon for the slow pace of negotiations and the lack of an agreement. "Shugart is trying to sort out who it is dealing with," says one source close to the negotiations. "Meanwhile, Jugi doesn't know whether he's giving away the family jewels or whether he's making a super deal."

Sources at Tandon see their own company pride as a major issue. "We want credibility for our design," says one insider. "We want Shugart to recognize that what they call their Bi-Compliant head is really a Tandon head." Shugart, however, appears unwilling to make that move. Shugart's Sanders says the Bi-Compliant head is definitely a Shugart design, although he concedes that, from an external point of view, they appear similar. There are differences, he stresses, although he would not state what they were, citing competitive reasons.

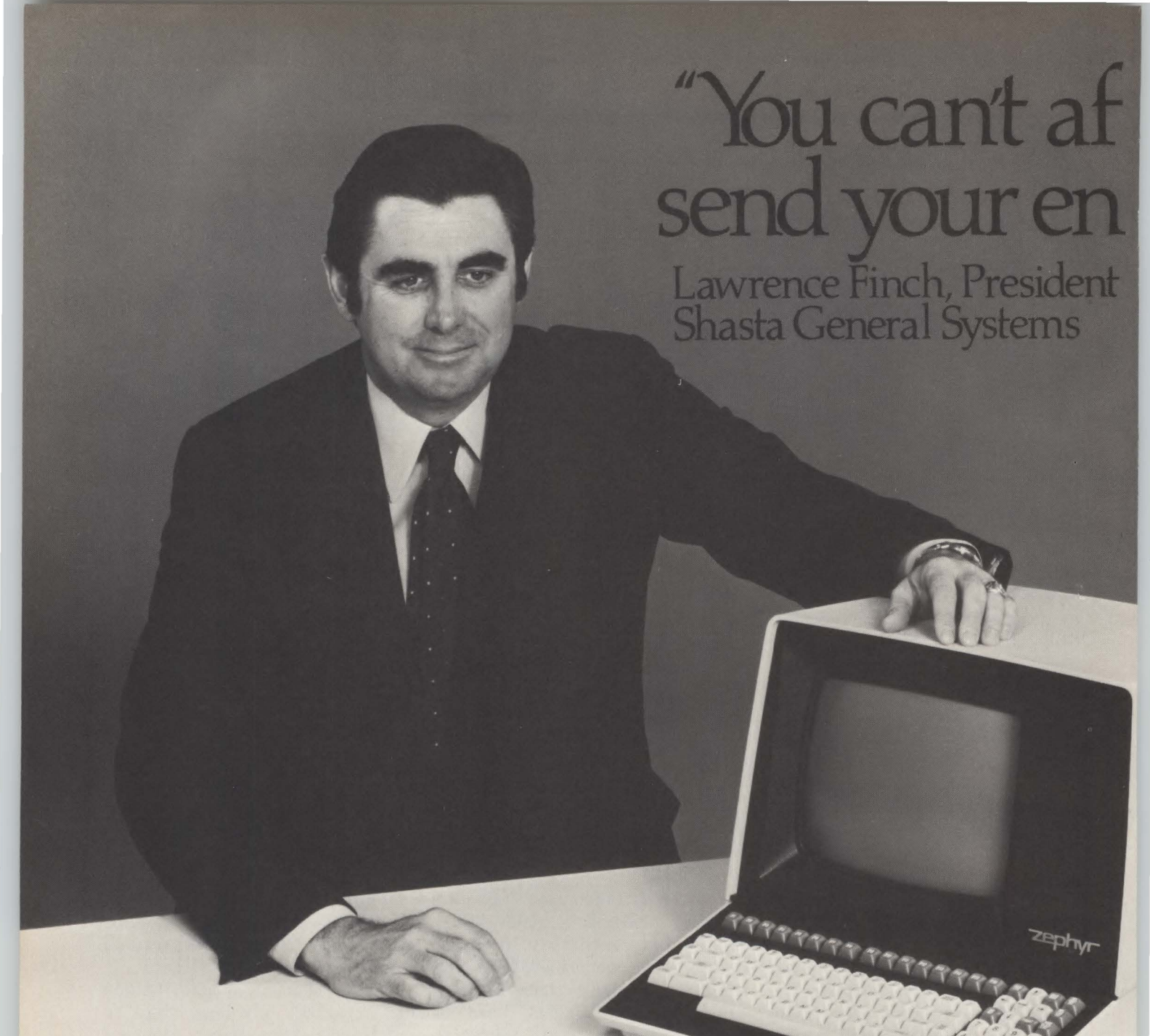
Jugi Tandon is more vocal about the two designs. "Shugart's Bi-Compliant head is a carbon copy of our own design," he states flatly. "All Shugart has done is put its name on it." Tandon says his patent supports his claim, and at first glance, the patent would appear to cover a lot of real estate. A summary of the head assembly describes it as "a device for effecting data recording and reproduction operations with each of the two sides of a pliant, nonrigid magnetic recording element (employing) a fixed transducer on one side and a resilient element supporting a movable transducer on the other." Changes in specifications, such as those suggested by Sanders, don't alter the validity of his patent, Tandon claims. For example, it is reported that Shugart's design uses a straddle erase, while Tandon's incorporates a tunnel erase feature.

For the moment, though, Tandon has not taken any legal steps to enforce his claim against Shugart, but he does not preclude this. Many industry sources report that Tandon is holding back for a good reason: "The front-end costs of such a suit would be very high," notes one hardware executive. "It would be 85 Xerox (Shugart's parent) lawyers against Tandon's small staff. He could easily lose out even if he wins in court."

Others claim that Tandon's patent won't hold up if seriously challenged, a notion Tandon dismisses out of hand. Many persist in questioning the patent's validity and point out that, so far, Tandon has not enforced the patent against any other makers of double-sided

"You can't af send your en

Lawrence Finch, President Shasta General Systems



When you're selling over 75 small business systems a month like Shasta General Systems, you've got to have terminals that are as reliable, if not more reliable, than the system itself.

That's why Shasta chose to integrate Zentec CRT's into their Diablo 3200 small business and word processing systems.

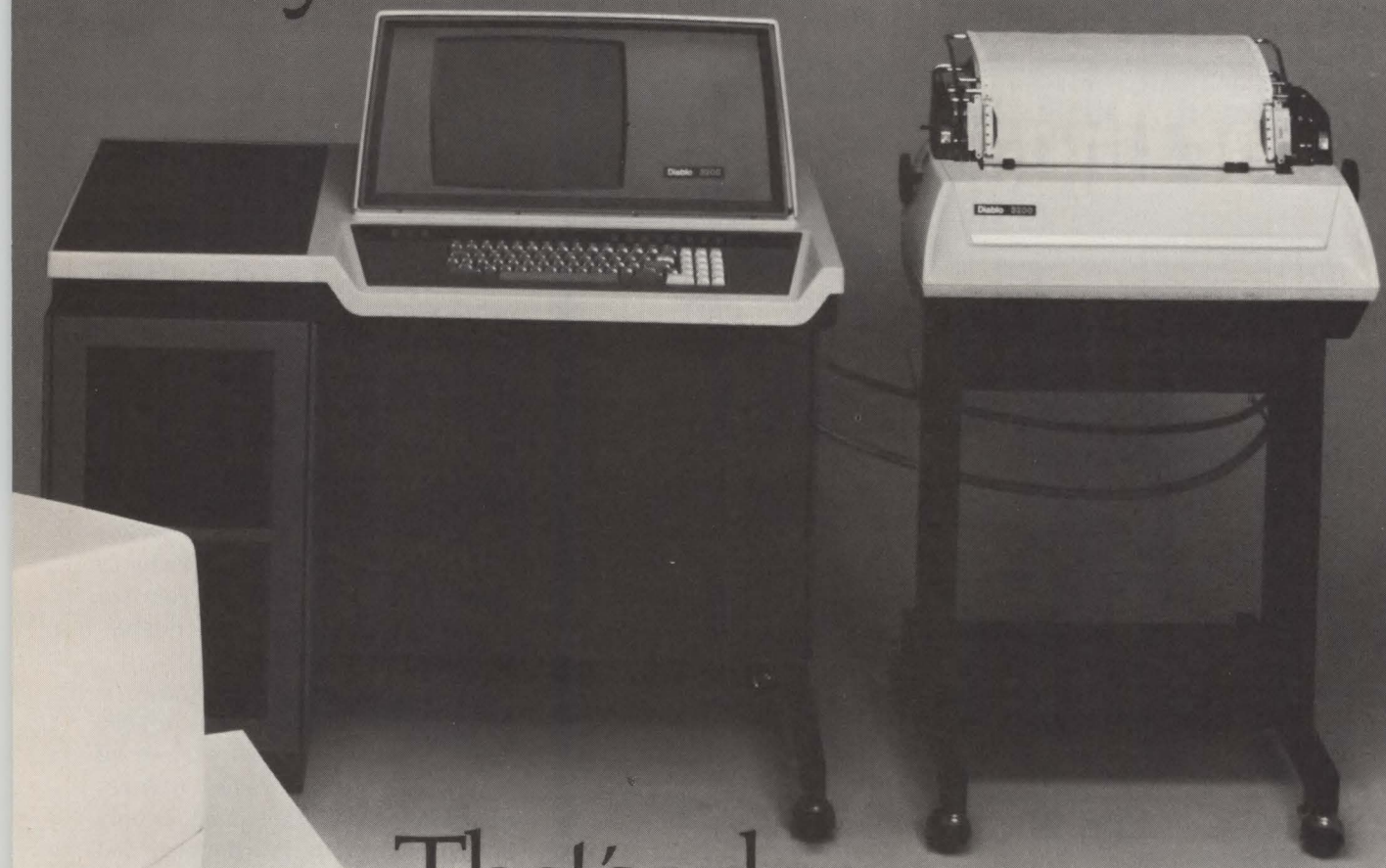
As the largest independent distributor of small business systems in the United States, Shasta is a real stickler for quality. "We're incorporating Zentec Zephyrs and ZMS-40s into our system for one main reason," commented Lawrence Finch, Shasta President. "In a word . . .

we're looking for quality. The CRT is the direct interface with our customers. In their eyes, if the terminal fails, we fail. And at $20K plus per system, we really can't afford that. We chose Zentec for that extra measure of reliability."

Getting the most from your host.

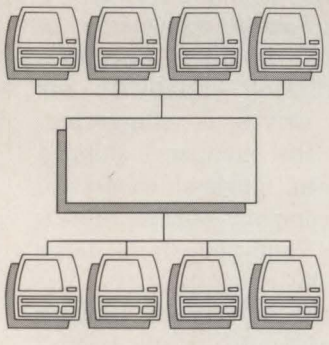
Shasta is now integrating Zentec's new Zephyrs and ZMS-40s into their Diablo 3200 small business system to satisfy a wide range of data processing and word processing applications. The system, expandable up to 8 CRT's, utilizes the Zentec Zephyr to perform all data entry and data processing functions. Capitalizing on the Zephyr's intelligent features such as full cursor addressibility, full editing and protected forms modes, the Diablo 3200 system offers users improved system throughput. The ZMS-40s, incorporating custom keyboards and firmware are designed

ford to have a defective tube tire system down the tubes."



That's why Shasta specified Zentec.

to Shasta's specifications,



handling all word processing functions. Word processing programs can now be downloaded to the terminal from the CPU and executed in firmware, relieving the CPU of valuable processing time. Together, they make powerful additions to an already powerful system.

Like Shasta, more and more people are turning to Zentec for intelligent solutions to their data and word processing problems.

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Don't let a defective CRT come between you and your CPU.

You really can't afford to become a victim of terminal trauma. Take a close look at the new Zentec Zephyr. Or any one of the growing ZMS Family of intelligent terminals. Like Shasta, they could be the most intelligent solutions to your data or word processing problems. For more information, just write: Zentec Corporation, 2400 Walsh Avenue, Santa Clara, CA 95050. Or call (408) 727-7662.

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CIRCLE NO. 18 ON INQUIRY CARD

Mini-Micro World

read/write head assemblies incorporating one fixed and one movable head, or against any of their customers. Tandon shrugs this off, too, noting that his firm has sent letters to a number of companies, informing them of his patent (MMS, July, 1979, p. 16). He says an extended law suit would not be in the industry's best interest.

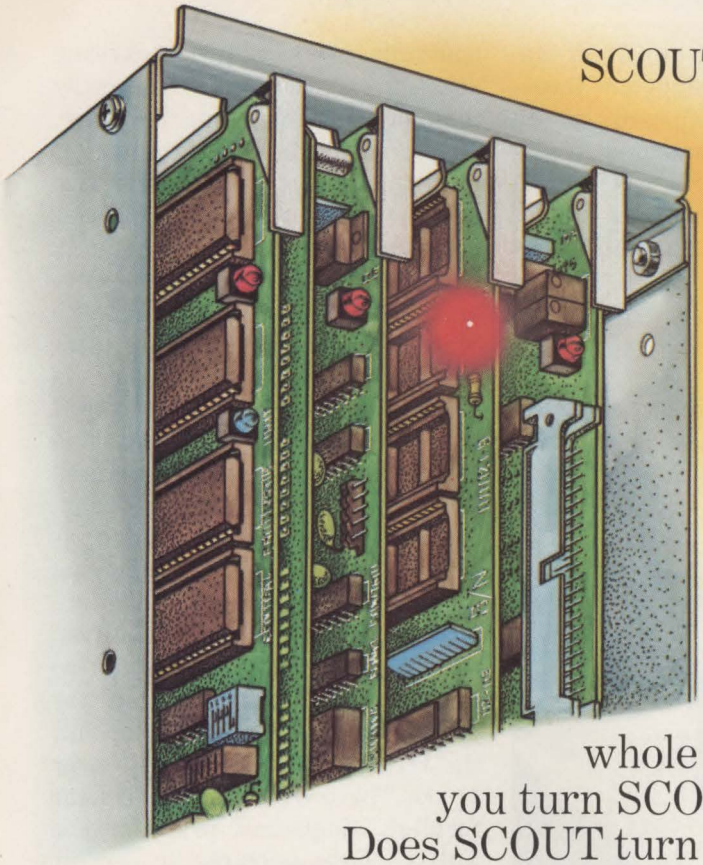
Tandon also feels that his real protection will lie with his manufacturing personnel, not his legal staff. As he sees it, Tandon Magnetics is prepared to outproduce Shugart, regardless of the outcome of negotiations. "We are way ahead of them when it comes to delivering volume quantities of these drives," he says, referring to shipments of his company's year-old TM-100 5¼-in. single- and double-sided drives.

Right now, he says, hardware is being produced at the rate of 8000 units a month—three-quarters of which are double-sided drives. Shugart, on the other hand, is only now revving up its double-sided 5¼-in. production lines. But once production gets rolling, Sanders says, large numbers of SA450s will be stamped out. By the end of the year, he says, production should hit 500 units a day.

Shugart's 8-in. SA850 will continue to be offered with the older clothespin head initially, Sanders adds, while the Bi-Compliant design is phased in. Sanders expects this to be completed in July. Shugart's total production capability for floppy-disk drives is staggering. Last year the company shipped 250,000 5¼-in. single-sided drives. This year, company sources report, more than 500,000 have been shipped so far.

Despite the differences between Shugart and Tandon, many observers feel that an agreement over the question of the Bi-Compliant head will be hammered out very soon. Sanders has no comment on any

Speak SCOUT, speak.



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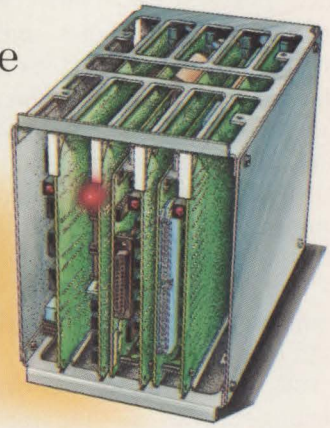

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aspect of the negotiations, but Jugi Tandon now seems somewhat optimistic about the final resolution. "Shugart has never said that they do not want to negotiate this issue," he says. "They are a responsible company, and we will solve this problem." —*John Trifari*

Hardware rental houses give IBM 3101 a boost

IBM's 3101 interactive ASCII terminal, available only by mail order since its introduction last fall, is rapidly moving into the hands of short-term hardware rental houses.

"We have three quarters of IBM's first production run," claims Joel Dolin, president of Leasametric, Inc., Foster City, Calif. "We'll be putting 350 of these units into inventory over the next six months, and we expect to be in the market for more." Leasametric plans to rent 3101s to IBM mainframe and minicomputer users temporarily needing ASCII-compatible terminals—especially Teletypes—and to non-IBM users attracted by the mainframe giant's reputation for high-quality hardware.

IBM, Dolin notes, has made no arrangements to service these markets with lease or rental plans. "As far as the 3101 is concerned, it's 'sales only,'" he explains. If a user wants one of these terminals, he dials a WATS number rather than calling his local IBM office and asking for a salesman. As a result, Dolin says, IBM regards rental houses such as Leasametric as complements to its 3101 marketing efforts, not as competitors.

But Dolin can't resist pointing out that short-term rental houses offer a number of advantages to users interested in the new IBM equipment. "Users ordering from IBM have a 60-day waiting period," he says. "We can deliver off-the-shelf."

Dolin's view is shared by Bill Grinker, president of Boston-based American Terminal Leasing. He is prepared to offer 3101s off-the-shelf—but on a minimum three-month rental as opposed to the month-to-month minimums available from Leasametric. "We anticipate moving the 3101 as a spot replacement for ASCII terminals now on lease," Grinker says. "It's a high-class product, and it will be widely accepted in the OEM market."

In addition to delivery schedules, both firms claim that their service arrangements are also superior to IBM's. Instead of its traditional handholding, IBM will offer 3101 buyers the option of shipping either terminals or any one of the major subassemblies, such as the keyboard, to a repair depot. Turnaround time, says IBM, is five days.

IBM's 3101, *an ASCII-compatible terminal, is available on a for-sale-only basis from IBM. But it's now finding its way into short-term hardware rental houses. Devices are available with 20 percent discount for purchases of 100 units or more.*

Both Grinker and Dolin say their firms will provide on-the-spot service for users who want it. But Federal Express, Grinker says, can do the job better. "Very rarely does something have to be fixed right away," he explains. "We can ship a replacement part or even a complete terminal, if necessary, anywhere overnight. It's a lot cheaper than sending out a serviceman."

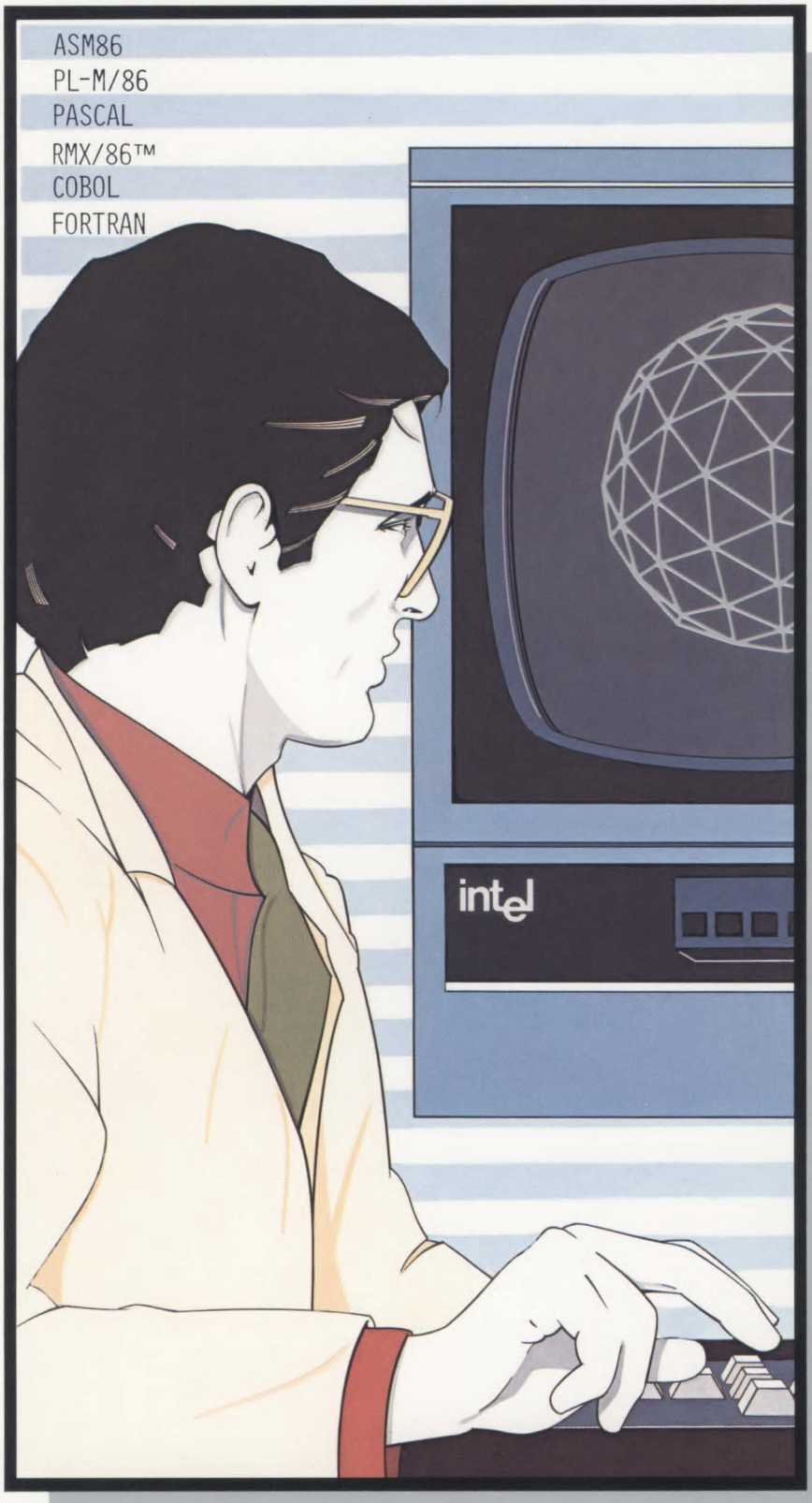
IBM's decision to go with mail-order sales and depot servicing does have its admirers—especially those offering competing hardware. "It's an efficient way to market terminals," says Phil Shires, vice president of marketing and sales at Lear Siegler's Data Products Division, Anaheim, Calif., vendors of the ADM-3 dumb terminal. To Shires, there's no mistaking IBM's move—the mainframe maker is moving aggressively into the OEM terminal business and is reaching out at a market that could total close to 300,000 units per year.

However, Shires feels that pricing may keep IBM from dominating the ASCII terminal market. In single-unit quantities, the 3101 sells for $1295, with a 20 percent discount available for quantity purchases. At that point, the terminal will cost a little over $1000. That's $100 more than Lear Siegler's single-unit price for the ADM-3. "Even with the 20 percent discount," Shires points out, "lessors will get a faster payout with our hardware."

Bill Hauf, marketing manager at ElectroRent, Burbank, Calif., also feels that pricing may dampen acceptance of the 3101 among OEMs. "It's nice to have IBM hardware in your inventory," he says, "but at their prices it won't move." Hauf cites ElectroRent's efforts to rent IBM 3277 terminals. "The potential market for this hardware was enormous," he says. "Despite this, the terminals just didn't move." ElectroRent no longer carries the 3277.

Instead, says Hauf, the company plans to stick with ASCII-compatible terminals such as those supplied by Lear Siegler. Rent for this hardware on a monthly basis is $80; rent on a yearly basis is $49 per month, with half being credited toward an equity buildup. A similar arrangement is at work for Teletype model 43 terminals. Purchase price for these devices is $1377, Hauf says. On a month-to-month basis, the hardware rents for $124; on a

Tools to solve the



How Intel delivers the key to productivity in the '80s.

As we move into the '80s, the increasing demand for complex computer programs, the critical shortage of programmers, and the seemingly unstoppable rise in software development costs will reach crisis proportions. To understand how to bring this situation under control, we have to understand its cause.

In the 1970s, the microcomputer was used successfully to lower the cost of hardware engineering. Each new microcomputer generation integrated more and more of the system, lowering the cost of design and making it easier to put electronic intelligence anywhere and everywhere. As hardware cost dropped, rising software costs became increasingly visible.

So, today, as costs climb, management puts everyone under increasing pressure to deliver projects on time and on budget. Yet, the cost of programming is still outpacing productivity. Software development and integration still lag the system hardware. The software crisis of the '80s rages on.

Tools for structured solutions

Once a problem grows beyond a certain point, the most efficient way to solve it is with a top down approach. You break the problem into units, program and debug each one, and combine the units into a unified solution.

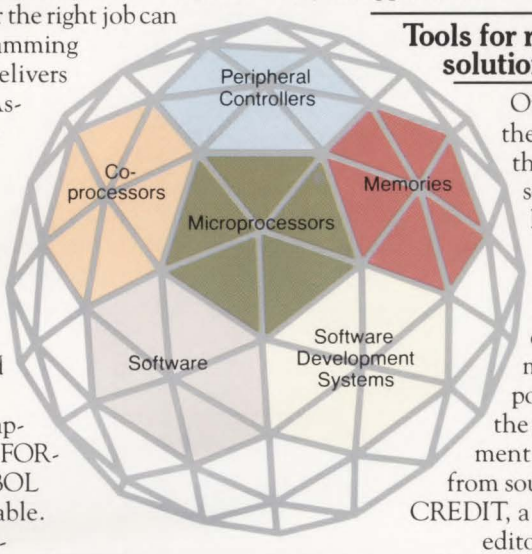
That's the concept. But you can't stop there. In the '80s, bridging the gap between a conceptual solution and a working one will require tools as efficient as the top down method. New tools, like a CPU with a dramatically different architecture. An architecture uniquely suited to a world of higher level languages and structured programming. Tools like a modular operating system, of a kind never before available on a 16-bit microprocessor. Tools like the

software crisis.

only complete family of programming languages, because no one language is right all the time.

Different languages have different strengths and weaknesses, and using the right language for the right job can make your programming easier. So, Intel delivers ASM86 Macro Assembly Language for space and speed sensitive modules. Our PL-M/86 systems programming language and PASCAL support structured programming at the systems and applications levels. FORTRAN and COBOL will also be available.

With Intel's relocation and linkage tools, modules written in the different languages are combined, with library utilities and operating system routines, into one, complete solution, automatically. Using this modular approach, and the right language for the right job, your finished product is clean, reliable, maintainable, and understandable.



Intel Structured System

The critical module

Since complex software requires sophisticated operating systems support, the operating system is the most critical module in your solution. It is the foundation upon which your application is built. It is also available, off the shelf, from Intel.

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Intel's investment in the development of RMX/86 is substantial. Depending upon the features you select, you save from two to forty man years of programming effort. That's an additional two to forty man years you can devote to your application.

Tools for realizing your solution

Of course, having the foundation and the concept of your solution doesn't help if you can't write the programs to implement it. So, Intel delivers development tools to support you through the entire development cycle. Support from source entry, with CREDIT, a CRT based text editor, through compiling and debugging, with an Intellec® development system and ICE™ hardware/software debugging system. Intel's tools work with you. They shorten development time and support the structured approach you've taken.

But debugging software on a development system is not the same as testing it on the actual hardware. The ICE modules help here, too. During development, these tools let you trace through your software and debug it, symbolically, at the source language level. Now, these In-Circuit Emulators replace your prototype hardware's CPU to speed hardware/software integration.

If your hardware is built from components, ICE Modules will help you separate the hardware and software bugs, so you don't spend your time fixing engineering problems. If your hardware is built around an Intel iSBC 86/12A™ Single Board Computer, you'll already have a known, working hardware environment for program testing. You can use ICE Modules to concentrate your efforts on debugging your software.

Either way, the same software, operating system support and debugging tools are available to help you bring your application to life.

Synergy for high performance

In the '60s and '70s, programs were used to instruct computers. Applications of the '80s require programs to be the solutions to problems. High performance solutions will be the result of synergy between the hardware and the software.

To create this synergy today, Intel delivers the 8086 processor. The 8086 processor is unique. Instead of a linear, or flat architecture, the 8086 is the only microprocessor optimized to work with high level languages and the structured solutions they implement.

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Your first step toward productivity

How to get more information on solving the software crisis of the '80s.

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yearly basis, it's $76 per month, of which $35 goes to equity.

The 3101, on the other hand, is pegged at $142 per month on a month-to-month basis at Leasametric, and $85 per month on a yearly basis, with no equity buildup, according to Dolin. Other hardware rental houses report that 3101 pricing will be higher than that for comparable terminals. The reason, according to Bill Rollnick, president of Rental Electronics, Inc. (REI), Palo Alto, Calif., is that the industry is uncertain about the mainframe giant's plans for the new hardware. "Rental people aren't sure about IBM," he says. "Maybe a year from now they'll chop prices 15 percent. A move like that could put a lot of people in deep trouble."

Rollnick advocates caution. "From our point of view," he explains, "the 3101 is a new terminal from a new company. We don't have the answers to the questions we have about it, so we're going to protect ourselves through pricing." Nonetheless, he adds, REI has been talking to IBM about the 3101, and most probably will start stocking the new device in the near future, as will ElectroRent, according to Hauf.

Also investigating the 3101 is U.S. Instrument Rentals, Inc., San Mateo, Calif. According to Alan Kest, vice president of data products, USIR has looked into the 3101, but has made no decision to order hardware because there has been no demand for it. "We don't make a market in rental hardware," Kest explains, "our customers do." So far no one has asked for the 3101, he says.

But "with IBM coming in, the market for ASCII terminals should get even better," he says. "That's good for hardware suppliers, and that's good for us."

Dolin at Leasametric is not waiting for his customers to make a market, however. Conceding his

company is taking a "speculative position" with the 3101, he nonetheless intends to move ahead with plans to inventory more IBM gear. "We're the largest single customer for Hewlett-Packard and Teletype terminals," he maintains. "And we intend to be the largest customer for IBM's 3101. We're just getting our feet wet." —*John Trifari*

Direct banks on 800/A as key to office market

A one-year-old company called Direct, Inc., is looking to sales of a VT-100 emulator as its passport to the "office-of-the-future" market.

Called the 800/A, Direct's Z80A-based intelligent terminal is being shown to systems OEMs hunting for the hard-to-find Digital Equipment Corp. terminal. According to John Darke, president of the Sunnyvale, Calif., hardware vendor, VT-100 emulation comes as a standard feature on the 800/A, with control codes needed to run DEC software preloaded into read-only memories. The 800/A can be used to emulate other intelligent terminals, Darke says, once the user has loaded in the appropriate control codes.

But demand for VT-100 emulators dominates the terminal emulation market, Darke says, and Direct already has a backlog. "As far as evaluation units of the 800/A are concerned, we're booked through August," he reports. "Getting orders for terminals does not seem to present any problems."

Although the initial order rate for Direct's version of the VT-100 is encouraging, the company does not plan to seek its fortune as a supplier of emulation hardware. Instead, Direct plans to sell the 800/A as a full-scale word-processing system in the office automation market. "Emulation is a launching pad for us. We ultimately see the device as a stand-alone desk-top system or as part of a distributed data-processing network," says Darke. He founded Direct after working several years in marketing for various companies, including Hazeltine Corp., Datapoint Corp. and Control Data Corp.

Darke also sees the 800/A as the first "take-home" word-processing system to hit the market. Design of the device permits the keyboard module to fold into the terminal itself and to lock over the CRT screen. As a result, he says in mock seriousness, a secretary could take the 32-lb. system home and work after hours. More practically, he says, the fold-and-lock capability will thwart unauthorized use of the device.

But before the 800/A functions as Darke envisions it, some upgrading will be required. First will be an increase in memory capacity. The 800/A now comes with 8K bytes of RAM as standard and as much as 32K bytes optionally. According to Darke, 64K bytes of RAM and a CP/M operating system will be added later.

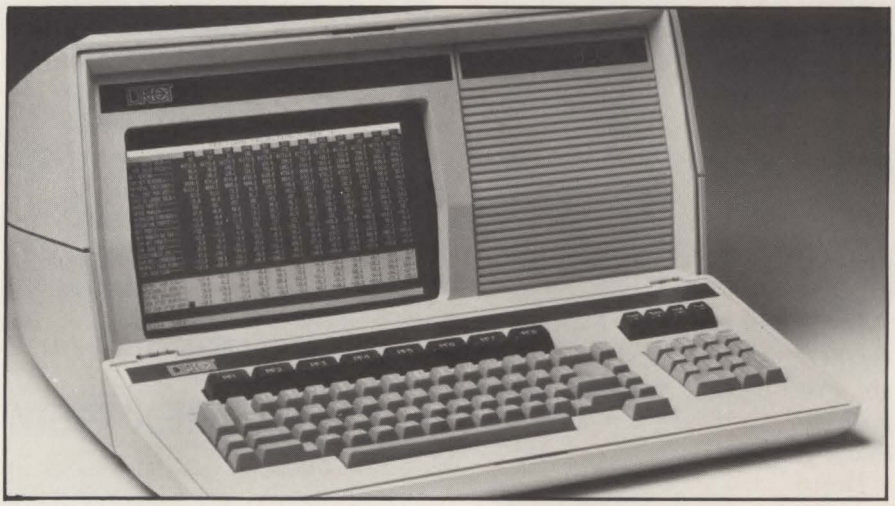
Complementing the increase in main memory capacity will be auxiliary storage—at which point the hardware changes names. As the 900, Direct's terminal will incorporate two 5¼-in. single-sided floppy-disk drives, an arrangement that Darke says may not offer enough capacity for future needs.

Darke, then, is already looking at the possibilities offered by 5¼-in. Winchester fixed-disk drives, which will be announced this month at NCC in Anaheim, Calif. Backup for a terminal incorporating one of these drives will probably come in the form of a low-cost ¼-in. tape-cartridge drive (MMS, February, p. 26). The 900 will also include other features now found on the 800/A—two I/O ports and support for letter-quality printers required for word-processing applications.

The company plans to announce the 900 around year-end. By then, Direct may be ready to jump into the office automation market, but is concentrating initially on the 800/A. First step, Darke says, is to firm up the venture capital needed to shift from building evaluation hardware to producing and shipping 200 units per month—a goal he expects to reach by midsummer.

Second, the company will introduce the 800/B, a text-editing version of the earlier hardware, and a VT-132 emulator. The 800/B may be announced this quarter.

Price for the 800/A—with an advanced video option that enables blinking, character reversal and underscoring, and packs 28 lines of 132 characters each onto a CRT screen—is set at $2250 in single-unit quantities. Price of the 800/B is said to be less than $2500. In comparison, base price of DEC's VT-100, without an advanced video option, is $2050. —*John Trifari*



Direct, Inc.'s 800/A *is a VT-100 emulator that features a fold-and-lock keyboard to thwart unauthorized access.*

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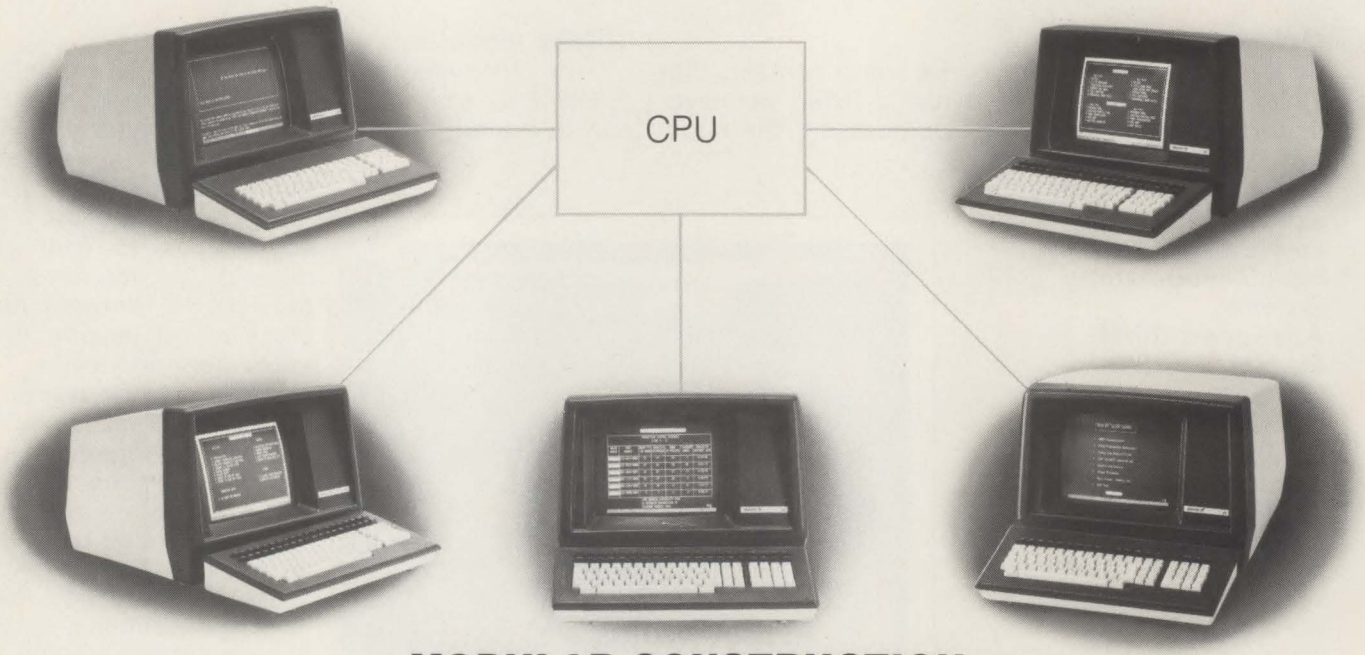

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Mini-Micro World

Sealing lowers ceiling on ribbon recyclers

Vendors who recycle computer printer ribbons are feeling a squeeze from OEMs, who are now sealing plastic ribbon cartridges. OEMs claim this move will improve product reliability.

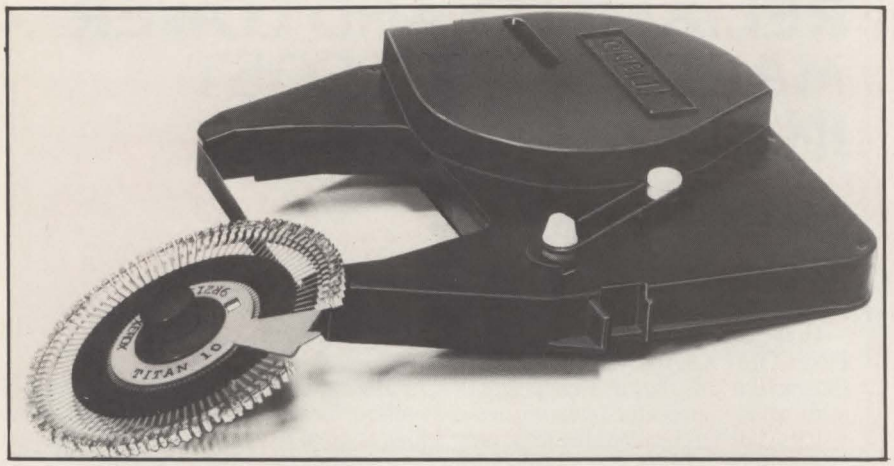
The rapid growth of both the word-processing and printer markets over the past few years is driving the ribbon market to an expected volume of 15.1 million orders, each consisting of a dozen ribbon cartridges, by 1984, according to a Creative Strategies International report. Because of energy-related costs in materials and manufacturing, ribbon price increases of 15 to 25 percent are anticipated over the same period.

As a result of the booming market, about 50 entrepreneurial ribbon-recycling vendors sprang up, offering users cost savings of as much as 60 percent and deliveries in only five to 10 days. They also gave customers the chance to be energy-conscious with these largely petroleum-based products. One entrepreneur started his recycling business thinking of the words of a former customer, who said it was an "ecological disaster every time a cartridge hit the wastebasket."

Apart from ecology, cost and reliability, the electrosonic sealing of cartridges—a process that essentially "melts" the two cartridge halves together—brings up serious questions about whether the process is a restraint of trade by large manufacturers, such as Qume Corp., Diablo Systems, Inc. and Xerox Corp.

Peter C. Williams, vice president of Aspen Ribbons Co., which has 3000 customers and derives 35 percent of its total business from recycling, believes it is a restraint, and he's prepared to take action.

Williams calls sealing "an outright attempt to stop the recycling business." He has already begun



Sealing of Diablo ribbon cartridges, *scheduled to begin this month, has received a mixed reception from ribbon recyclers.*

action against Qume, which started sealing its cartridges last spring. Williams says his attorneys sent a letter to the corporate counsel of Qume's parent company, ITT, asking Qume to "cease and desist" from sealing cartridges, and citing antitrust violations. He says he has not yet received a response.

Anne Adams, Qume's product manager of supplies, says she is not aware of the letter, but admits that Aspen Ribbons has been vocal in its response to sonic sealing.

"It is not Qume's intent to drive the restuffers out of business," she says. She adds that the company has worked on sealing ribbons for two years, determining the action necessary and assuring recyclers that it was not an attempt to drive them out of business. This month the company will start sonically and chemically sealing cartridges.

Adams points to sealing as a way to ensure integrity of the cartridge, indicating examples Qume has that cartridges can separate and that internal components can shift, especially when shipped over long distances. Qume ships its ribbons from Puerto Rico, notes Adams.

Additionally, Adams says, cartridges were not designed to be reusable, and plastic parts wear out. She adds that Qume has a recycled cartridge in-house that had been sealed, showing that sealing does not prohibit recycling.

Qume has looked into recycling, she explains, but decided that it could not recycle and maintain product quality. "If there was a way, Qume would consider doing it," Adams says.

Williams agrees that component wear can be a problem, but indicates that his company carefully inspects all cartridge parts during recycling.

Diablo is scheduled to begin sealing this month—also for reliability reasons. Louis Kavanau, manager, printer supplies, says Diablo will increase ribbon reliability to about 99 percent through sealing.

He notes that a ribbon failure may involve more than replacement of just the faulty ribbon. A ribbon may catch onto a daisy print wheel and break it. Then, both the ribbon and the wheel, which costs about $35 in a metallized version, would have to be replaced.

"We've had some problems with recycling," Kavanau admits, although he won't discuss competitors. "But there are a large number of people using recycled ribbons," he says, "so they must be acceptable to some."

One indication of the size of the recycling market can be seen by looking at Wordex, a major vendor. The company processes 1500 to 2000 ribbons per day for its customers, which number between 1200 and 1800, according to president James P. Daughters.

Wordex began recycling ribbons in March, 1977, and the process accounts for 50 to 60 percent of the company's business. Daughters says some of the reasons given by manufacturers for sealing are legitimate, and he does not plan to sue. He adds, though, that because of the rising costs of plastics, which make up almost 100 percent of each cartridge, the recycling market will increase. For example, he says the price of styrene—used for cartridge shells—was 24¢ per lb. in October, 1978. It rose to 52¢ per lb. by last month—a 117 percent increase.

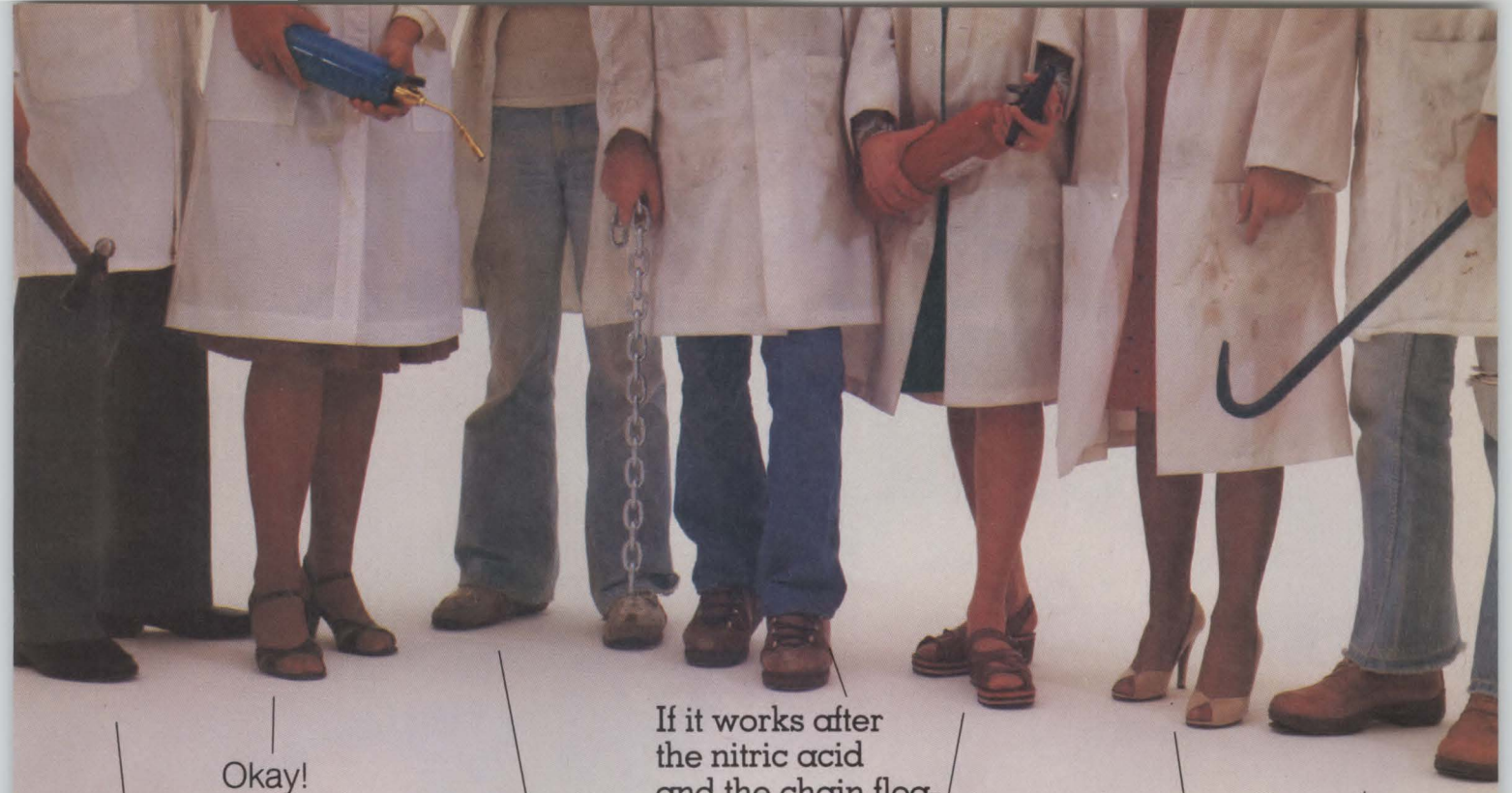
Daughters says he will benefit from the decision to seal because sealers are going against the public and ecology. "They're eliminating for the customer the opportunity of choice to be environmentally concerned."

Daughters indicates high quality standards as a key to his success, adding that he can even improve an original product design in some cases. "We need a good product the first time around to get people to come back the second time," he says. Typically, his customers order four times a year, spending an average of $400 annually.

He notes that cartridges can always be recycled, but increased welding will decrease the number of vendors with "kitchen table operations" who open cartridges with a butter knife. He says about 48 recyclers fit into that category.

Daughters says his recycling business will drop to below 50 percent in six months because of sealing. He admits there are not enough cartridges in existence to maintain his business, and he does not choose to crack them open when they are sealed. So he will make his own cartridges, which are designed for recycling.

"This builds a two-way street," he notes, because the cartridge he plans to make can be recycled by other recyclers. *—Lori Valigra*



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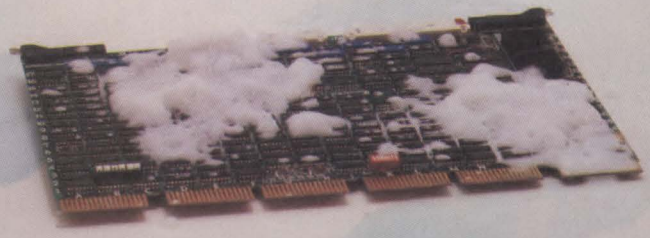

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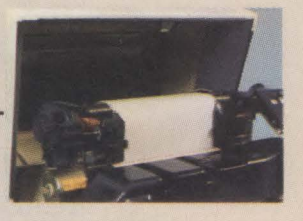

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Mini-Micro World

Newest 8-in. Winchester maker aims to be number 3

Not content to be simply one more supplier of 8-in. Winchester disk drives, newly formed Quantum Corp. plans to hit the small-business computer market with a low-end, low-cost device that will compete with the hardware announced last year by Memorex and Shugart Associates.

At the moment, however, pricing, storage capacities and other specifications of the San Jose company's new drives remain unclear. Also unclear is whether the new devices will use voice-coil motors or stepper-motor actuators tied to band positioners. It is known, however, that the new hardware will be physically compatible with Shugart's SA1000 5M- and 10M-byte Winchesters, and with its 1M-byte SA850 double-sided floppy-disk drives.

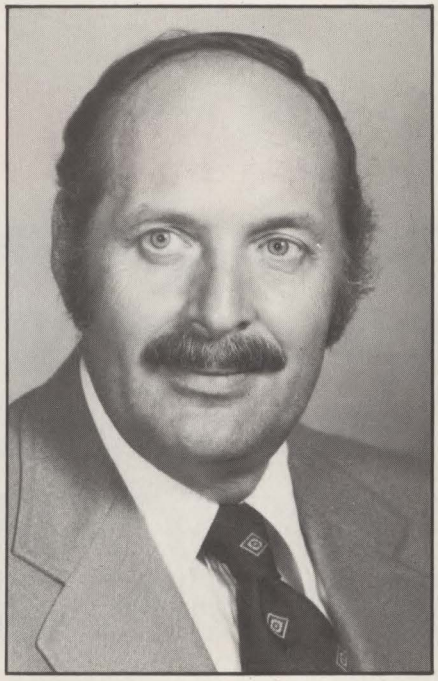
Quantum has also set its initial management team. President of the new firm will be James Patterson, former vice president of engineering at Systems International, Sunnyvale, Calif. Also joining the new company as co-founders are Don Daniels and Howard Medley, both of whom left Shugart in 1979, and Dave Brown, Joel Harrision and Jim McCoy, all of whom resigned simultaneously from that company early last February.

First products from Quantum are due out during the second half of this year, reports one source, with production versions of the low-cost drive set for the first quarter of 1981. —*John Trifari*

Peripherals boom in short-term rental market

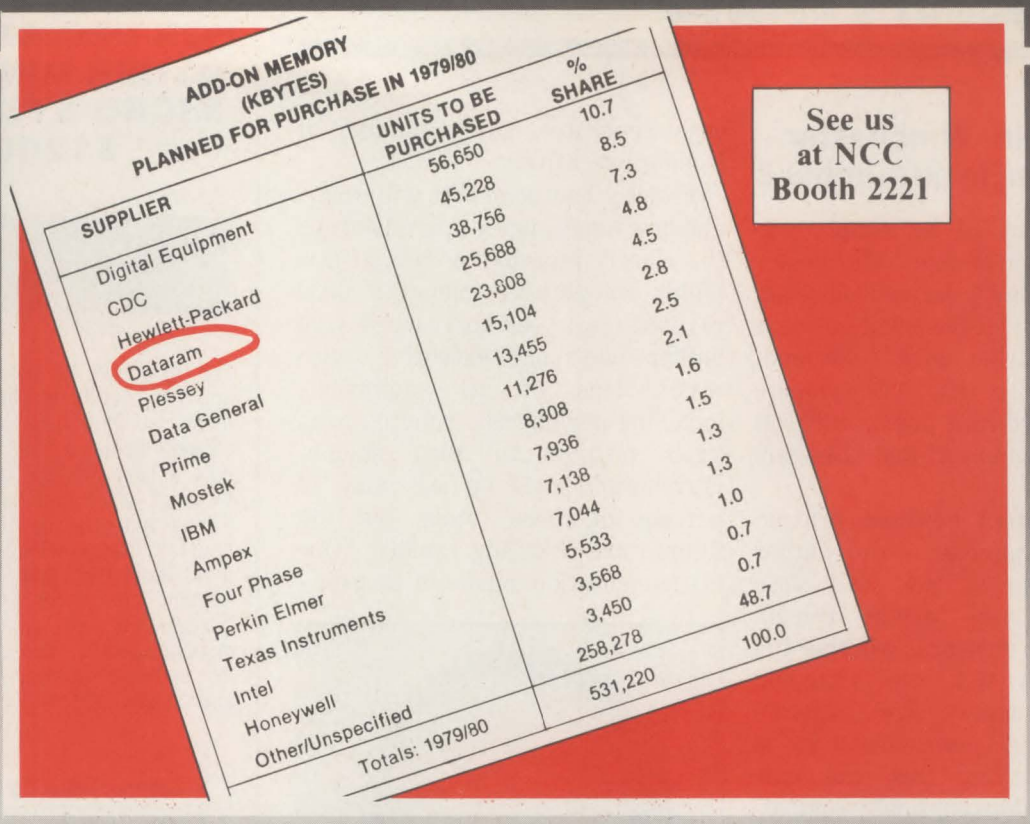
Mini- and microcomputer peripherals comprise only a small percentage of the total inventory carried by short-term rental houses. Yet, that type of gear soon will surpass test and measurement equipment as the industry's leading cash generator, say a number of leasing executives.

Exactly how soon this will occur, and how much money is involved are the closely guarded secrets of this highly competitive industry. Total revenues last year approached $120 million, says one executive, with inventories of all equipment, including peripherals, running from $150 million to $200 million. Peripherals made up less than 10 percent of these totals, but the figures are changing rapidly. "Our instrumentation business is growing at about 20 percent per year," he says, adding that some of his peripheral business is growing at 80 percent per year.



USIR's Kest: *"The high cost of money is pushing the rental business."*

Regardless of the exact figures, businessmen in this market regard terminals, printers, modems and acoustic couplers as recession-proof. "The high cost of money is pushing the rental business," explains Alan Kest, vice president of data products at U.S. Instrument Rentals, Inc. (USIR), San Mateo, Calif. "When money is tight, people want to conserve capital and minimize down-side risk."



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Moreover, short-term rentals offer an effective means of meeting seasonal demand, Kest adds. "We're looking at the CPA who needs an additional terminal at tax time, or at universities strapped for data-entry capability during fall registration," he says. Before short-term rental houses jumped into the peripherals business, he adds, users with these demands would have had to commit themselves to peripheral equipment for at least a year.

Bill Hauf, marketing manager at Electro Rent, Burbank, Calif., notes that short-term rentals also offer users access to scarce hardware, such as Digital Equipment Corp.'s VT-100 intelligent terminals. Hauf concedes, however, that there aren't too many for rent. "They seldom stay off lease very long," he says. "Everything that comes in goes out pretty quickly." Still, he suggests that hard-pressed users give rental houses a try: "We had some come in a while ago, and surprisingly, they sat around for a while. Then zip, they were all gone."

Although some leasing houses have looked at VT-100 emulators to meet the demand for these terminals, USIR has not. "We guarantee that the product we put out on lease will operate as specified; we can't guarantee that it will emulate," Kest says.

Electro Rent's Hauf: *"The capabilities of peripheral hardware are constantly changing."*

Short-term rentals also safeguard the user against getting obsolete equipment. Says Hauf, "The capabilities of peripheral hardware are continuously changing. Terminals are becoming smarter, and some users feel that what's on the market now may not be what they need six months from now."

For the most part, rental houses offer commonplace peripherals—Teletypes, Lear-Siegler CRTs, DEC printing terminals and low-speed data-communications equipment. Leasametric, Inc., also offers Hewlett-Packard Co.'s 2630 and 2640 intelligent CRTs, according to Joel Dolin, president of the Foster City, Calif., firm. Under this arrangement, H-P handles all software maintenance, while Leasametric takes care of hardware support on a swap-out basis. But such devices are the exception. Says Dolin, "We're cautious about what we put into our inventory. Part of our job is to buy the right hardware."

Almost all arrangements for renting hardware are handled under an operating, or non-full-payout, lease. Under this lease, hardware comes back into inventory before it has been fully paid off by the rental house.This provides a twofold advantage to users: In addition to shorter terms, users get the advantage of an immediate tax write-off. Secondly, they don't have to worry about service. One disadvantage of this type of lease is that users can't build any equity.

Kest points out, however, that some equity can be accumulated under an operating lease, depending on its terms. And under some conditions, rental houses offer financial, or full-payout, leases, whereby the user owns the hardware at the end of the rental period. Kest stresses, however, that these are exceptions. The primary focus of hardware-rental houses is the short-term operating lease.

One reason for the widespread acceptance of the operating lease, explains Dolin, is the philosophy of the data-processing industry. "Computer users have a history of writing off computer operations as operating expenses," he explains. "Test and measurement people, on the other hand, look to renting as an expediency and not as a basic financial consideration." Kest agrees: "you used to rent equipment when the world was coming to an end. Now all that has changed."

—John Trifari

New technology needed for cable-TV computers

The implications of cable television extend far beyond home entertainment, but a number of new technologies must be further developed before the promise of two-way cable TV and home computers can be realized. This was the gist of a recent talk by Gary S. Tjaden, vice president of engineering for Cox Cable Communications, Atlanta, Ga., to faculty and students at Northwestern University in Evanston, Ill.

Tjaden, who before joining Cox in 1979 was director of advanced technology for Sperry Univac, described the technologies needed in terms of both their applications and their economics. "The way to make decisions about what research is needed and useful has to be very closely correlated with what makes good business sense," he said.

Cox Cable Communications is the fifth largest cable TV company in the U.S., with some 800,000 subscribers in 19 states. Its 49 systems generate $95 million in revenues. But the high capital requirements of cable TV, particularly during its start-up stages, leave little of that revenue for research. Consequently, Cox is merging with General Electric Co., which has substantial R & D resources and an expressed commitment to cable TV development.

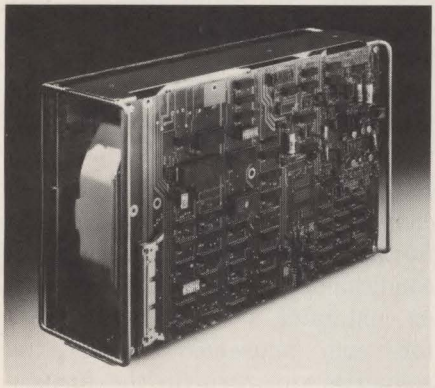
VARIATIONS ON A THEME BY PRĪAM

DISKOS 2050 AND 3450 8" WINCHESTER DISC DRIVES

This Tune May Sound Familiar . . .

Variations are created from the elements of a composition, changed to create a new and interesting idea. PRIAM's DISKOS 2050 and 3450 are variations on a Winchester disc drive design theme that has been proved in concept, performance, and production.

PRIAM design engineers followed the same design composition that has made the 14-inch-disc DISKOS 3350 efficient, reliable and cost effective. They scaled the DISKOS 2050 and 3450 to fit exactly into the space required by a standard floppy disc drive. This noteworthy accomplishment provides capacities of 20 and 34 megabytes, with 40 and 68-megabyte capacities to follow, with the same size and weight.



Interface Harmony

PRIAM's DISKOS 2050 and 3450 play from the same interface music as the DISKOS 3350, so that a single controller can be used with PRIAM Winchester disc drives covering the capacity scale from 20 to 154 megabytes. Head positioning times, data transfer rate, data and command functions and lines . . . every pin connection is the same. And *data separation is included* in all PRIAM drives, saving you expense in interfacing.

Sing Along With SMD

An optional interface permits you to use PRIAM drives with existing controllers for CDC Storage Module Drives. You can stretch the life of your SMD controller and get on the air more quickly with the low cost, high capacity, and splendid reliability of PRIAM Winchester disc drives.

See us at N.C.C., booth #347 & 349, Disneyland Hotel underground exhibit facility.

Presto Positioning

PRIAM's proprietary linear voice coil head positioner provides fast access to data and still lets the DISKOS 2050 and 3450 exactly replace a standard floppy disc drive. Positioning is fast and precise, with an average access time of 50 milliseconds, and a track-to-track time of only 10 milliseconds. Because of the exact positioning provided by PRIAM'S voice coil system, data recovery is positive and reliable. DISKOS drives will tolerate the harsher environments in which computers, word processors, and communications systems of the future will operate.

Brushless DC Spindle Motor

A brushless DC spindle motor provides reliable operation with a simple, low-cost design, doing away with belts and pulleys and extra bearings. PRIAM's DC spindle motor eliminates alternating current entirely from the DISKOS 2050 and 3450. They will operate anywhere in the world without change.

Microprocessor Maestro

Economy, flexibility and reliability result from PRIAM's use of a microprocessor to control head positioning and to perform self test and diagnostics. The number of parts and electrical connections in the system are reduced to lower cost and improve reliability.

Welded Steel Rod Frame

PRIAM's DISKOS 2050 and 3450 mainframe castings are mounted in sturdy welded steel rod frames that permit ready circulation of cooling air. These frames also reduce weight and cost. Heavy metal is used only where it is needed, so the DISKOS 2050 and 3450 weigh only 20 pounds. Shock mounts protect the drives and isolate them from system ground.

Air for Reliability

PRIAM disc drives use a unique air management system to prevent contamination. Valuable data is protected by creating positive air pressure at the spindle bearings, where contamination is most likely to enter. PRIAM drives include permanent absolute filters that constantly purge the air inside the sealed disc assembly.

Specifications

DISKOS 2050 Capacity (unformatted)	20 Megabytes
DISKOS 3450 Capacity (unformatted)	34 Megabytes
Transfer rate	1.03 Mbytes/Sec
Track-to-track positioning	10 milliseconds
Average positioning	50 milliseconds
Tracks per inch	480
Bits per inch	6646
Height	4.62 inches
Width	8.55 inches
Depth	14.25 inches
Weight	20 pounds

Interface Efficiency

Interfacing DISKOS 2050 and 3450 disc drives to your controller is economical and efficient because it is designed for connection to the most widely used 8-bit and 16-bit microprocessors. Daisy chaining is easy and functional, and overlapped seeks may be used. Data separation is included in drive electronics, so controller design is simplified and reduced in cost.

Smart Interface

PRIAM's SMART Interface Adapter provides serialization and deserialization of data, disc formatting, sector buffer,polled or interrupt operation, defect mapping, overlapped commands, implied seek, selectable sector sizes and microdiagnostics. Up to four drives can be interfaced easily to the I/O bus at the byte level.

For a brief and handy history of Winchester technology and its advantages, call or write to PRIAM and ask for a copy of WHO'S SELLING RIFLES TO THE INDIANS? A Winchester Disc Drive Technology Primer. It's FREE!

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CIRCLE NO. 34 ON INQUIRY CARD

Spurring the use of cable-tied computers in the home, Tjaden says, is the Federal Communications Commission, which in 1972 required all cable systems built from that date to provide two-way communication. The FCC's move has triggered speculation about the potential for home access to specialized data bases, such as for weather information, stock market prices and yellow-pages-like listings of local vendors and services. Experimental versions of these "Viewdata" and "Teletext" systems are currently installed. But much new technology in terminals, data base design and distribution must be developed before these systems can be offered to the 80 million homes in the U.S.

Tjaden sees the need for an assortment of new technologies. Microprocessors and fiber optics are likely to be the leading technologies for cable operators; satellite and data base hardware/software for the operators' suppliers. But these technologies are interrelated: as one is implemented, the need for others increases. Moreover, each contributes to the economics of the others.

As an example of this technological and economic symbiosis, Tjaden cites the evolution of cable services from simple retransmission to pay TV. "Around 1975 somebody got the bright idea to sell uncut versions of movies via satellite to cable operators who, in turn, could resell them to their cable subscribers. That idea has taken cable TV from a marginally successful business to a very attractive investment opportunity."

The key technology was the satellite earth station, but from it developed additional needs for higher-bandwidth (e.g., fiber-optic) cable to support more channel capacity, and for microprocessor-based converters to restrict movie viewing from nonsubscribers.

The converters Cox is installing at Orland Park, a Chicago suburb, are linked to a 400-MHz 52-channel cable system. It is the first such system in the U.S. Normal converters handle only 35 channels. Additionally, Tjaden points out, "they look like computer terminals." They incorporate a keyboard input, a digital readout and a microprocessor. Channel selections are keyed in, and there is a parental discretion feature for the four channels that show R-rated movies. Only someone who knows a secret code can access those channels.

Implementing this computer technology doubles the cost of the converter from $50 to $100. But, as noted, the economics improve with each additional technology-provided service. The added ability of cable operators to offer pay (movie) TV, for example, added more than 4 million subscribers and $438 million to 1979 cable revenues—nearly one quarter of the industry's total. And converter costs are typically amortized in just over a year. Consequently, Tjaden expects even more computer technology to find its way into cable systems.

Tjaden described two services being implemented by Cox Cable as representative of those that will eventually be available on a nationwide basis. Cox subscribers in Norfolk, Va., and Jacksonville, Fla., are offered a home security system consisting of a 4-bit microcomputer wired to smoke and intrusion sensors. The microcomputer monitors the sensors and sends status information every three seconds to one of a number of Z80-based concentrators. The concentrators communicate with a central HP-1000 minicomputer that stores critical household information—such as number of children, elderly or handicapped family members, personal medical data and location of gas and electrical shutoffs—on a disk. Alarm information or the absence of status signals triggers the minicomputer to retrieve this data from the disk and include it in a message to the appropriate emergency services. The minicomputer also sets off home alarms and displays an action message on the home terminal.

Tjaden: *"Cable TV could create the world's largest distributed processing system.*

Cox Cable offers a second service — for energy management — to its subscribers in Pensacola, Fla. They tie their cable converters into the controls for furnaces, water heaters and air conditioners. A central minicomputer containing a schedule of events for each household signals the converters to turn up the furnace before the family gets home and to turn on the water heater before the family arises. Pilot experiments indicate this approach can result in energy savings of as much as 30 percent.

Tjaden described these applications as models of the full-fledged home computer distributed-processing system of the future: "The important thing, from my point of view as a computer scientist, is that we're talking about microprocessor-controlled terminals in every home connected to central computers via cable. There is a way to get input into the system and to take information off the cable. And that is a rudimentary home computer distributed-processing system."

—Alan R. Kaplan

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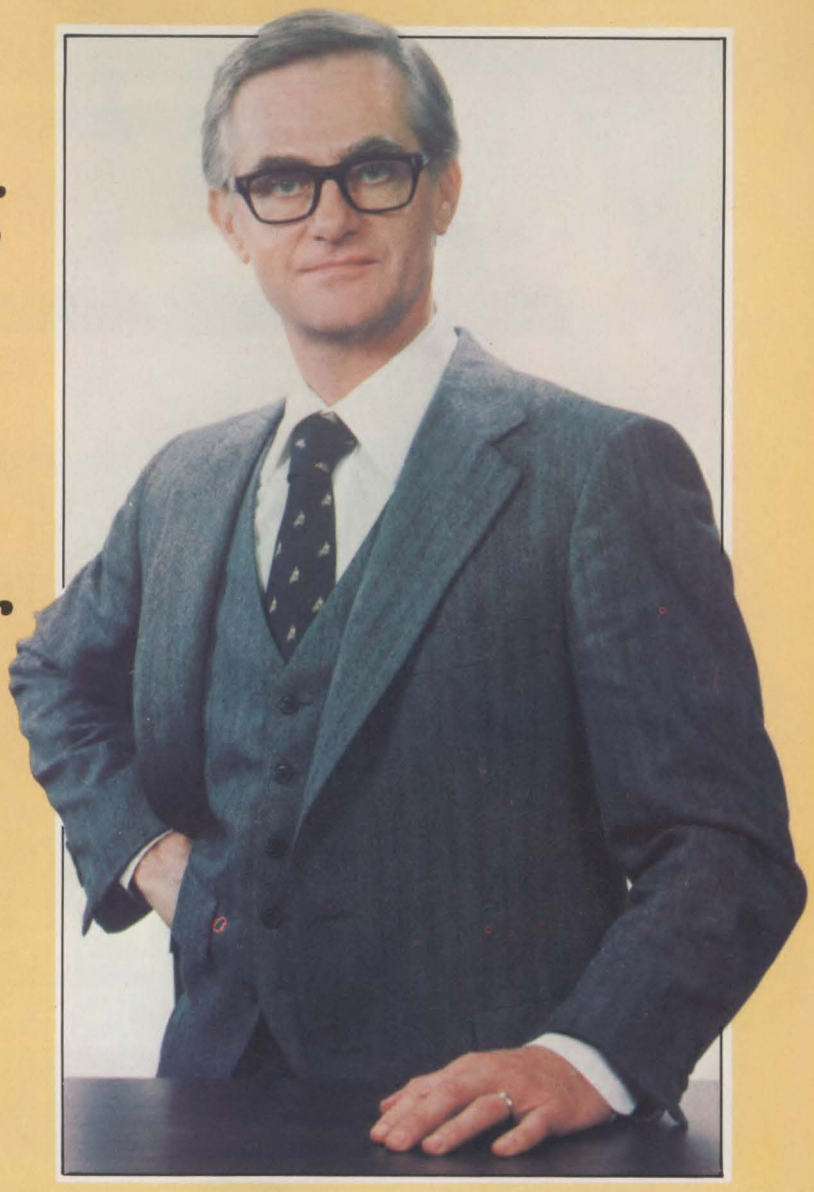

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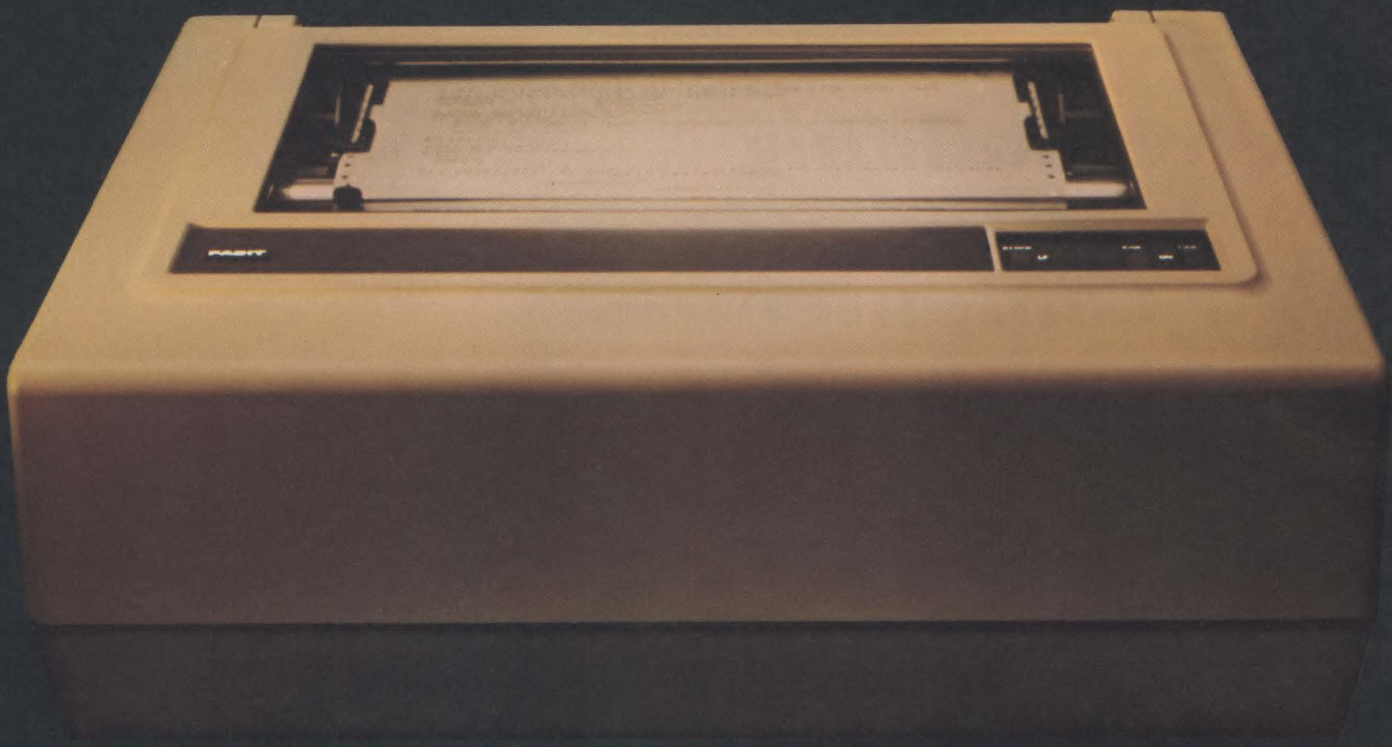

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Polaroid looks for a niche in computer graphics market

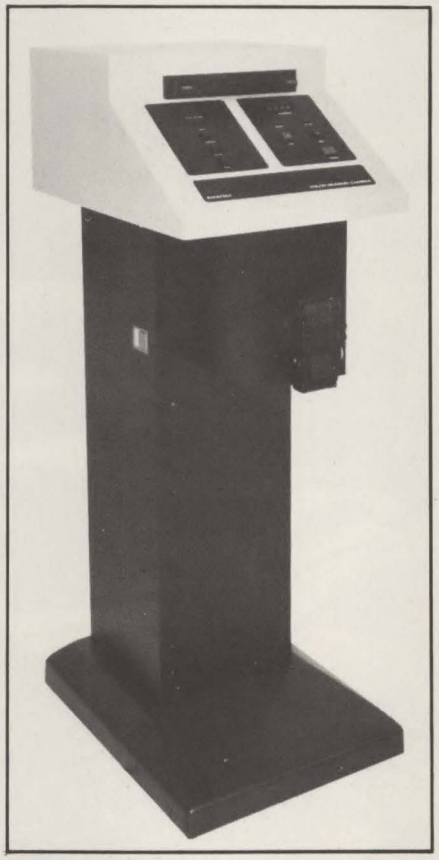
With its consumer business maturing, and having taken a $68-million write-off on its Polavision instant home movie system last year, Polaroid Corp. is looking for new markets to nurture long-term growth. Recently, the Cambridge, Mass., instant photography giant introduced several products for the medical imaging market, and now it may have found another potentially lucrative opportunity: computer graphics.

Indeed, the company sees a vast new market for its products in color graphics hard-copy applications. "We're talking about a market valued in the hundreds of millions of dollars annually," says Morris L. Samit, marketing manager for Polaroid's recently formed computer graphics product group.

Hoping to capitalize early on this market, Polaroid has launched an ad campaign in trade publications to promote the use of its Polacolor 2 instant film in color hard-copy applications. In addition, the company plans to develop other film products geared specifically to the graphics market, according to Samit.

But while Polaroid will supply film, it has no plans to manufacture the specialized—and expensive—camera systems required to reproduce color graphics displays photographically. Instead, Samit says, Polaroid will rely on independent hard-copy camera manufacturers, of which there are two: San Francisco-based Dunn Instruments, Inc., and Matrix Corp. in Northvale, N.J. (MMS, January, p. 104).

Both firms make camera systems selling for about $15,000 that use the 8 × 10 Polacolor 2 instant film, which was originally developed for the professional photography market. In addition, Matrix's system accepts a smaller-format film originally intended for use in Polaroid's SX-70 camera for amateur photographers.



Matrix Corp. *hard-copy camera uses Polacolor 2.*

While Samit denies that Polaroid has any special relationship with these manufacturers, he says the company has worked closely with them to ensure that their cameras are compatible with Polaroid film. In addition, he notes, Polaroid has exhibited with the camera vendors at trade shows, and features their systems in its ads.

While Samit is closemouthed about future Polaroid product plans, his very presence at the company suggests that Polaroid won't stop at supplying only Polacolor 2 film. Samit is a founder and former vice president of marketing at Summagraphix Corp., a leading manufacturer of low-cost digitizers. After leaving Summagraphix a year ago because of "business differences," he worked briefly as a consultant before joining Polaroid last fall.

"We're just studying the market right now," he says, but he sees a demand for color transparency film among graphics hard-copy users. Users have also expressed interest in automatic film processing. Polaroid's current Polacolor film processor—a $625 stand-alone unit—processes only a print at a time.

But while users would also like lower-cost hard-copy film (Polacolor costs $6 a print), Polaroid has no plans in that direction. "We're top-of-the-line, and we intend to stay that way," Samit insists. "People sometimes get hung up on Polacolor's cost, but I don't see it as a legitimate argument. Speed of interfacing and ease of use are more important in this market than cost."

—Paul Kinnucan

NEXT MONTH IN MMS

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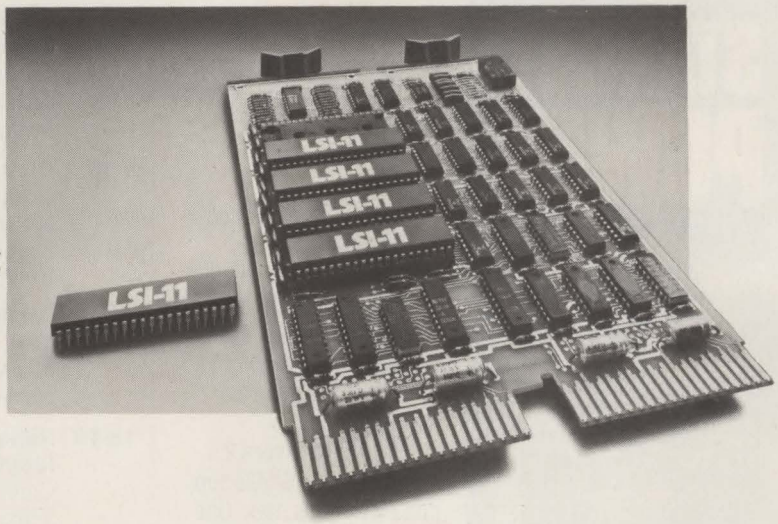

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CIRCLE NO. 37 ON INQUIRY CARD

Calendar

SHOWS & CONFERENCES

MAY

19-22 1980 National Computer Conference, Anaheim, Calif., sponsored by the American Federation of Information Processing Societies, Inc., the Association for Computing Machinery, the Data Processing Management Association, the IEEE Computer Society and the Society for Computer Simulation. Contact: American Federation of Information Processing Societies, Inc., 1815 North Lynn St., Arlington, Va. 22209, (703) 243-4100.

19-23 Software Summit Series Conference, Los Angeles, sponsored by the American Institute for Aeronautics and Astronautics and the Data Processing Management Association. Contact: AIAA Seminars, Department SWS, (5959 W. Century Blvd., Suite 1016), P.O. Box 91295, Los Angeles, Calif. 90009, (213) 670-2973.

20-22 SEMICON/West '80, San Mateo, Calif., sponsored by the Semiconductor Equipment and Materials Institute. Contact: Semiconductor Equipment and Materials Institute, Inc., 625 Ellis St., Suite 212, Mountain View, Calif. 94043, (415) 964-5111.

21-22 Clemson Small Computer Conference and Exhibit, Clemson, S.C., sponsored by Clemson University. Contact: J.K. Johnson, Continuing Engineering Education or W.J. Barnett, Conference Chairman, Electrical and Computer Engineering Department, Clemson University, Clemson, S.C. 29631, (803) 656-3308.

JUNE

2-3 Corporate-Wide Packet-Switched Data Networks Conference, New York, presented by McGraw-Hill. Contact: McGraw-Hill Conference & Exposition Center, 1221 Avenue of the Americas, Room 3677, New York, N.Y. 10020, (212) 997-4930.

9-10 Distributed Data Base: Design, Operations and Communications Conference, Boston, presented by McGraw-Hill. Contact: McGraw-Hill Conference & Exposition Center, 1221 Avenue of the Americas, Room 3677, New York, N.Y. 10020, (212) 997-4930.

17-19 IMM/DATACOMM '80 Exposition, Geneva, Switzerland. Contact: Industrial & Scientific Conference Management, Inc., 222 West Adams St., Chicago, Ill. 60606, (312) 263-4866.

18-19 National Estimating Society Second Annual Conference, Anaheim, Calif. Contact: Noel Hargrove, Conference Chairman, P.O. Box 5009, Westlake Village, Calif., (213) 889-2211, ext. 2868.

23-25 Second World Computing Industry Congress, San Francisco, sponsored by the Association of Data Processing Service Organizations, Inc., the Canadian Association of Data Processing Service Organizations, the European Computing Services Association and the Japanese Software Industry Association. Contact: Thomas V. Farewell, Assistant to the Executive Vice President, Suite 1100, 1925 North Lynn St., Arlington, Va. 22209, (703) 522-5055.

23-27 IBI World Conference on Transborder Data Flow Policies, Rome, Italy, sponsored by The Intergovernmental Bureau for Informatics. Contact: IBI, P.O. Box 10253, 00144 Rome, Italy, (396) 591-5041.

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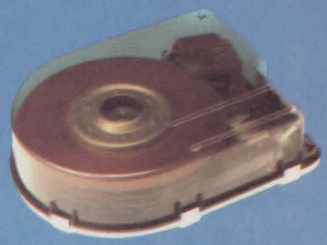

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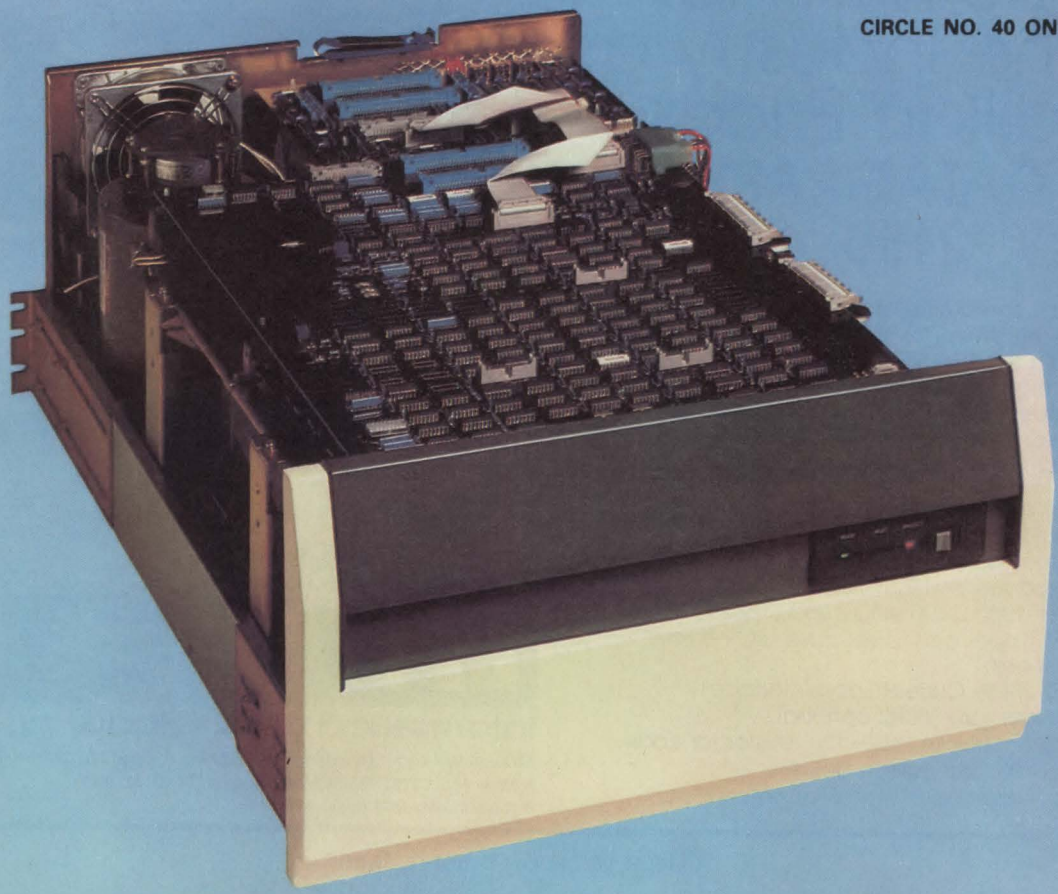

Calendar

JULY

1-3 **TRANSDUCER/TEMPCON (Transducer Exhibition and Temperature Control and Measurement Equipment Exhibition),** London, England. Contact: British Information Services, 845 Third Ave., New York, N.Y. 10022, (212) 752-8400.

7-11 **"Computers and Related Equipment" Exhibition,** Seoul, Korea, sponsored by the U.S. Department of Commerce. Contact: Robert Wallace, U.S. Department of Commerce, OIM Room 6015A, Washington, D.C. 20230, (202) 377-2433. (Also to be held in Hong Kong, China, July 14-18.)

14-18 **SIGGRAPH '80,** Seventh Annual Conference on Computer Graphics and Interactive Techniques, Seattle, Wash., sponsored by The Association for Computing Machinery Special Interest Group on Computer Graphics. Contact: Harvey Kriloff or Bob Ellis, Conference Co-Chairmen, SIGGRAPH '80, P.O. Box 88203, Seattle, Wash. 98188, (206) 453-0599.

AUGUST

18-21 **First Annual National Conference on Artificial Intelligence,** Palo Alto, Calif., sponsored by the American Association for Artificial Intelligence. Contact: Louis G. Robinson, Stanford University, P.O. Box 3036, Stanford, Calif. 94305, (415) 495-8825.

24-26 **New England Typo/Graphics Exposition,** Boston, sponsored by Type-X Exhibits. Contact: Type-X Exhibits, Inc., 15 Oakridge Circle, Wilmington, Mass. 01887, (617) 658-6876.

25-27 **HP-1000 International Users Group 1980 Conference,** San Jose, Calif. Contact: Glen A. Mortensen, Intermountain Technologies, Inc., P.O. Box 1604, Idaho Falls, Ind. 83401, (208) 523-0383.

SEMINARS

MAY

19-21 **"Computer Controls" seminar,** Philadelphia, sponsored by the Canadian Institute of Chartered Accountants (CICA). Contact: Kim Kugel, Seminar Coordinator, RHY Consultants, Inc., 1444 Balsam St., St. Paul, Minn. 55122, (612) 452-7913. Other dates and locations available.

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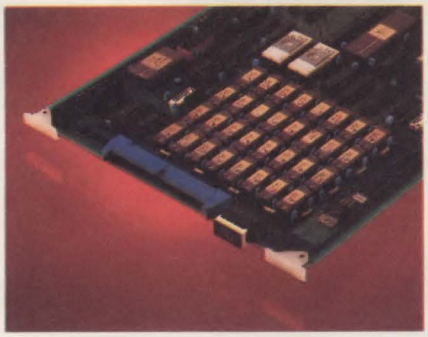

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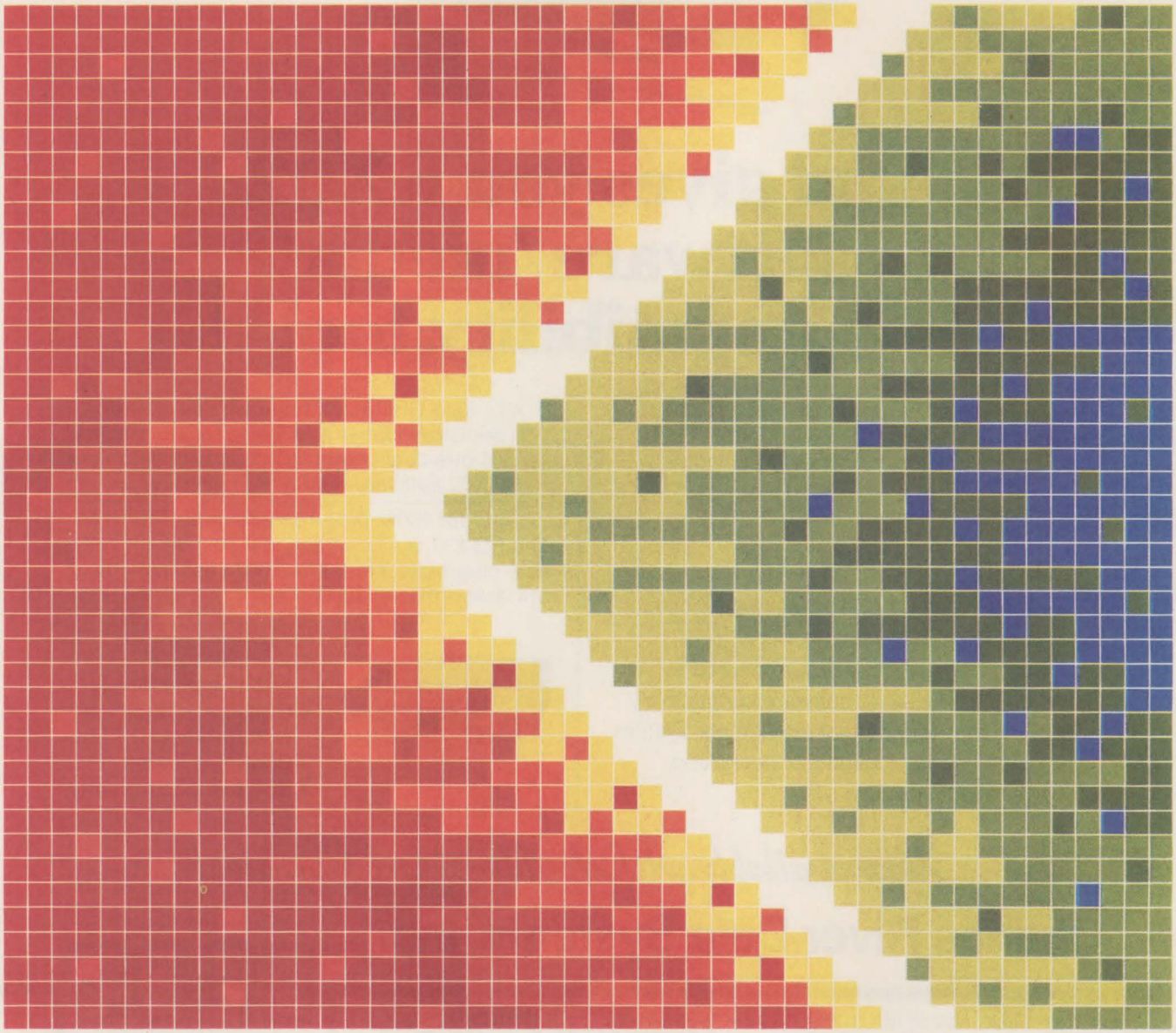

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CIRCLE NO. 43 ON INQUIRY CARD

Microprocessor problem puts a glitch in Centronics growth

(Michael D. Kaufman succeeded Robert Howard as president of Centronics after this article was prepared, but too late for the change to be reflected in Howard's title, below. He remains board chairman and chief executive officer.)

When Centronics Data Computer Corp. introduced its model 730 miniprinter at last year's National Computer Conference, the company had high hopes for the product, predicting sales of 100,000 units in the first year alone. Instead, the $795 printer—Centronics' first entry in the under-$1000 printer sweepstakes—has become something of a headache. Model 730 production delays, caused by a microprocessor problem in the printer, are cited as the reason for the Hudson, N.H., firm's reporting the first no-growth quarter in its history. The glitch in the growth curve also precipitated an earlier-than-planned reorganization of the company along product lines.

Starting in mid-January, Centronics shut down its model 730 production lines for six weeks to allow engineers to correct a microprocessor runaway problem attributed to static electricity (see "What caused all the static," p. 63), which was causing the printer to run out of control (MMS, April, p. 28). As a result, says Robert Howard, Centronics president and board chairman, "we were unable to deliver $4 to $5 million worth of the miniprinters during the third quarter." The lost revenues, in turn, meant that Centronics' third quarter results remained flat—about the same as second quarter revenues, which Howard concedes, were "disappointing." He originally expected a 25 percent growth in revenues in both the second and third quarters, based on past performance, but second quarter revenues grew only 12.8 percent, from $29 million to $32.7 million.

The model 730: *grief from a runaway microprocessor.*

The microprocessor runaway problem first surfaced during routine life cycle testing of the printer in January—about two

WHAT CAUSED ALL THE STATIC?

It isn't clear what caused the microprocessor runaway in the model 730. Centronics president and chairman Robert Howard and NEC Microcomputers, Inc., the alternate source for the chip, are agreed about it, but prime source Intel Corp., which developed the 8-bit 8049, has a different view. In any event, the problem has been corrected in machines produced after the shutdown, Centronics claims.

Howard attributes the runaway to a microprocessor packaging problem. The affected chips have two exposed bias leads brought out of the microprocessor package. The leads, used by the microprocessor manufacturers to test the chip, allowed static electricity to "leak" into the chip under certain conditions, scrambling the microprocessor's programs.

Howard says that Centronics solved the problem by shielding the microprocessor and by installing a safety circuit that automatically resets it in the event of a runaway.

Moreover, the runaway problem affected only the chips supplied by the microprocessor's primary source. The second-source chip, he says, does not have the exposed bias leads because the second source tests its chips in a different manner.

David Millet, microcomputer product marketing manager at NEC Microcomputers, confirms Howard's explanation of the runaway. He says the Intel and NEC chips have the same number of pins, with identical functions. However, two of the Intel chip's pins can also be used, in addition to their normal functions, to put the chip into an internal test mode, which Millet claims Intel uses during production testing. Both pins must be set high to trigger the test mode, Millet says, and this condition never arises during normal chip operation.

An abnormal condition, however, such as static electricity, can trigger the test mode in the field, causing the microprocessor to do "funny things." "We don't have that problem," Millet adds, "because we have chosen to do our testing by a different method."

Intel's Lionel Smith has a different explanation. Smith is micro components applications manager at Intel's micro control operation in Phoenix. He claims that the problem was occurring because the 730's microprocessor was not adequately protected against power supply transients caused by the print head and paper-feed solenoids. "We recommended that they install bypass capacitors on the microprocessor board, and they seemed happy with the solution," Smith says.

Smith disputes the static electricity explanation. "The printer was failing when no one was touching it; it's difficult for me to believe that can be caused by static electricity."

As for the possibility that static electricity might cause the 8049 to go into an internal test mode in the field, Smith confirms that some Intel customers had that problem with the 8049's forerunner, the 8048 single-chip microcomputer. But that test mode was used for debugging the 8048 during design—not for production testing—and was eliminated from the 8048 in late 1978. "It was never in the 8049," Smith adds.

Centronics' Howard: *breaking the business into more manageable pieces.*

months after initial shipments of the 730 began. Howard explains that the testing involves, among other things, running a 1000-unit sample of the printers under high, normal and low humidity conditions, with each test taking 30 days. "The problem showed when we did the low-humidity test," Howard says.

Centronics does not plan to recall approximately 15,000 of the 730s that were shipped before the January shutdown, or to alert their owners to the runaway problem. Howard says this is not necessary because the probability of the runaway problem occurring is statistically low—1.7 percent. Instead, Centronics will replace printers in which the problem shows up, under the company's normal warranty.

Radio Shack is a major user of the 730 in the TRS-80 microcomputer. Jon Shirley, vice president of the computer division at Radio Shack, says that 730s already in customers' hands will be replaced on a one-for-one basis as malfunctions develop—no questions asked.

Shirley says that as a result of the difficulties with the 730, the Fort Worth, Texas, Tandy Corp. subsidiary held off delivering any more of the errant printers until Centronics came up with a fix. Centronics apparently has done so, he says, and testing of revised 730s was finished in early April. Shipments of the altered printers to Radio Shack retail stores began late last month.

The 730 production stoppage is the latest problem besetting the high-flying Centronics, which in 10 years has carved out a leading position in the low-cost printer market and grew to $121.5 million in sales last year, thanks to its pioneering of matrix printers.

The model 730, which was Centronics' initial response to that onslaught, had, itself, been a source of problems before the latest one with the microprocessor chip. Initial production of the unit was delayed four months when Centronics decided to come out with a 100-cps version of the printer immediately instead of waiting, as originally planned. The version originally announced operated at 50 cps, but the company decided that this would not be competitive with other under-$1000 printers, which operate in the 100-cps range.

According to Howard, however, the 730 problems are symptomatic of a deeper concern. Centronics, he says, has reached the stage where "a business becomes difficult to manage unless you break it up into smaller pieces. We recognized that, but we did it one product line too late."

To get the miniprinter back on track, Howard has named Kendrick Estey, vice president of field service, to the newly created position of vice president and general manager of the miniprinter product line, which includes the 730 as well as the model 737 draft-quality printer introduced in early March. Howard says the appointment is the first step in the reorganization of the company along product lines to make it more manageable.

He adds that Estey will continue to act as vice president of field service, but not on a day-to-day basis. Howard insists, however, that the disappointing second and third quarter results do not signal a downturn in the company's growth. "The fourth quarter will be a record one on both orders and revenues," he predicts. *—Paul Kinnucan*

ISC brings new ingredient to accounting: color graphics

In the congested small business computer market, a newcomer must offer something special to stand out from the crowd. Intelligent Systems Corp., a Norcross, Ga., firm best known as a pioneer in low-cost color CRTs, thinks it has such an ingredient for success: color graphics accounting at a price competitive with black-and-white systems.

"The small business market is fairly crowded in terms of the number of systems being offered," acknowledges ISC marketing vice president David Deans, whose company recently contributed three new systems to the market fray. But, he claims, the ISC systems have a unique competitive edge: they are the only small business systems on the market to offer color graphics accounting.

Color graphics accounting can have significant benefits for the business user, Deans says. He explains that the ISC system reports the same accounting data as an ordinary black-and-white system. But, instead of being represented as tables of figures, the accounting data is displayed as a series of color

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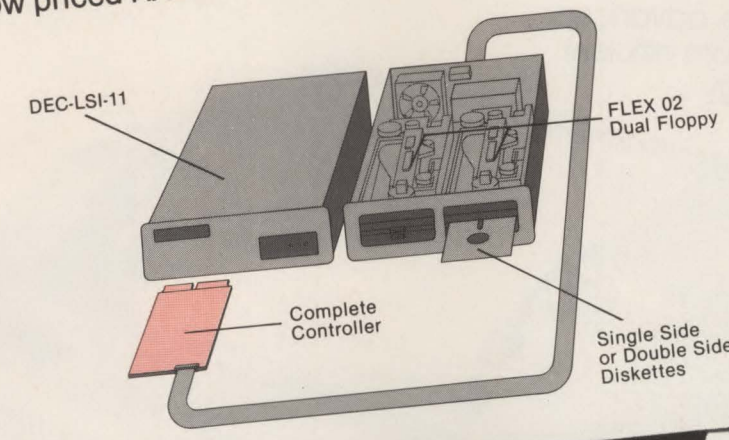

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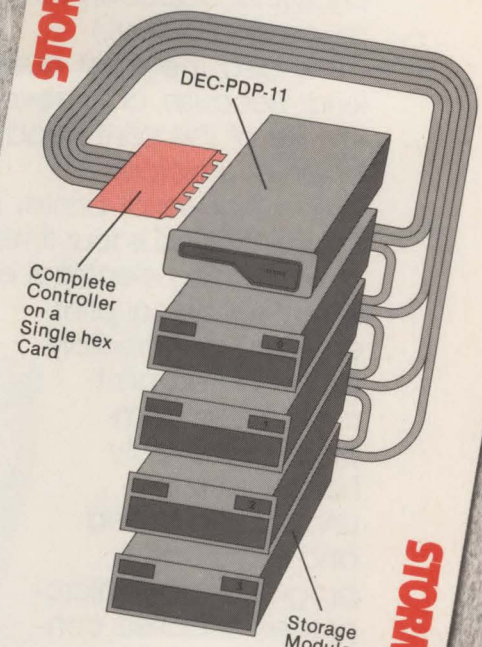

STORM02

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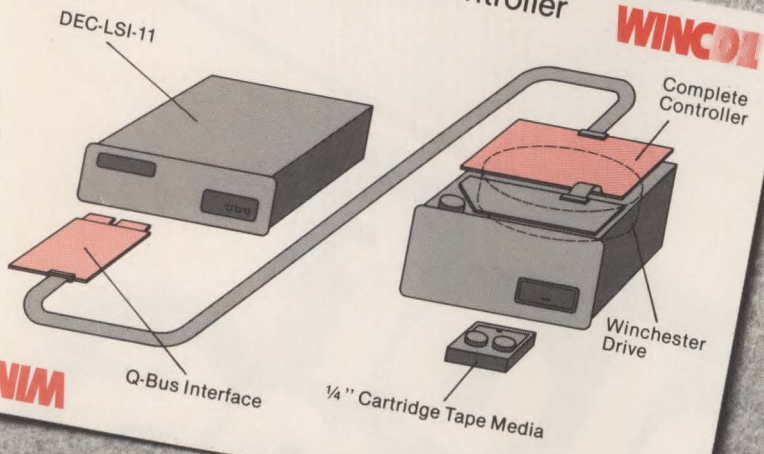

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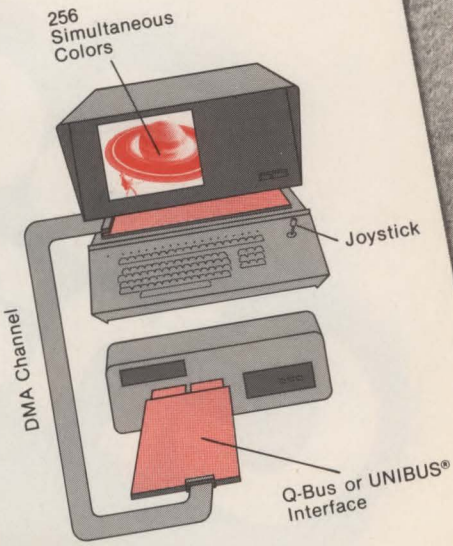

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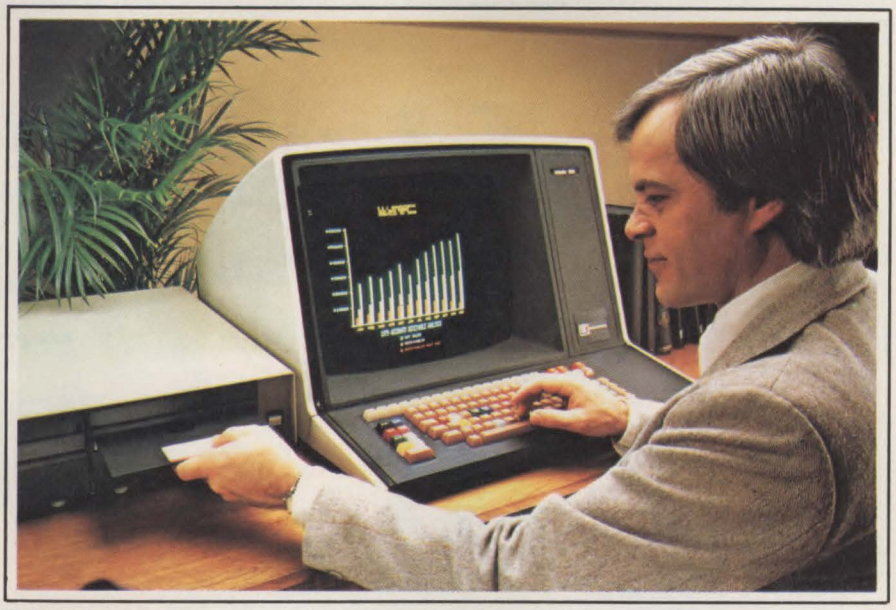
bar charts. This allows "an awful lot of information to be conveyed to an operator much quicker than with conventional black-and-white tabular displays," Deans says.

Moreover, he claims the color graphics capability does not entail a price premium: "A customer can buy a color system from us at the same price he could a black-and-white system from another manufacturer."

Deans attributes ISC's ability to offer color systems for the price of black-and-white to manufacturing economies. For one thing, he points out, ISC, which pioneered low-cost, color-CRT technology in the early seventies, manufactures the most

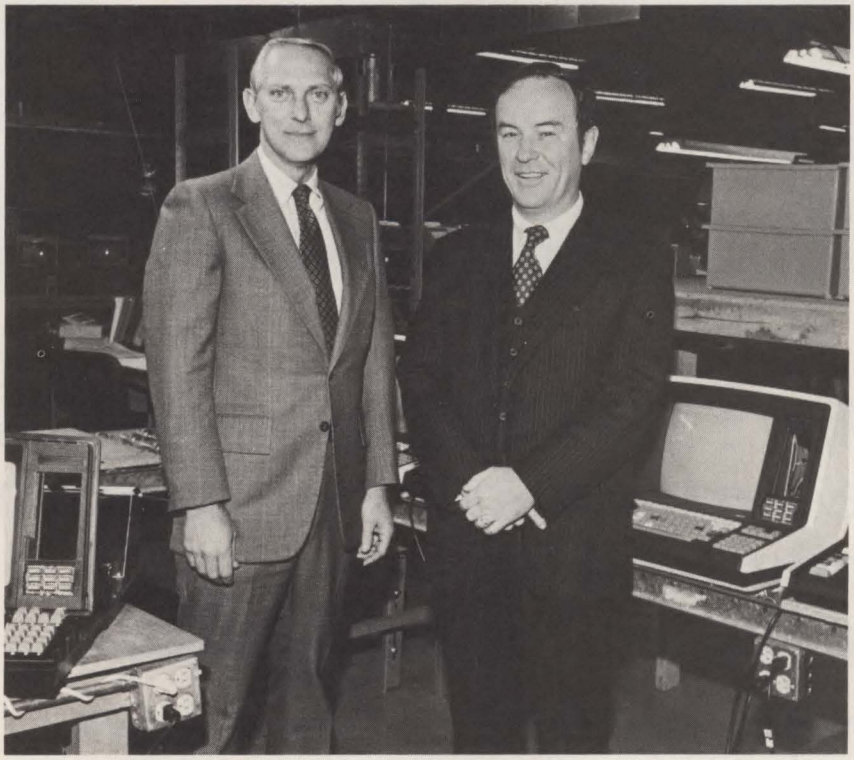


ISC business systems *use color bar charts to display accounting data.*

ISC GETS A NEW PRESIDENT

ISC's push into the small business computer market coincides with the arrival of a new president, Peter J. Curnin. The 47-year-old IBM veteran succeeds Ezra Mintz, who becomes ISC board chairman.

Curnin's IBM background suggests that he is well-qualified to guide ISC's new venture into the business market. Among other job responsibilities during his 23-year tenure at IBM, Curnin was the original product director and principal marketing strategist for the 5100 series desk-top computer, which was developed to facilitate IBM's entry into the small business market. Immediately before joining ISC, he was manager of customer relations at IBM's General Systems division in Atlanta, where, in addition to his other responsibilities, he developed a system used by IBM marketers to evaluate the effectiveness of new marketing strategies.

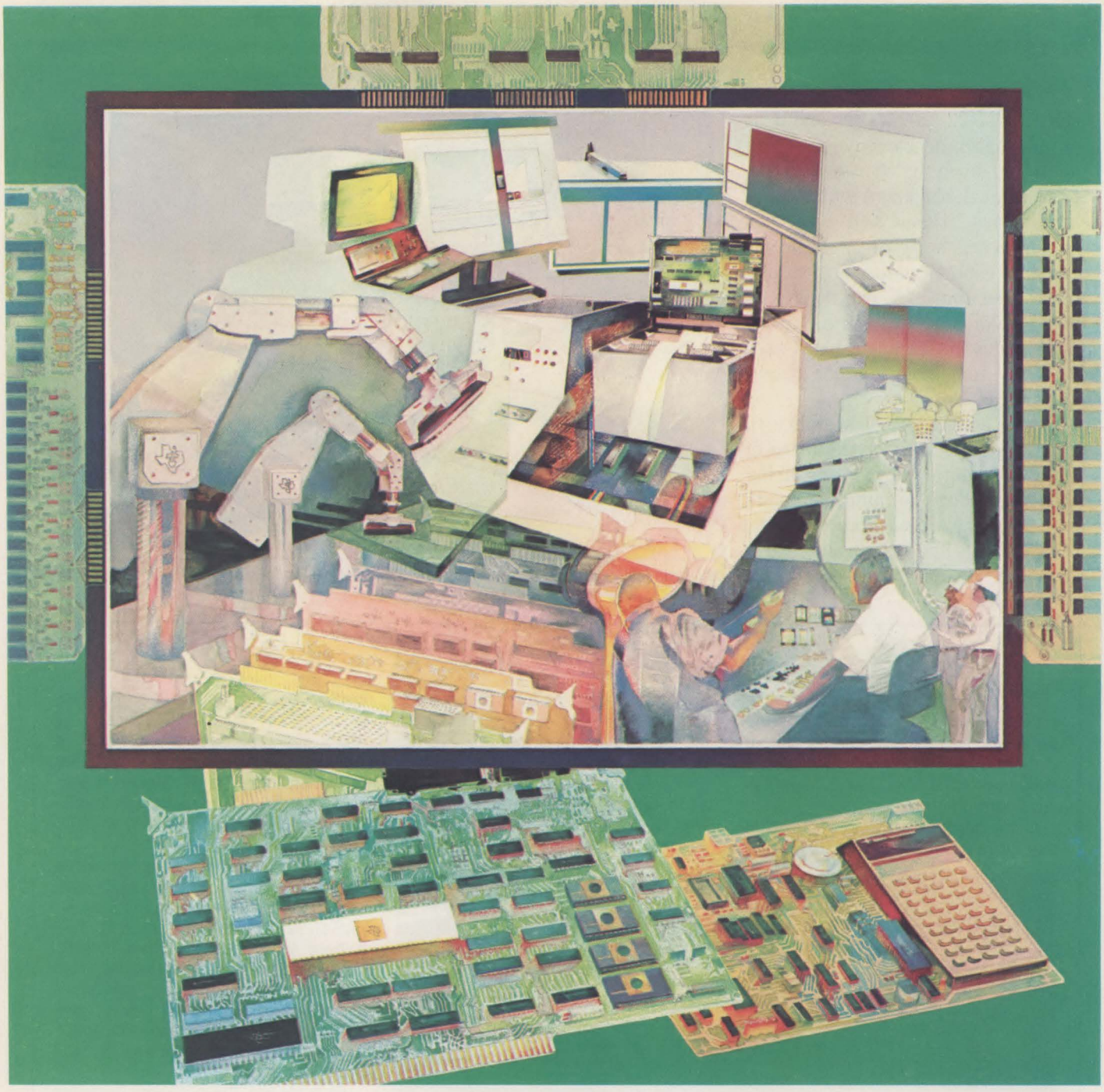


Peter J. Curnin, *right, stands with Ezra Mintz, the man he succeeds as ISC president.*

Curnin says ISC's dynamic growth is what attracted him to the company. "When I was first approached by ISC and shown the financial figures, I had a hard time believing what I saw," Curnin says. For example, he says that ISC turns its working capital 15 times a year and has never used outside financing for growth capital, except for loans from the ABN Bank of the Netherlands.

As a result, "the company founders have been able to make the company grow rapidly while preserving their equity position," says Curnin, who was given an equity position and a seat on the board of directors as an inducement to join the company.

Despite the enticements, the decision to exchange the security of an IBM career for the hazards of a small company presidency was not an easy one, Curnin says. In fact, he turned the job down when it was first offered to him by Mintz, primarily because he thought the loss of security might be difficult for his wife Nancy. Curnin says it was his wife's urging and support, however, that finally convinced him to take the job.



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expensive component of its systems—the color monitor—in house. Moreover, the company, which claims to be the world's leading supplier of color terminals, also benefits from economies of scale. "We ship more unit volume—600 a month—than all the other color display vendors combined," Deans says, "therefore, our costs are less."

The $15 million-a-year privately held company has had its largest success to date in the process control market for color displays, where it reportedly holds an 80 percent market share. In addition, it markets a line of "deluxe" color-oriented desk-top computers through its Compucolor subsidiary as well as supplying color monitors to other vendors.

As its initial business product venture, ISC has introduced a series of three microcomputer-based color display systems selling for $6000 to $8000 without a printer. That price range is "very competitive," Deans claims, with those of comparable black-and-white systems marketed by IBM, Digital Equipment Corp., Hewlett-Packard and a host of lesser companies.

The ISC 8063 series systems all include an Intel 8080 microprocessor, 48K bytes of memory, dual floppy-disk drives and a 13- or 19-in. eight-color display with an 80 × 24, 148-character capacity and 160 × 192 graphics resolution. The systems differ primarily in floppy storage capacity (512K to 1.2M bytes) and cabinetry (industrial or office style).

Turning to outside sources for software to go with its new systems, ISC has picked up an operating system (CP/M) from Digital Research, three high-level languages (Business BASIC, COBOL and FORTRAN) from Microsoft and a set of basic accounting packages from Peachtree Software in Atlanta, which is enhancing them to use color. ISC also offers an internally developed word-processing package that uses color to improve text legibility in cut-and-paste and printer formatting operations.

CPM and Business BASIC are included in the price of the ISC systems. The other software packages cost extra, with COBOL selling for $250, FORTRAN $165, the business software $3300 and the word-processing package $900.

ISC will expand this basic software repertoire, Deans says, in the third quarter with the introduction of two color-graphics packages aimed at business executives. They are a sales analysis package and a plotting package called Execugraph, which allows an executive to create his own color charts from time series data.

The third quarter will also see an expansion of the ISC systems' disk capacity, Deans says. The company plans to add 13M- and 26M-byte Winchester drives, both to be supplied by Shugart Associates.

ISC has targeted its new color systems at two types of customers: small businesses (less than $10 million in annual sales) and executives in larger companies who want to use the systems as stand-alone management information systems.

To reach this market, ISC plans to sell through business systems houses, which will supply applications software and install the systems. ISC already has one systems house customer, Scott Computing in Atlanta, and hopes to have 30 by year-end. The firm's ultimate goal, Deans says, is to be represented by two or three local houses in every major metropolitan market.

Deans is confident that goal can be attained. For one thing, he says ISC will offer security to its systems houses by pledging never to compete with them directly for end-user business. He claims that with IBM, DEC and other manufacturers entering the end-user market, systems houses are worried that competition from their existing suppliers may drive them out of business. Also, Deans points out, ISC offers a unique system that will give its customers a performance advantage over systems houses marketing black-and-white systems.

ISC will not be alone in the market for long, however. The major computer manufacturers, led by IBM and DEC, have begun to introduce color displays, although none are aimed specifically at small businesses. Independent color display vendors, such as Tektronix and Ramtek, have also let it be known that they intend to pursue small businesses when the time is ripe.

But the prospect of such competition doesn't faze Deans, who believes ISC's color technology know-how and in-house manufacturing capability will enable it to survive a confrontation even with industry giants. Drawing an analogy to the aircraft industry in the 1960s, he says, "We have the jet engine of the 1980s."

—Paul Kinnucan

Diablo, Dataroyal unveil word-processing printers

The market for word-processing typewriter-quality printers, still dominated by fully formed character printers, is getting new products from those manufacturers, as well as entries from dot-matrix-printer vendors.

Diablo Systems, Inc., Hayward, Calif., a leader in the high-quality printer market, has introduced a low-cost, low-speed daisy-wheel printer, said to be the first of its kind—allowing the interchange of plastic and metal wheels.

Dataroyal, Inc., Nashua, N.H., has joined the high-level dot-matrix market with its first entry in the word-processing arena: a high-density dot-matrix printer.

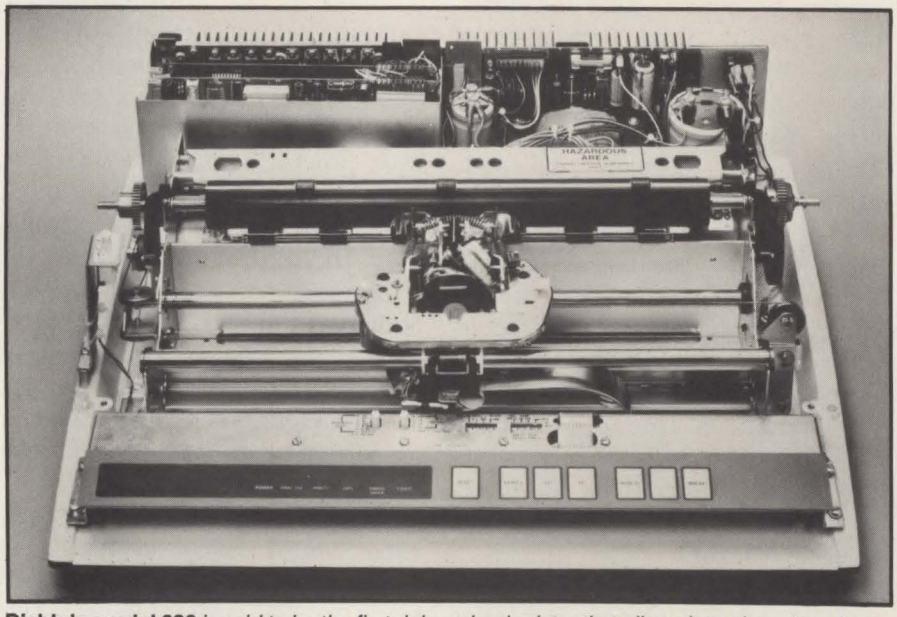
Diablo's model 630 produces both draft-quality print with plastic wheels and final-version quality

with metal daisy wheels, eliminating the need for two dedicated printers. Although it is slower than the company's popular 55-cps HyType II printer, the model 630 runs at 32 cps (metal) and 36 cps (plastic) and costs 30 to 40 percent less than the HyType II. Price is $850 in OEM quantities of 500, and $1705 for same-quantity fully configured versions.

Diablo's vice president Rigdon Currie says the 630 complements Diablo's current product line, but "lowers the cost of daisy printing—both initial and the cost of ownership."

The major thrust, Currie says, will be in the low-end, low-speed portion of the market that includes applications in stand-alone word processing, 300-baud terminal output and desk-top personal computing. He sees this market as a long-range one, expecting to build and ship—primarily to OEMs—more than 100 printers a day by next year.

Model 630 sales will cut into the HyType II market to some extent, Currie admits, with customers considering adding a machine. But the HyType II will still be sought by



Diablo's model 630 *is said to be the first daisy-wheel printer that allows interchanging plastic and metal wheels.*

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CIRCLE NO. 50 ON INQUIRY CARD

those requiring higher speeds, he says.

Industry observers speculate that Qume Corp., San Jose, Calif., has a similar product, but sources in the company deny it. One Qume source questions the effectiveness of interchanging metal and plastic wheels, saying the mass and weight of the two vary enough to require different motors to make the wheels spin. Diablo's Ron Ogg, product marketing manager for printers, counters by pointing out that custom LSI circuitry enables the printer to sense and compensate for either plastic or metal mass.

Currie says the requirement for high-quality output will continue, but admits there is a place for the high-end dot-matrix printers using multiple-pass, condensed or high-density print. Diablo has an entry in that market—a high-density dot-matrix printer that operates at 200 cps in regular mode, and 100 cps in high-density mode.

Addressing that market as well, Dataroyal will announce at this year's National Computer Conference a high-density dot-matrix printer for long-document word-processing applications. High density means printing nine horizontal dots rather than the five typically printed in normal-density runs.

The model 759 is available in both parallel- and serial-interface versions. Both high- and normal-density are software-controlled at 80 and 160 cps, respectively. Unlike other dot-matrix-oriented vendors with similar technologies that print high density exclusively, the Dataroyal machine can print in both modes, according to Dennis Buckley, vice president of engineering. In addition, it has proportional spacing between words, allowing for right-hand margin justification. Although the print quality is not as high as that of Diablo and Qume, Buckley says, it will find its niche producing offset material for manuals and other long documents requiring fast print speeds.

—Lori Valigra

Software firm succeeds with hardware additions

Several minicomputer companies start by selling hardware, then add software to their product line. But Point 4 Data Corp., Irvine, Calif., is reversing that path.

The 10-year-old private company made its mark by selling Data General Nova-compatible software called IRIS, for "Interactive Real-Time Information System." It later developed Nova-compatible hardware that led to the introduction last year of its first minicomputer, the Point 4. The 16-bit Point 4 has a Nova-compatible instruction set and

contains as much as 128K bytes of memory on one board. A 128K-byte version in single-unit quantities sells for $4860 per board, and $7300 fully configured.

Point 4 president Paul Davies explains that an integration of several elements, including hardware, software and support, has been the key to the company's success.

"We would not have attained success if we stayed only with software, because we were competing with Digital Equipment Corp. and Data General Corp.," he says. "They bundle software and basically 'give it away.'" Davies says his strength lies in developing software, then making the hardware to fit "hand in glove" with it.

Point 4's first hardware product, a direct memory access channel multiplexor serving as a universal front end, was a first for a Nova-type minicomputer. Its announcement coincided six years ago with the company's first profitable year. Davies says both the DMA multiplexor and the minicomputer are financial successes. In the fiscal year ended March 31, Point 4 revenues exceeded $5 million, and next year's projections are for $12 million.

Davies admits the company was slow getting started. Founded in March 1969 as Educational Data Systems (the name was changed in March), Davies and partner Daniel Paymar, now vice president of R & D, began with a few thousand dollars and operated out of Davies' home until five years ago, when the employee count reached 17.

Early in the company's development, Davies met with Data General when it was still a storefront operation with only a computer prototype. He wrote a core-only, stand-alone BASIC for the first Nova. Davies says this BASIC was the first high-level language Data General offered, and was run on subsequent models, including the 800, 1200 and newer Novas. He retained the right to distribute that software.

Then Davies decided to develop his own proprietary software package—business BASIC—to be followed by hardware. Davies points out that he "consistently beat DG to the punch" by first offering a disk-oriented filing system and business BASIC.

Next came IRIS, a business-oriented operating system that supports real-time, time-shared and batch processing on Nova-compatible hardware. He licensed it and business BASIC to systems houses and OEMs, including Nixdorf Computer, Sweda International and Lear Siegler.

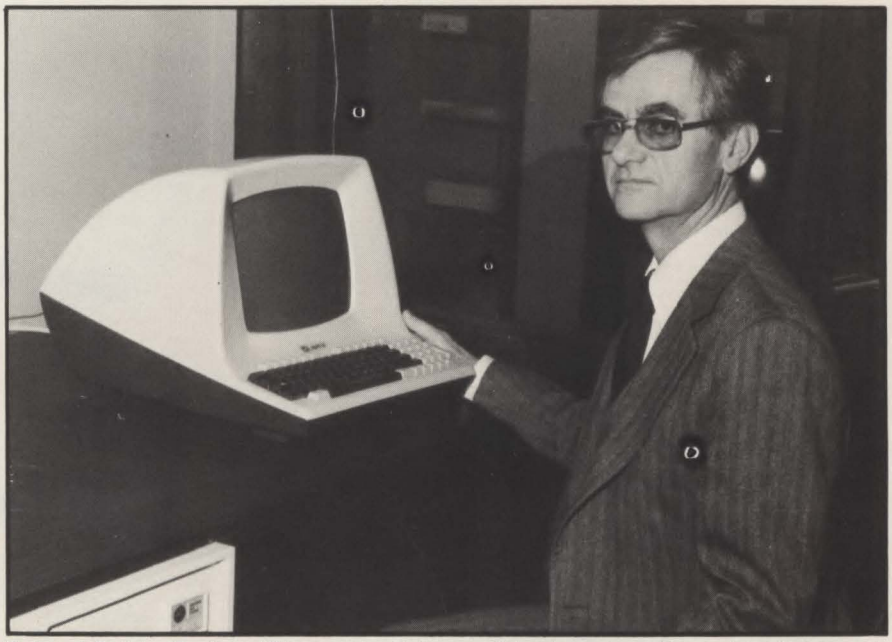
After introduction of the DMA-multiplexor a year later, additional hardware was introduced, including the Micro-N microprogramming processor, the Point 4 minicomputer and two disk controllers. These, along with the scheduled announcement this month at the National Computer Conference of an automatic programming system implemented under IRIS, further Point 4 Data's move into business data processing, data base management and data communications.

Davies has not entered into the recent onslaught of lawsuits surrounding DG's software licensing agreement for Novas. DG requires that its software be run only on its own processors. As a result, Nova-compatible hardware sellers, including Fairchild Camera and Instrument Corp., are alleging antitrust activities against the company.

Although Davies admits that technologically, his hardware should be able to run DG software, he says he is not aware of anyone running it on the Point 4, and he has not tried to run it. And DG has not approached him about a lawsuit. DG declines comment about the initial software agreements with EDS and about any legal actions between the two companies.

Davies explains that Point 4 supports, as much as competes against, Data General. "Users buy DG hardware to run our operating software, so I help sell their hardware," he says. "And, there are cases where DG customers selected our software."

There is no mechanism in the Point 4 minicomputer to ward off those who might try to run DG software, but Davies admits that his software license comes with a



Point 4 Data's Davies: *"We would not have attained success if we stayed only with software."*

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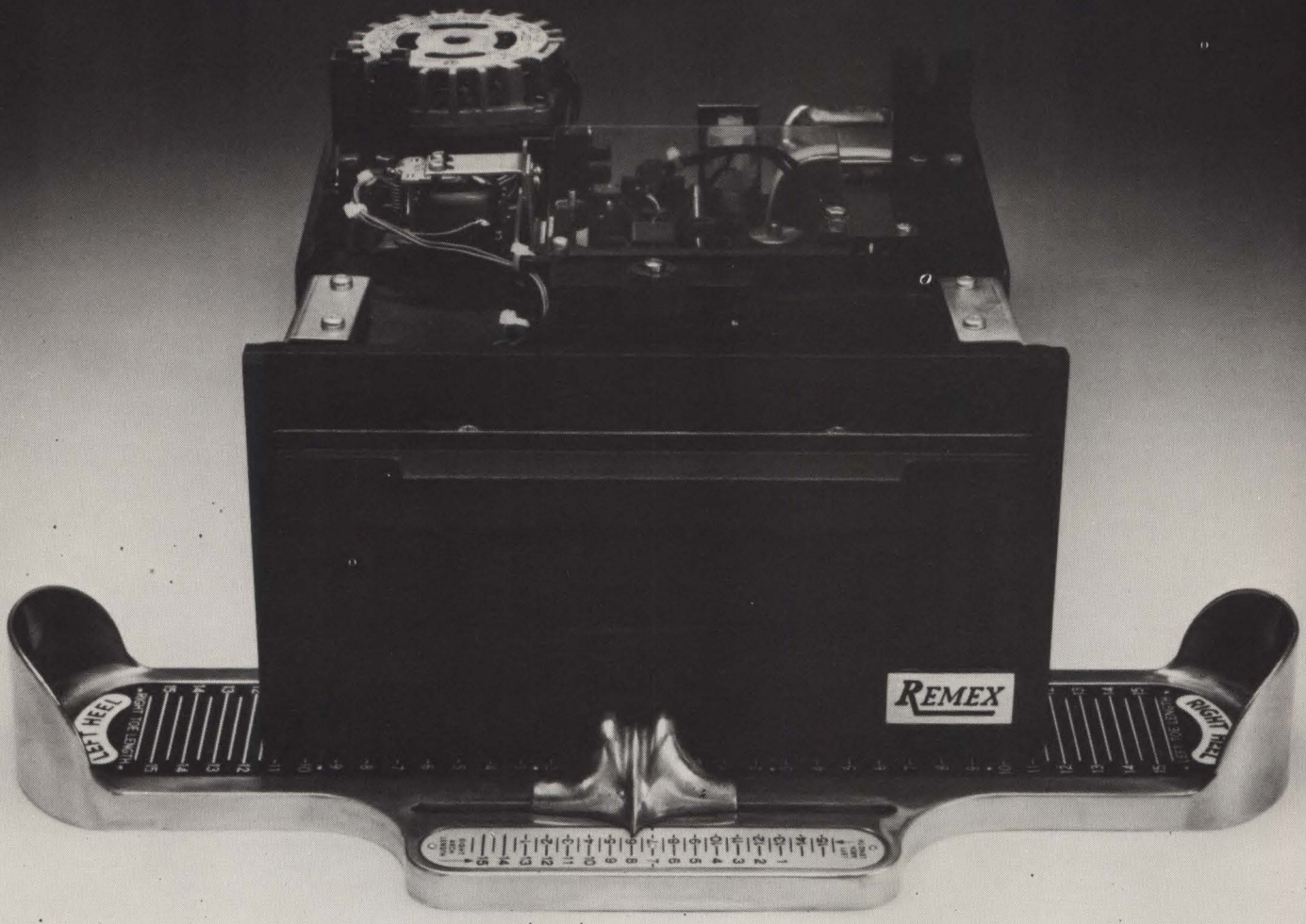

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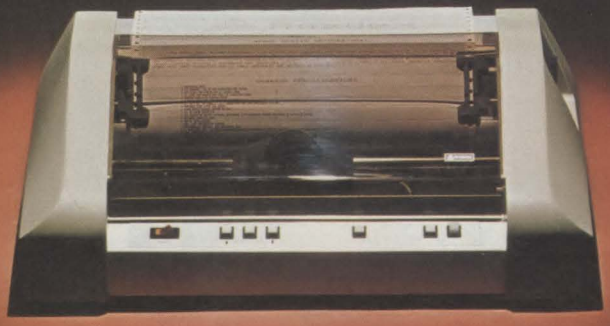

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device to prevent IRIS use on unauthorized machines. The PICO-N device, he explains, attaches to the backplane of each computer and, in a sense, activates IRIS. He says he is not aware of any similar devices by DG.

Davies has operated the company with debt capital and retained earnings, and has been profitable for the past six years. He will be moving his 115 employees to a new 25,000-sq.-ft. headquarters in Irvine this month. The company is a closely held and carefully controlled "family" according to Davies, who owns more than 50 percent of the stock. He encourages employee participation, claiming no turnover problem, with most upper management averaging five years of tenure. He has, however, had a succession of marketing managers. He says he has not yet found the right person for the job, and enjoys the marketing task himself.

Although one customer says Point 4 Data has weak management, comprised mostly of technical people, Davies sees the management team as strong. In late March he pulled David Costine in to act in a combined sales and finance role. Costine is a former EDS director and former senior vice president of New Court Securities. In late March, Davies also added Dennis Bress as director of international sales.

Davies says he plans "to continue a controlled growth rate through our own resources and retained earnings. We could bring in equity capital if we needed to grow faster, but that might be too fast." He intends to double revenues, more than double profits and increase personnel, but at a slower rate.

Product plans include integrating hardware and software aimed at the electronic office market and increasing shipment rates of 100 Point 4's per month to 200 per month by year-end. —*Lori Valigra*

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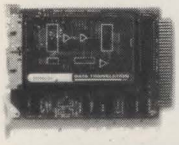

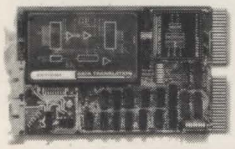

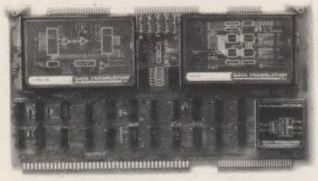

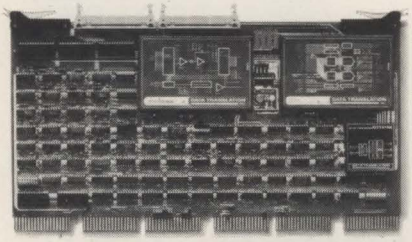

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CIRCLE NO. 55 ON INQUIRY CARD

Computer Automation rebounds with top-of-line Naked Mini

After overcoming manufacturing problems and the first unprofitable year in its history, Computer Automation's Naked Mini division in Irvine, Calif., is trying to bounce back with a top-end machine that will debut at the National Computer Conference this month.

Dubbed the Naked Mini 4/97, the system combines a new processor with what Computer Automation calls a "software factory"—a powerful software system that, when used with the CPU, provides a 30 percent improvement over anything the company has offered before.

The new processor—a 16-bit machine with a 32-bit address—is designed to handle as much as 8M bytes of memory, although the first systems delivered will be limited to 1M bytes because of chassis size restrictions. According to the company, the 4/97 will include a memory management unit (MMU) that will handle all system mapping functions, and will translate the 16-bit logical address into the 22-bit physical space. There are 16 2K-byte maps—15 for the user and one for the system.

The 4/97 will be the first Naked Mini to incorporate cache memory: 2K bytes of cache included on each MMU board and what Computer Automation calls a "micro cache" (only four words long) with a look-ahead capability on each main memory board. These memories, with access times of 50 and 125 nsec., respectively, are said to improve overall memory access time within the system.

Together, they provide a 125-nsec. access time and can handle 90 percent of all system memory references, leaving 10 percent for the 550-nsec. main memory.

Error correcting memory will be standard on the 4/97. Both 128K- and 256K-byte boards will be available, although the former will be shipped first. The ECC memory is single-bit error correct, double-bit error detect, but, according to Computer Automation, the memory's smart refresh cycle should help prevent a large percentage of double-bit errors.

The 4/97's software—Protos—is not new; it was "quietly announced at the last minute" at the 1978 NCC. The company says Protos is a multi-user system that is optimized for the OEM/system integrator environment. The company points out that the CPU was designed specifically to run Protos software and as a board-level CPU for OEMs. There was no machine on which the software could run until the 4/97 was developed.

Protos uses a new high-level implementation language developed at Computer Automation's Austin, Texas, software design facility. Called Alamo, it is a block-structured language, similar to Pascal, says the company.

Computer Automation feels the 30 percent throughput improvement is conservative because the estimate is based on benchmarks using only the cache memory. Taking full advantage of memory management, cache and some new Protos instructions, a 50 percent throughput improvement over other Computer Automation systems is possible, the company says.

Computer Automation has yet to quote prices for a bundled 4/97. Pricing for the 4/95, a board-level CPU with the same hardware features as the 4/97 but unable to run PROTOS, is expected to be $8500. A 1M-byte configuration for the 4/95 is priced at $30,000. Delivery for the 4/95 is 90 days. The 4/97 won't be available until October. —*Larry Lettieri*

DG's software packages aimed at commercial ECLIPSE system

Data General has put in its bid to increase minicomputer management tools by introducing three software packages for its commercial ECLIPSE C/150, C/350 and M/600 systems. The new packages are the DG/DBMS data base management system, an INFOS II upgraded file management system and an Interactive Query language.

With DG/DBMS, DG is undercutting prices of similar mini-based management tools offered by competitors, such as Digital Equipment Corp. and Prime Computer, Inc. DG claims that, at $9500 for an initial license, DG/DBMS has the lowest unbundled price in the industry. Competitive software sells for as much as double the DG/DBMS, according to Roy Schulte, software product marketing specialist at the company. He adds that since Hewlett-Packard Co.'s DBMS is bundled with hardware, the software appears to be free but is really part of the overall cost.

Schulte says DG/DBMS is the only CODASYL-based DBMS developed in-house by a minicomputer vendor. By using CODASYL, DG conforms to industry data base system standards, he explains, allowing easier conversions or system expansions involving minicomputers and mainframes.

"It is a full-fledged data base management system, not a stripped-down version for minicomputers," he maintains. Functions include data security, data definition and hard crash recovery.

Schulte defines the market for DG/DBMS as Fortune 1000-sized companies with hardware valued at more than $150,000. Less than 10

Data General's *data base management system can save as much as 40 percent in programming time by eliminating redundant tasks.*

percent of installed minicomputers now have DBMS, he says, but by the end of the 1980s a majority of users will have increased applications for them because of higher programmer costs.

Additionally, DBMS can save as much as 40 percent of a programmer's time by eliminating redundant tasks.

Schulte expects more than half of the commercial ECLIPSE systems sold over the next five years to include DBMS. DG/DBMS operates under ECLIPSE's AOS (advanced operating system) and manages as many as 4.4 billion characters in as many as 16 subsystems on-line.

With DG's XODIAC network management system and AZ-TEXT word-processing software, the three new packages mark another step by DG toward distributed data processing.

Among the other new management tools, the INFOS II file management system is said to be 30 to 40 percent faster than AOS INFOS and adds logging and hard crash recovery. And the Interactive Query language allows nontechnical users to access data bases in English. Each costs $2500 for an initial license.

A typical small ECLIPSE configuration of a C/150—consisting of 768K bytes of memory, a 96M-byte disk, a 300-lpm printer, eight CRTs and an 800-bpi tape drive with DBMS software, IQ, AOS, COBOL and SORT—is priced around $140,000. The same configuration with INFOS II software, INFOS II Query, AOS, COBOL and SORT costs around $124,000. Prices for both systems can run as high as $400,000.

—Lori Valigra

Formatter links cartridge drive to Winchesters

The only hardware vendor in the 8-in. Winchester market that also builds the tape-cartridge drives needed for file backup has introduced a microprocessor-driven formatter that combines many of the control functions of both devices onto one board.

The vendor is Kennedy Co., and the formatter—called the model 650—operates with Kennedy's model 640 ¼-in., 17M-byte tape-cartridge drive. The formatter is intended to simplify small-system controller design. It also reduces host-processor overhead while increasing data integrity, says Darell Meyer, tape product manager at the Monrovia, Calif., hardware house.

The 650 incorporates an 8-bit data bus and eight control lines. Each control line has been given logical definitions, resulting in bus and handshake-signal conventions that are common to both the Winchester-fixed disk drive and tape-cartridge transport. This permits the use of a single DMA controller for both, Meyer says. Differences in data transfer and access rates, however, as well as other speed and timing differences between the two peripherals, must be compensated for through software drivers.

The formatter's 8048 8-bit microprocessor and two bipolar microsequencers handle all control functions relating to the tape transport. The formatter handles all communications with the host processor, provides transport control, initiates read/write sequences on the cartridge and monitors the timing and I/O commands in progress. Included with the microprocessor are special routines to sense broken tape or the loss of tape from any of the cartridge reels.

The microsequencers incorporated into the formatter provide write encoding and read synchronization and decoding. All data on the cartridge is encoded using the group code recording (GCR) technique, rather than conventional modified frequency modulation (MFM) schemes commonly associated with this type of hardware, Meyer points out. The reason, according to Meyer, is that GCR provides better margins of error during read operations, while at the same time providing the unique control characters needed for file partitioning. GCR also provides the

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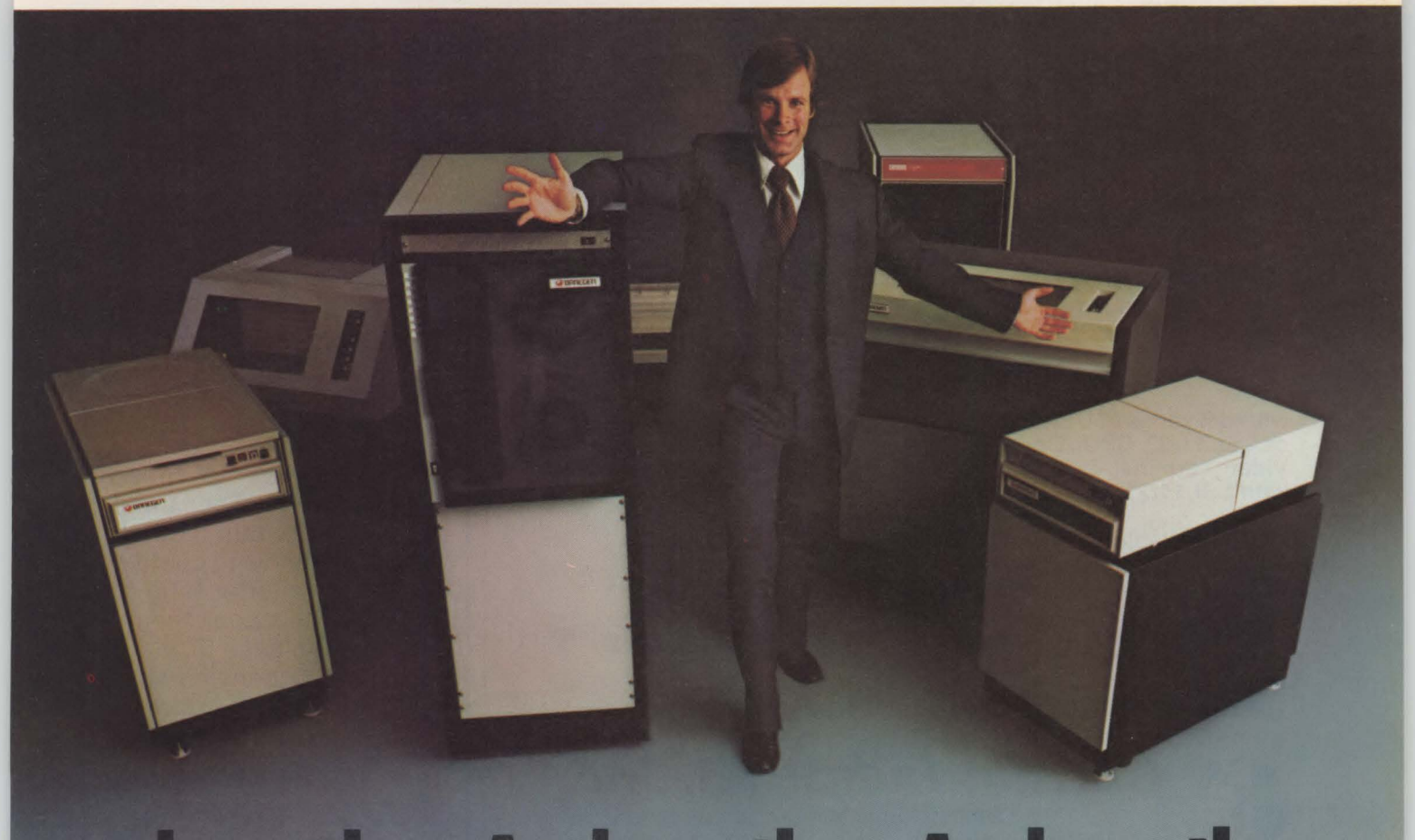

and another. And another. And another.

Mini-Micro World

hooks needed to add in other features later—especially burst error correction and data resynchronization.

Kennedy's tape-cartridge formatter also writes 16-bit cyclic redundancy check (CRC) characters at the end of each record on the tape. During read operations, the formatter calculates the CRC and compares it with a prerecorded data check sum. The model 650 also checks the parity of data and incorporates a series of diagnostic routines controlled by on-board DIP switches.

In addition to the model 640 tape-cartridge drive, the model 650 works with Kennedy's line of 4M- to 20M-byte 7000 series 8-in. Winchesters. The company has no immediate plans, Meyer says, to incorporate both peripherals into a single package. Price for the the 650 formatter is $400 in single-unit quantities. Prices for the model 640 17M-byte tape-cartridge drive start at $1200 (without the formatter) in single-unit orders, $2100 for the low-end 4M-byte 7000 series Winchester. First deliveries on the formatter are scheduled to begin in July. *—John Trifari*

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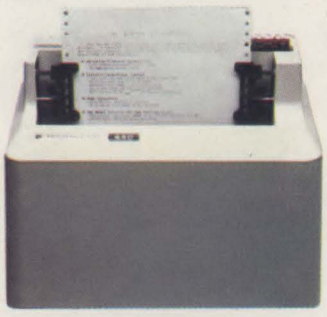

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CIRCLE NO. 60 ON INQUIRY CARD

Gaffney smoothes the marriage between Lexitron and Raytheon

Raytheon Co. and Lexitron Corp. have widely varying backgrounds. When the former acquired the latter in early 1978, many observers wondered how successful the two would be in jointly developing products that merge data processing with word processing. That effort culminated recently with the introduction of RayText, a system that combines the editing functions of a word processor with the power, data resources and communications-network capabilities of distributed data processing systems.

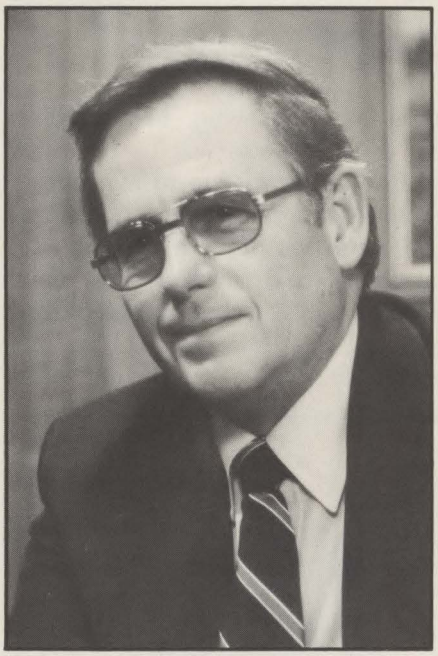
As if to silence those who questioned the fruits of the merger, Lexitron officials say that RayText generated 200 sales leads the very day it was announced. And judging from the response of the Lexitron staff to both RayText and new president Richard P. Gaffney, the joint development appears to have resulted in one of the happier marriages of its kind.

When RayText was aired in prototype stages a year ago, Raytheon Data Systems' president J. Thomas Markley, to whom Lexitron reports, was heard by one industry source to say he was not as worried about the product as he was with the joint development effort.

"I feel a thousand percent better now," Markley explains. "The product is more mature. And Dick Gaffney, as an integral part of RDS' staff, helped with some of the human issues that can hold up a product line."

Gaffney, a 23-year Raytheon veteran, brings an extensive background in communications networks, having most recently served as general manager of RDS' Minicomm division. There, he was responsible for the RayNet multi-access airline reservation system used in airport terminals. He was named president of Lexitron in February, having served as interim president there since last November, just prior to the death of former president Richard O. Baily.

Baily, who started at Lexitron in April, 1976, was the first professional manager brought into the company since its start-up in 1971. Realizing Lexitron needed capital, he negotiated the deal with Raytheon. According to one source close to the industry, Baily's philosophy of "keeping it simple" seems to be continued by Gaffney, who is bringing needed technical depth to the company as it grows.



Lexitron's Gaffney: *planning to apply knowledge of networks in word processing.*

Gaffney views the presidency at Lexitron as a move that will expand his "knowledge of marketing and the word-processing industry." He also plans to push his knowledge of communications and network processors into the word-processing business and apply it at Lexitron.

Gaffney explains that upon acquisition, the management of Lexitron remained intact, with few people coming in from Raytheon. Gaffney was the first Raytheon "company representative" to enter Lexitron. He has been followed by a few others, including Larry Gerhard, a former member of RDS' advanced development group. Gerhard is vice president of engineering.

Gaffney says that overcoming the traditional word-processing and data-processing barriers was "a natural process via acquisition." He adds that the company was driven by external pressures because "word processing and data processing are coming together."

Education is a major factor in smoothing the transition, he explains. "When two good-sized organizations come together, one to two years of education is not unusual," says Gaffney. He adds that the two groups are working together on product development, even though Lexitron is located in Chatsworth, Calif. and Raytheon in Lexington, Mass.

But the introductory process seemed to move along even more smoothly when Gaffney went to the West Coast. Each company's knowledge of the others' organization, product reviews and personnel is a major factor. Further, Gaffney and RDS' Markley communicate frequently: each has an interactive Lexitron VT 1303 terminal outside his office to send and receive messages.

Another factor of physical logistics will be overcome when Lexitron moves its now-scattered forces in Chatsworth into a more-consolidated 180,000-sq.-ft. facility in Thousand Oaks, which is nearer to Raytheon support groups in Ventura. The move is planned to begin in September, and will be virtually completed next January.

Since joining the company, Gaffney has moved new products out on schedule. In addition to the RayText system, he has announced

upgrades to stand-alone products, including a records-management system. At the International Word Processing Association's Syntopican show in June, the company plans to announce a BASIC capability and second-generation software for stand-alone systems, magnetic tape facilities on RayText and a multiplexing product called Scylla, which will allow multiple terminals to access multiple printers.

With Gaffney's direction, Lexitron watchers can expect to see more networking. RayText already has six communications protocols. "With RayText and RayNet, networking is a natural capability," says Gaffney. "But we must be concerned with protocols, diagnostics, SNA, data base and private network management." Industry sources point out that this combination would enable multiple RayText clusters to be linked while sharing access to a common data base. Markley says the April announcement of a concept connecting RayText, RayNet and terminals using software and a new board that fits into any current Raytheon Co. product, will provide the needed links.

Gaffney plans Lexitron growth at 30 percent annually over the next few years. A company source says Lexitron's total of more than 10,000 word-processing units shipped since 1972 will be doubled over the next 18 months, indicating a 550-unit-per-month shipping rate. Gaffney will expand the work force accordingly, at a planned 20 percent annual rate, primarily in sales and service. —*Lori Valigra*

Gary Sharpe turns Racal-Milgo into networking 'supermarket'

The ability to nurture a new product into the market seems natural to Gary Sharpe, new general manager of Racal-Milgo's Computer Products Division. His track record includes the development and launching of the Inforex 5000 data entry system and the initiation of Raytheon Data System's PTS-1200 distributed data-processing terminal.

In addition, Sharpe's experience in multiple-product environments, including his former position as RDS' director of industry marketing for its manufacturing and distribution groups, was a key factor in bringing him to Racal-Milgo, according to president Edward Bleckner, Jr.

Sharpe's talents behind the Computer Products Division's new product line may give the boost the division needs to gain ground in the end-user system business. A spin-off from the company last year, the division faced major obstacles. For one, the 4000 series clustered terminal system with emulators was canceled just before its scheduled announcement because it was deemed uncompetitive. Secondly, the division lost its general manager, Dennis J. Daniels, who said he resigned because of harassment following his termination of the 4000 series.

Despite knowledge of his predecessor's experience, Sharpe seized the opportunity in March to introduce and market the new product—an Intel 8086-based distributed clustered terminal system called the 4270, which emulates IBM's 3274 control unit and 3278 display station.

Sharpe: *moving toward a "one-stop supermarket" for network services.*

Sharpe describes the 4270 as the bedrock technology needed to launch the product line, which will fan out to include more distributed processing capabilities.

He adds that Racal-Milgo's modems are a logical addition to terminal sales, and he is basing his competitiveness on the idea of a "one-stop supermarket for network services"—a single-source vendor for modems, terminals, installation, field service and maintenance. The company has offered the modem/terminal combination before, but only in stand-alone environments, according to 4270 product manager Paul Cooper.

One industry observer says competitors have eyed Racal-Milgo curiously, wondering why the company had not made an earlier move to offer network resources in a terminal system. The observer notes that Racal-Milgo has both the resources and the products to form a marriage between the terminal and network markets, a pairing that would represent a new and formidable market contender for modem makers. Cooper agrees that the combination is new, saying that he knows of no modem makers other than Bell and Racal-Milgo that now sell terminals also. He adds, however, that Paradyne and Codex are exploring the idea.

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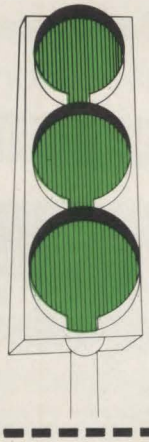

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Mini-Micro World

Cooper cites the IBM 3274 and 3278 with an IBM modem as the major competition. The Yankee Group, a Boston market-research company, estimates that 3270-type shipments for this year, including both IBM and plug-compatible models, will total between $200,000 and $250,000. Between 125 and 175 IBM 3278s will be shipped this year (as many as 32 3278s can be run on a 3274 controller). Compared to what the division is accustomed to, that market is sizable.

Sharpe describes the division's products so far as very specialized, but mature. It has carved out niches in low-noise competition markets and has become a major competitive force within them. The markets include those of the 8A1 protocol and stand-alone terminal emulators for the Univac 200, IBM 2265 and IBM 3275. The company is now broadening its approach to capture Fortune 500 companies that need follow-up equipment, Sharpe says.

Described by some as a conceptualizer who translates ideas into products and markets them, Sharpe will first build a "solid young management team of industry superstars." He will also increase the research and development staff. The division, which has fewer than 100 employees, still draws on its parent company for support in sales, manufacturing and engineering, says Sharpe, but he intends to make it more self-sufficient.

Sharpe has his own idea for making a good general manager: combine a basic education and an affinity for technology and creativity with 10 years of experience as a product manager. This yields a person who must be accountable, says Sharpe, "by virtue of sound reasoning and better argument." Time will tell how that formula will work in Racal-Milgo's drive to broaden its market and to develop new products. —*Lori Valigra*

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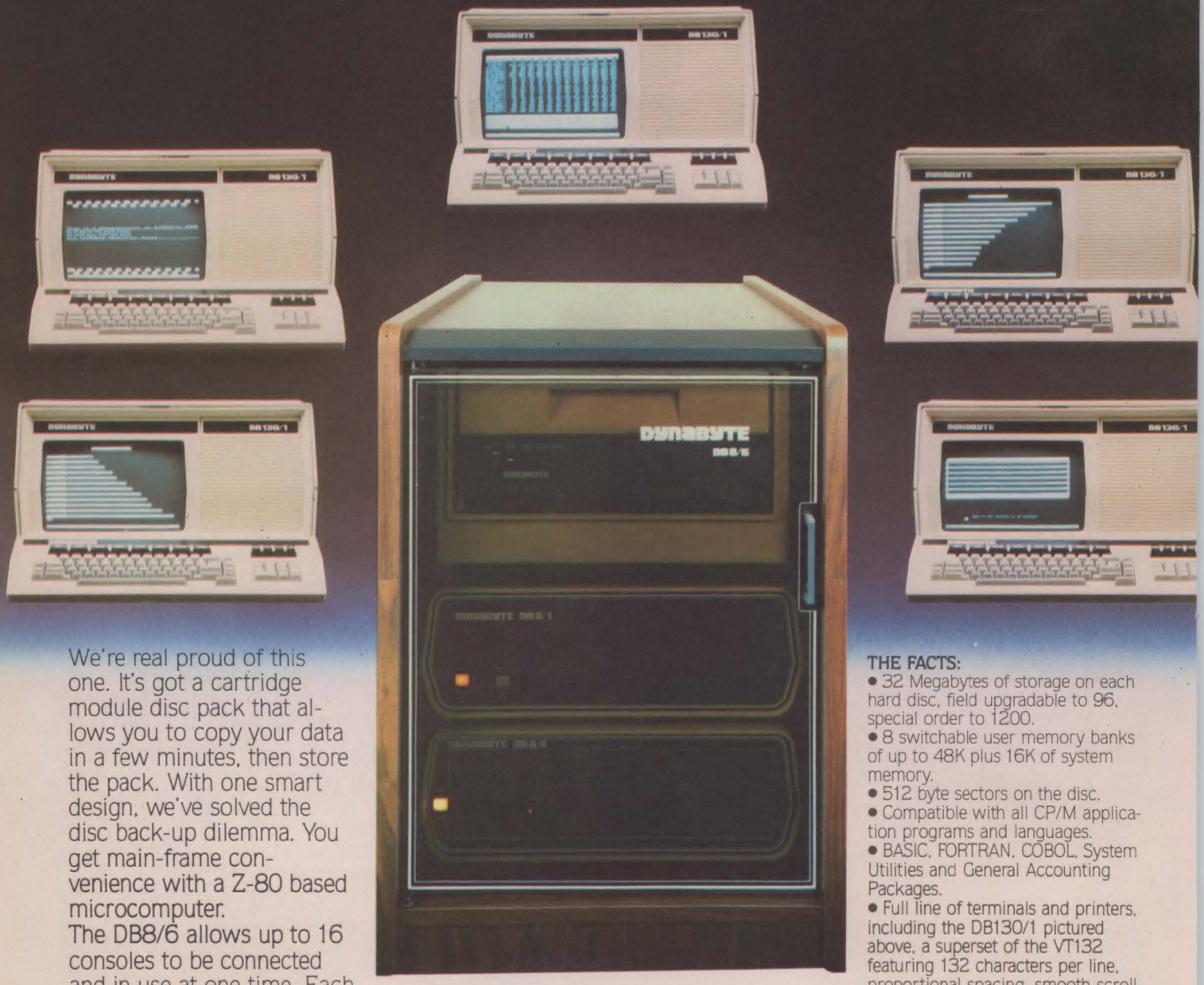

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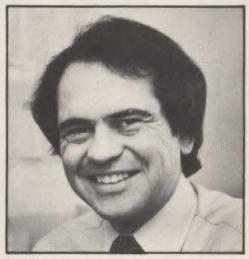
Trifari

Last month in this column we told you about two newcomers to our editorial staff and a change of assignments for another. We're still growing, and I'm delighted to reintroduce an old friend and welcome yet another newcomer. Those of you who remember *Modern Data* magazine, our progenitor, may remember that Alan Kaplan was editor for more than six years. Alan rejoined the *Mini-Micro Systems* staff as executive editor in late March, after serving *Electronic Business*, our sister publication, in the same capacity for two years.

The newcomer is Larry Lettieri, associate West Coast editor, who came aboard just a month ago in our San Jose, Calif., office. Larry's position is a new one, reflecting the importance we attach to the growing computer industry on the San Francisco peninsula. Larry reports to John Trifari, who has been representing us so well out of the Los Angeles office for two years. John says he is delighted to "share the wealth" of important developments in the West.

Alan's computer background goes back to 1964, when he was a technical editor at Cambridge Communications Corp. He later established a consulting operation there, assisting, among others, the Friden division of Singer Corp. and MIT's Electronic Systems Laboratory. Before joining *Modern Data*, Alan was senior technical editor at a Boston area consulting firm specializing in minicomputer communications and control applications. He was also director of computer consulting for Venture Development Corp., a management consulting firm, and director of program development for the Interface Group, sponsor of the Interface Conference on data communications. We welcome Alan back, and I'm sure we and our readers will benefit from his 16-year association with the computer industry.

Larry Lettieri and Alan were once friendly competitors, when Alan was with *Modern Data* and Larry served *Computer Decisions* in several capacities. He joined that magazine in early 1973, and worked his way up from assistant editor to associate editor and managing editor at the New Jersey headquarters. Then Larry became western editor, a position he held until he went to National Semiconductor Corp. a year ago as a public relations specialist for the Computer Products Group. Larry's background also includes some hands-on IBM 370 experience, and a degree in English from Rutgers University.

S. Henry Sacks

S. Henry Sacks
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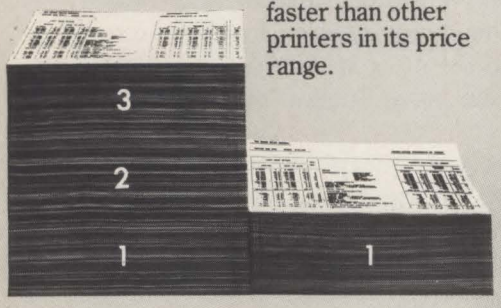

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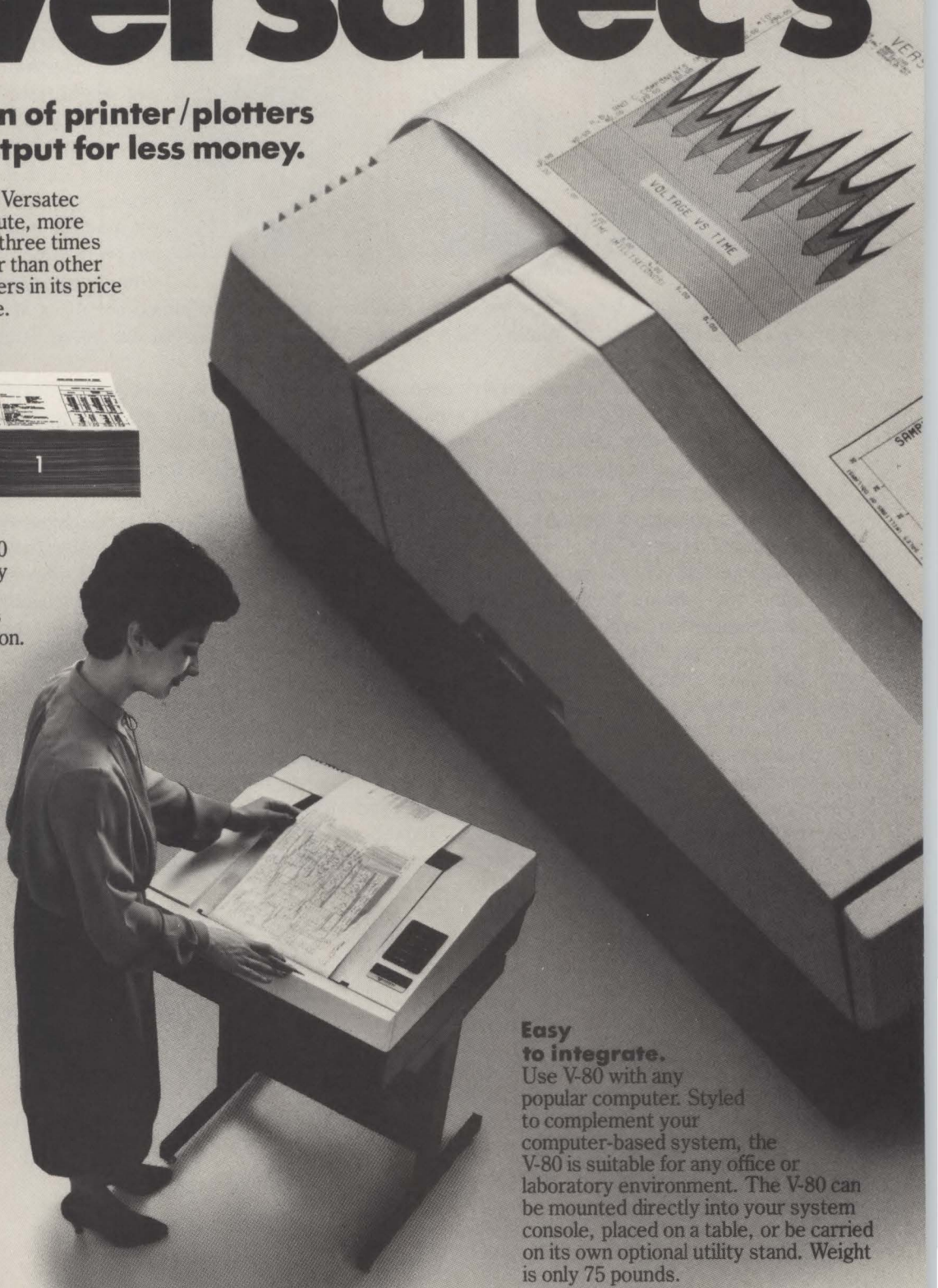

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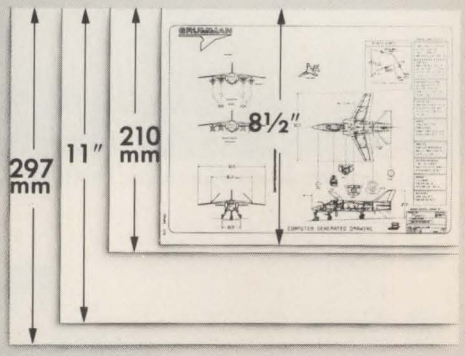

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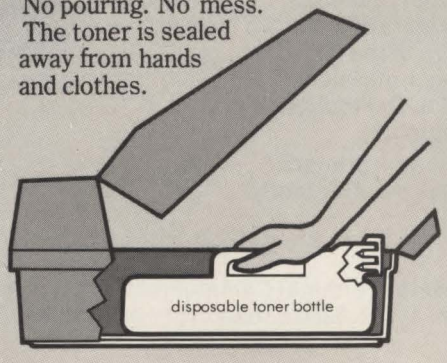

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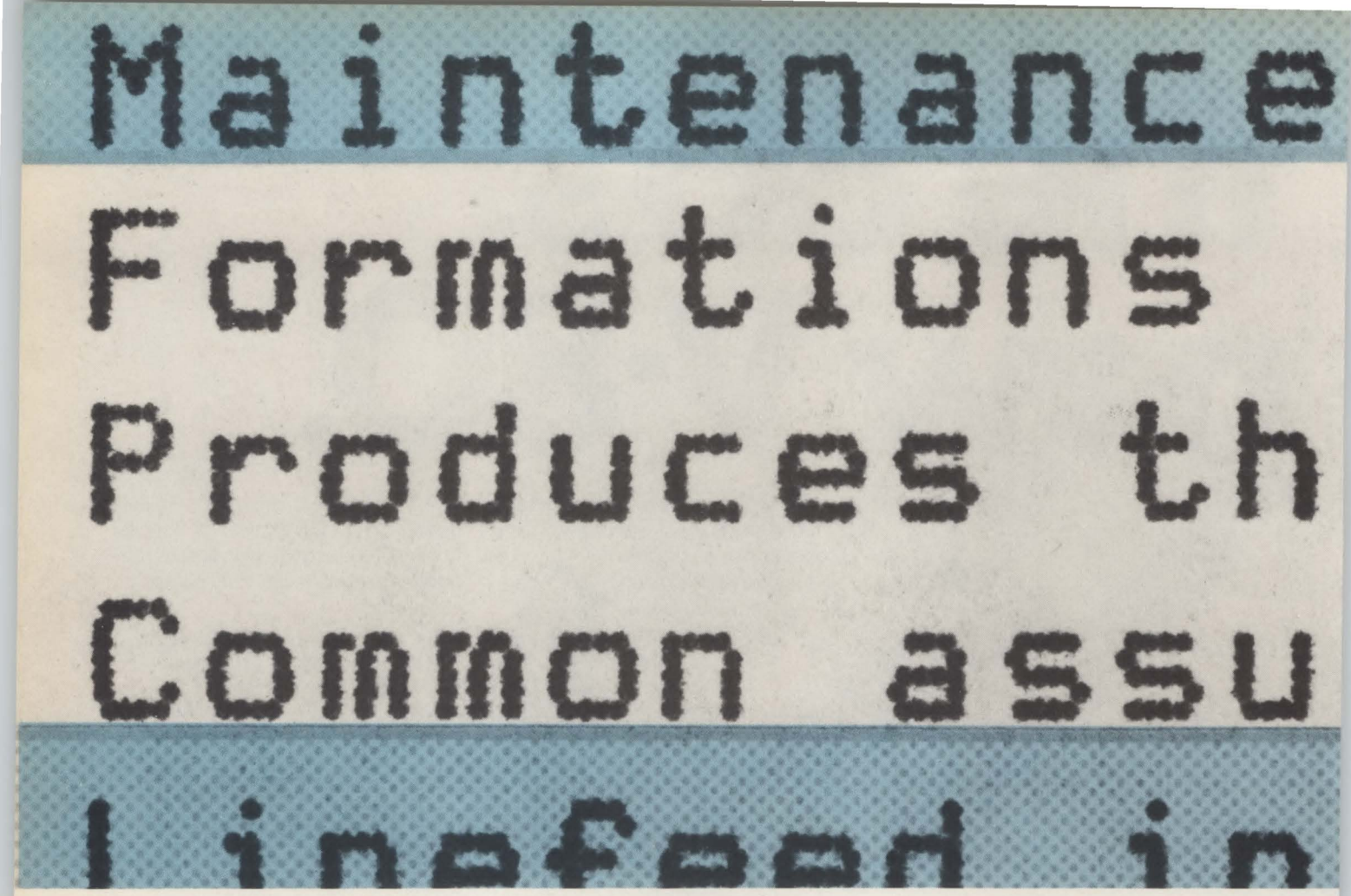

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Doldrums in processorland

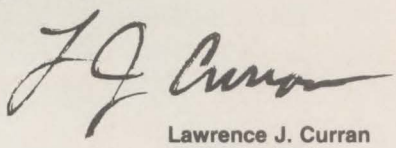
There seems to be a slowdown in the pace of new minicomputer processor introductions. Until Data General unveiled its long-awaited 32-bit ECLIPSE machine late last month, there had been an unusual season of doldrums. Anticipation of the National Computer Conference often triggers major processor introductions in the first three months of each year by the leading minicomputer manufacturers.

But this year has been different. True, Prime Computer announced its Prime 250 in January, which is a competitor in the 32-bit market, but Prime has had 32-bit machines for years; the 250 isn't innovative in that sense. The only other new processor we can recall that's bowed this year from one of the minicomputer leaders is Hewlett-Packard's HP 1000L scientific-market mini. It's built around silicon-on-sapphire semiconductor technology, but HP has also used SOS previously—in processors intended for the commercial market.

It's not our intention to say that there's little innovation in these 1980 minis; it's just that they are additions to existing product lines whose progenitors were undoubtedly more difficult to design. We wonder, then, what's going on in whatever "skunk works" exist at Digital Equipment Corp., and at Texas Instruments, Honeywell, Perkin-Elmer or Systems Engineering Labs?

Rumors abound that DEC may be poised to unveil its so-called "baby VAX," a second-generation 32-bit entry. Again, though, its 11/780 forerunner probably posed a tougher technical challenge. We see an almost-imperceptible slowdown in innovative new minicomputers. Innovation and new technical frontiers don't usually beckon when computer makers are running as fast as they can to build and ship machines to meet existing orders. Business seems to be so good that new products would be a bad idea because they couldn't be delivered for several months. Technical innovation can't be assigned a low priority, though, just because sales and profits are strong. Innovation often provides the computer user a competitive edge.

A former boss of ours has long asserted that the time to worry about future business is precisely when business is good. We agree; such a strategy forces planners to be ready with new products if and when a downturn comes. We hope the management teams in the minicomputer world are appropriately worried.



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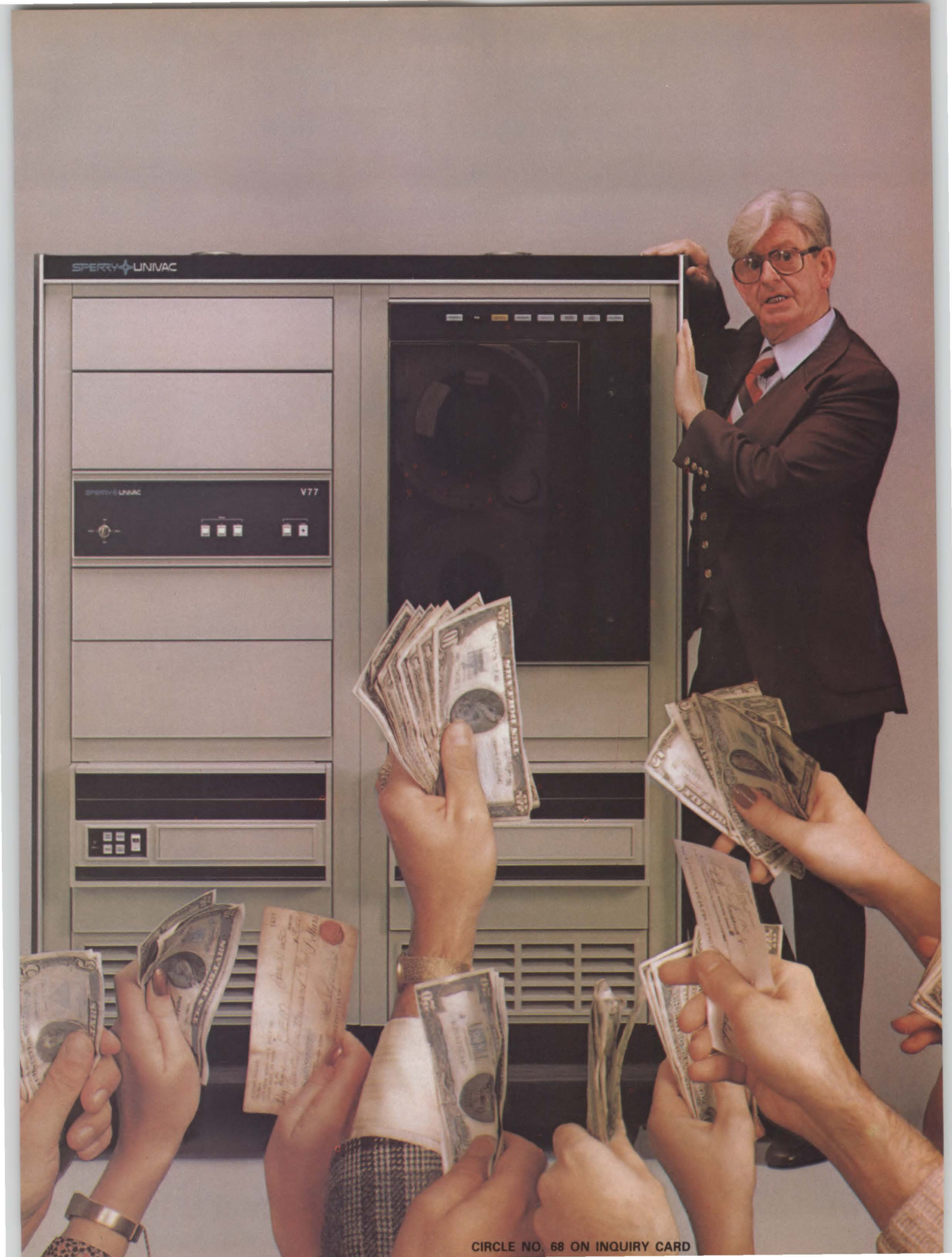

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MORE ON WINCHESTERS

To the editor:

The article "Winchester boom to broaden" (MMS, February, p. 82) was interesting, but somewhat misleading in one of its major points—the cost effectiveness of 8-in. Winchester-disk drives. The author claims in his text and in his "Fig. 3—OEM price curve" that 8-in. Winchesters offer a lower cost per megabyte at capacities under 100M bytes. This is a popular misconception that does not even remotely square with the facts, one that may trap systems designers into making uneconomic decisions.

The fact is that the 8-in. drives have an inferior cost position at capacities above 10M bytes. There are three less-than-100M-byte 14-in. Winchester-disk drives now in production that are lower cost per megabyte than any 8-in. drive of which I am aware (Fig. 1).

If we take a similar look at the leading 8-in. disk drives, which won't really be in high-volume production until late in 1980, we see a higher cost per megabyte, and in most cases a higher cost per unit (Fig. 2).

So it's clear that 8-in. drives only have a cost advantage if the system mass storage requirement is less than 10M bytes. The reasons are simple. To get the equivalent capacity on 8-in. disks, the disk drive manufacturer needs to use three times as many disks (which are almost as expensive as 14-in. disks) and twice as many heads. These are the most expensive components in a disk drive. And other costs do not decline—the drive manufacturer still needs to provide a spindle motor, a head positioner and all the electronics to control the drive and perform read-write functions. In fact, the electronics need to be physically compressed for an 8-in. drive to fit the floppy-disk drive form factor, and this also tends to increase cost.

The advantage of the 8-in. drive is primarily its floppy-disk drive form factor, not cost. And even this advantage is not as dramatic as it first appears. In the author's "Fig. 5—Size comparison" he shows the Priam 14- and 8-in. drives side by side and says they "clearly illustrate the smaller drive's compactness." But not so clearly, really. The 14-in. drive is 1.3 cubic ft., the 8-in. drive 0.33 cubic ft., but the 14-in. drive includes a 0.2-cubic-ft. power supply, which must be mounted external to the 8-in. drive. This raises the disk subsystem package size for the 8-in. to 0.5 cubic ft., not including the controller.

Thus, the 0.8 cubic ft. saved with an 8-in. drive cost $400 or a loss of 10M to 20M bytes. This may be a reasonable trade-off if the systems designer is retrofitting a system designed to mount floppy-disk drives with a Winchester or is designing a desk-top system. But he should know he is paying a price—not saving money!

Thank you for the opportunity to tell a different 8-in. Winchester story.

William J. Schroeder
Priam Corp.
San Jose, Calif.

(The author replies: When analyzing the data from a very narrow mathematical viewpoint, the larger 14-in. Winchester drives may offer a lower cost per megabyte, just as a 68-passenger bus yields a lower cost per passenger when compared to a compact car like a Honda. But when the 8- and 14-in. Winchester drives are regarded from the system user's viewpoint, other drive characteristics and costs must be considered. As computer systems move from traditional computer-room environments into offices, there will be a greater emphasis on box size, packaging, noise, power, weight, safety and other total operating environment considerations. Many mini/microcomputer systems do not require such high storage on one spindle nor so much data under one access. Applications in which smaller data bases are needed—desk-top computers, microcomputers and DDP minicomputers—cannot justify the cost of a 14-in. drive. Indeed, from a data-throughput viewpoint, if all the system data is stored on one spindle, the program execution becomes I/O bound. This dictates a requirement for multiple cost-effective spindles, such as is offered by 8-in. drives. Therefore, my conclusion and opinion remain the same, that 8-in. Winchesters are more cost effective from a total system viewpoint.)

Andrew Roman
Newark, Calif.

Drive	Manufacturer	Capacity (MBytes)	OEM price	Cost per megabyte
Open-Loop Stepper Motor				
MRX101	Memorex	11	$1290	$110
SA1000	Shugart	5	1245*	235
		10	1455*	137
Closed-Loop Voice Coil				
6170	BASF	8	1560	195
		24	2050	85
7700	IMI	11	1775	161
		20	2090	105
Microdisk	Micropolis	20	1782	89
		35	2068	59
D8000	Pertec	20	1800	90
DISKOS	PRIAM	20	1650	83
		34	2060	61

*NOTE: OEM price adjusted to include data separation and MFM encoding/decoding circuitry. This option, standard on most drives, is priced at $250 by Shugart Associates.

Fig. 1. 14-in. *disk drive costs.*

Drive	Manufacturer	Capacity (MBytes)	OEM price	Cost per megabyte
Open-Loop Stepper Motor				
SA4000	Shugart	14	$1250	$86
		29	1650	57
Marksman	Century Data	20	1500	75
		40	1900	48
Closed-Loop Voice Coil				
DISKOS	PRIAM	33	1650	50
		66	2060	31

Fig. 2. 8-in. *disk drive costs.*

Letters

To the editor:

The article "Winchester Boom to Broaden" contained some excellent information and several useful charts. Such an article is sure to be used as a reference tool for OEMs seeking suppliers of Winchester drives. For this reason we would like to clarify a few points about BASF Systems's representation.

On the chart on p. 84, BASF Systems was listed as a European manufacturer. Our affiliate, the BASF Group of West Germany, is the leading independent supplier of computer peripherals in Europe, and does manufacture 14-in. Winchester drives there. However, BASF's 8-in. fixed-disk drives were developed and are produced in Los Gatos, Calif., for worldwide distribution. We are therefore an American manufacturer of this type of drive, and feel this is an important advantage in supplying U.S. customers.

In addition, the product chart on p. 86 referrred to the BASF Systems model 6171 8M-byte drive as our primary product. In fact, our model 6172 24M-byte version (incorrectly identified on the chart as the model 3330) was our first product offering, and is now one of the few 8-in. drives being shipped in quantity.

Kathy Stanford
BASF Systems
Bedford, Mass.

OUT OF COURT

To the editor:

In Dick Brandon's article, "Staying Out of Court" (MMS, February, p. 127), his otherwise insightful comments are marred by confusion regarding the law of "computer malpractice." To date, no court has awarded damages to a party for "computer malpractice." In two recent cases, Triangle Underwriters, Inc. vs. Honeywell, Inc., 7CLSR 36, 604 F. 2D 737 (2nd Circuit 1979), and Chatlos Systems, Inc. vs. NCR, 7 CLSR, 479 F. Supp. 738 (D.N.J., 1979), the courts addressed this issue and ruled out malpractice as a theory of recovery. Perhaps the principle will be established in an appropriate future case, but there is no judicial support for it presently.

The crucial question is not whether the vendor knew the system sold to a user was inadequate—that is probably fraud, not malpractice; rather, what degree of care does a computer vendor owe its customer in giving advice? As Mr. Brandon states, a well-drafted contract specifically setting forth the user's needs may obviate the need for struggling with that question—either the vendor supplies such a system, or the user has a much clearer case for breach of contract.

Edward C. Saltzberg
Bigelow & Saltzberg
Woburn, Mass.

(The author replies: With respect to Mr. Saltzberg's letter, I make the following comments:

1. Judge Constance Baker Motley, in Schaefer vs. EDS, 76 Civ 3982 (SDNY - Nov. 15, 1977), ruled that malpractice was an applicable doctrine to a data-processing service company.

2. The cases cited by Mr. Saltzberg are hardware cases—malpractice is far more likely to occur when the vendor provides a complete system, or provides "professional" or quasi-professional services.

3. The entire computer legal practice is of course brand new. There are many issues which have yet to be resolved. I

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am confident that vendors in the field will be held liable for "malpractice" routinely in the future.)

Dick H. Brandon
New York, N.Y.

To the editor:

Mr. Brandon's article is right at the heart of the matter. Vendors' proposed contracts are often carefully composed legal instruments designed to relieve the vendor of obligation. The customer is carefully limited in his rights. The differences in perception between the vendor and customer are often more fundamental than those Mr. Brandon describes. Does the vendor perceive that it is delivering anything more than a "black box" and some instructions on how to operate it?

Obviously, the customer must assume responsibility for determining what his needs are. These needs must be stated in terms that are both understandable and measurable. It is the vendor's responsibility to determine how it will provide equipment and software to meet these needs. The customer, being a novice, must rely heavily upon the representations made by the vendor. Unless the customer retains the assistance of professionals, he usually finds that he must blindly trust the vendor—sometimes with unpleasant, costly results.

Neither the vendor nor the customer wants to become involved with litigation. A well-written contract that carefully defines the responsibilities and obligations of both parties and includes a definition of the system being supplied goes a long way toward reducing the risk of subsequent problems. Vendors serving my clients have often said they prefer working on projects involving competent consultants. It makes their job easier and the installation is more likely to be successful.

Alan C. Verbit
Verbit & Co.
Bala Cynwyd, Pa.

BEST WISHES

To the editor:

Regarding your editorial, "An NCC 'wish list,'" (MMS, February, p. 11), I wish you will get your wish. I also wish I will suffer few of the mentioned abuses upon the press. All too often the pressure is on the public relations person in a company to have press conferences when the product does not quite merit that treatment. Your editorial is the best ammo I could have for those pressures. Thank you!

Eric Janson
Analog Devices
Norwood, Mass.

CORRECTION

In a "A primer on modems" (MMS, March, p. 111), information on six Bell-compatible modems recently announced by Penril Corp., Rockville, Md., was inadvertently omitted. Penril's Data Communications Division has added the 7201C-DN, 7202S and 7208B models for DDD networks, which are compatible with Bell 201C, 202S and 208B sets, respectively. For dedicated leased lines, Penril has added the 7201C-PL, 7202T and 7208A models, which are compatible with Bell 201C, 202T and 208A data sets respectively.

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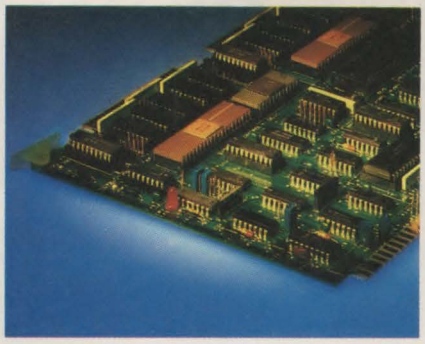

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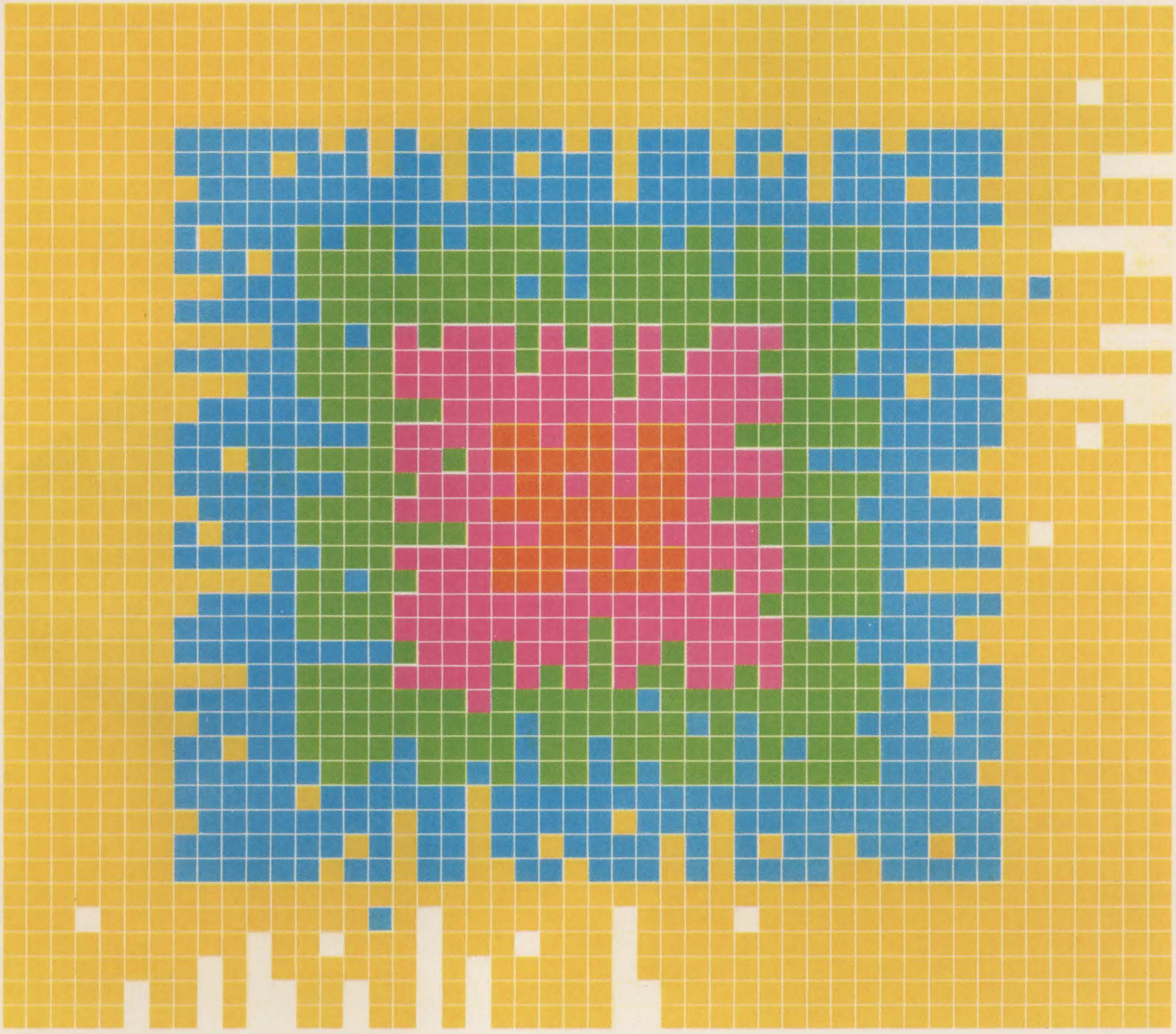

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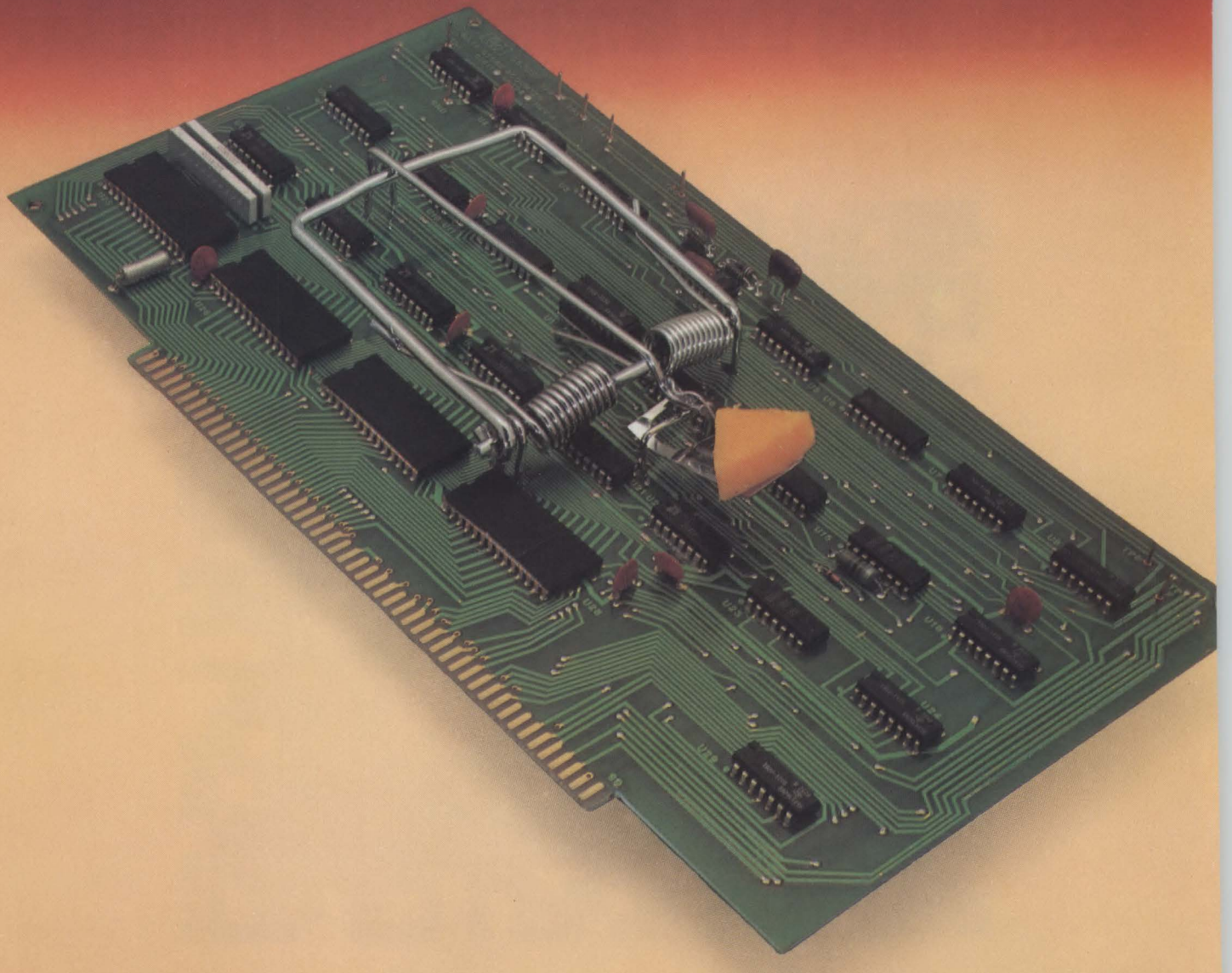
CIRCLE NO. 73 ON INQUIRY CARD

The best way to catch a glitch is to trigger on it...



with HP's 1615A Logic Analyzer.

Glitches. They're hard to see and difficult to trap. They can appear almost anywhere. And you can seldom predict when they'll cause trouble. But when they do, HP's 1615A Logic Analyzer is the way to catch them. Here's why:

1) It's the one analyzer that triggers on glitches. It can actually differentiate between valid signals and troublesome glitches. Then trigger on a glitch so you can see where it is and what your system was doing when it occurred.
2) With the 1615A's simultaneous state and timing capability plus interactive triggers, you can capture both state flow and timing relationships. That means you can trigger on a glitch and view program execution. Or, you can trigger on the glitch and view control lines to see what may have toggled simultaneously. Either way, it's a powerful technique to relate a glitch to system operation.

Simultaneous synchronous/asynchronous analysis

Since today's systems utilize both synchronous and asynchronous activity, your analyzer should be able to analyze both simultaneously. And HP's 1615A does just that. For example, you can analyze:

Memory transactions related to handshake signals

DMA and control-line relationships

Control sequence for I/O port data

Activity on the input and output of I/O ports

And, of course, the 1615A, with 24 channels, lets you analyze relationships between activity on synchronous buses such as combinations of address, data and I/O.

Glitches aren't the only faults

Since there are other failure modes, you want more than glitch triggering and simultaneous synchronous/asynchronous analysis in a logic analyzer. And HP's 1615A gives you a lot more. Such as pattern triggering for isolating program or data related faults; occurrence triggering for debugging complex loop problems; menu formats for easy set-up and analysis; and more.

For more information

There's much more to the 1615A ($6800*) and it uses in system design and troubleshooting. For complete details and a copy of an application note on glitch detection, write to: Hewlett-Packard, 1507 Page Mill Road, Palo Alto, CA 94304. Or call the HP regional office nearest you: East (201) 265-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 955-1500, Canada (416) 678-9430.

*Domestic U.S.A. price only.

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HEWLETT PACKARD

CIRCLE NO. 74 ON INQUIRY CARD

NCC engulfs Anaheim

MALCOLM L. STIEFEL, Contributing Editor

The managements of the Anaheim, Calif., Convention Center, along with those of sundry hotels and restaurants in the Disneyland environs, are bracing for the expected influx of more than 70,000 when the National Computer Conference moves in May 19-22. The convention center and nearby Orange County facilities groaned under the onslaught two years ago of more than 57,000 attendees, and the attendance last year of nearly 80,000 overflowed New York City's Coliseum. If this year's crowd approaches the New York total, attendees should be prepared to spend some time in lines—to register, to eat and in nearby freeway traffic.

More than 400 companies are exhibiting this year, and the booths will spill over from the convention center to the Disneyland Hotel, where space for more than 100 companies became available within the last month. Those exhibits should have more widespread appeal than they did previously, when only companies in the personal computing category were assigned there. For a whimsical but informative guide to spotting trends at NCC, please turn the page.

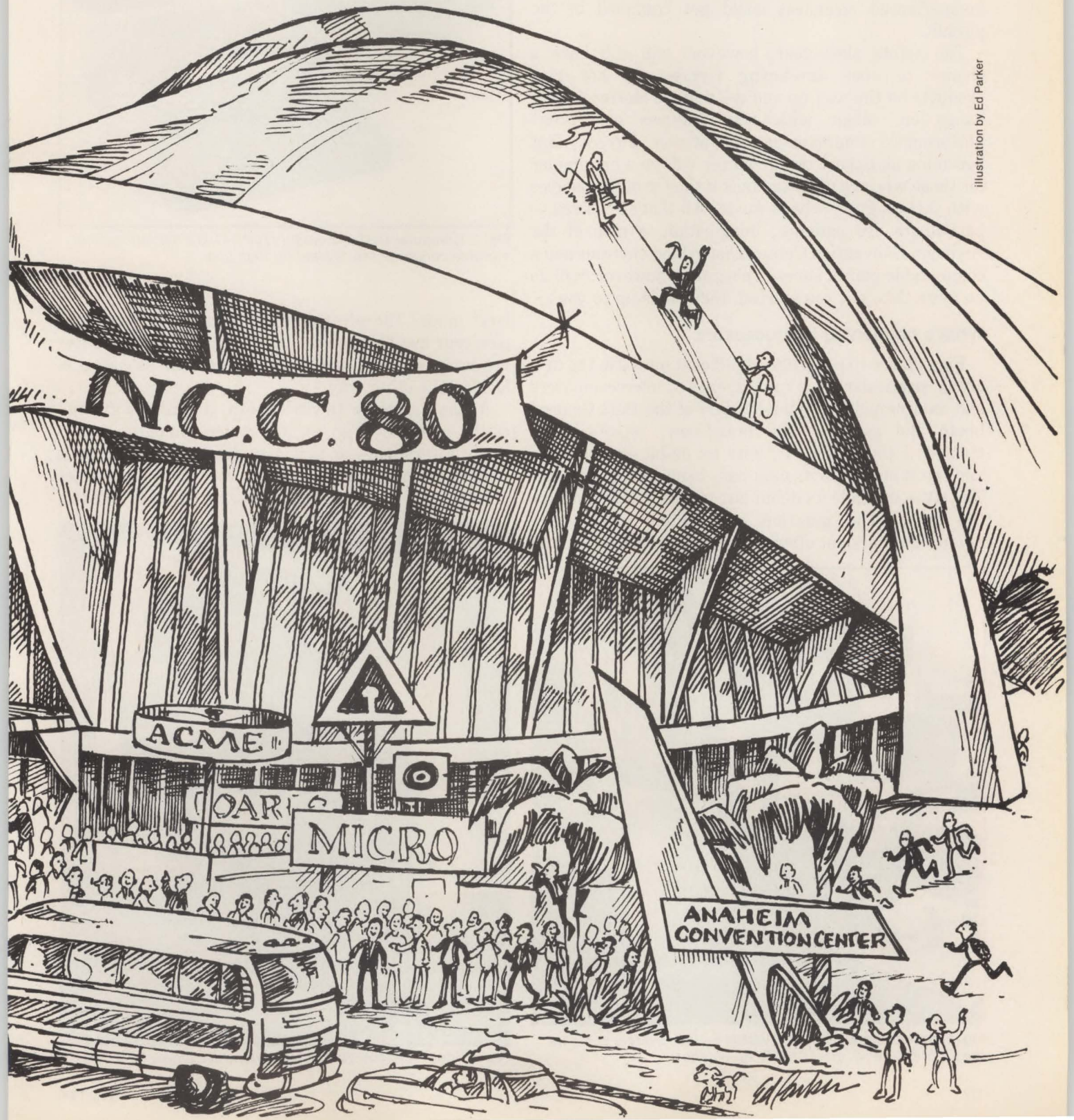


illustration by Ed Parker

Data General's 32-bit Eclipse minicomputer made its debut late last month, just in time for the show.

Continual technological advancement has always characterized the computer industry, and the National Computer Conference has become the big showcase toward which the industry points each year to reaffirm that progress continues apace, and to find out what's new. But the show has become so big and crowded that inexperienced attendees could get trampled in the pursuit.

The astute show-goer, however, will still have a chance to spot developing trends—the hot new products on the way up and the mature hardware that hangs on, albeit with new features and price/performance improvement to attract buyers. But becoming an expert trend-spotter will be a bit simpler for those who are up to the task if they arm themselves with this tongue-in-cheek guide. All that's required to participate are patience, imagination, a map of the Anaheim Convention Center/Disneyland environs and a comfortable pair of shoes. This guide, however, will do no more than get you started; the rest is up to you.

What's happening in processors

First, learn to recognize significant moves in the CPU arena, particularly the convergence of microcomputers and minicomputers. You may start at the Data General booth and gawk at the brand-new, top-of-the-line MV/8000 Eclipse (Fig. 1), with its 32-bit architecture, and the M/600, with its data base management system. The MV/8000 made its debut last month, just in time for the show. The question immediately arises: Are microcomputers yet offering serious competition to the large minis? The adrenaline starts to flow as you deftly pick your way through the throng to the microcomputer vendors and peek at the specs when the salesman is looking the other way.

Fig. 1. Data General's *32-bit MV/8000 Eclipse system could be the hit of the show, after its late April debut.*

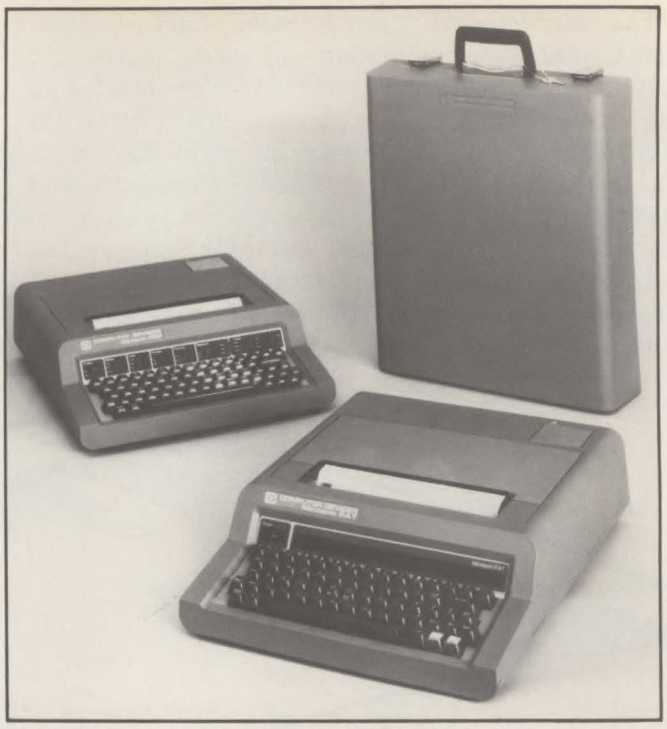


Fig. 2. Computer Devices' *model 1206 PAT is a self-prompting portable computer that's ideal for field use.*

At the Computer Devices booth, you catch a glimpse of the 1206/PAT (Fig. 2), a portable computer that is really a terminal—or is it a portable terminal that is really a computer? It has proper credentials—64K bytes of memory, an 80-column, 50-cps thermal printer,

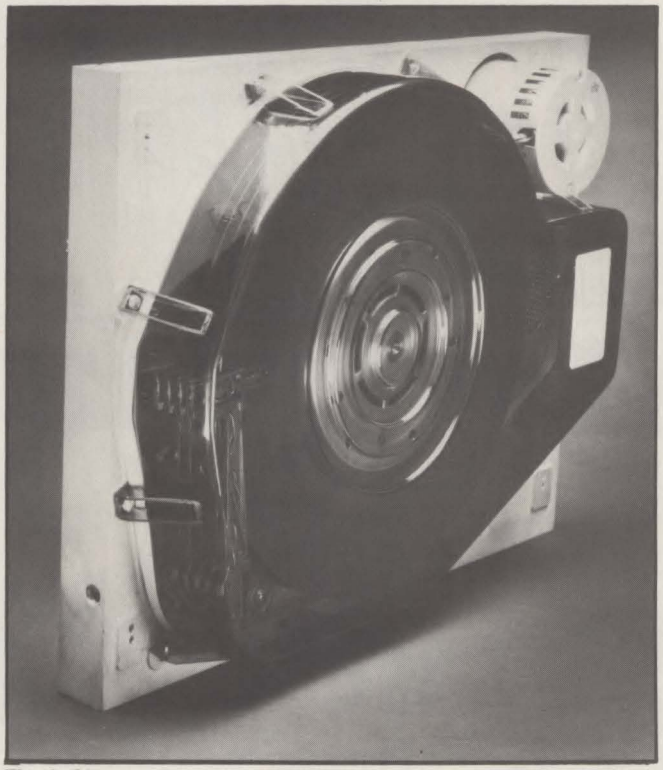
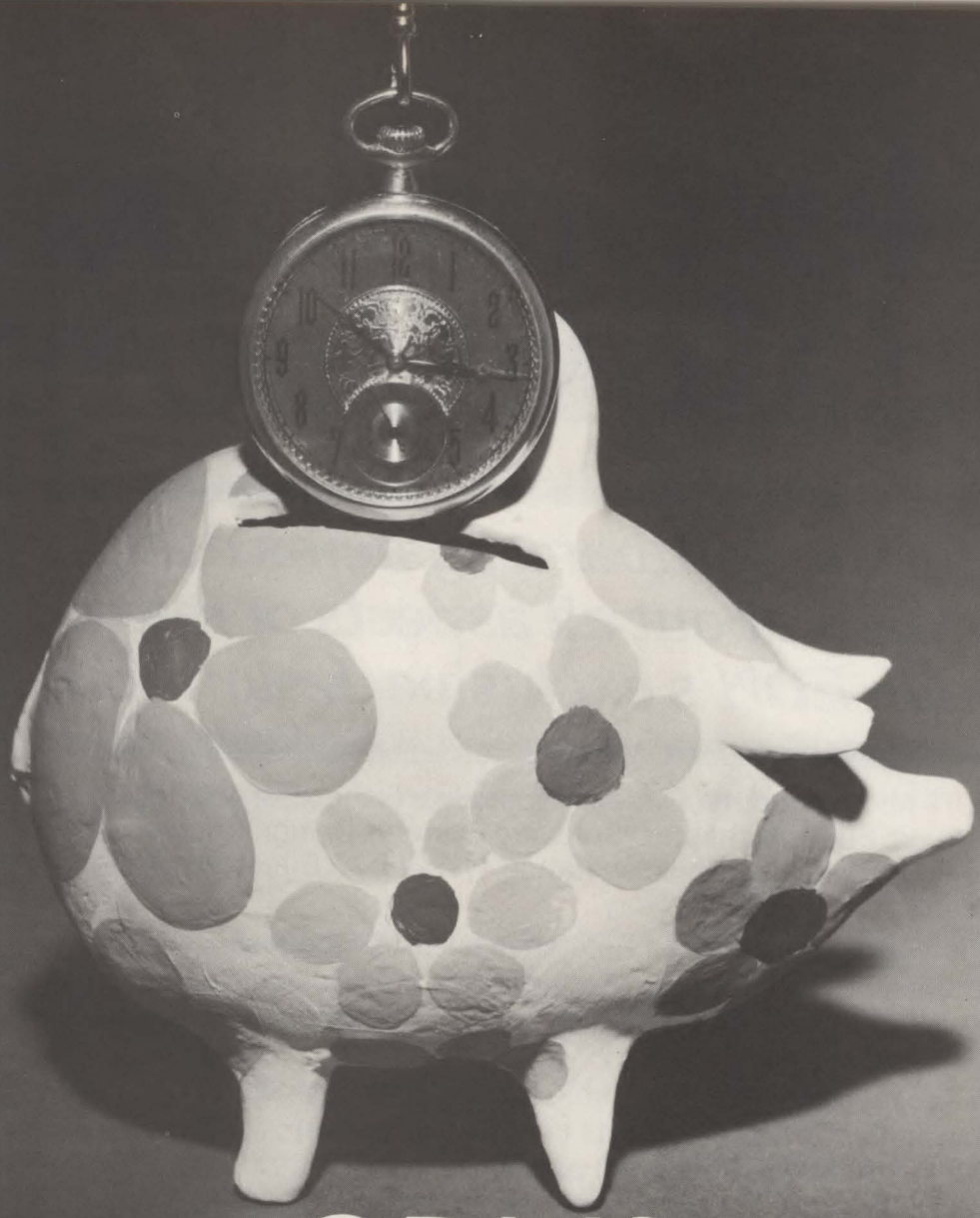


Fig. 3. Shugart Associates' *Winchester drive stores 58M bytes.*



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In hard-disk drives, the watchword is still 'Winchester,' with platters in three diameters — and new backup tape drives abounding.

cassette drive and modem. You decide, though, that while it may be fine for field use, it's certainly no threat to the megaminis.

Moving on, you find the Intertec Data Systems exhibit, where a machine modestly called the SuperBrain OD is on display. Again, 64K bytes of memory, two Z80 processors, 715K bytes of floppy-disk space and a CRT terminal. Still no minicomputer but, at $3995, it is $1000 less than the 1206/PAT.

For comparison, you pause to peruse the DOSC, Inc., TDB-85E single-board computer, which has the obligatory 64K bytes of RAM and an Intel 8085A-2 CPU that runs at 10 MHz.

You notice, in passing, that Intel isn't neglecting mainframes, while it continues to build faster and faster

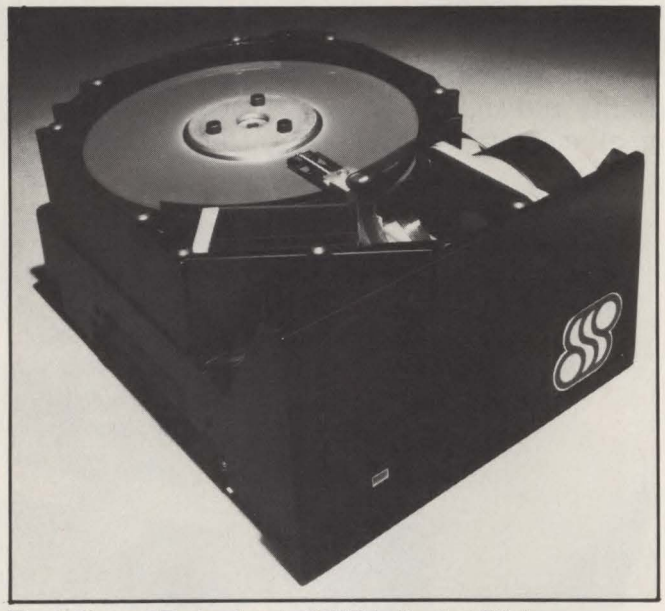

Fig. 4. Shugart Technology's *ST500 is the first 5¼-in. Winchester.*

chip-level microprocessors and microcomputers. The company is unveiling a new device, called Multiple Systems Coupling (MSC), which underscores one of the most important trends in the industry—the design of redundant subsystems to achieve high reliability. Following the lead of Tandem Computers, which introduced the Non-Stop computer system a couple of years ago, Intel offers MSC to provide channel-to-channel communication among two or more IBM processors. This information exchange, which is transparent to the user, gives rise to intriguing possibilities: automatic backup, partitioning of functions among processors (applications on one, data base management on another), load balancing. IBM has had a channel-to-channel adaptor in its mainframe product line for years, but it's significant that a vendor such as Intel is addressing that market.

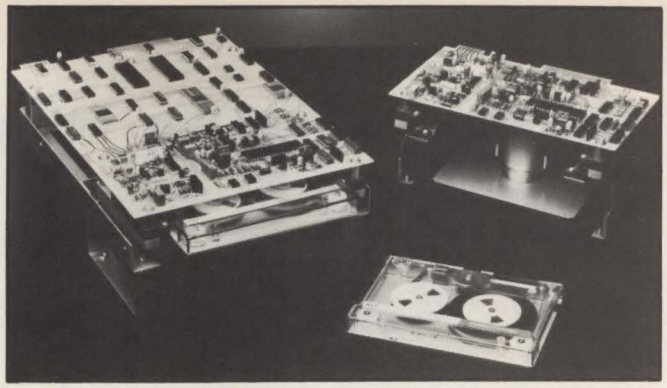

Fig. 5. DEI's *streaming cartridge tape drives are intended for backing up Winchester disk drives.*

Picking up the NCC trends in peripherals will be a cinch, even for the rankest amateur. All you need to know is how to spell W-i-n-c-h-e-s-t-e-r. Winchester disks, from companies like Shugart Associates, of course (Fig. 3): under $1000 in OEM quantities, 14-in. diameter, 58M bytes. Or Plessey Peripheral Systems: DEC PDP-11-compatible, 25.3M bytes. Then there's newcomer Shugart Technology (Fig. 4), with the industry's first 5¼-in. Winchester drive (MMS, April, p. 79). And the trend toward Winchester technology is suitably supported in the intermediate-capacity 8-in. drives, including entries from BASF Systems, Kennedy Co. and Priam.

The emergence of Winchester hard-disk drives on a broad front has triggered a companion development—tape drives to back them up, providing a means for dumping and restoring files. Winchester-backup tape drives will descend upon the convention center like so many locusts. Data Electronics' 10M- and 20M-byte cartridge drives (Fig. 5): $746 to $788 in OEM quantities. Cipher Data Products' Microstreamer: runs at 25 in. per second in normal operation, and at 100 ips to dump data, holds 37 to 46M bytes per reel. Emulex Corp.'s TC01 and TC70, designed for the LSI-11 and PDP-11/70: both feature triple-density recording—200, 800 or 1600 bits per in. on the TC01 and 800, 1600 or 6250 bpi on the TC70. If you doubt the trend toward-triple density recording, visit the Aviv Corp. booth, where 800/1600/6250 bpi drives are on display, along with a series of controllers for PDP-11 and VAX-11/780 tape drives.

And Dennison Kybe Corp. has just the thing to complement the new tape units—a cleaning and testing system that works on 1600- and 6250-bpi tapes, and another that tests "live" tapes without erasing stored information. We wouldn't call that a trend, but let's jot it down as a manufacturer's response to user demands for testing tapes without wiping them out. That's how trends are born.

In the printer arena, the changes are less dramatic, so you may have to struggle a mite to spy a genuine trend. You'll probably find many desk-top units, like the Okidata Microline III, which runs at 120 cps, or the Telex 287C that zips along at 200 cps. They are all microprocessor-controlled, of course, but that's an old

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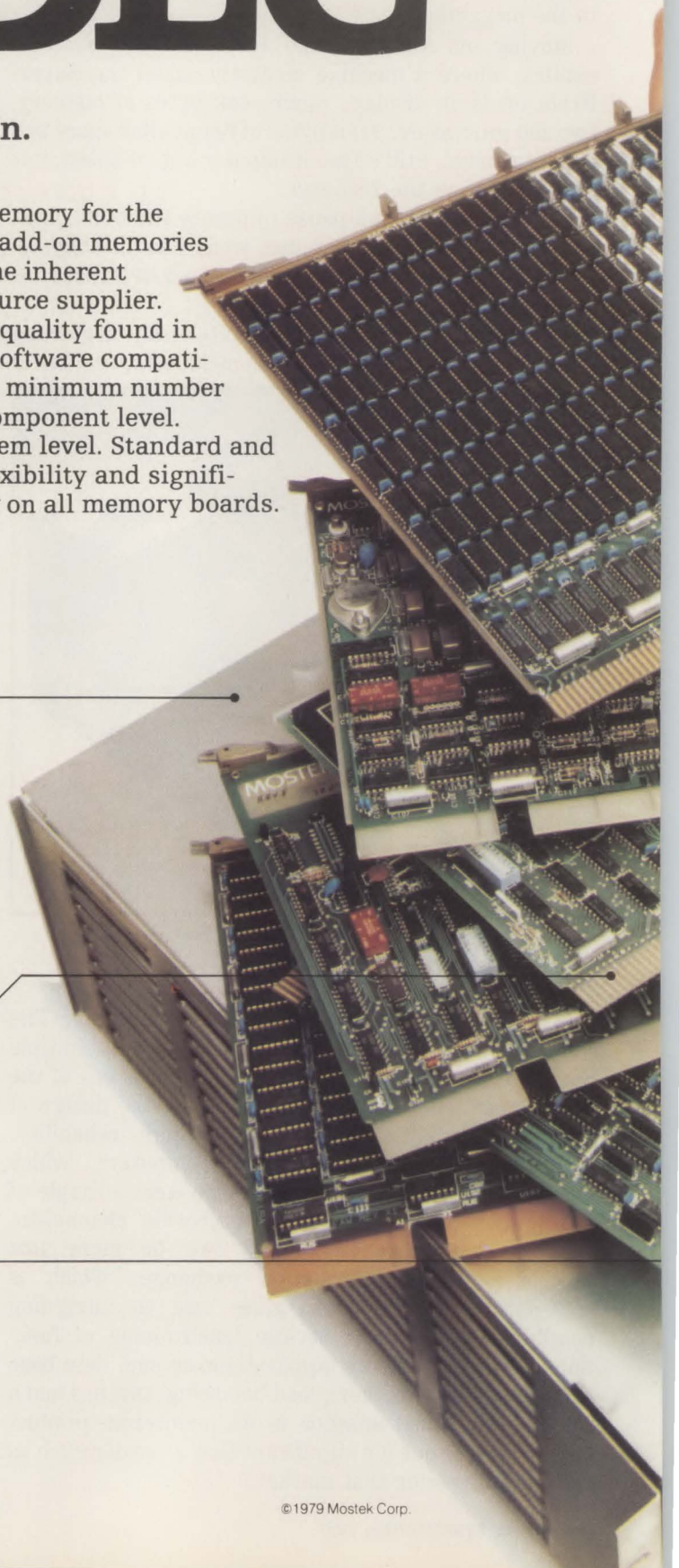

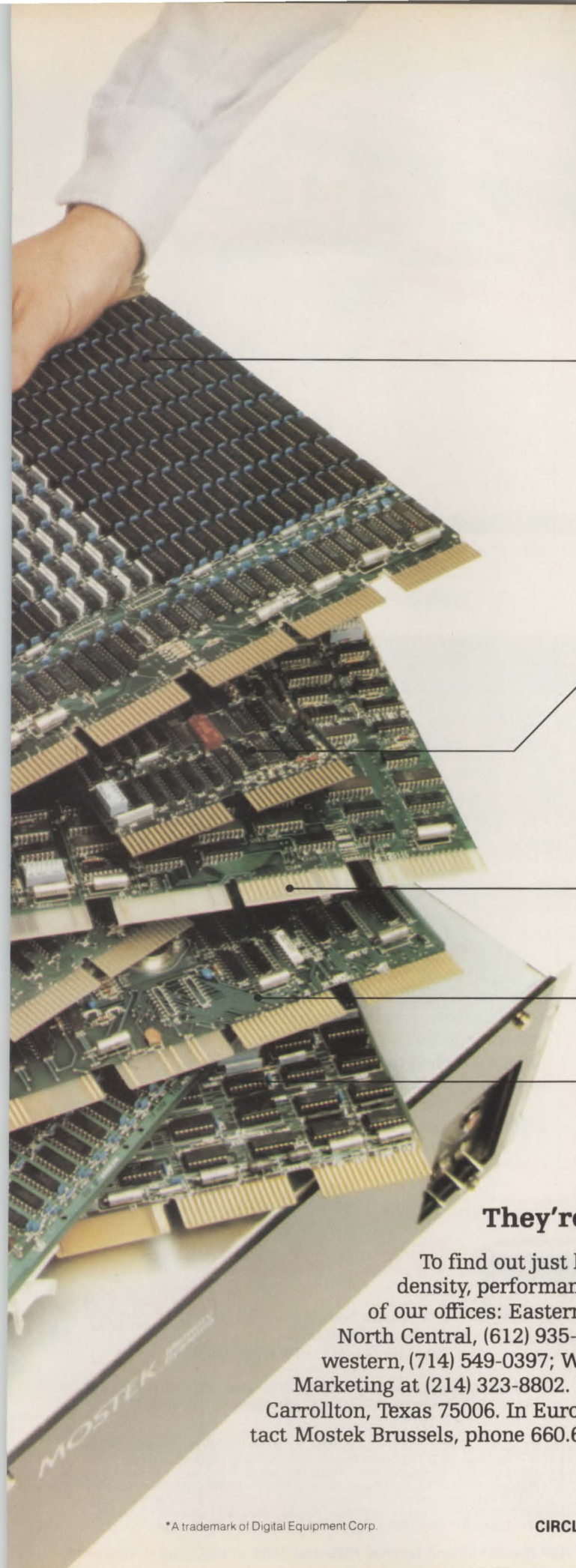

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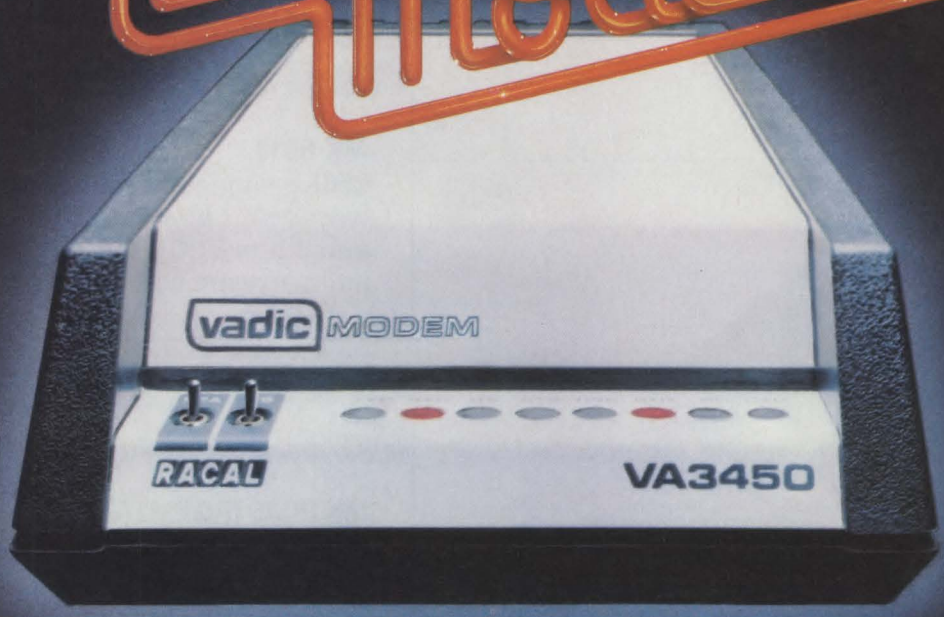
CIRCLE NO. 77 ON INQUIRY CARD

Triple Modem



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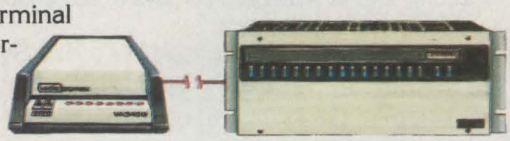

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CIRCLE NO. 78 ON INQUIRY CARD

Visit Racal-Vadic in booths 1838 and 1840 at NCC Show, Anaheim.

The trends in graphics are toward higher resolution and color displays.

story. You get no points for putting that one in your trend notebook. But the speeds are increasing. Centronics also has a 200-cps model at the show, the 737, plus a new gimmick—it prints subscripts and superscripts. That may be a trend-starter, with more vendors sure to follow.

Data entry and communications

Trend-spotting in source data entry devices is a task demanding the more advanced practitioners, because the products are so diverse in function. For example, Heuristics, Inc. will be showing a speech-recognition board that plugs into a Lear Siegler ADM-3A terminal. How many other speech-recognition boards will surface at NCC? Maybe two or three. So how do you spot

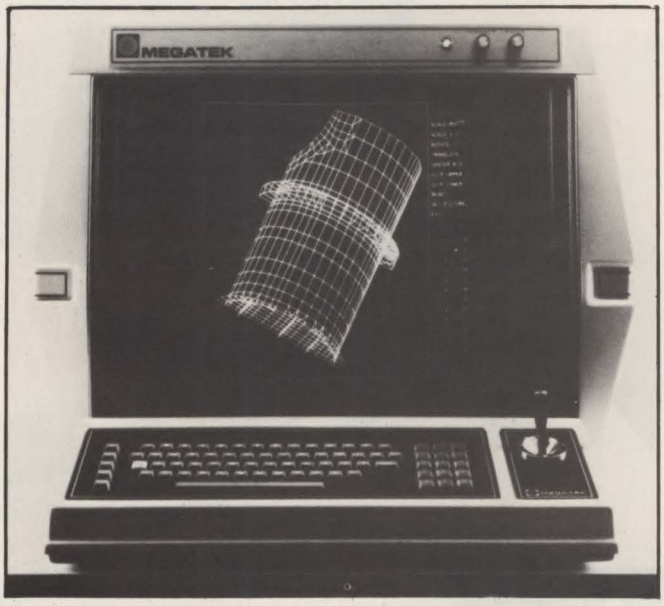


Fig. 6. Megatek's *model 7250 "Whizzard" is the company's first color raster graphics terminal.*

trends? You remember what happened last year, when another speech-recognition system was on display. Therefore, you conclude that demand for these devices is continuing. Also, you find that this board is plugged into the terminal to ease the process of interfacing. This indicates that users had difficulty working with earlier devices, which connected directly to computers. You sense a trend away from direct CPU interfaces. The ability to compare current units with items offered in the past is a mark of the advanced trend-spotter.

Another example: American Magnetics introduces the Model 44 Reader/Encoder, which reads and encodes magnetic-stripe cards. Previous units from the company could read, but could not write. Another trend? Users want compact units that will perform both functions. The subliminal message is there also: demand continues for the magnetic-card systems.

Communication devices that transmit source data to computers for processing will also abound at NCC. Racal-Vadic will show a combined voice telephone and modem, which may or may not signal a trend. It isn't clear whether these devices are much in demand for some applications—such as remote diagnostic testing of computers—in place of more conventional modems that do not have built-in voice phones. You may be bold, and call it a trend, but I'd rather wait. In fact, it will be more interesting to observe the non-trends in communications at NCC—the absence of modems-on-chips (industry observers say it will never happen) and the scarcity of RS-449-compatible modems (still a year or two away).

Another important trend, however—toward faster and faster communications on minicomputers—will be in evidence, as MDB Systems exhibits two new synchronous interfaces for DEC LSI-11 and PDP-11 computers with data rates as high as 500K bits per second.

Getting the graphics picture

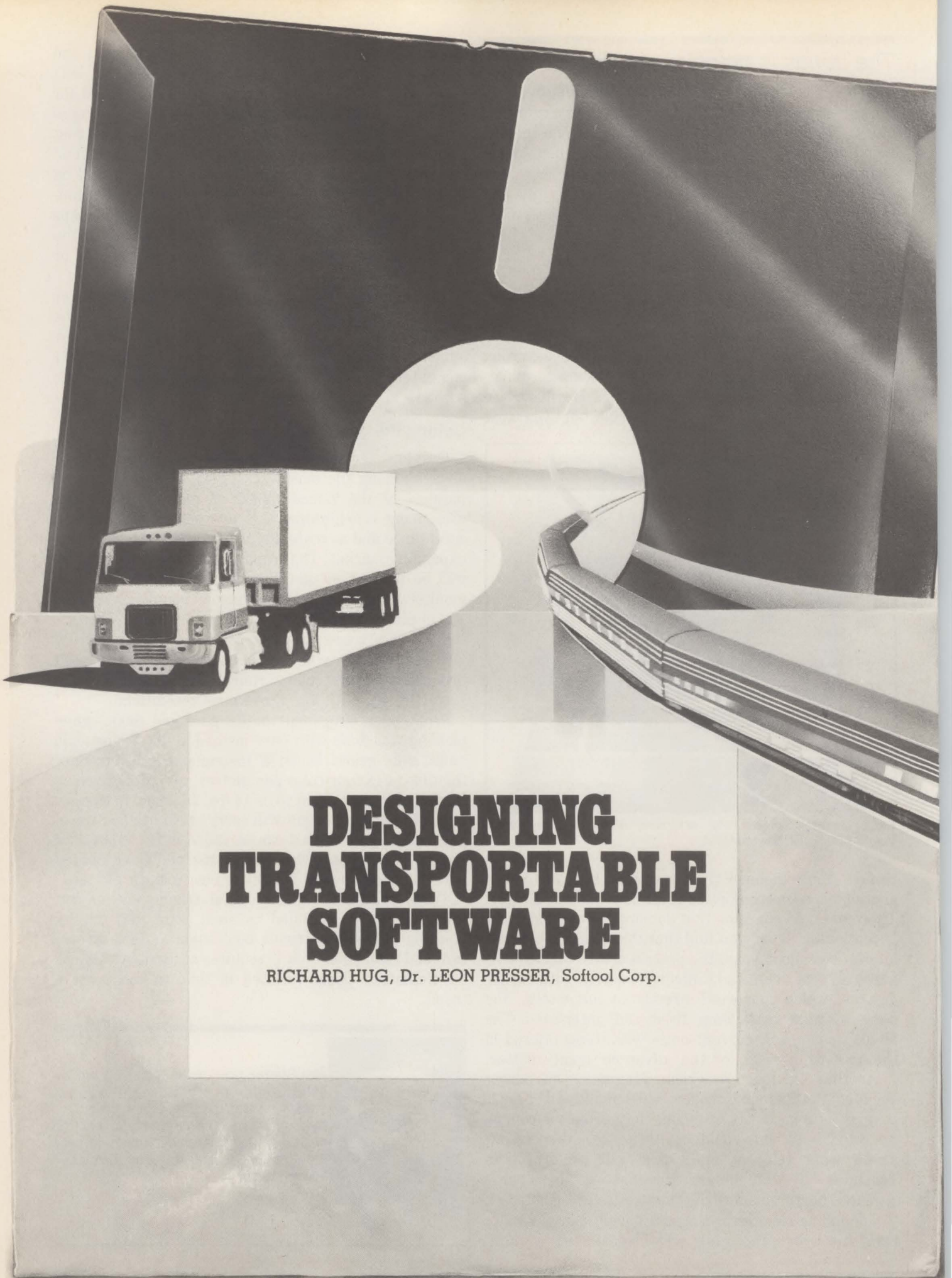
Graphics terminals and other graphics devices are always among the most exciting at a computer show, because of the visual impact of their outputs. The excitement is heightened this year as graphics gains in acceptance and as more and more products bow in this expanding market. The trend toward higher resolution will be evident in the Hitachi 19-in. and 13-in. color monitors, with resolutions of 1280 × 960 pixels and 720 × 540 pixels, respectively.

And the trend toward color graphics, already well-established, will be strengthened as Megatek brings out its first color terminal, the Whizzard Model 7250 (Fig. 6), with 512 × 512 pixel resolution.

What ever happened to the good old days, when plotting was done with pens instead of dots? Nostalgia buffs, take heart! Houston Instrument will introduce the CPS-14/15 four-color pen plotter, in widths from 22 in. to 34 in., writing to 10 or 15 ips. In a bow to current technology, the plotters will carry up to 172 firmware-generated symbols that can be called in the input data stream. Otherwise, the unit seems oddly out-of-step with the trend toward dot-raster electrostatic plotters.

There you have a quick look at trend-spotting, but this guide isn't intended to steal your NCC fun by pointing out all the trends beforehand. Use it as you can, and remember that it requires at least two similar developments closely related in time to constitute a trend. ■

Mal Stiefel, now on the technical staff at Mitre Corp., has worked as a systems analyst, systems engineer and programmer on military command and control systems, hospital administration, investment securities and municipal information systems.



DESIGNING TRANSPORTABLE SOFTWARE

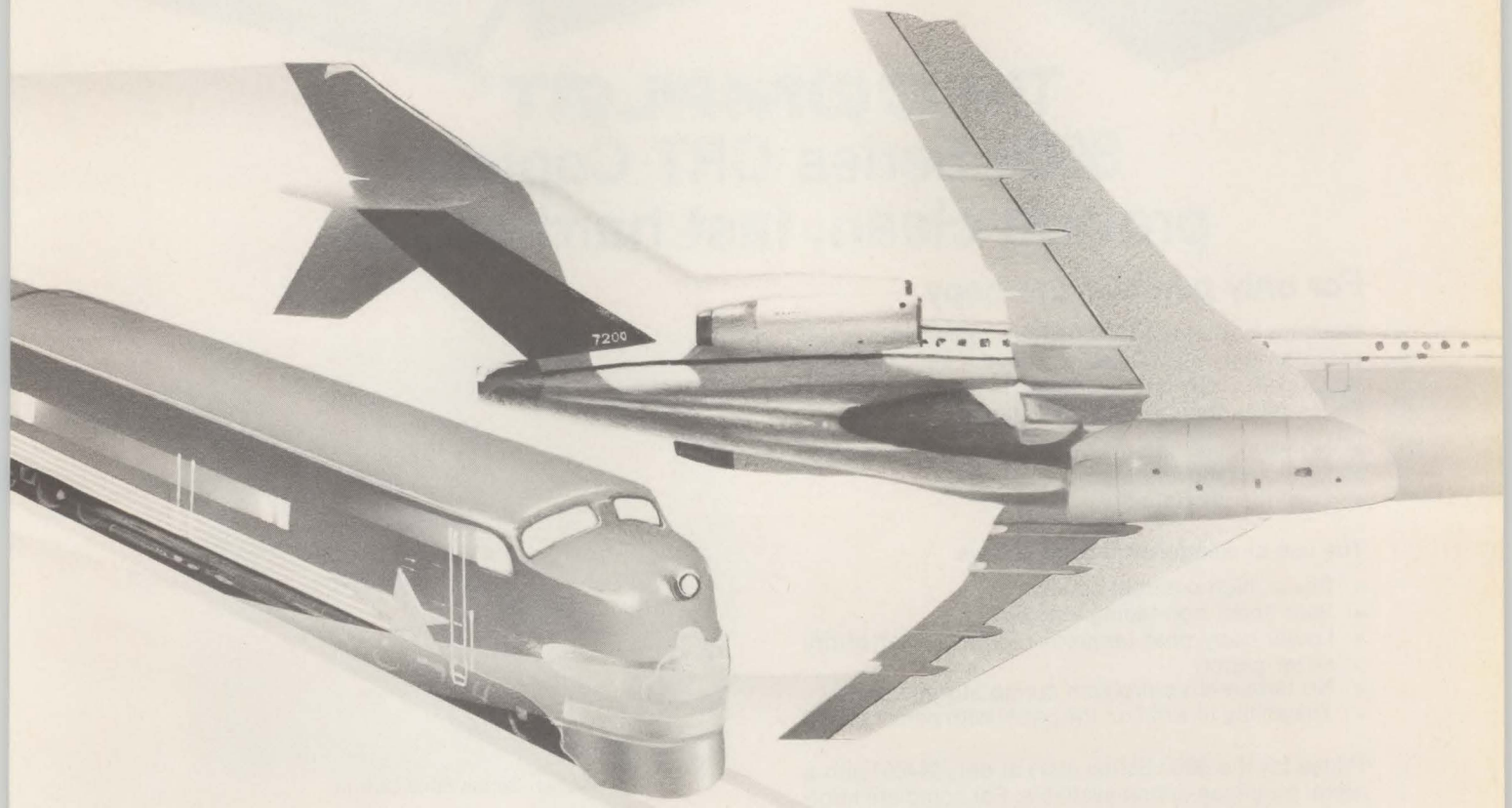
RICHARD HUG, Dr. LEON PRESSER, Softool Corp.

Illustration by David Biedrzycki

Software development has become so expensive that every effort must be made to spread that cost over as many computer installations as possible. But creating portable software that works in various environments requires planning. The goal of portability must permeate the software construction process, from specifications to maintenance documentation, and, to succeed, it must have strong management support, an established methodology and effective tools.

This article presents a pragmatic methodology for the transportation of software, which is supported by an integrated set of available tools, or software products. Extensive experience with this strategy indicates that explicit attention to portability issues leads to quality software that is easy to maintain, modify and support. It also leads to overwhelming savings.

The software construction process begins with a specification of requirements that serve as the root of the design phase. The requirements are than continually refined until a level of design detail is obtained from which computer programs can be written in some



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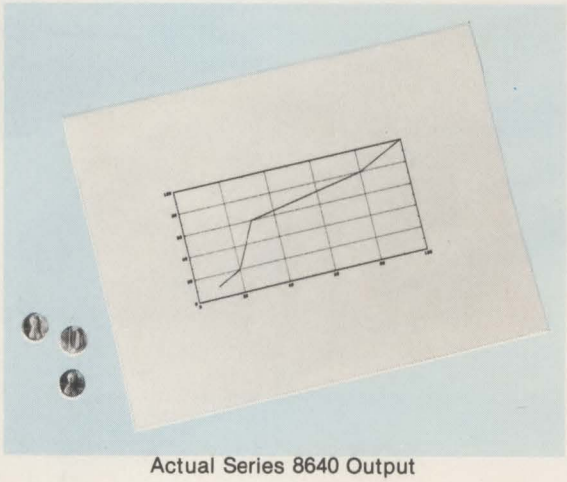

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CIRCLE #13 FOR LITERATURE
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Much criticism of FORTRAN and COBOL centers on their lack of both control and data structures facilities. This is valid, particularly in view of modern programming concepts. But these deficiencies can be effectively overcome by using a preprocessor, which can give a language an appropriate set of control structures.

specific programming language. The final software product is then transported to several different environments.

The requirements phase and the actual software design must identify and modularize those aspects that may change across environments. A software design that has evolved with attention to portability considerations will be easy to modify and maintain.

The methodology and tools described here have been used for some years by Softool Corp.'s employees and customers. A respectable base of experience using FORTRAN has been accumulating, and COBOL data is beginning to accumulate. For example, all of the software tools referenced here have been developed using the strategy described. Versions of these tools for several computer systems (e.g., IBM, Data General, Systems Engineering Laboratories) have been generated with relative ease.

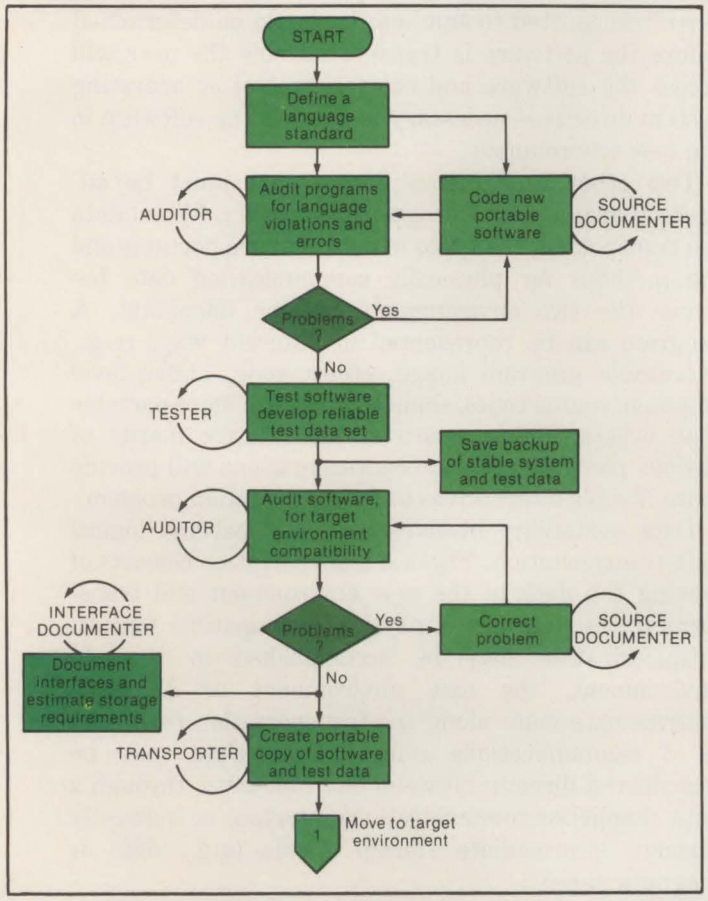


Fig. 1. Program transportation process: *source environment activities.*

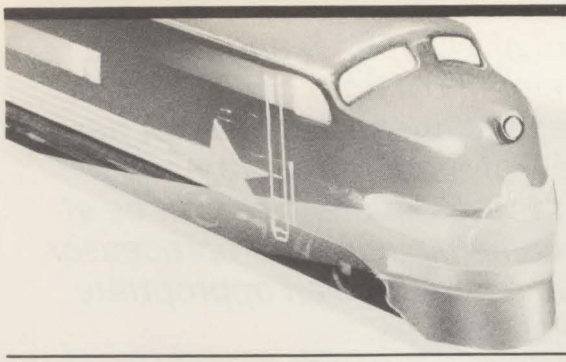
To achieve portability, it seems logical to use higher-level languages, such as FORTRAN, COBOL and PL/I. But, before a programming language is selected, the standardization, availability and structure of each language must be critically examined. Because FORTRAN and COBOL have been evolving longer than any other languages, their standardization has been under scrutiny longer. Standard definitions for these languages are readily available from the American National Standards Institute (ANSI) (see references 1, 2, 3), making them natural candidates for generating portable software. To minimize ambiguities and potential dialect differences, a language should be selected whose definition provides the fewest opportunities for diverse interpretations.

Despite claims made by vendors, all COBOL and FORTRAN compilers we have examined implement languages that differ to varying degrees from the ANSI definition. Ensuring that programs are written in compliance with the ANSI standard represents a major step forward in maximizing program transportability. But in writing portable programs in FORTRAN and COBOL, two key portability issues must be faced: 1. Most manufacturers have deviated from the ANSI standards in implementing their compilers, particularly in the many extensions offered. 2. The ANSI definitions contain ambiguities and unresolved issues that are implemented differently by different compilers.

The need for restriction

In order to generate portable programs then, coding should be limited not only to ANSI constructs, but the ANSI definition should be effectively restricted so that ambiguous or potentially troublesome constructs are not allowed. If allowed, they should at least be properly documented. Ensuring that programs are written in a properly restricted version of FORTRAN or COBOL minimizes potential transportation problems and cost.

Both FORTRAN and COBOL are popular. FORTRAN is widespread in scientific environments and has been taught extensively in universities. COBOL, which is preferred in commercial environments, enjoys much wider usage. Many distinct compilers are commercially available for both. A popular software directory lists 30 compilers for each language across a spectrum of computers. Further, optimizing compilers exist for both languages.



Functional compatibility between old and new environments is an issue that can decide the feasibility of transportation. The new environment must provide the resources the software requires. It can be disconcerting to transport, say, a disk-oriented DBMS, only to find that the new environment supports paper tape readers.

An important consideration in selecting a programming language is how well the language design supports the intended application. The original definition of FORTRAN was influenced by many machine considerations (e.g., an integer is associated with one storage unit), yet FORTRAN possesses a number of characteristics that facilitate software transportation (e.g., independent units of compilation). The original definition of COBOL, on the other hand, explicitly addressed portability (e.g., the environment division), yet it included a number of features that hamper the creation of portable software (e.g., reserved words). For writing portable programs, then, selecting between FORTRAN and COBOL is subject to differences of opinion.

Much criticism of FORTRAN and COBOL centers on their lack of both control and data structures facilities. Such criticism is valid, particularly in view of modern programming concepts. However, these deficiencies can be effectively overcome by using a preprocessor, which can provide a language with an appropriate set of control structures, such as IF-THEN, CASE, DO-UNTIL. Further, a support library facility can provide a language with an appropriate set of encapsulated data structures—high-level data structures that can only be manipulated via a well-specified collection of operations supported by the library. For example, the data structures library may support a "table" by offering routines for initializing, reading, writing and searching instances of a table.

Enhancing a portable subset of ANSI FORTRAN or ANSI COBOL with powerful control and data structures has a tremendous impact on programmer productivity and software quality. If an appropriate collection of support routines for encapsulated data structures exists in the support library, programming can be done at a higher level, and the programmer typically can pull in major portions of his code from the library. If this code is well designed, thoroughly tested, modularized and portable, it serves as a pillar for attaching the rest of the programmer's code.

Software transportation

Software transportation involves much more than moving programs from one environment to another. It is critically dependent on properly modularizing those aspects that change across environments. The key areas that must be addressed include: functional compatibility between the old and new environments, software—data interdependence, user interface compatibility, data portability and program portability.

Functional compatibility between the old and new environments is an issue that can decide the feasibility of transportation. The new environment must be able to provide the resources the software requires. It can be disconcerting to transport, for example, a disk-oriented data base management system only to discover that the new environment supports only low-speed paper tape readers and punches.

Software-data interdependence can dramatically affect the scope of a transportation effort. If the software depends on certain permanently stored data (e.g., an employee master file), the data may have to be transported with the software. Transportation of the data then becomes an important issue.

User interface compatibility can also determine the success of transportation. Software that is simple to use in one environment can prove impossible to use when transported to another. It should be determined before the software is transported how the user will access the software and the job control or operating system directives necessary to operate the software in the new environment.

Two other fundamental issues that must be addressed are data and program portability. When data are transported, the types of data that are portable and the methods for physically communicating data between the two environments become important. A program can be represented in different ways (e.g., executable program image, object code, higher-level language source code), some of which are more portable than others. Being aware of the relative merits of various portable program representations will provide more flexible alternatives to a transportation problem.

Data portability involves both physical and logical data transportation. Physical transportation consists of moving the data to the new environment and transforming the data into a physically compatible format. Transformation may be accomplished in the old environment, the new environment or at some intermediate point along the transportation path such as a communications control unit. Data may be transferred directly between environments, through a data channel or communications interface or indirectly through intermediate storage media (e.g., disk or magnetic tape).

Logical transportation consists of ensuring that the data is correctly interpreted in the new environments.

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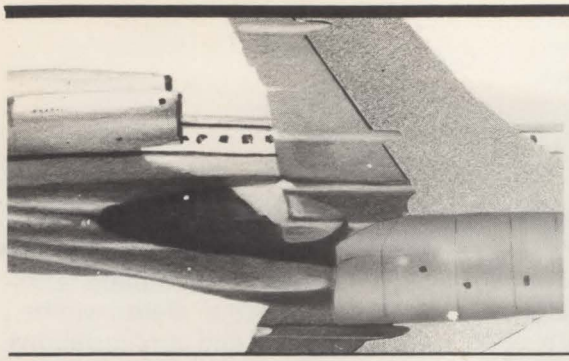


There are three aspects to program portability. First, a program is data and is subject to data portability considerations. A second aspect is machine or environmental dependency. Programs that make assumptions about the execution-time environment limit their portability. The third consideration is the difference between dialects.

The meaning of the data must not change across environments. Each computer architecture has its own intrinsic data structures (e.g., byte, word) into which are mapped various data representations (e.g., character, fixed-point number, floating-point number). The data representations are manipulated through the machine's instruction set. The meaning of the data is defined by its representation and the manner in which it is manipulated. The logical transportation of data can involve mappings of both data representations and data manipulations.

There are three aspects to program portability. First, a program is data and is subject to data portability considerations. The least portable representations of a program are generally machine or object code data. The portable representations are higher-level language source code data, such as FORTRAN or COBOL. Because higher-level-language source code consists of strings of characters, the data portability issue reduces to translating the source program into the character code—ASCII, BCD, EBCDIC, for example—used in the target environment. The meaning of the program represented in a higher-level language is established with respect to a symbolic environment provided by the language processor. The language processor maps this symbolic environment into a specific machine environment. Ideally, all language processors that implement a specific language should provide the same symbolic environment.

A second aspect to program portability is machine or environmental dependency. Programs that make assumptions about, or take advantage of, the execution-time environment limit their portability. Assumptions made about machine word-size, available hardware or instruction execution times fall into this category. A third consideration is the difference between language dialects. Two different implementations of a programming language probably differ both in the languages they implement and in the symbolic environments they provide. These differences between language implementations have given rise to programming language dialects and further portability problems.

Approaches to transportation

A number of techniques have evolved to assist in software transportation. These can be roughly categorized into automatic, semi-automatic and manual methods. Manual techniques are mentioned here only for completeness. They will not be discussed further. Automatic transportation techniques include simulation and emulation. A simulator or emulator is a piece of software resident in one computer environment that simulates another environment. Emulators are typically assisted by special hardware—or microcode—while simulators are not. Simulation and emulation methods operate upon machine code that has been developed in the environment being simulated.

The major advantage of these techniques is that most programs that exist in the environment being simulated usually can be quickly transported to the new environment. A disadvantage is that software executes more slowly and less efficiently in the simulated environment. Other disadvantages include the cost of the simulator or emulator, particularly if machine-dependent logic needs to be addressed, and the inherent problems in assuring continuing compatibility between the simulation and the environment being simulated.

Semi-automatic techniques include cross-compilation, translation, decompilation, verification and auditing. A cross-compiler is a language processor executing in one computer environment that generates object or machine code for another environment. Cross-compilers operate upon higher-level language source code. Cross-compilation methods are useful in developing software for machines on which software development is not feasible (e.g., memory-limited microcomputers), or when the target hardware is not available. Cross-compilation is often used with a simulator for the target machine to enable software to be developed in a single environment.

To be applicable to software transportation, a cross-compiler that accepts implementation language of the software being transported is needed. This usually means that the cross-compiler must accept the same language dialect as the language processor that was used to develop the software. It is quite possible to cross-compile source code that will not work correctly in the new environment. Source code containing machine-dependent logic based upon the old environment may cross-compile with no errors, yet the resultant machine code will not execute correctly in the new environment. A transportation problem can exist between the old environment and the cross-compiler. Moreover, cross-compilers, ignore any language processors that already exist that usually generate efficient code. Other disadvantages of cross-compilation

include the high cost of a cross-compiler and the need to ensure continuing compatibility among the cross-compiler, the original environment, the new environment and the language implemented by the cross-compiler.

Translation techniques include preprocessing and higher-level language translation. Translators accept higher-level language source code as input. Output is a different higher-level language or language dialect. Translation techniques generally do not cope with machine-dependent logic problems. Other disadvantages include the increasing amounts of manual intervention in the translation process that are required to translate increasingly dissimilar language dialects, the cost of the additional software and compatibility problems.

Decompilation means generating a higher-level-language version of an assembly (machine) language program. This higher-level program is then transported using techniques such as (cross) compilation and translation. The main disadvantages of decompilation are the high cost of the manual intervention required and the complexities of developing the decompilers.

Verification and auditing

Verification techniques usually are more flexible as transportation aids than are simulation, cross-compilation, translation or decompilation. Verification techniques attempt to make existing software more portable, rather than trying to automate the transportation process between two specific environments. A verifier typically accepts as input high-level-language source code that is then validated for its portability and compatibility with other specific language processors. The user is informed of the problems involved in transporting before the software has been transported. Disadvantages of verification include the cost of the verification software, the amount of manual effort involved and the problems of maintaining consistency between the verification software and the language dialects being verified.

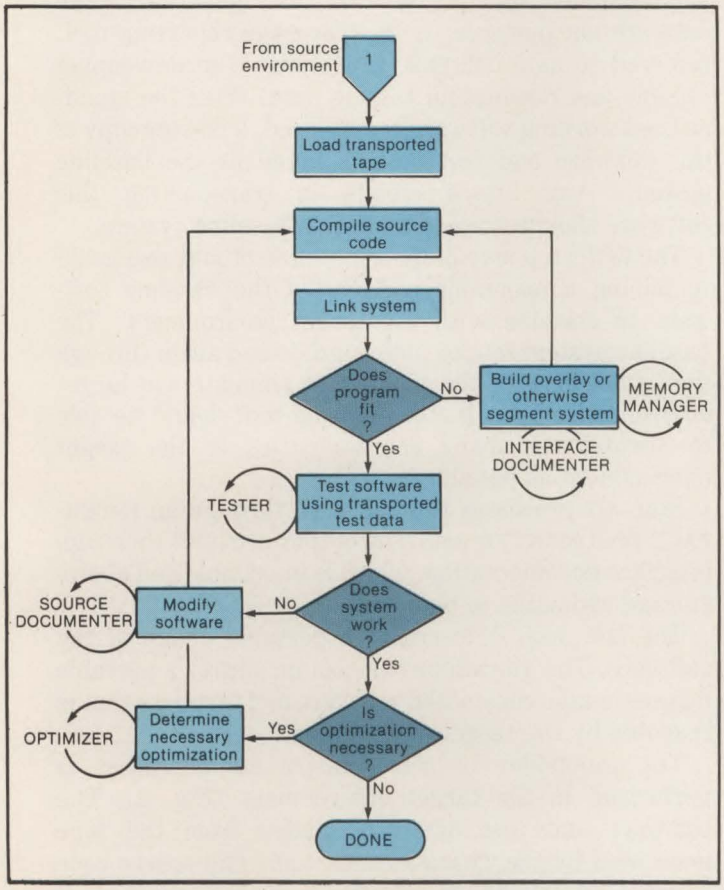


Fig. 2. Program transportation process: *target environment activities.*

Auditing techniques offer perhaps the most flexible and cost-effective of transportation strategies. Auditors combine verification techniques with language and logic diagnostic capabilities for a language that is a portable subset of existing language dialects. An auditor accepts higher-level-language source code as input. The code is audited for deviations from the portable subset language and for machine-dependent language constructs and logic. The results of the audit are then quantized. The user is informed not only of specific portability problems but also of general ones. This information allows the user to develop portable software once rather than to transport nonportable software numerous times. The user can estimate the scope of the transportation effort before fully committing to it. Additionally, auditors can often point out hidden bugs and logic errors that were not caught by software developers or the compiler. Use of a good auditor results in higher quality software requiring less maintenance.

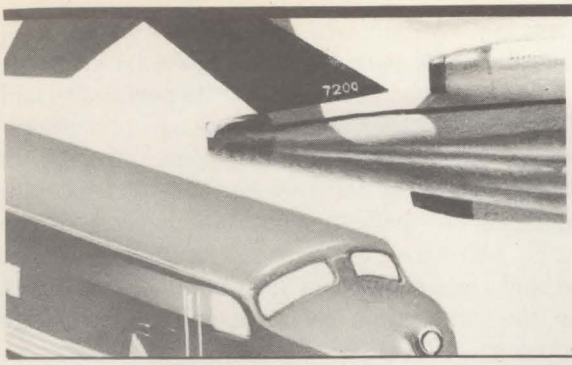
The various approaches described here are not necessarily mutually exclusive. For instance, when a software-development environment hosted in a mid- or large-sized computer system is employed to create software for a microcomputer, auditing followed by cross-compilation is a powerful strategy.

Methodology

Proper software specification, design and documentation—coupled with an auditing technique based on a portable subset of ANSI FORTRAN or ANSI COBOL—would maximize program portability. It would minimize future transportation costs. But this strategy is feasible only if there is a clear methodology supported by appropriate tools to transport software.

There are two kinds of program transportation—the development of software that is portable and the transporting of existing software. Both can be similarly managed, the key to successful transportation being effective planning. The following is an outline for the methodical transportation of programs:

1) a portable subset of ANSI-standard FORTRAN or COBOL is selected as a programming standard;
2) new and existing programs are audited for violations of the standard. The violations are removed or carefully documented;
3) machine and environmental dependencies are removed from the software, or are carefully documented;



Auditing techniques offer the most flexible and cost-effective of transportation strategies. Auditors combine verification techniques with language and logic diagnostic capabilities for a language, that is a portable subset of existing dialects. Auditors often point out hidden bugs and logic errors not caught by the compiler.

4) the software is tested with a set of reliable test data. The test data and results are both saved;
5) violations of the programming standard, plus machine and environment-dependent logic in the source code that have not been removed, are modified to conform to the target environment;
6) the source code and the set of test data are translated into a portable format that is compatible with the environment;
7) the software and test data are transferred to the target environment;
8) the source code is compiled in the new environment. There should be no errors;
9) the software is linked, loaded and tested. The test data transported with the software should produce the same results as in the old environment; and
10) the software is optimized for the new environment.

There are three key points to be noted about this methodology. First, most of the transportation effort is performed in one environment. Second, much of the process is repetitious and mechanical. Further, the methodology cannot be performed by hand. An appropriate set of tools should be developed to automate this methodology.

Providing the tools

The development and transportation of portable software requires an integrated set of tools that enable users to carry out a series of discrete steps (Figs. 1 and 2). The first step involves the informed selection of a language standard, which will later be enforced using an AUDITOR tool. The language standard consists of those constructs that will be permitted in the software to be transported. The selection of the standard is influenced by the decision to: 1. generally maximize portability to the greatest number of environments; or 2. specifically maximize portability between two environments.

Software that has been transported once tends to be transported again; hence, a recommended language standard that generally maximizes portability consists of only those language constructs that are unambiguously defined in the ANSI standard.

The second step in transportation is to audit all the source code to be transported with the AUDITOR tool and to analyze the output. The output from this tool should consist of a series of audit reports. At the end of this step, the scope of the transportation effort can be easily quantized. The audit reports provide metrics that can be employed to estimate the effort required to complete transportation.

Step three is to correct any source code flagged as violating the language standard, posing portability problems or containing errors. Machine- or environmental-dependent logic is removed or carefully documented. Any source program unit that is modified should be processed again through the AUDITOR tool. Programming modifications, modularization and consistent documentation is facilitated with the aid of a SOURCE DOCUMENTER tool, which should incorporate a library and an include facility, both of which are of great assistance in centralizing and managing machine dependencies in the source code.

Next comes ensuring that the standardized software is working properly, and developing a set of reliable test data. Developing test data may involve designing and implementing a portable test data generator if the data are not portable. A test coverage reporting tool, referred to as a TESTER, is invaluable in developing reliable and meaningful testing data. Once the standardized working software is stabilized, a master copy of the software and test data is saved as the baseline system. Any future efforts in transporting this software should proceed from this baseline system.

The fifth step is to pinpoint, document and change all remaining nonportable portions of the baseline software to coincide with the target environment. The baseline system source code is processed again through the AUDITOR with the tool set to simulate the target environment. That is, the auditing tool should be able to simulate as many characteristics of the target environment as possible.

Step six processes the software through an INTERFACE DOCUMENTER tool. The output provides thorough interface documentation, which is invaluable and allows storage estimates to be made.

The last step is to create a portable image of the software. The TRANSPORTER tool generates a portable magnetic-tape copy of the software and test data that is readable by the target environment.

The remainder of the transportation process is performed in the target environment (Fig. 2). The software and test data are loaded from the tape generated by the TRANSPORTER tool. The source code is compiled and linked with the run-time routines. If the software does not fit in the target machine, the

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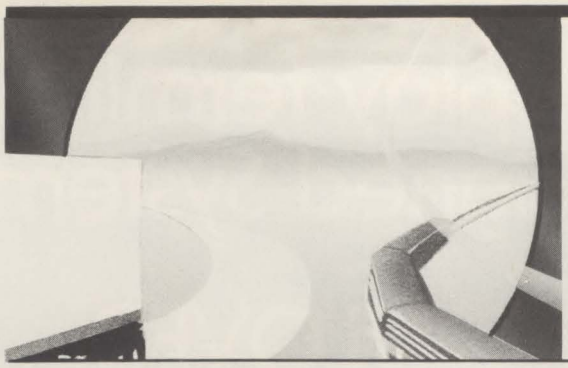

The development and transportation of portable software requires an integrated set of tools that enables users to carry out a series of discrete steps. The first step involves the informed selection of a language standard consisting of those constructs that will be permitted in the software to be transported.

storage issue must be addressed, which could be fatal to the process. However, previous storage estimates would have helped to flag the problem earlier. The storage problem can be addressed with a number of appropriate tools. Specifically, a MEMORY MANAGER tool on the target environment helps greatly because it offers dynamic memory management, including virtual storage for machines that do not support a virtual architecture such as Data General computers. Finally, the software is loaded and tested. Once a working system is obtained, the OPTIMIZER is employed to optimize it. Should any modification be necessary, the SOURCE DOCUMENTER is employed anew.

An example of the power of the methodology occurred in the middle of a major project when one of Softool's customer's discovered that its development computer, a Data General Eclipse, was no longer readily accessible for the project. Not much effort was required to develop and test all the software, approximately 28,000 lines of code, on an IBM System/370, subsequently move it to the Eclipse and then onto a third system.

The applicability of FORTRAN to applications other than scientific computations has not been a problem. Tools, training programs, personnel and data base management systems have been programmed with ease and elegance in the structured FORTRAN mentioned. Indications are that similar statements can be made about COBOL. The language obtained when FORTRAN is structured generally resembles the language obtained when COBOL is structured.

Finally, our experience strongly indicates that there is a definite relationship between software portability and software quality. Consideration of portability issues contributes much to the creation of quality software. Similarly, portability considerations lead to easy-to-maintain software.

Economic issues

The economics of developing portable software defies quantization, but use of the types of tools described here leads to major savings. Two example should suffice to make the point.

Example 1. The AUDITOR (reference 8) can detect, on the average, three hard errors per 1000 lines of *production* code analyzed. Assuming that an error requires 16 man-hours to fix and carry out the necessary configuration control updates, and that one man-hour costs $20, use of this tool during software development results in a savings of $1 per line checked.

Example 2. A single line of code is conservatively estimated to cost $50 to produce. Testing is estimated to account for 50 percent of the software development cost. Our experience indicates that use of the INSTRUMENTERS 10 (i.e., TESTER) tools reduces testing costs by at least 20 percent. Consequently, the cost of a line of code is reduced by 10 percent. That is, use of the INSTRUMENTER tools saves at least $5 per line produced. ■

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Dr. Leon Presser is president and founder of Softool Corp., a software development and consulting firm in Goleta, Calif.

Richard Hug is a senior project manager at Softool Corp.

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The advantages of intelligence

GARY SCHRATZ, Remex Division, Ex-Cell-O Corp.

Floppy-disk drive's design is an example of the added capabilities resulting from microprocessor control, benefiting system designers

Intelligent computer peripherals have arrived. The words "microprocessor controlled" dominate the headlines of computer ads, and even the most basic tape drives are smart enough to perform their own diagnostics. This is a happy development for system builders because, in a sense, with the development of intelligent peripherals the microprocessor has come to its own rescue. By dividing system responsibility among a number of microprocessors in the CPU and peripherals, designers overcome the speed and memory limitations of the microprocessor—limitations which might otherwise outweigh the benefits of low cost and size reduction that make the microprocessor so attractive for today's systems.

The resulting advantages of intelligent peripherals to the systems designer include:

- the ability to achieve required system performance with a less costly CPU or, conversely, upgraded performance in an existing system without a CPU upgrade;
- simplified interface and software design;
- small system size;
- lower cost;
- reduced system design time and, therefore, faster market entry.

Intelligence defined

For purposes of this article, "intelligent peripheral" is a peripheral in which a microprocessor (or in some cases, discrete logic) is employed to translate a group of macrocommands from the CPU into individual control functions. Such peripherals are usually tape drives, hard-disk drives, punched-tape equipment and, as will be outlined later, flexible-disk drives. Interestingly, the device that many people consider the original intelligent peripheral, the microprocessor-based CRT terminal, does not fit this definition. In a CRT terminal, the microprocessor is used largely to reduce the amount of software required in the host and to make the terminal a limited-function CPU itself—not a peripheral by our definition. The forerunner of the true intelligent peripheral is found in test equipment such as autoranging meters. While early units used small-scale integrated logic (SSI) elements rather than a microprocessor, these meters were able to perform certain decision-making functions without operator intervention.

Intelligent peripherals range from those that perform a single function under microprocessor control, such as internal diagnostics or servo control on tape drives, to peripherals with built-in file management. How does an intelligent peripheral differ from a microprocessor-based system or subsystem? The dividing line is hazy. However, it is logical to assume that an intelligent peripheral will have all controlling electronics built into standard-sized peripheral housing and that no interface will be required between the peripheral device and these electronics.

The floppy example

An example of such an intelligent peripheral, how it works and what it can offer the system designer is the RFS4800 dual-head, double-density intelligent flexible-disk drive manufactured by the Remex Division of Ex-Cell-O Corp. While the RFS4800 looks like an ordinary "dumb" 8-in. drive, and will fit into any industry standard floppy-disk slot, it has a 6800 microprocessor-based controller/formatter housed on the same board with drive electronics, which perform a range of functions that significantly reduce the need for host computer intervention and which extend the performance of low-cost computer systems. Among these functions are the ability to read and write data on both sides of an 8-in. 2-D or equivalent diskette in eight double-density and five single-density formats. The intelligent drive will also perform multiple sector data transfers, automatic copying, formatting and initial program loading, plus density switching and sector

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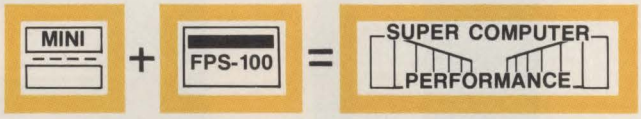

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An intelligent peripheral will have all controlling electronics built into the standard-size peripheral housing.

sizing, with no more than two host commands. In addition, the Remex drive has the ability to control more than itself. It can be daisy-chained to as many as three low-cost minimum-electronics "slave" drives, providing the designer with an economical multidrive system.

Fig. 1 is a block diagram of the RFS4800 electronics. The configuration is unique in that the electronics needed to perform double-density formatting—considered 10 times more difficult than single-density formatting—has usually required an outsized or multilayer controller board. Such electronics could not have been employed in an industry-standard-sized intelligent floppy; they would be housed on a separate controller requiring a computer slot, interfacing, etc. On the Remex built-in board, these electronics have been reduced to require only about a third of the available board, leaving the rest free for read/write

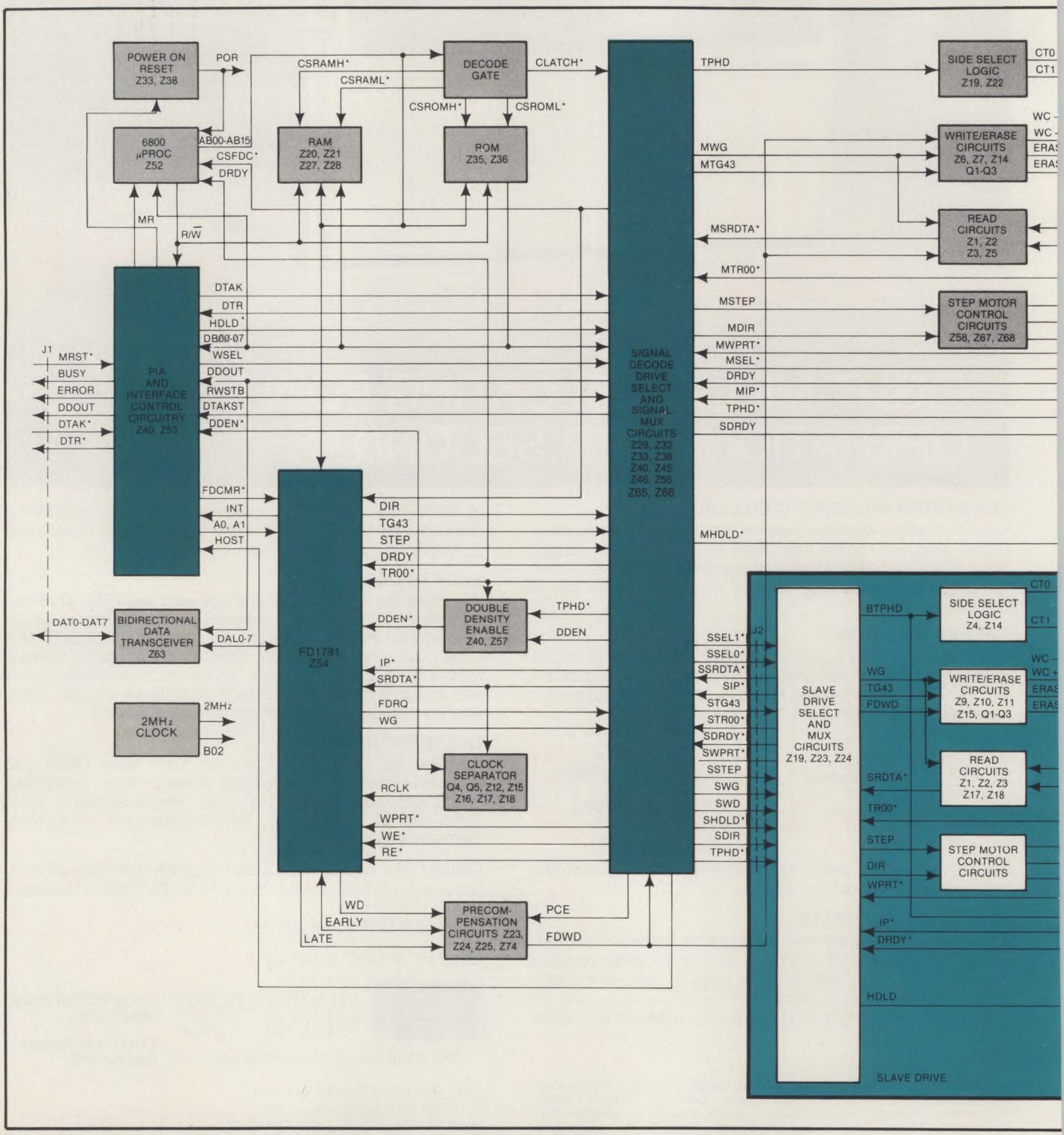
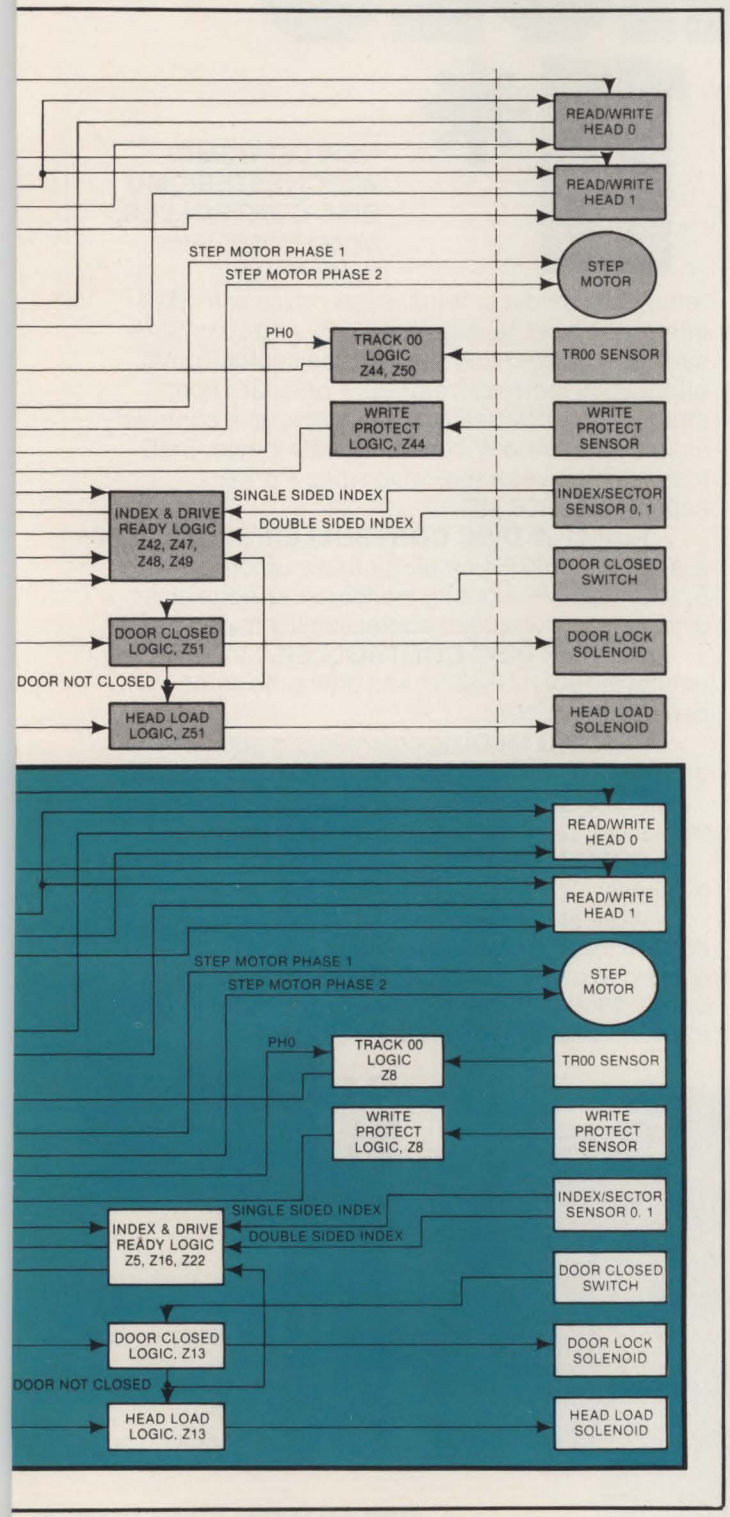


Fig. 1. Block diagram *of Remex RFS4800 shows how a master and slave drive can be arranged together.*

electronics, special-features implementation and interface chips. In fact, the design is so compact that extra onboard ROM capacity is available for special customer programs, such as file management or for an on-board RS232 port.

The controller size reduction results from a number of design efficiencies:

- a unique digital design of the phase-lock loop. The PLL is necessary for double-density encoding and has traditionally been implemented in a far more complex, space-consuming analog configuration;
- elimination of the electronic redundancies. Embedding the controller in the drive gives its microprocessor direct access to signal, status and control lines, eliminating considerable extra logic required for interfacing to an external controller. This directly affects the interface design;
- the use of LSI components, such as an 8-bit 68B00 microprocessor, the Western Digital 1791 floppy disk controller chip, which itself is a limited-function microprocessor, and large-capacity RAMs and ROMs. This last design consideration is the major contributor to size reduction and the upgraded performance of the controller.



LSI chip selection

The 6800 microprocessor chip selected for the RFS4800 design is the 2-MHz Motorola "B" version. The data rate of double-density encoding requires this speed. The 6800 was selected primarily because of its two general-purpose 8-bit registers, which made it more suitable for data manipulation. In the Remex controller, one register is used for data transfer and the other to sample status. If a single register chip had been used, data would have to be stored elsewhere in memory while status was checked. It would take nearly twice as many instructions to perform the same task. This, in turn, would take more ROM space, and the same controller capabilities might not have been achieved on such a small board. This is not to say that a dual-register microprocessor is always superior to a single-register device; it depends on the application.

The Western Digital 1791 floppy disk controller chip was the only LSI chip of its kind at the time of the RFS4800 design. The 1791 is a hybridized microprocessor with an arithmetic logic unit and five registers for data, command, sector, track and status. The 1791 makes it possible to perform functions with a single chip that formerly required a large board of small- and medium-scale logic. The controller reduces host processor operations and logic elements.

Unloading the host

While the 1791 alone significantly reduces the space required on the controller board, it is the interaction between the controller chip and the microprocessor that saves computer time and memory. Without the microprocessor, the CPU would have to pay dedicated attention to the controller chip, which, by itself, places great response time requirements on the host. With the embedded microprocessor, the host control program can be reduced by 80 percent, and timing demands can be reduced also.

To see how the controller chip interacts with the processor, let's look at a simple seek operation. If the CPU were operating directly with the controller chip, the operation would go something like this: assuming the 1791 has the track address in its register, the CPU would select the data register, transfer the desired track number with a write pulse, address the command register and output the seek command.

When the 1791 moves the read/write head to the

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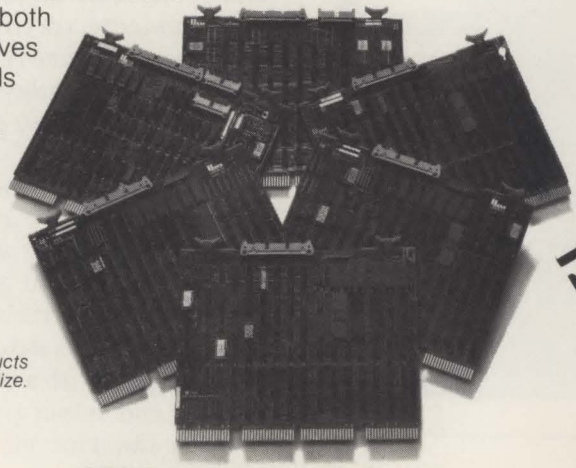

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An intelligent drive performs multiple-sector data transfers, automatic copying, formatting and initial program load, plus density switching and sector sizing—all with no more than two host commands.

assigned location, the head will read the disk ID field to verify its location. The host must be ready to receive the completion signal interrupt. The CPU then addresses the status register, reads it, examines the 8-bit status byte and performs retries if there is an error. If no error occurs, the CPU accesses the data register to issue the sector number and accesses the command register to issue the read or write command. The CPU must then be available to respond to a data request. It then selects and reads the data register.

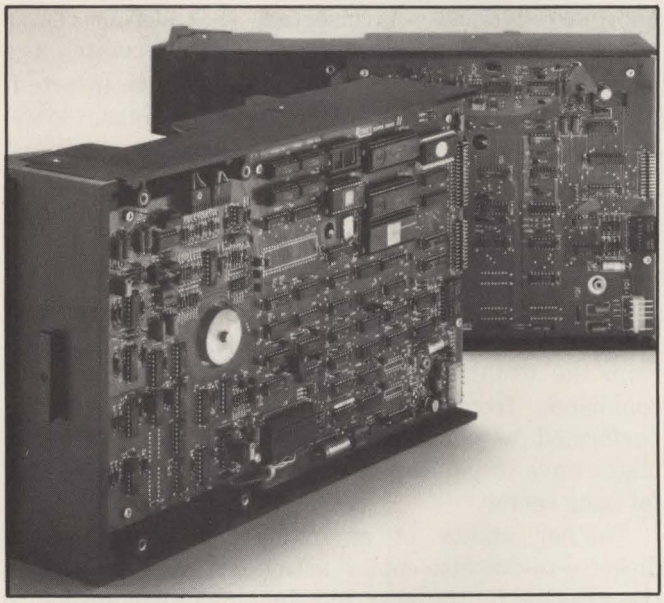


Fig. 2. Uncovered view *of drive shows the drive electronics.*

This last operation must be done for every byte in a sector within 16 μsec per byte. This becomes virtually a full-time job for a small CPU. But with the 6800 intervening between the host CPU and controller chip, the CPU outputs a read or write command, and the 6800 takes over. The host responds to a data transfer request by outputting a track number byte and a side/unit/sector byte, and then makes itself available for data transfer. The host involvement in software and time is significantly reduced when it does not have to directly manipulate the 1791.

In the operation described, the host does not even have to respond to a data transfer request if the intelligent floppy has been provided with a data buffer, which is the case with the Remex drive. The microprocessor permits implementation of a 1024-byte buffer requiring only two chips beyond the 6800's scratchpad memory. This allows the use of a data buffer on the peripheral without increasing the controller board size significantly. The greatest benefit of the buffer is the reduction of timing demands on the host. The built-in buffer is also very important in communications operations in which the CPU cannot tolerate interrupts because it needs to service higher-priority devices. Without the onboard microprocessor, a buffer would have to be designed as part of the interface—a job that would usually fall to the system builder.

Interface design is also greatly simplified by the addition of intelligence to a peripheral. First, only one interface is required—from the peripheral control electronics to the CPU—rather than one interface from the dumb peripheral to the controller and another from the controller to the CPU. And the microprocessor makes it simple to design the one interface required. Several simple programmed I/O designs have been accomplished using only nine to 12 chips. The number of host interface lines in the RFS4800 is reduced from 25 (as required by a dumb drive) to 15 because many of the status and control lines are immediately available to the

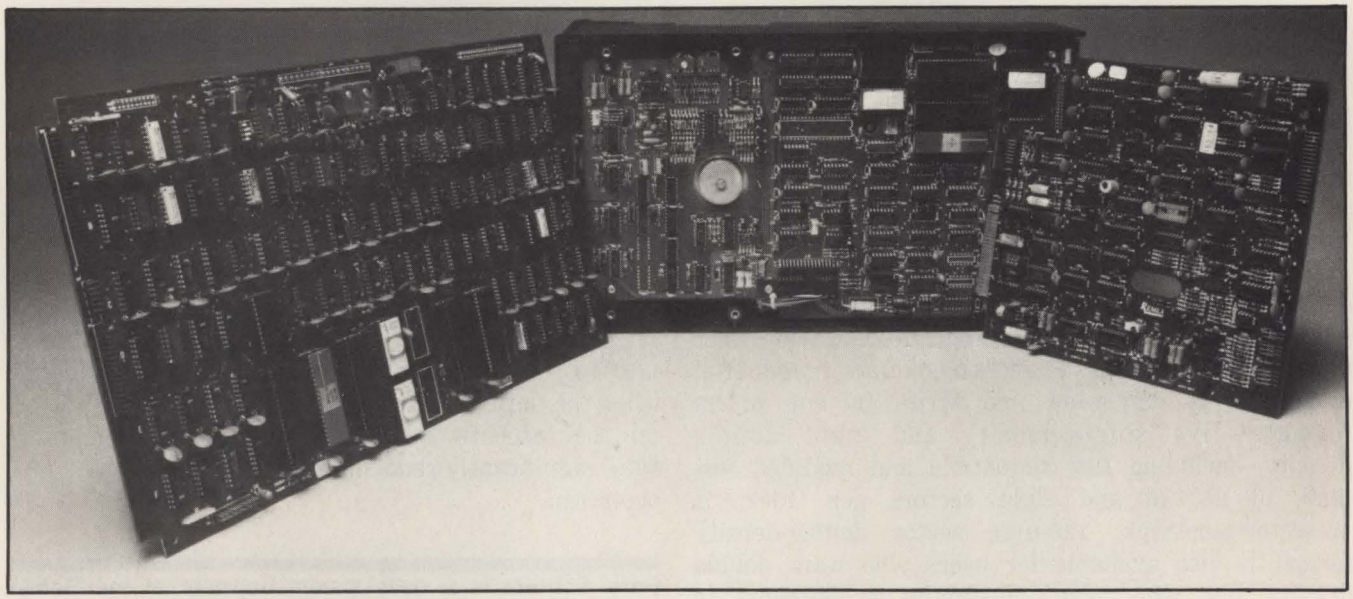


Fig. 3. Standard "dumb" floppy disk *electronics board (right) and separate floppy-disk-drive controller that might be used with it (left). The capabilities of both boards, plus many more functions, are compactly housed in the 6800-based RFS4800 (center).*

Interface deisgn is greatly simplified by the addition of intelligence to a peripheral; the microprocessor makes it very easy to design the only interface that is required.

onboard processor for sampling or control, rather than requiring host computer control. For example, the switch to a low-current write on track 44 is handled locally rather than by the host computer or interface.

The intelligent peripheral has a beneficial impact on software development, as well. The size of the software driver for the RFS4800 is reduced by an estimated 80 percent when compared with a drive written to handle a floppy disk controller chip directly. The reduction of driver size decreases the amount of host memory required to store disk-controlling software, which, in turn, leaves far more host memory available for system programs. Because more system memory is available, I/O is typically reduced and program operation is speeded significantly. This all adds up to economy for the system builder.

A significant "host-relieving" feature of intelligence in a floppy is the error-checking and retry operation. Checking status after a read/write operation with a dumb drive may require as many as 12 individual machine-level instructions by the host, while the Remex intelligent drive requires only two instructions. In addition, in an SSI/MSI implemented design, several chips are required to implement a cyclic redundancy check, while the controller chip performs this function automatically in an intelligent floppy, thus saving space.

The automatic retry capability of the intelligent drive also reduces host computer software because the drive's intelligent controller electronics will do most retries completely transparently to the host. As part of the intelligent drive's retry discipline, the 6800 will automatically verify its track position after a seek by reading the track address. This permits the drive to recognize a "bad track" written during a format, and progress to the requested logical track automatically without the need for error-checking routines, thereby saving host computer intervention and time.

Intelligent features

Intelligence in a peripheral not only reduces the demands on the host computer, it also permits extra performance features that would be difficult with other system configurations. The RFS4800 offers a number of examples. It can read and write in any of 13 formats—five single-density and eight double density—including IBM-compatible and modified formats of 26, 15 and eight sectors per track. A 46-sector-per-track, 128-byte sector double-density format is also available for users who want double density but who have substantial investments in operating system software based on a single-density 128-byte sector size. This multiformat ability is a function of onboard intelligence—specifically of the 6800 microprocessor.

In a two- or three-byte transaction with the host, the processor can transfer the data byte sequence for each format to media. The processor transfers more than 9000 bytes per track to the 1791 in formatting 77 tracks—all offline to the host. If this procedure were controlled by the host, a substantial chunk of computer time and memory would be required to send unique track and sector data marks, gap bytes, etc. Because few designers want to use computer memory for such a "frill," this time-and-money-saving feature is seldom offered in systems without intelligent peripherals.

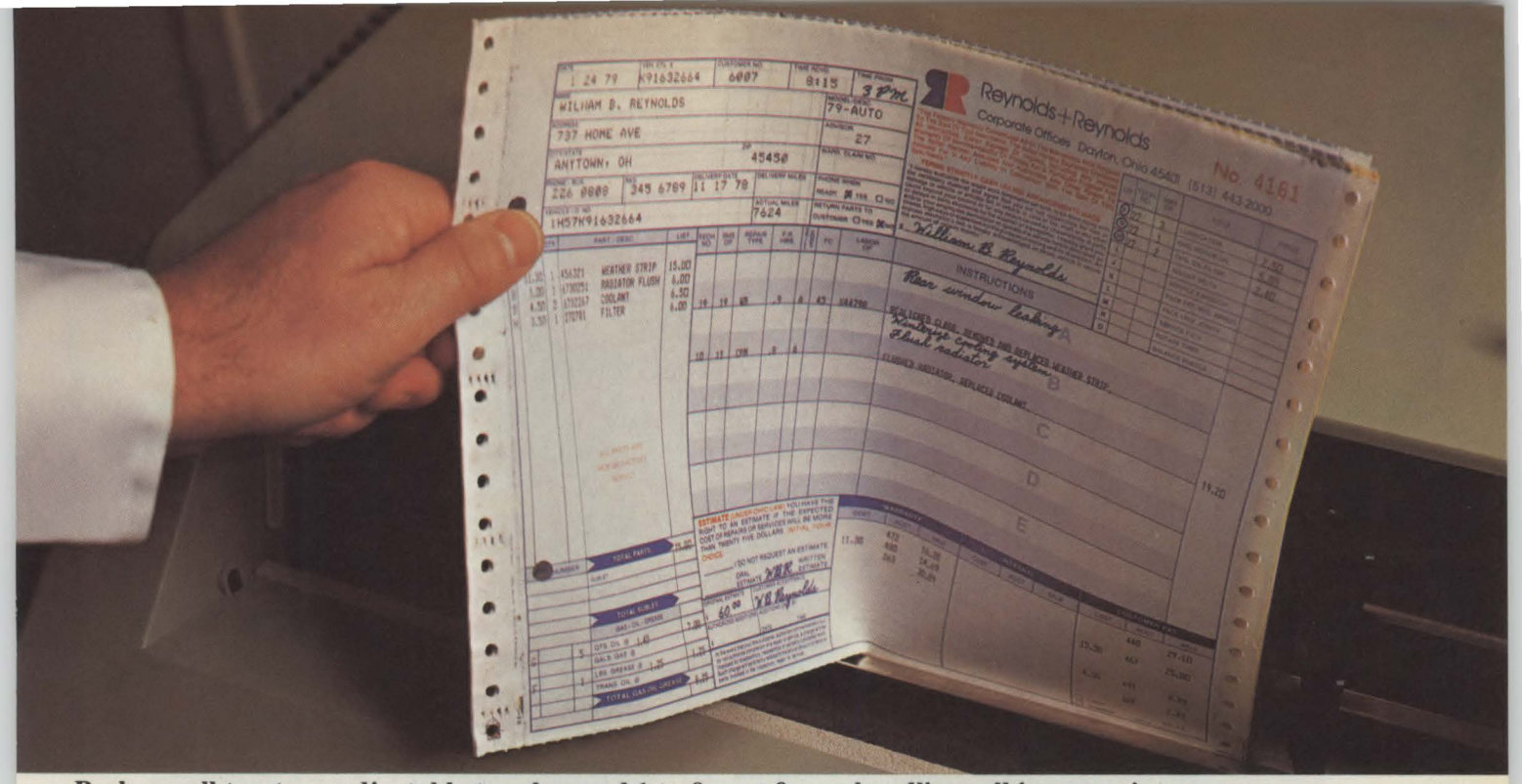
The RFS4800 takes full advantage of the intelligent drive's error-checking ability, and is equipped with automatic density switching, which eliminates time-consuming error checks caused by inserting diskettes of the wrong density. Each drive is set up to "prefer" either single or double density; if a diskette of the unpreferred density is inserted, the microprocessor will perform an error-checking routine, switch the density and automatically read the diskette inserted. This could require additional discrete logic in an SSI/MSI controller, but is inherent to a microprocessor-based peripheral.

A feature of onboard intelligence that saves substantial transaction time for the systems user is the multiple-sector transfer capability of the RFS4800. Implemented by the 6800, this allows the transfer of multiple contiguous sectors over any number of tracks, from one sector to a full diskette side, with only two commands from the host. If this function were performed without the onboard processor, the host might have to generate read/write or seek commands for each sector.

Another ability of an intelligent floppy is the diskette-to-diskette copy function, which is initiated in the RFS4800 by the host and then continues offline to the computer. The computer specifies with a load sector count the number of sectors to be copied and gives the starting side, unit, track and sector of the source and destination. The computer is then free to perform other functions while the 6800 microprocessor controls the copy. Without the onboard control, a copy would have to be performed by reading data into the computer memory from the source diskette, and then writing it out onto the destination diskette.

Finally, bootstrap programs can be loaded from the Remex intelligent drive to computer memory with a single command byte. The microprocessor instructs the 1791 to read two sectors into the onboard buffer, and when the buffer is full, to transfer to the host. The host can then execute the data as a program to load more data, significantly reducing the size of a key-in or ROM bootstrap. ■

Gary Schratz is a development engineer at the Remex Division of Ex-Cello-O Corp., Irvine, Calif.



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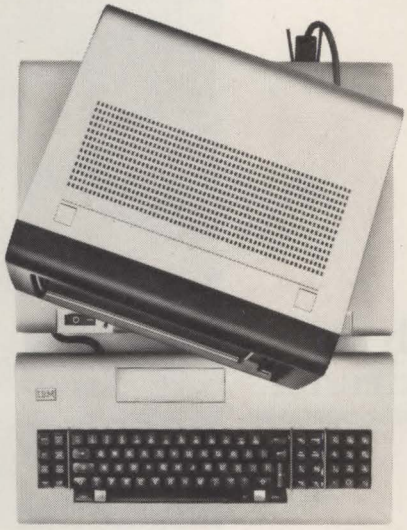

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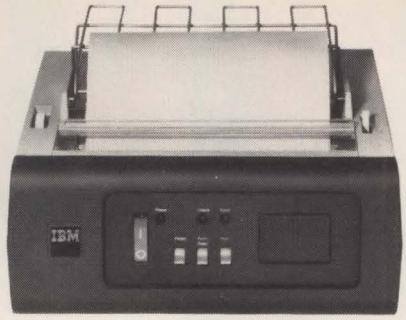

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DATA COMMUNICATIONS: PART III

Optimizing computer access in multi-user systems

ROGER L. EVANS, Micom Systems, Inc.

Getting by with fewer ports than terminals

This article is the last in a three-part series on data communications, taken from the notes for Micom Systems' new seminar, "Data Communications for Minicomputer Users." Part I (MMS, March, p. 97) discussed the types of data terminals, the terminal-to-computer connection, communication protocols and modems. Part II (MMS, April, p. 114) covered multiplexors and their use in cutting line costs.

Last month's installment of this series (MMS, April, p. 114) discussed ways of enabling more than one dumb terminal to communicate with a computer over a single data line. It was taken for granted that there would be as many computer ports available as terminals to feed them. In practice, however, that assumption is often false. A processor can support only a limited number of ports, and a user might want to economize by not installing as many of them as the machine can handle. It can easily turn out, especially in a commercial time-sharing system, that the number of terminals seeking access to the computer exceeds the number of ports available to accommodate them.

One benefit of a true communication protocol, supported in software on the host computer, is that it enables polling of multiple terminals from a single computer port. The trouble with this solution is that it requires special software.

Port concentrators

In a statistically multiplexed system, the problem can be partially overcome by port concentrators, which reduce the host software requirement by more than half. A port concentrator functions as a single-channel master statmux (statistical multiplexor), enabling a computer port to communicate with multiple channels attached to a remote statmux using a simple asynchronous or synchronous protocol (Fig. 1). Transmissions to and from the computer consist of simple lines of text, preceded by a terminal address.

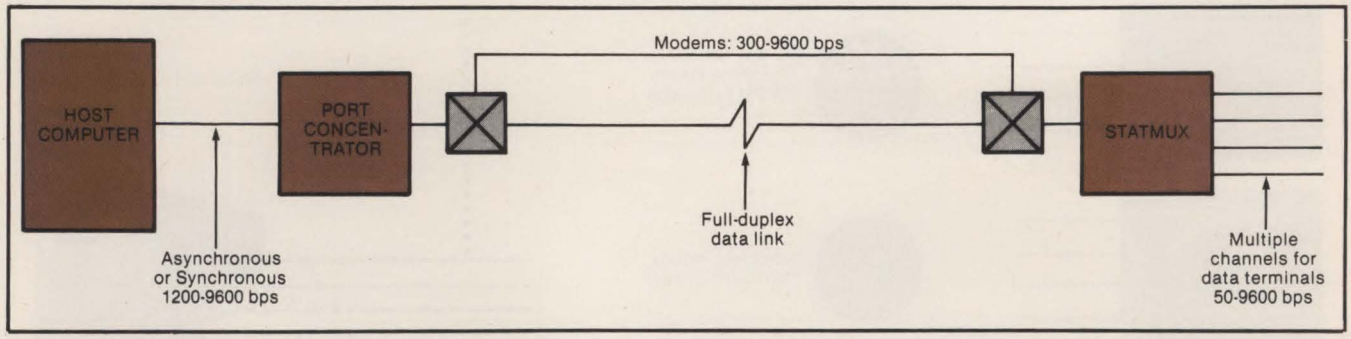


Fig. 1. A typical port concentrator configuration. *A port concentrator acts much like a statistical multiplexor, except that it does not receive from or transmit to multiple computer ports; all data enters and exits through a single port. For that reason, the host computer must provide a terminal address for each outgoing message and be able to recognize the terminal addresses attached to incoming messages. The port concentrator performs all other communication tasks for the host.*

A port concentrator functions as a single-channel master statmux, enabling a computer port to communicate with terminals attached to a remote statmux.

All data flow between statmuxes is in numbered blocks, each terminated by a 16-bit cyclic redundancy check (CRC) character. The port concentrator assumes full responsibility for the complex task of error control and transfers to the host computer only error-free blocks. It also performs any buffering necessary to handle data backups during retransmissions or temporary line outages on the link to the remote statmux.

The port concentrator also assumes responsibility for synchronization with the remote statmux. This is necessary even when no data is being transmitted, to ensure rapid response and minimum delay when there is data to send. Without a port concentrator, this need for constant synchronization might impose a significant burden on the host computer.

The port concentrator's sole disadvantage is that it requires special software support. This is unavoidable, however, if all terminals sharing the port must be on line at all times. But for applications that involve a "session," in which a terminal need only be on line for a few hours at a time, other solutions are available.

One of these solutions is dial-up access, which uses the standard voice-telephone network to link terminals to the computer. It enables a large number of terminal users to contend for a smaller number of computer ports on a first-come-first-served basis, with the telephone rotary providing a busy signal when all ports are in use. In a typical time-sharing application, the contention provided by the telephone rotary enables support of as many as four terminals per port, on average, yielding considerable savings in port hardware and much better use of the ports that are installed.

Dial-up access also enables users to access ports connected to different computers. Fig. 2 shows a facility with two HP 3000 systems for business applications and one DEC system supporting time-sharing, each with 16 ports. Each computer is assigned to a separate telephone rotary group, so that any terminal can access any of the three services by dialing its telephone number.

The disadvantages of dial-up access result from the fact that the dial-up network was designed for telephones, not data terminals. Its performance limitations and expense are sometimes intolerable.

In the past, dial-up access was a very cost-effective connection method, because the telephone companies based their tariffs on voice usage. A typical telephone call lasted from three to five minutes, and the company based its billing on the number of completed calls. With the growing use of the switched telephone network by data terminals, the length of a typical call has greatly increased. Many terminal users dial a computer in the morning and remain connected throughout the business day. The telephone companies decided to penalize terminal users by implementing a new tariff, under which local service by business users is measured in increments of five minutes or less, with a single message-unit charged for each increment. The conversion to single message-unit rate timing will eventually affect all parts of the U.S.

Single message-unit rate timing does not affect users with in-house PABX or Centrex service. But the long duration of terminal-computer conversations, which caused the telephone companies to seek a new tariff, also causes bottlenecks in PABX systems, whose design criteria are also based on the expectation of many short calls rather than a few long ones. Use of a PABX for computer access may not be as "free" as it appears; it may result in the need for a larger PABX long before voice traffic warrants it.

Another potentially expensive characteristic of

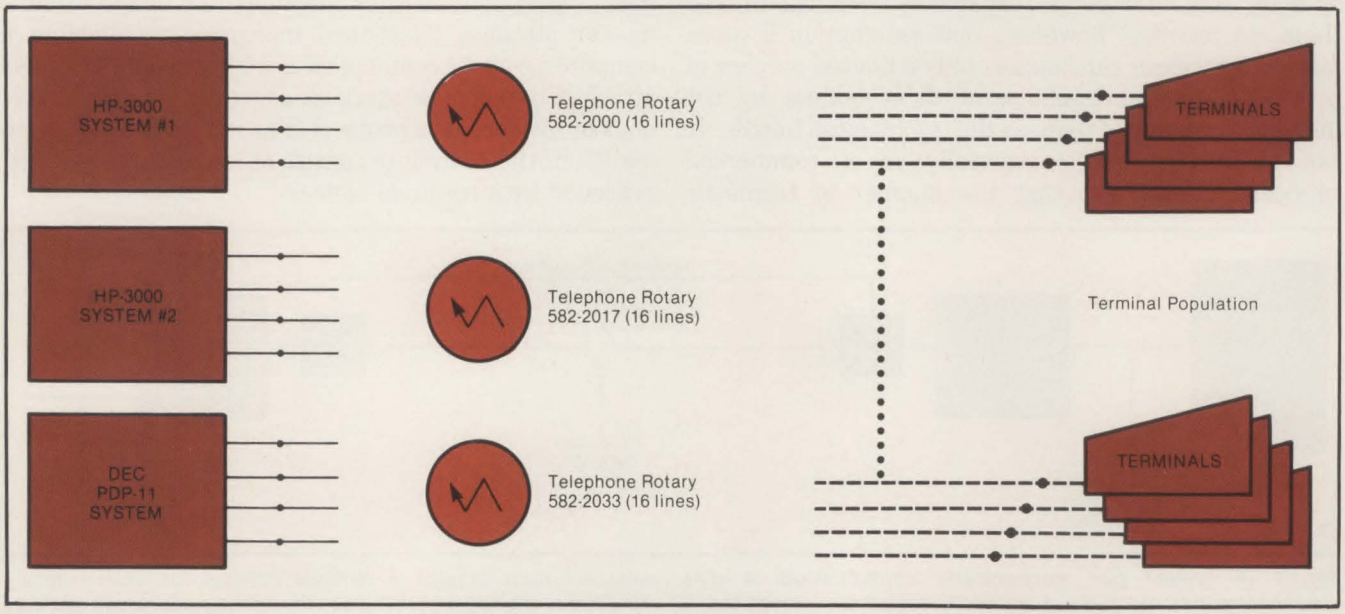


Fig. 2. Dial-up access *provides contention for available ports, and port selection via use of different telephone numbers for different systems or groups of ports.*

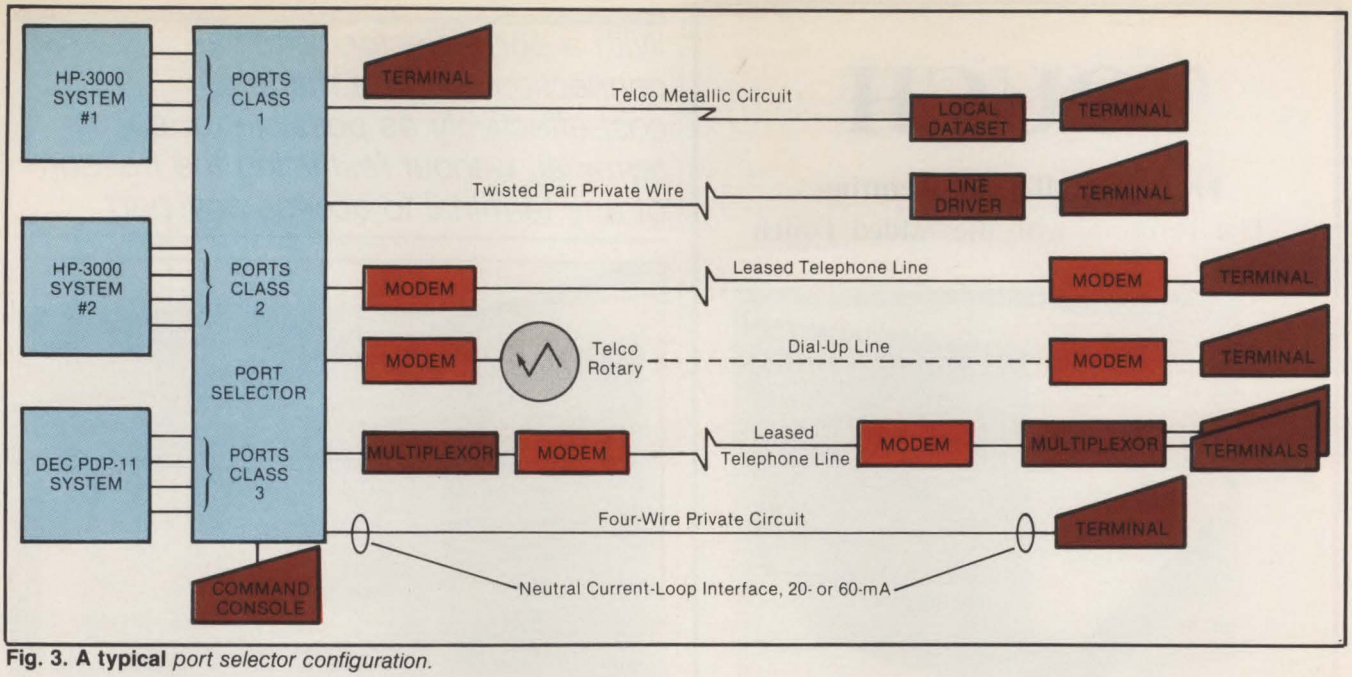


Fig. 3. A typical *port selector configuration.*

dial-up access is that it demands the use of modems, even for terminals at the computer site within a short distance of the CPU. Direct terminal connection, even if it requires the use of line drivers or local data sets, can provide savings by eliminating modems.

The main performance restriction is on transmission speed. A dial-up connection uses a two-wire line, and the maximum speed for full-duplex data transmission over two-wire circuits is 300 bps, or 1200 bps with the more expensive Racal-Vadic VA3400 or Bell 212A modems.

A particularly frustrating problem with dial-up access is that it normally implies that some callers will be answered with busy signals at peak periods. This gives rise to "panic dialing" as frenzied callers repeatedly attempt to assert their right to the next available line.

An alternative approach is to use a port selector to control and coordinate terminal access to a computer facility. Such a device can integrate dedicated terminal connection with dial-up access, if required, providing the advantages of both without the disadvantages of either.

The port selector is installed between the computer (or computers) and the terminals (Fig. 3). Like the telephone rotary, it provides first-come-first-served contention between terminals for the available computer ports. But unlike the telephone rotary, this facility is available to all terminals, whether their connections are dial-up or dedicated.

In the simplest applications, all terminals are in contention for all ports, but the ports may also be partitioned into "classes" to provide contention for each of several computer systems. When multiple port classes are defined to the port selector, the user enters the desired class (i.e., computer system) from his terminal keyboard, rather than dialing a different telephone number for each system.

The heart of a port selector such as Micom's Micro600 (Fig. 4) is a time-division switch—a solid-state electronic version of the electro-mechanical crossbar switch used in most conventional telephone exchanges. The time-division switch operates under the direction of a microcomputer, which controls all connections and disconnections. Once a connection is established, operation is completely transparent. The time-division switch transfers data directly from terminal to port at very high speed: the microcomputer controller is activated again only when the connection is to be broken.

To the computer port, the selector may appear either as a dedicated terminal or as a modem emulating the full answering sequence of a Bell 103 modem. Each port interface on the selector has a class defined in the selector's control memory. This class definition can be modified at any time.

Terminals can be connected to the port selector by direct cabling or by line drivers, local data sets or modems on dial-up or leased lines. If the selector is a Micro600, the terminal operator requests connection by depressing any key on his keyboard. The Micro600 responds with the prompt message CLASS=, to which the operator responds with the desired class number. If the Micro600 can make a connection to a port of the specified class, it transmits GO to the terminal. If unsuccessful, it transmits BUSY, UNAVAILABLE, UNASSIGNED, UNAUTHORIZED or WRONG SPEED, as appropriate. If all ports are busy, the operator may elect to "camp on," or wait in line; the Micro600 automatically displays the number of terminals ahead of him and transmits a GO message as soon as it is his turn.

The Micro600 disconnects a terminal when its port interface sees that the computer port has dropped the data terminal ready interface signal, when it detects a "break" from the terminal or after a specified period of inactivity.

With a port selector, terminal connections can be made as cost-effectively as possible for each terminal, without restricting the freedom of any terminal to access any port.

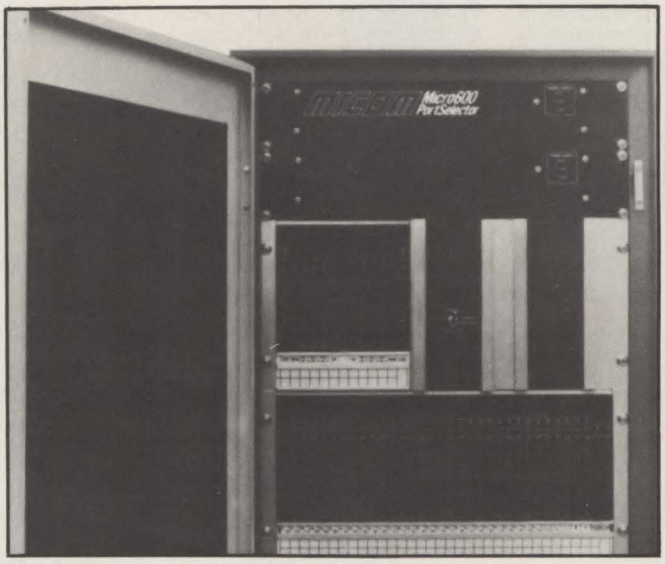
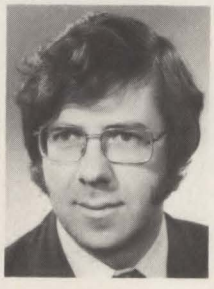


Fig. 4. Micom's *Micro600 port selector.*

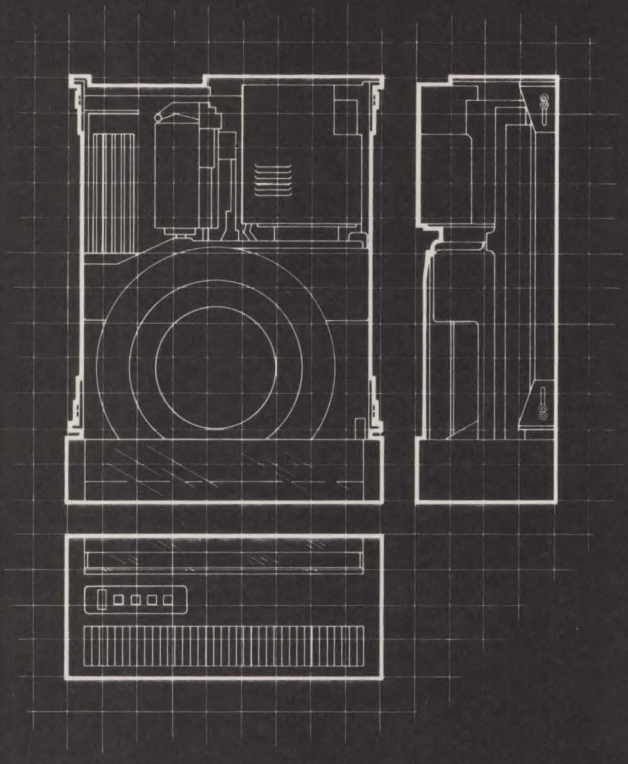
The contention facility provided by a port selector reduces the number of computer ports needed to support a given number of terminals without requiring dial-up access. A port selector can also provide multiple-computer access for dedicated dumb terminals, or can restrict access to certain computer ports from certain terminals. It can also operate independently of the computer to transmit special messages to terminal users to advise of system problems and scheduled restoral of service after downtime.

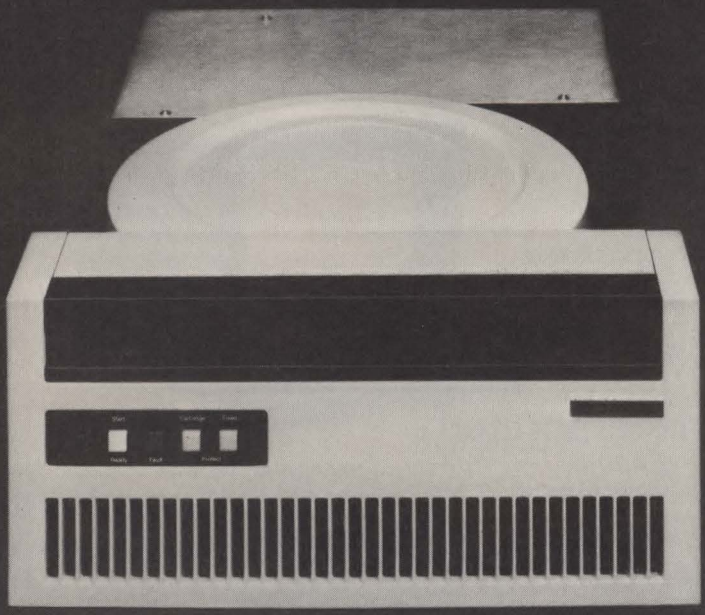
With a port selector, terminal connections can be made as cost-effectively as possible for each individual terminal, by direct-interface cable, limited-distance line driver or local data set or by modem over dial-up or dedicated lines, without restricting the freedom of any terminal to access any computer port. In addition, the selector can maintain usage statistics, enabling the computer manager to monitor usage of each group of computer ports. The port selector thereby enables proper access management and significantly improves the manager's ability to ensure optimum service to all terminal users, while keeping port costs minimal. ■



Roger L. Evans is marketing vice president of Micom Systems, Inc., a Chatsworth, Calif., manufacturer of data communications equipment.

Perkin-Elmer presents a complete rethinking of the cartridge disk drive.





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Reliable file backup on low-cost cassettes

VINCENT C. JONES, Hewlett-Packard Co.

Here's how users of small business systems can avoid big backup costs by using inexpensive audio cassettes

Computer professionals or managers of small businesses who use a floppy-disk-based microcomputer system quickly discover an expense they may not have anticipated: the cost of extra diskettes for program and data backup. Only the desperate or naive have sufficient faith in floppy-disk hardware and operating systems to rely on a single copy of a program or data base.

For the user of a relatively inexpensive small computer who doesn't have time to recreate weeks of work, the question is not, "Do I need file backup?" but rather, "How do I get adequate file backup at minimum cost?" Low-cost audio cassettes can be an effective answer in cost-critical backup applications, as long as adequate software is provided.

The alternative backup selections include additional diskettes, certified digital tape and top-quality audio cassettes, any of which may be appropriate for applications in which cost is not a major concern. But a viable backup (or fail-safe) system for a small-business computer has to combine convenience with reliability and cost effectiveness. When these characteristics are all carefully weighed, low-cost audio cassettes can provide enough incentive to use them if their limitations can be overcome.

Assessing the alternatives

Among the alternatives, diskettes provide convenient backup as long as at least two drives are available. Besides their cost, however, they suffer from one critical weakness. Being the same medium as the active system diskettes, they are subject to the same environmental failure mechanisms as the files they are intended to protect. Even worse, a single error in any directory block can render an entire diskette unreadable, increasing costs with the need to back up the backups.

Digital cassette recorders—another alternative—come in two classes: good and cheap. But good digital recorders, which provide all the features required for a complete fail-safe system, generally are even more expensive than using diskettes. Consequently, their use is restricted to specialized applications in which backup on diskettes is impractical for physical, rather than monetary, reasons.

Both low-cost digital recorders and audio recorder data interfaces exhibit three primary characterisitics:

1. The ability to use consumer quality audio rather than certified digital cassettes;
2. The inability to incrementally read a single byte or block of bytes from tape (i.e., the software must keep up with the tape data rate at all times);
3. A relatively poor bit error rate—in the range of 10^{-4} to 10^{-6}.

The need for the software to keep pace with the tape data rate, plus the poor bit error rate inherent in low-cost cassette mass storage, are chief among the earlier-mentioned limitations that have to be overcome,

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1	2	3	4	5
1	X	X	X	X	X	X	X	X									X				
2	X	X	X	X					X	X	X	X						X			
4	X				X	X			X	X			X	X	X				X		
8		X			X		X		X		X		X	X		X				X	
16			X			X		X			X	X	X		X	X					X

Fig. 1. Bits *affecting each parity bit.*

Audio cassettes can be an effective answer in cost-critical applications, if adequate software is provided.

with the bit error rate being the critical problem. Although that error rate may not seem especially poor, it translates into a probability of failure greater than 10 percent every time a mere 1350-byte file is restored. Clearly, a backup system that works less than 90 percent of the time can't be fail-safe.

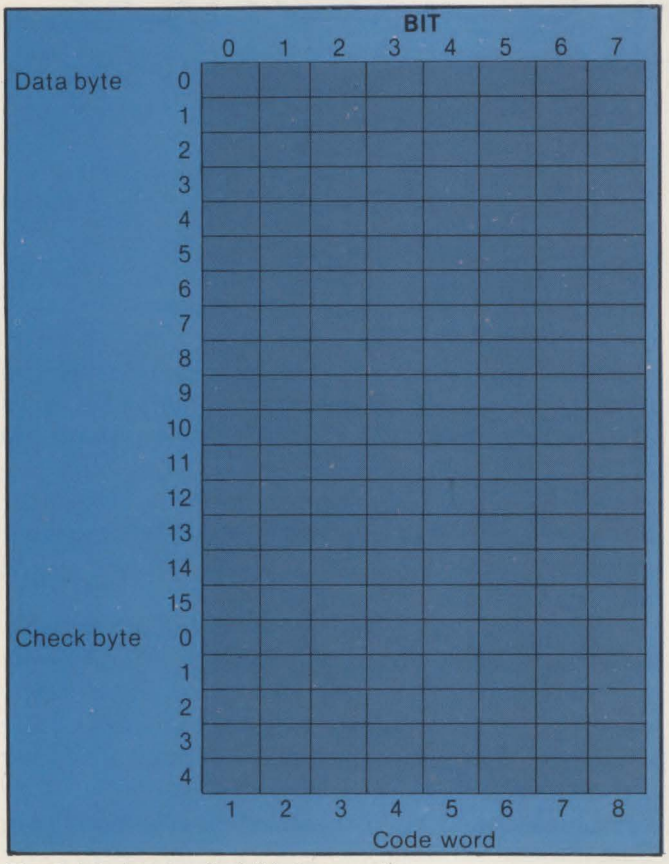

Fig. 2. Interleaving *for full byte correction.*

By using the algorithms in this article, however, the typical bit error rate of 10^{-5} can be improved to 10^{-9}, while the chances of any error going undetected are so small as to be dominated by processor and memory failures. This level of protection requires 377 bytes to be recorded on tape for each 256 bytes of data. Significant CPU resources are also required. It can take as much as 40 msec. to detect, locate and correct all the errors in a single 16-byte block of data using an 8080 microprocessor running at 2MHz.

The other limitation—the necessity to process characters synchronously without being able to reliably stop or start the data flow—is easily surmounted. Data can be processed in fixed blocks, and the time required for processing during readback can be provided during recording. Even though this slows recording and restoral, the penalty exacted by always allowing for worst-case timing possibilities does not need to be excessive. However, the faster the recorder interface, the higher the percentage of time lost to overhead. For example, the 8080 FAILSAFE program developed and used by the author allocates 24.4 sec. for processing for every 4096 data bytes. Total overhead, including all coding bytes, is slightly more than 50 percent using a 1200-bps interface. While this may not seem efficient, it is very cost-effective. A standard 50¢ C60 audio cassette will hold nearly 225K bytes of data—almost the entire contents of a standard floppy disk.

Coding theory decoded

The key to lowering the bit error rate lies in coding theory. The fundamentals of coding theory are not nearly as esoteric as most people believe. It is based on the sorting of objects into categories and labeling each object with its category. For example, the front of a car is labeled with headlights, the back with taillights. If you're driving, all cars in front of you in your lane display the same label, or code—taillights—because they are all in the same category; they are headed away

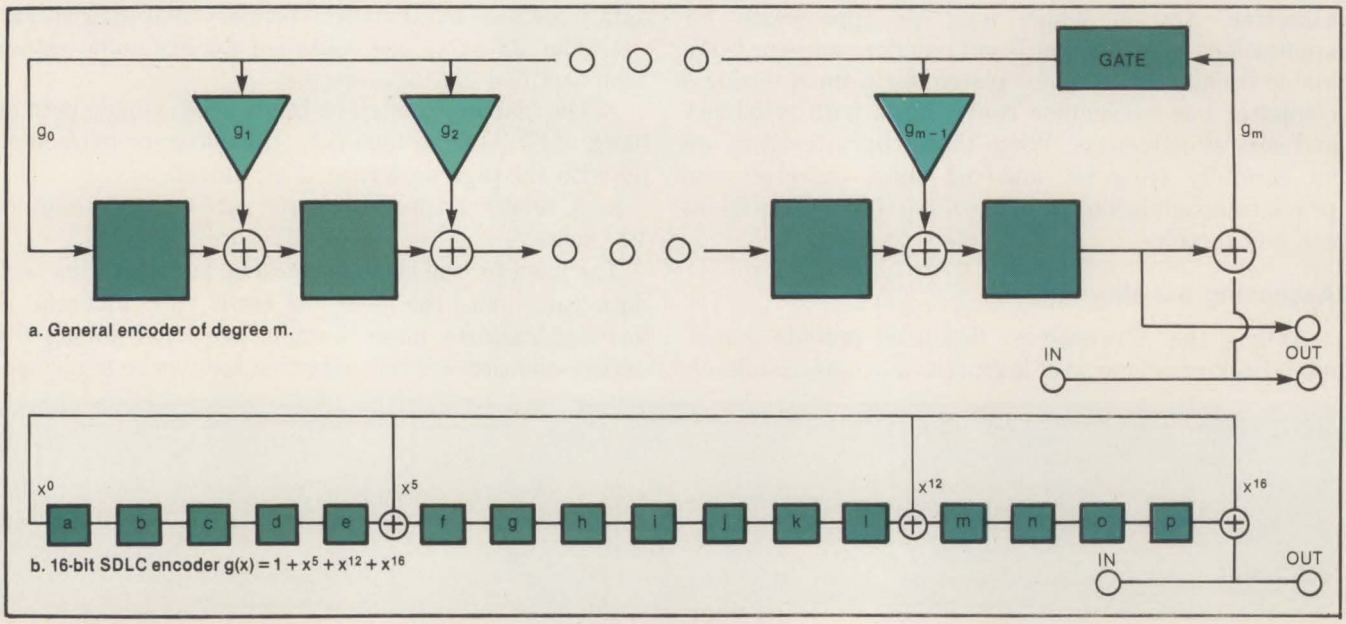

Fig. 3. Shift register logic *of a cyclic redundancy check (CRC) recorder.*

START	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
D_7	D_7 p	a	b	c	d	D_7 pe	f	g	h	i	j	k	D_7 pl	m	n	o
D_6	D_6 o	D_7 p	a	b	c	D_6 od	D_7 pe	f	g	h	i	j	D_6 ok	D_7 pl	m	n
D_5	D_5 n	D_6 o	D_7 p	a	b	D_5 nc	D_6 od	D_7 pe	f	g	h	i	D_5 nj	D_6 ok	D_7 pl	m
D_4	D_4 m	D_5 n	D_6 o	D_7 p	a	D_4 mb	D_5 nc	D_6 od	D_7 pe	f	g	h	D_4 mi	D_5 nj	D_6 ok	D_7 pl
D_3	D_3D_7 pl	D_4 m	D_5 n	D_6 o	D_7 p	D_3D_7 p la	D_4 mb	D_5 nc	D_6 od	D_7 pe	f	g	D_3D_7 h pl	D_4 mi	D_5 nj	D_6 ok
D_2	D_2D_6 ok	D_3D_7 pl	D_4 m	D_5 n	D_6 o	D_2D_6 D_7p ok	D_3D_7 p la	D_4 mb	D_5 nc	D_6 od	D_7 pe	f	D_2D_6 g ok	D_3D_7 h pl	D_4 mi	D_5 nj
D_1	D_1D_5 nj	D_2D_6 ok	D_3D_7 pl	D_4 m	D_5 n	D_1D_5 D_6o nj	D_2D_6 D_7p ok	D_3D_7 p la	D_4 mb	D_5 nc	D_6 od	D_7 pe	D_1D_5 f nj	D_2D_6 g ok	D_3D_7 h pl	D_4 mi
D_0	D_0D_4 mi	D_1D_5 nj	D_2D_6 ok	D_3D_7 pl	D_4 m	D_0D_4 D_5n mi	D_1D_5 D_6o nj	D_2D_6 D_7p ok	D_3D_7 p la	D_4 mb	D_5 nc	D_6 od	D_0D_4 D_7p emi	D_1D_5 f nj	D_2D_6 g ok	D_3D_7 h pl

Fig. 4. Shift register *contents for eight successive data bits.*

from you. Suddenly the car ahead displays headlights. Something is amiss. Either the label is incorrect, and some maniac is backing up at 55 mph, or the code label is correct, and the vehicle is in the wrong lane. Either way, the mismatch between observed code (headlights) and desired category (heading away) instantly alerts you that an error exists and corrective action may be required.

In communications, the coding applied by the originator can be considered a supplementary label that helps the receiver interpret the message. The chief goal of coding theory is to find labels that provide the best protection with the least effort. The use of coding is normally a three-step procedure. The originator examines the message (data), attaches a descriptive label (code word) and transmits both to the receiver. But transmission can introduce errors into the message and label. The receiver examines the message, determines the appropriate descriptive label and compares it to the label provided. If they do not match, an error has been detected. If they do match, one of two things has occurred: either the data is error free, or it is so badly garbled that the label matches anyway.

Going one step further, we can forbid the use of some labels, and thereby correct errors instead of just detecting them. By carefully selecting which labels are still permitted, the following situation is created. If an error occurs, the label will be changed slightly, but not enough to be close to any other legal label as it is to the correct one. By looking at the difference between the correct label and the calculated label, it is possible to determine what is wrong with the message and fix it to yield the proper label. How well this scheme works depends upon how far apart the legal labels are from each other. There must be at least two forbidden labels between any possible pair of allowable labels to determine which valid label is the correct one.

How does this help improve the reliability of cassette mass storage? First, take an error-correcting code and apply it to the data. By careful selection of the coding used, most common readback errors can be corrected automatically. Those that get through are detected by an overall error-detection code.

Error-correction coding

The vast majority of tape-read errors can be corrected by using a single bit-error-correcting Hamming code. This code applies simple parity checks to five different selections of eight bits each in the 16-bit data block. These five parity bits are then appended to the 16 data bits to form a 21-bit code word. The bit selections used to determine each parity bit are shown in Fig. 1.

The actual bit combinations used are arbitrary as long as two conditions are met: No two data bits may affect exactly the same parity bits, and every data bit must affect at least two parity bits. The former condition forces any data bit error to be reflected by a unique change in parity bits, while the latter allows detection of a parity bit that's in error. These two conditions determine the maximum number of data bits that a given number of parity bits can protect from single-bit errors. In our case, five parity bits provide 32 possible combinations, yielding 31 possible ways the check code can differ from the correct check code. Five of these correspond to check bit errors (remember, we are allowing only one bit in the entire block to be in error), and the remainder can each be coded to identify a

The poor bit error rate of audio cassettes can be greatly improved by using these algorithms.

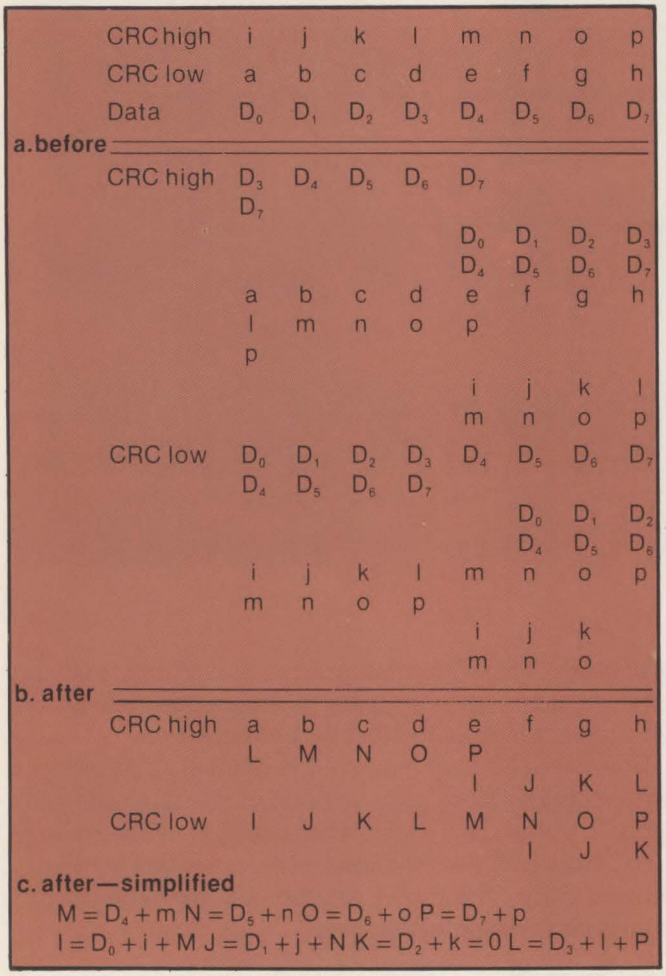

Fig. 5. CRC value *before and after one full data byte.*

different data bit in error. So the five check bits are capable of single-bit error correction of as many as 26 data bits. Extension to any number of check bits yields the familiar formula for single-bit error correction,

$$n = 2^m - m - 1,$$

for the number n of data bits protectable with m check bits.

Unfortunately, with many audio cassette interfaces, errors are not random isolated bit errors. Usually an entire 8-bit byte is in error. Interleaving is used to overcome this problem. As shown in Fig. 2, the Hamming code is interleaved eight times so that each bit in a byte is protected by a different set of check bits. As long as only one byte in the 21-byte block is affected, any number of bit errors will be fully corrected. Performance is actually better than this because bit errors can be scattered over more than 1 byte as long as there are not two or more bits in error in the same code word.

The same procedure is used for both code generation and code checking. The individual parity calculations can be decomposed into a series of exclusive-or logic operations. If the individual bit codes are interleaved so that bit position in each byte is consistent, the necessary parity calculations can be done for all eight code words in parallel, with no bit manipulations required. Fig. 2 shows how the first bit in each byte can make up one 21-bit code word, the second bit in each byte, another code word and so on. This considerably simplifies software implementation, with negligible loss of effectiveness.

To generate the check bytes, they are initialized to zeros and the code-calculation routine executed. On readback, the code-calculation routine is executed with the check bytes set to the values read from the tape. If no errors have occurred, the check bytes will all be zero. Any errors in either data or check bytes will result in one or more check bits being set, and it will be necessary to locate and correct the error(s). The check bits for each code word are assigned values, then summed to determine if there are any errors in that column. This is termed calculating the syndrome. As the syndrome for each column is calculated, a syndrome table is checked to determine which bit, if any, requires correction. That bit is then complemented to return it to its correct value. Because we are using a code capable of protecting 26 data bits, some syndromes are impossible to obtain unless at least two bits are in error. When one of these is detected, further processing is futile.

Error-detection coding

To protect against undetected or misidentified errors, data can also be protected by a cyclic redundancy check (CRC) code. CRC coding is a popular error-detection method for a number of reasons. The most important are its high efficiency in number of code bits required for a given level of protection, and its extremely low-cost hardware implementation; it requires only a shift register and a few gates—Fig. 3.

Logically, CRC code generation is simple long division. The entire stream of data bits is considered one huge binary number. This number is divided by a second number, called the generating polynomial, and the remainder from this division is the CRC code for that data stream. Careful selection of the generating polynomial provides codes that approach the theoretical optimum performance from a given number of check bits. The generating polynomials can also be optimized to detect nonrandom errors or to match other special conditions.

Because neither bit-oriented shift register emulation nor multiple-precision long division is efficient on 8-bit microcomputers, yet another approach to CRC calculation is required. Taking advantage of the full byte orientation of the cassette data, the effect of eight successive bits of data on the encoder logic of Fig. 3b is tabulated, bit by bit, in Fig. 4. Fig. 5 summarizes the results and some of the simplifications made possible by grouping terms. All the calculations required to encode a full byte's contribution to the CRC can be reduced to

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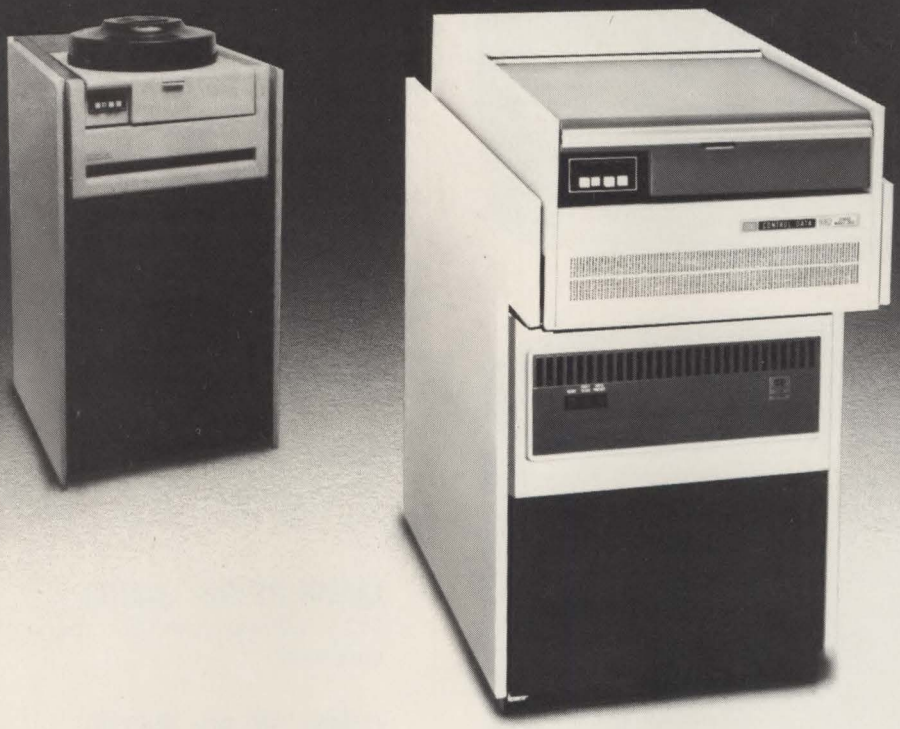

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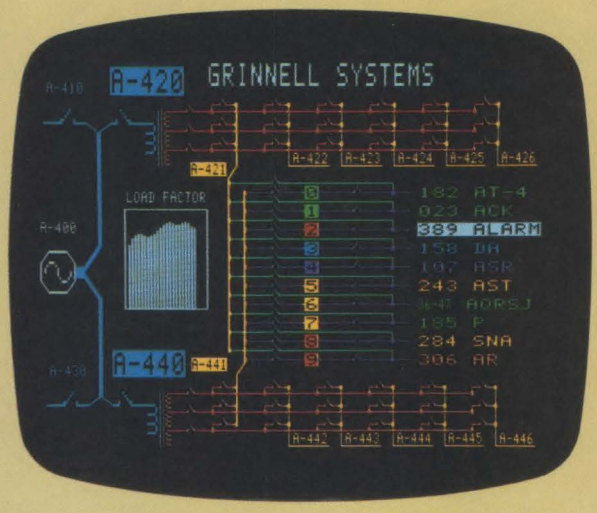

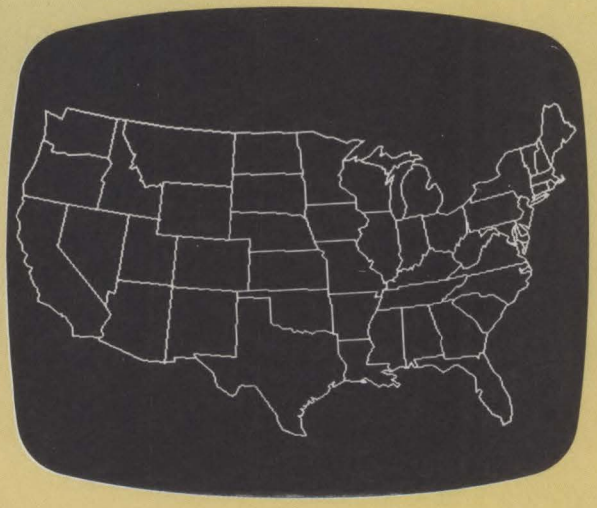

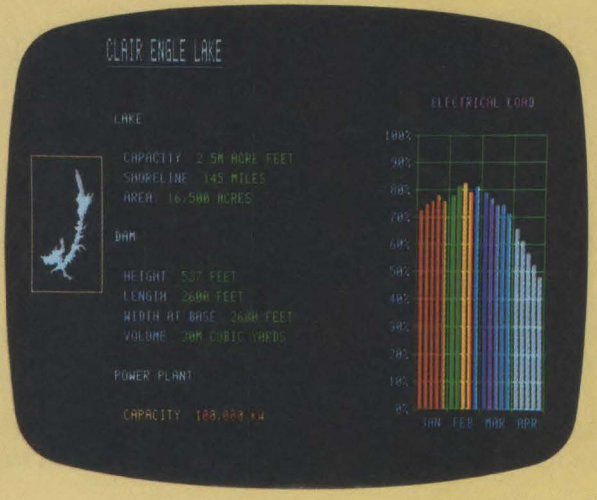

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The key to lowering the bit error rate lies in the coding theory.

7-byte-wide exclusive ors and five multiple-length shifts. CRC calculation for a 256-byte data block requires less than 20 msec. on a 2MHz 8080.

When reading data back from tape, the Hamming code must be evaluated first to permit correction of errors in the data. The corrected data can then be checked to see if it generates the CRC originally recorded. If the CRC codes match, the data can be assumed to be valid. A good 16-bit CRC will detect more than 99.998 percent of all blocks that are in error.

Data synchronization

To allow reading from an unknown starting point on the tape, the start of each block must be flagged. The typical scheme of using a series of all ones or all zeros is

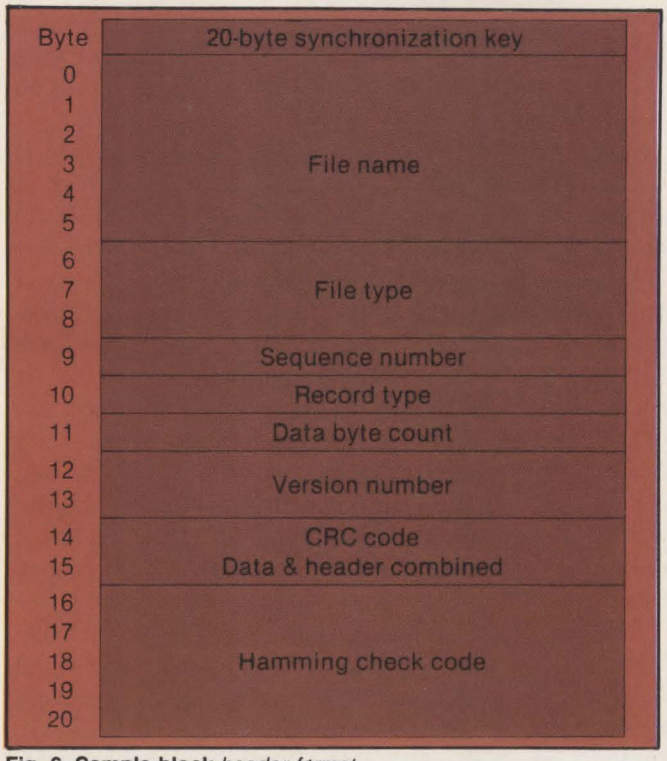


Fig. 6. Sample block *header format.*

inadequate where high reliability is required in the presence of read errors. All the coding in the world will not help if just a single bit that's in error prevents location of the start of data. Any flag that is based on repetition of a single byte, and the change to a different value, to signal the start of data further suffers from the requirement that the first byte of data must differ from the flag byte value.

Coding theorists have shown that the best possible flag sequence to use on a channel subject to random errors is a random number. It is also probably the most cumbersome. Assuming that a 20-byte key is being used, the last 20 bytes read from the tape must be compared with the desired key. As each byte is read from the tape, it is shifted into the lead byte position, and all previous bytes are shifted down one, with the oldest byte being discarded. Each byte is then compared to the corresponding byte in the synchronization key, and the number of bits that differ is counted.

On the 8080 microprocessor, counting these bits limits the maximum tape data rate. If the byte string is not a key sequence, an average of half the bits (80) will be different. By allowing a few (less than 10 percent) of the bits to differ, the effective length of the key is only slightly reduced, while its tolerance to data errors is increased so that it ceases to be a factor in determining the readability of a tape. Even with a bit error rate as bad as 10^{-3}, less than one legitimate key in 10^{12} will be missed. In the extraordinary circumstance of an invalid key being used for synchronization, files are still protected by the need for a valid header and CRC code.

Data formatting

The third requirement for a viable backup system, convenience, also requires appropriate tape formatting during recording. Ignoring the need to arrange the data in blocks to apply error correction and detection codes, a straight dump of data from disk to tape is only marginally useful. Data could be lost every time the program stopped to write data to the disk, while the logistics to keep track of which files were where on which tapes defies imagination.

Based on the speed of his tape interface, the author chose a format of blocks of 256 data bytes protected by a CRC. Each block is subdivided into 16-byte subblocks for protection by the Hamming code. A 16-byte header block, also protected by a Hamming code, precedes each data block to identify it. Retries after block read errors are simplified by supplying a complete header with each data block. The header format used is shown in Fig. 6. The first nine bytes after the synchronization key identify the file. The block sequence number insures that blocks are not skipped, and permits backing the tape to try again after a read failure. The format field distinguishes the end of a file block from normal data blocks; the data byte count is the number of bytes of data included in the CRC code. The CRC code is calculated only on the first 14 bytes of the header and the data buffer as read from the disk. No padding or coding bytes are included in the CRC code.

A 50-msec. delay after each 21-byte Hamming subblock is provided to correct any errors detected. An additional 50-msec. delay follows each data block to allow CRC checking and program overhead, and a 10-sec. delay is included after every 16th block (normally every 4096 data bytes), permitting disk write operations without stopping the tape player. On systems that allow start/stop control of the recorder, the recorder could be stopped for disk write operations during playback. Tapes recorded for use on these systems need only provide enough time for the recorder to coast to a stop and reliably start again.

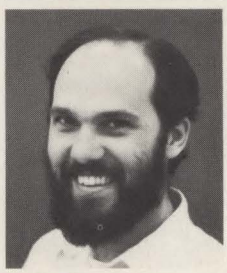
Files recorded in this fail-safe format can be conveniently and reliably restored upon demand. The tape is read until the synchronization key is found. Once

Logically, CRC coding is simple long division; the stream of data bits is considered one huge binary number.

a key has been recognized, the next 21 bytes are checked by the Hamming decoder. If no uncorrectable errors are detected, the first 16 bytes, constituting the header data for the block, are checked against the desired header data for the file requested by the user. If the names match, the sequence number is checked. If the sequence number is incorrect, one of two actions is taken. If the sequence number is too low, the routine assumes that the tape was backed up to reread a block and the recorder reenters the key search mode. If the sequence number is too high, the desired block is assumed to have been missed and an error return is taken. This provides a convenient re-try capability while avoiding the problem of endless searching if a block is missed. As an added convenience, header data can be listed on the console to indicate progress in reading the tape.

Once the desired header is found, the block size is checked to determine how many subblocks to read. A subblock must be read for every 16 bytes of data. If the number of data bytes is not an even multiple of 16, the last subblock would have been padded to the next multiple of 16 to permit error-correction coding. These padding bytes are not checked by the CRC code. Each subblock is checked by the Hamming decoder as it is read off the tape. If no uncorrectable errors are detected, the data bytes are stored in a full-block data buffer. After the entire block has been read, the CRC code is calculated using the data as written in the buffer. This maximizes the probability of detecting not only tape-read errors but also processing and memory failures.

The algorithms and programs described have all been implemented on an 8080 and actively used for archival file backup under a CP/M-derived disk operating system. Because of its slow speed, the system is used in conjunction with diskettes providing rapid-access, short-term backup capacity. In more than two years of use, only one file has not been recoverable and its loss was caused by recording on the wrong side of a cassette and erasing the original contents. Files recorded almost three years ago, while the software was still being debugged, on moderate-quality audio cassettes (Ampex 370) are still easily read on the first try. ■



Dr. Vincent C. Jones is a research and development engineer in the peripherals product line at the Desk-top Computer Division of Hewlett-Packard Co., Fort Collins, Colo.

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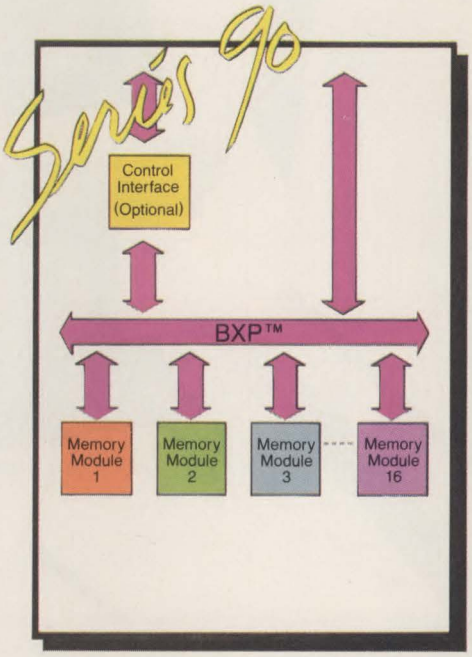

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Multilingual software cuts development costs

EDWIN J. KROEKER, Data Translation, Inc.

Assembly language routines can be incorporated into high-level language programs for improved performance in real-time applications

Developing real-time software can a be tedious and expensive proposition if programmers are forced by the relative slowness of high-level languages to work exclusively in assembly language. But by applying a multilingual programming approach to their software packages, real-time systems designers can combine the cost benefits of a high-level language (HLL) with the speed and performance benefits of assembly language. The result is a reduction of development time and expenses of 50 percent or more, cutting the design-to-

Assembly Language	High Level Language (HLL)
Internal program control structure	
Must be explicitly programmed — all constructs, such as looping and other iterative structures, must be individually programmed and tested every time they are needed in the program.	Many common constructs, such as REPEAT — UNTIL, WHILE, FOR — NEXT, etc., provided in the language. Constructs do not require debugging at every usage — only testing of the limits and terminating conditions.
Data types and structures	
All but the most basic data structures and types must be explicitly programmed. Exotic structures that might exactly fit the application are very difficult to program and debug.	Several data structures supported. Many new languages enable users to define new data types and structures as appropriate for the application and to define operations on these new data types.
Computation — functions, expressions	
All but the most basic operations must be explicitly programmed (floating-point operations, extended-precision fixed-point, complicated boolean functions). All of these functions must be programmed and tested, with exception conditions checked for each.	Many preprogrammed, error-free functions provided (transcendentals such as SINE and COSINE, floating-point operations, complicated expression handling, etc.). Exception conditions, such as division by zero, log (negative number) and so forth, are detected and reported.
Debugging	
Errors have a remarkable tendency to crash the machine — typographical errors in BRANCH or JUMP statements, for example. Debuggers tend to be low-level — must refer to variables in terms of storage addresses.	Errors produce diagnostic messages and graceful program termination. Debuggers allow the use of high-level variable names, for easier debugging.
Focus	
Tends to be on the machine being used, rather than on the needs of the application. The tendency is to squeeze the application to fit the requirements of the assembly language, resulting in perversion of the application.	Tends to be on the application, rather than the software implementation. More thought spent on the application; the software is more likely to function correctly in the specific application.
Programmer productivity	
A day's output usually will cover only some small facet of the application, although in great detail (as forced by usage of assembly language). Software reliability is uncertain — subtle bugs might lurk in the required copies of many control structures.	An entire application might be programmed in a day's worth of HLL code. Much more confidence in reliability: basic language constructs always work. More attention paid to algorithm implementation than to details of machine control.

Fig. 1. Comparison of *high-level versus assembly languages.*

Until recently, few manufacturers went even so far as to supply software diagnostics and calibration aids with their real-time products.

product time in a market where new products are the key to survival. Multilingual programming can enable industrial designers to quickly develop reliable, high-performance real-time control products or laboratories to generate high-speed data-acquisition software without using up large parts of their research grants.

Systems designers would like to program real-time applications entirely in high-level languages, simply because the cost of an HLL development project is very low compared to the cost of an equivalent assembly language project. Fig. 1 lists the advantages of HLLs relative to assembly languages, highlighting the characteristics that affect software development time, and thus the ultimate cost of the project. The thrust of these differences is that an HLL can provide in a single statement a function or structure that could take tens or hundreds of assembly language instructions to achieve.

It is an old maxim that a programmer can write only a certain number of lines of code per day, regardless of the language. In a high-level language, those few lines could represent thousands of lines of assembly language code. An HLL programmer is effectively several orders of magnitude more productive than an assembly language programmer, solely because he is using a high-level language.

Software performance requirements

A project manager in a data-processing environment probably doesn't care how long a program takes to run; his overriding concern is the cost of developing the software. He chooses an HLL that enables him to program his application quickly and cheaply with little or no regard to execution speed and efficiency.

The manager of a real-time project, however, lacks this luxury of choice. His software must interact with a world that doesn't stop to wait for his program to digest data. It is important, then, that his software doesn't take too long to process data and respond to new events. The HLL that enables him to develop algorithms at the lowest cost is worthless unless the software can perform reliably, efficiently and consistently in real time.

The project manager for a real-time application must determine what performance levels are required for the control software to operate properly. Two basic parameters are involved: how fast certain sections of the software must execute and how fast other code sections must respond to external events.

Execution speed limits the number of control paths or loops the software package can support. For example, an application might have several different control loops operating simultaneously, each of which must be executed (serviced) at least once every predetermined time interval (Fig. 2). The user's software must meet all of these maximum service intervals for all control paths simultaneously. Usually, this requirement is met by having the software for each loop execute as quickly as possible, leaving the maximum amount of time for the processor to service other control paths before the original path needs servicing again.

In most applications, real-time response is more important than execution speed. Many control tasks are not internally initiated, but rather are executed after the occurrence of an external event, usually flagged to the controlling software as an interrupt. The application limits the permissible delay between the trigger event and the execution of the corresponding control task (Fig. 3). This time limit, or response latency, is the amount of time the process can afford to wait for the control software to act.

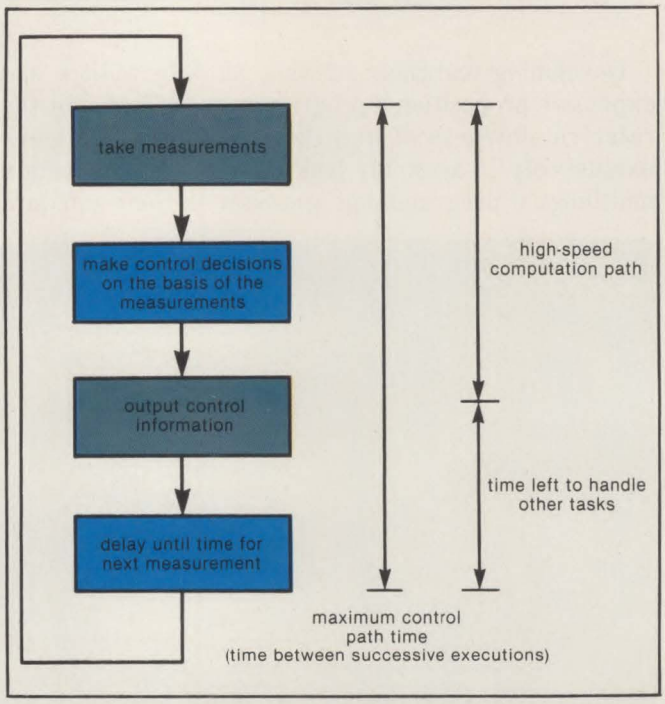

Fig. 2. Real-time software *must cycle through all of its control loops as often as necessary. For that reason, it must execute each loop as quickly as possible, to leave time for servicing of the other control paths.*

Most minicomputer language compilers and an increasing number of microcomputer compilers support modular software development. Each code module is written and compiled separately. The final program consists of several modules linked together by a special utility program (called a linker, linking loader or link editor). Although this procedure is intended to enable designers to divide the functions of their final products into smaller, more easily manageable projects, it also provides a key performance tool to the real-time software designer.

The basic idea involves using multiple code modules to isolate the time-critical paths and the interrupt-response tasks from the less sensitive portions of the application, then programming only the critical modules in assembly language (Fig. 4). This hybrid HLL/assembly language combination gives the local

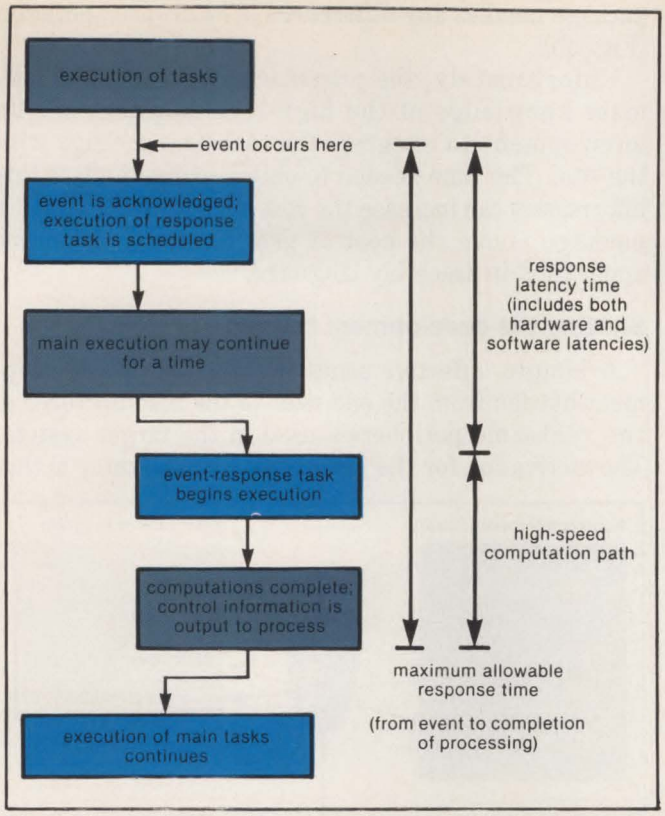

Fig. 3. The application determines *the permissible delay (response latency) between the trigger event and execution of the corresponding control task.*

speed and performance needed for real-time functions, without sacrificing the advantages of an HLL in the remaining modules that tie the package together. The overall implementation cost is significantly less than for a pure assembly language solution, while providing the necessary performance.

Software libraries

In real-time applications, most time-critical paths and real-time response requirements relate to a few very general functional operations, including:

- scheduling the execution of a routine on the occurrence of an event, either external or internal
- supporting asynchronous data collection, triggered by either a fixed stable time base (real-time clock) or a variable external source
- supporting asynchronous output of control information on the occurrence of external or internal events.

These operations usually involve specific signal-conditioning hardware, such as analog-to-digital (A/D) converters, digital-to-analog (D/A) converters, digital I/O devices, real-time clocks and so forth.

In light of these underlying operational similarities, it makes sense to have a general library of preprogrammed, application-independent assembly language routines that provide high-speed control structures tailored to the needs of process-control and data-acquisition software. The actual control computations and algorithms are still programmed individually for each application, but virtually all of the complicated real-time interrupt and pseudo-multitasking support comes from the pre-programmed routines. Once these routines are written, the user never again has to go to the trouble and expense of coding and debugging interrupt-driven peripheral managers and task schedulers for every application (the most time-consuming and, therefore, most expensive type of software development).

These special routines, in conjunction with the user's HLL program, coordinate the overall activities of the software package and perform process computations and high-level I/O (file management, distributed network support, and so forth). At several lower levels, transparent to the HLL program, high-speed assembly language routines from the special collection handle device interrupts, schedule HLL response routines and collect or output data. Very complicated real-time programs can be quickly developed using such a support structure.

A major drawback to this approach is that the assembly language routines must still be interfaced to the high-level language—a difficult, expensive task which requires that much information about the HLL's run-time environment be available to the assembly language programmer. To the high-level program, these routines ideally should look like built-in procedures and functions, thereby eliminating much of the software interface confusion that normally results from mixing code modules written in different languages.

Another potential problem is program size. With such a large collection of support functions, each routine can be coded in a separate module or all can be combined in one large code module. Having separate modules makes linking programs difficult. The user must know exactly which routines his HLL program is calling and include the appropriate code modules in his final linked program—an error-prone situation when 20 or 30 code modules are involved. Using a single module guarantees that all routines called by the HLL program are linked to the final package, but it also means that

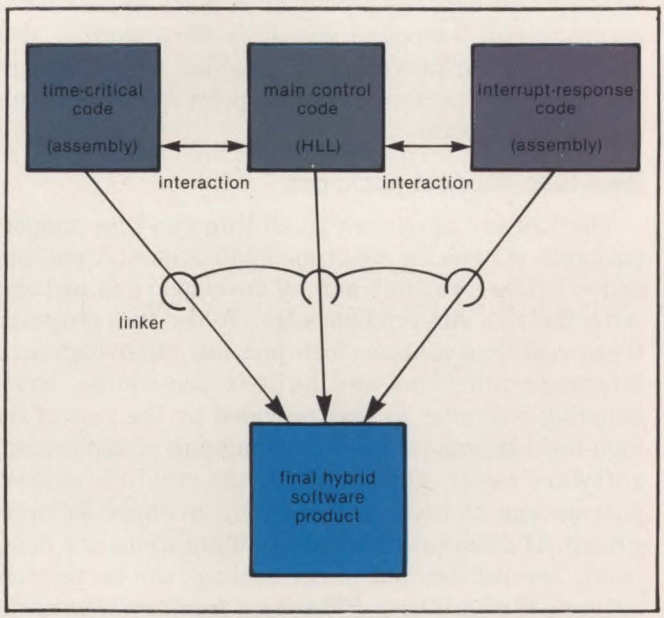

Fig. 4. Time-critical paths *and interrupt-response tasks are isolated from the rest of the application and programmed in high speed assembly language modules.*

Multilingual software gives the local speed and performance needed for real-time functions without sacrificing the advantages of a high-level language in the remaining code modules.

many extra lines of code (representing all of the routines not being used) are linked into the program, wasting memory space.

HLL run-time support packages

Designers of high-level languages also have to deal with problems of software interfacing and program size. Their languages often include special packages of high-speed assembly language routines that are linked and loaded with the user's final compiled program. These routines, collectively called run-time or object-time support packages, perform operations such as computing transcendental functions, floating-point multiplication, checking array bounds on array references and handling run-time program errors.

Size and interfacing problems are minimized by structuring each package as a library that is completely transparent to the user. The linker automatically searches the code library, extracts only the routines called by the HLL program, inserts them and links them to the final compiled code (Fig. 5a). Thus, if the user's HLL program performs no floating-point operations, the floating-point routines from the library will not be inserted into the final linked program. This scheme provides high-speed routines where they are needed, but does not add extraneous code that will never be executed.

One convenient feature of this technique is that different packages can be used for different hardware configurations. For example, a system with a floating-point processor can be supplied with a run-time support package that uses the processor as much as possible to increase HLL execution speed; systems without such specialized hardware can be provided with a support package that performs floating-point operations completely in software.

Real-time support packages

The library approach to adding run-time support packages is ideal for real-time applications. A package of real-time routines can be developed and included with the HLL run-time package. To the HLL program, these real-time routines look just like other high-level language functions and built-in procedures. Error handling is similar to that provided by the rest of the high-level language, making debugging of applications software easier. Once written, the real-time support package can be used repeatedly by an entire software group. If different hardware configurations are being used, several versions of the package can be written, masking the hardware differences from the view of the HLL. HLL programs can remain the same, despite drastic hardware changes, while the real-time support package handles any differences in hardware operation (Fig. 5b).

Unfortunately, the programmer still requires intimate knowledge of the high-level language and its environment to integrate the real-time package with the HLL. The time needed to obtain and assimilate this information can increase the cost of writing the support package above the cost of programming the entire application in assembly language.

Shifting the development burden

A simple, effective solution is to shift the development burden from the end user to the manufacturer of the real-time peripherals used in the target system. The motivation for the peripheral manufacturer is that

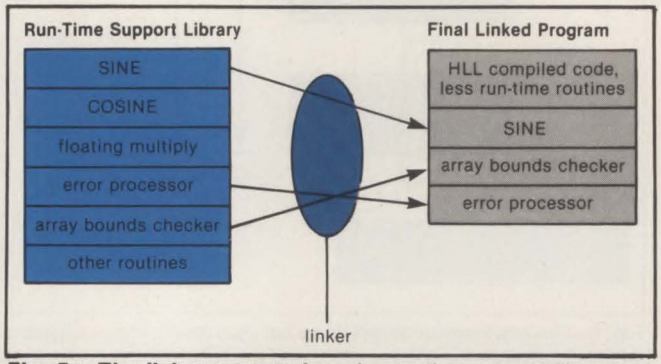

Fig. 5a. The linker extracts *from the run-time support library only those routines required and inserts them into the final code.*

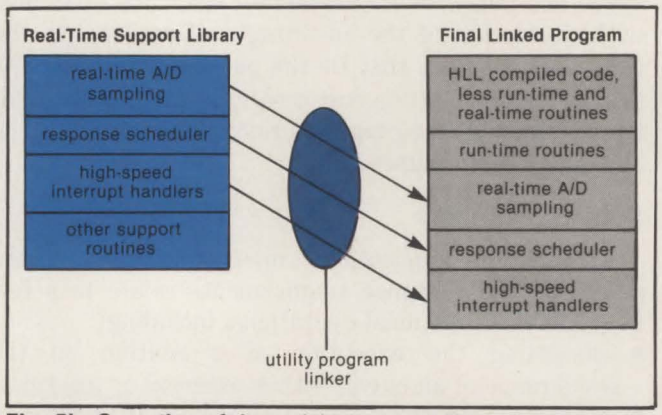

Fig. 5b. Operation of *the real-time support library is analagous to that of the run-time support library. Both are transparent to the user.*

he can use the support software to increase sales of his real-time data-acquisition and control products. The benefit to the consumer is that the manufacturer's expenses for designing and writing the software can be amortized over hundreds of users and projects, enabling the user to buy the development time represented by the support package (with a rough value of $25,000 or more per man-year) for $500 to $1000. The user gets, in effect, instantaneous development at a fraction of the cost he would have to pay if he were to write the routines himself; months of development time can be shaved off a project.

Another advantage of this approach is that the manufacturer's software engineers, being very familiar with the products, can immediately bypass operational

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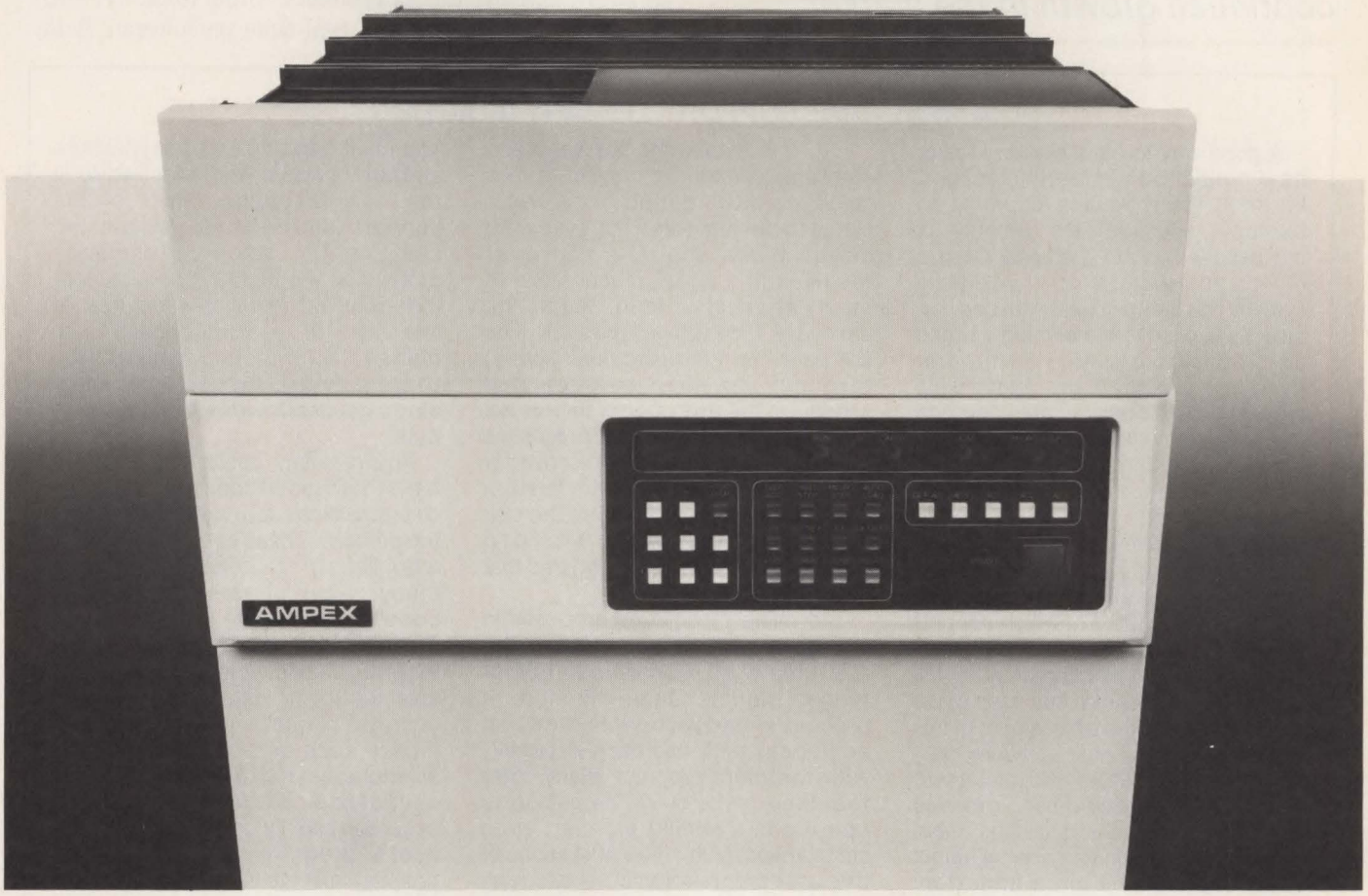

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CIRCLE NO. 96 ON INQUIRY CARD

Unfortunately, corporate commitment to software support is rare in the real-time peripherals field, although manufacturers are gradually coming to realize that it is essential to their continued growth in the market.

idiosyncrasies of particular peripherals, instead of flushing them out at debug time. Consequently, they can write more efficient peripheral-management code than the user, with less wasted time and effort.

But for this scheme to work, the peripheral manufacturer's software engineering department must be competent and backed by a corporate commitment to software support for its products. Unfortunately, such commitment is rare in the real-time peripherals field,

A REAL-TIME SUPPORT LIBRARY IN ACTION

A good way to get a clearer idea of how multilingual real-time support libraries really work is to look at an example. Although the computer in this case is Digital Equipment Corp.'s LSI-11/23 using the RT-11 operating system, the techniques discussed can also be applied to the coming 16- and 32-bit microcomputers from other vendors, provided the relationship between the high-level language and the linker remains as described, with the linker fulfilling HLL requests for assembly language routines by extracting code from one or more software libraries.

Data Translation's DTLIB peripheral-support library consists of many routines, most of which support real-time asynchronous control structures. Our example concerns a small part of a user program that uses DTLIB to provide real-time extensions. In this application, the control software must scan 16 input channels of an A/D converter every 100 msec., examine the data and make decisions about the signal levels on four analog output (D/A) channels. If more important activities require the attention of the central processor, the data-processing phase of the sampling task may be deferred, but no input data may be lost: all data must be collected, regardless of the demand on the processor.

Fig. 6 illustrates the hardware and software used for this procedure. The real-time clock generates a trigger signal to the A/D converter every 100 msec. When the A/D converter receives this signal, it scans the 16 input channels, then flags the software through an interrupt. The software (from the peripheral library) responds to the interrupt and schedules the execution of the control algorithm, which, in turn, processes the data acquired by the A/D converter and adjusts the levels of the four D/A output channels accordingly. The CPU then returns to whatever it was doing before the A/D converter signaled that data was ready.

The entire process repeats itself in another 100 msec., when the real-time clock generates another trigger signal. Once initiated, it proceeds independently as an additional task operating in parallel with the main program. Many other real-time tasks could be set up to operate in a similar manner, even simultaneously in different sections of the user program (until the CPU runs out of time to handle the load).

Although FORTRAN IV is the high-level language actually used in this application, it is not the only possible choice. Another language, such as PASCAL, could be substituted, if the peripheral-support package's argument-handling and data-structure support routines were modified to fit the new language. Most of the support library would remain the same, as the majority of the code deals with the handling of language-independent real-time structures. In this case, FORTRAN was chosen for its numeric computation features, with DTLIB providing the real-time extensions needed to collect and process data.

The real-time control structure we have discussed requires only three DTLIB routines to initiate and control the process. These calls, representing a few lines of HLL code, would require many pages of assembly language code to perform the same functions. Furthermore, all of that assembly language code would require extensive testing to determine whether it operated correctly in all situations. A library such as DTLIB is a pretested structure in which the user can have confidence. Should external events occur too rapidly or frequently for the user's program to handle, DTLIB provides mechanisms for flagging the overrun conditions, enabling the program to recover gracefully. An equivalent set of discrete assembly language routines would be more likely to crash when confronted with event or interrupt rates too fast for it to handle.

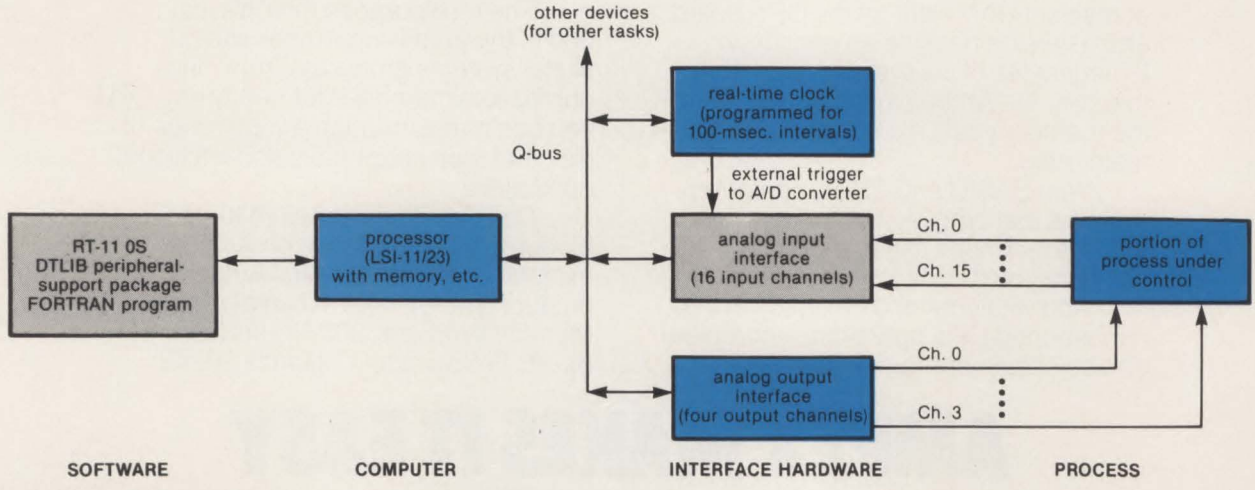
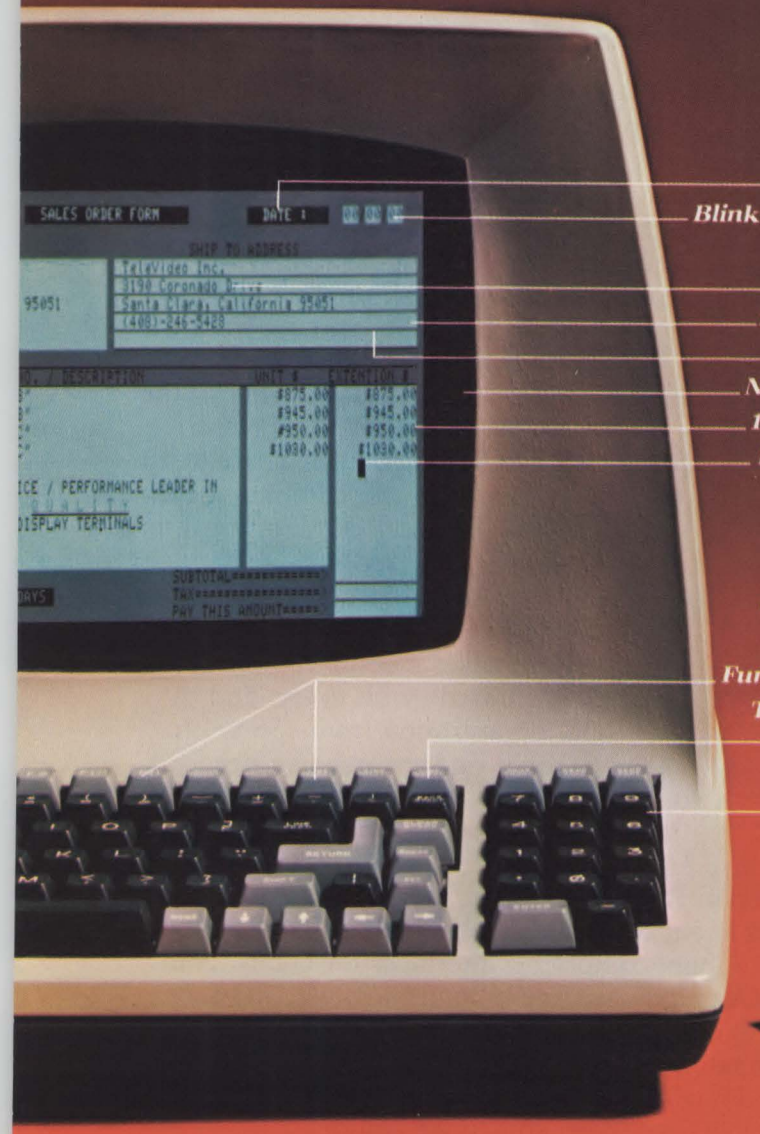


Fig. 6. Block diagram of *a process-control system using the DTLIB real-time support library.*

COMPARE SMARTS.



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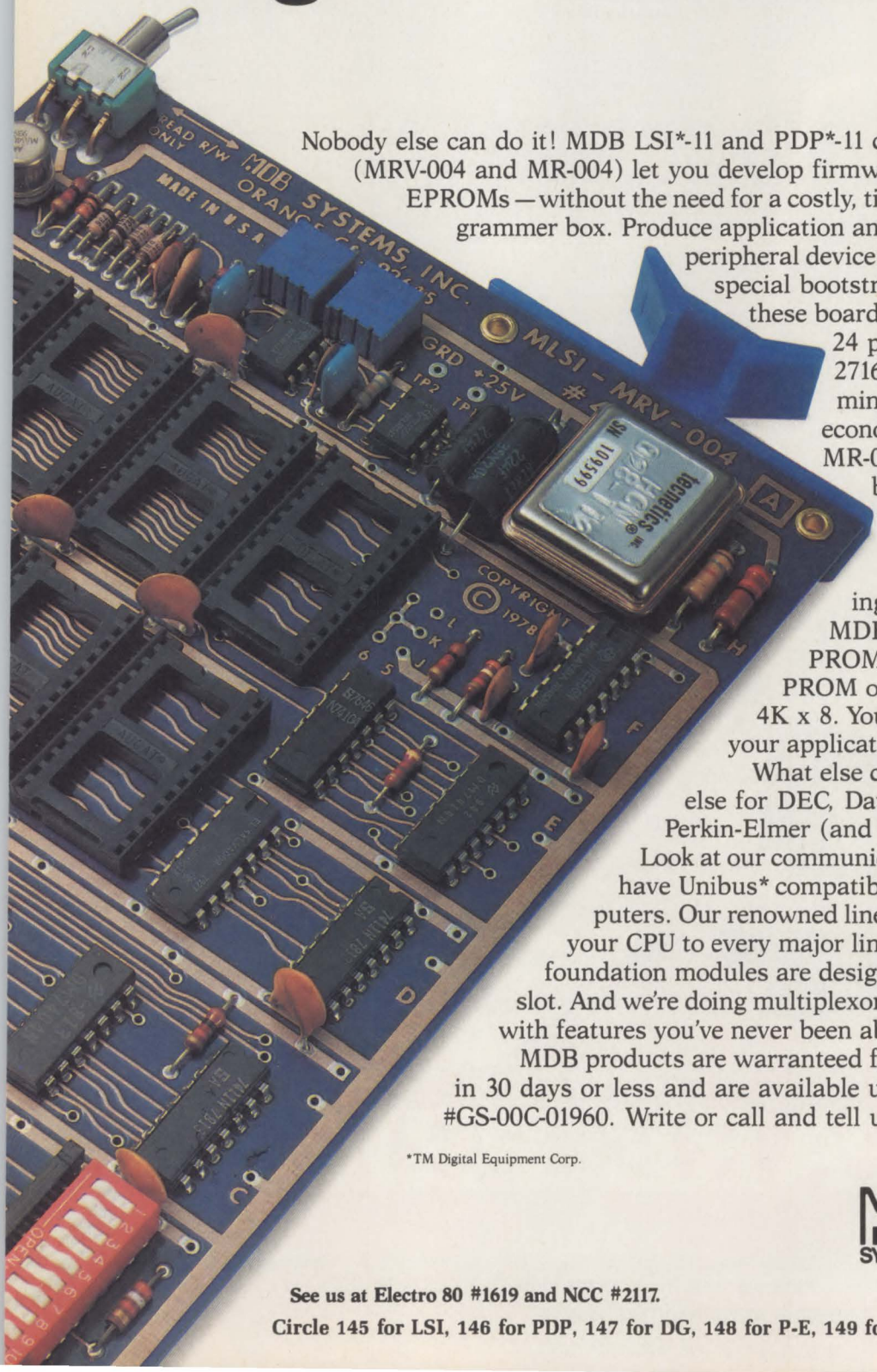

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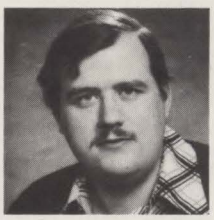
A high-level language can provide in a single statement a function or structure that could require tens or hundreds of assembly language instructions.

although manufacturers are gradually coming to realize that it is essential to their continued growth in a market in which software development costs for an application far outweigh the cost of the necessary hardware interfaces. Even so, until recently, few manufacturers went so far as to supply software diagnostics and calibration aids with their real-time products, and several still don't.

And a user who needs support for any real-time peripherals not manufactured by the supplier providing the support software library faces an additional obstacle: no manufacturer is interested in writing support code for its competitors' products. Unless the user buys all his real-time peripherals from one vendor or writes his own software, he will be hard put to get a single package to support all of his needs.

In the long run, however, real-time software libraries seem destined to win out. They are the culmination of the multilingual approach to reducing real-time software development costs. Combining efficient assembly language routines for sensor management and control with HLL software, they extend the capabilities of high-level languages into the realm of real-time data-acquisition and control software. And the ability to use the same support library in many projects can reduce by a factor of two redundant development efforts. The advantages of using real-time software libraries warrant serious consideration when new control projects are started. ■



Edwin J. Kroeker is director of software engineering at Data Translation, Inc., a Natick, Mass., manufacturer of analog I/O equipment.

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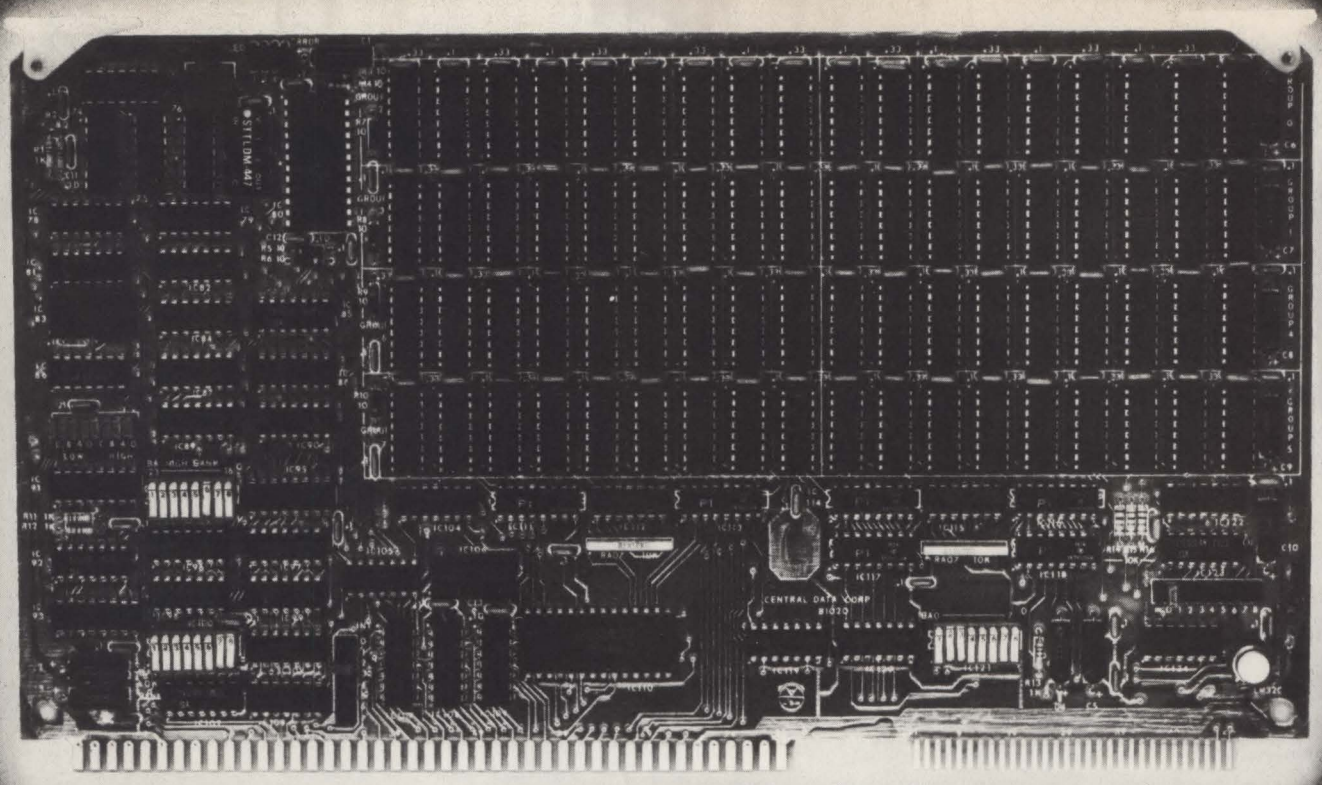

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CIRCLE NO. 100 ON INQUIRY CARD

Streaming revives ½-in. tape market

L.D. HEMMERICH, Cipher Data Products, Inc.

Forecasts call for 30 percent annual growth as more designers choose ½-in. streaming tape for their backup solution

Despite predictions of its demise a decade ago, evolutions in ½-in. tape storage are causing many to take a second look at this old standard. Recent market reports forecast that the use of tape as a data-storage medium will grow more than 30 percent a year. That's not as flashy as the forecast of 50 to 60 percent growth for the Winchester-disk-drive market, but it's still impressive for a medium often described as "dead."

What's behind the "resurrection?" Because of the rapid growth in the use of Winchester drives, system designers have had to search for a way to back up these nonremovable disks in a world of small computers where the trend is from batch-oriented to transaction or on-line systems.

The backup solution for a growing number of system designers is ½-in. streaming tape. This solution provides the user with data backup, input/output capabilities, inexpensive archival storage and room to grow. That last factor could be the most important. Although systems may not be initially configured with a 20M-byte drive, most designers agree that systems ultimately will reach that level, so the backup system also must allow for growth.

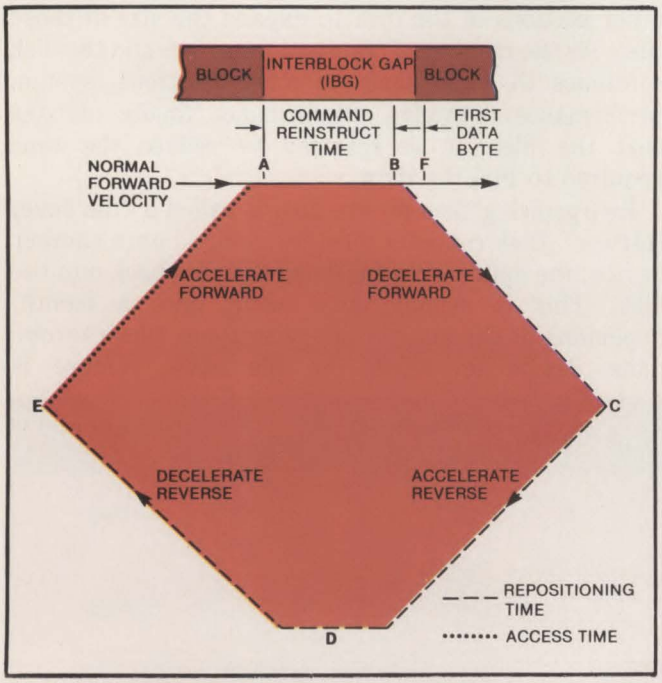


Fig. 1. IBM's 8809 *streaming-tape drive employs a technique called repositioning, in which the tape is repositioned any time the drive stops, automatically adjusting for the inter-record gap.*

TECHNOLOGY	PRICE/BIT RANGE (SYSTEM)
DYNAMIC NMOS RAM	0.1-0.5¢
BIPOLAR RAMs	10-15¢
BUBBLE MEMORIES	0.05-0.4¢
CCD MEMORIES	0.05-0.4¢
MAGNETIC DISKS (FIXED)	0.005-0.03¢
MAGNETIC DISKS (FLEXIBLE)	0.002-0.01¢
MAGNETIC TAPE	0.00005-0.0001¢

Fig. 2. How the costs *of leading memory technologies compare.*

What is backup?

Generally, "backup" refers to the ability to provide redundant storage in a system that uses a Winchester or another type of disk device in case of a head crash or other disk failure. The term also applies to archival storage applications in which it is more cost-effective to provide mass storage outside the computer system. But nothing should prevent the designer from making the backup unit perform other functions, such as input/output or variable-data file storage.

As the number of fixed-Winchester devices increases, system designers will be forced to handle variable-data files on batch-oriented systems. Users of medium-sized and larger systems are accustomed to having the convenience of 2315, 3330 or storage module technology, which provides variable data readily accessible as the removable portion of the disk. These devices, although removable, are not used in a backup role as previously described. Payroll, accounts receivable and other batch-oriented functions—including the pro-

Cost once mitigated against the use of ½-in. tape, but the advent of streaming-type devices makes it an attractive solution.

grams and all data files—are stored off-line and loaded back into the system when they are to be run. Without the convenience of variable data, system designers must increase disk size to handle those files.

The new streaming drives

An alternate solution to the problem of not having variable data readily accessible is the use of ½-in. tape, which until recently, was too expensive to use. But the advent of streaming devices, which offer higher transfer rates at much lower cost, make ½-in. tape an attractive solution.

(NONRECOVERABLE HARD ERRORS)	
• ½ " TAPE	
—800 BPI	10^9
—1600 BPI	10^{10}
—6250 BPI	10^{11}
• CARTRIDGE TAPE 1600	10^8
• CARTRIDGE TAPE 6400	10^8
• CASSETTE. PHILLIPS	10^7

Fig. 3. Average *reliability among competitive storage technologies.*

"Streaming" means that data is written onto the tape on the fly, interjecting the inter-record gaps after each data block without starting and stopping the tape drive between blocks of data. The concept is not new; all traditional ½-in. tape drives have streaming capability. The technique was enhanced by IBM when it introduced the 8809 streaming-tape drive. The significant difference between IBM's 8809 streaming tape and traditional ½-in. tape drives is that the 8809 eliminates possible starting and stopping of the tape in an inter-record gap, which is necessary for data integrity. But the capability involves long ramp times to bring the tape up to speed and to stop it. While the need for long ramp times precludes the use of 8809 in on-line applications, it significantly increases hardware reliability by eliminating the need for expensive, high-speed vacuum column drives and formatting electronics dictated by the rigid start/stop requirements to prevent overrunning inter-record gaps. To maintain ANSI-standard tapes, the 8809 employs a technique called repositioning, in which the tape is repositioned any time the drive stops, automatically adjusting for an inter-record gap (Fig. 1).

The streaming-tape solution to the system designer's backup problem must be matched, however, with improved software techniques to optimize performance of streaming-tape drives. Merely substituting a streaming-tape device for a traditional start/stop device will, in most cases, result in poorer performance because of the repositioning time required for each start and stop. Software designers have depended on the tape drive's ability to start and stop within a few milliseconds, but no consideration has been given to providing data in a streaming flow.

Traditionally, the tape-drive controller and disk controller are independent devices, but in streaming-tape drives, many attempts are being made to combine tape and disk controllers. A Winchester drive coupled with a ½-in. streaming-tape drive and a common controller can appear as an addressable subsystem.

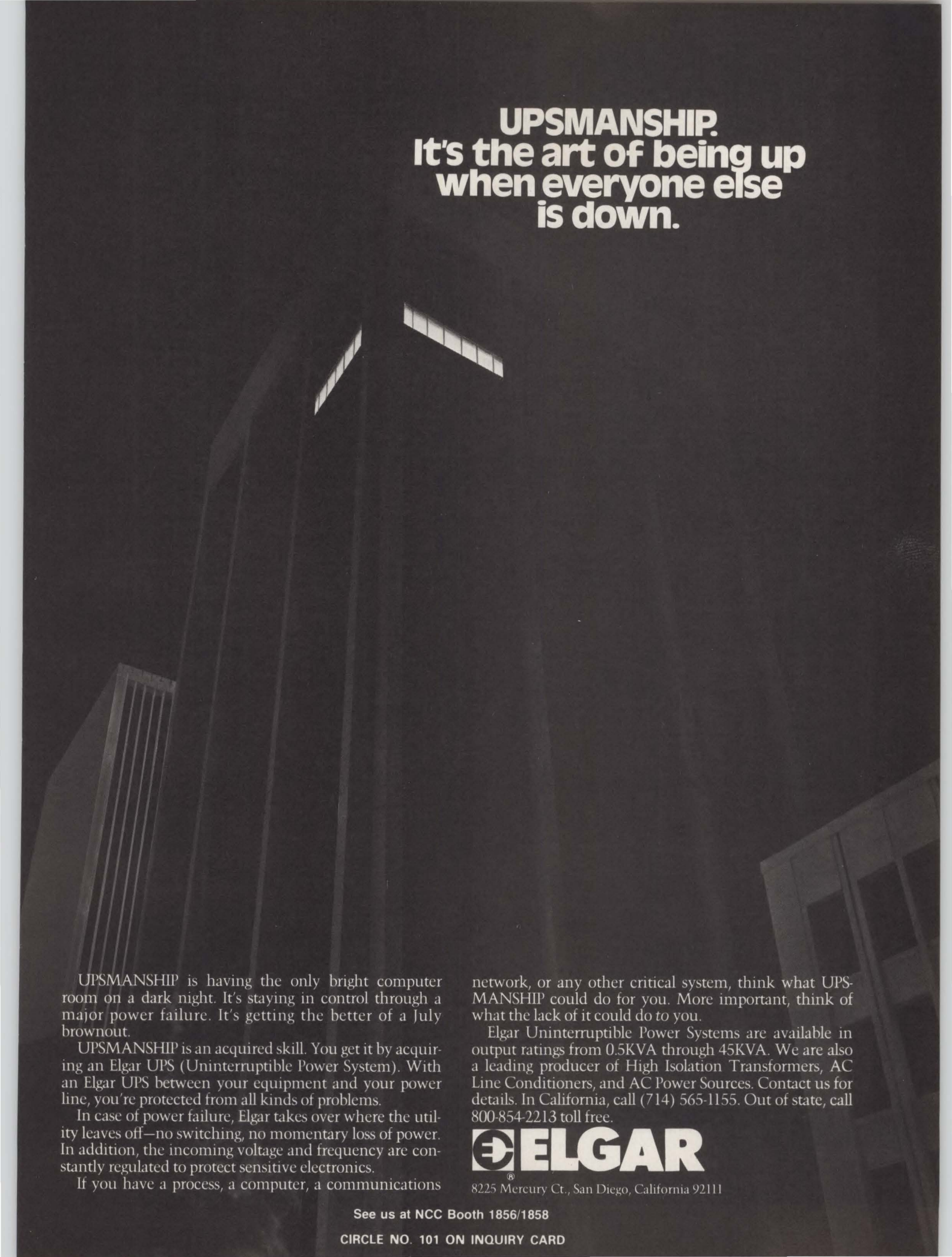
Another interesting possibility is the use of a more intelligent interface, such as the one offered by Storage Technology Corp. in its 2700 disk drive. A streaming tape with a similar interface then can be addressed as any other addressable peripheral, enabling disk-to-tape dumps without necessarily tying up the CPU. When there are two disks on 2700-type systems, disk dump from one peripheral to another can be done without affecting operation.

Transaction-oriented systems (data base or on-line systems) also present a problem for designers. These systems usually assign various segments of the disk to certain transactional tasks, and as that section of the disk is filled, system programs automatically assign other sections of the disk to expand the size of those files. As the number of transactions grows and the disk continues to daisy chain to other locations, system performance degrades. Performance finally dictates that the files be reorganized to reduce the time required to find the data.

Reorganizing files on the disk is called a "file save, restore." Disk contents must be dumped onto another device, the data reorganized and then fed back into the disk. This is usually done about once a month, depending on the number of transactions. The intermediate device in which the file save, restore is

	SPEED	10½-IN. REEL DATA CAPABILITY	DATA RELIABILITY	MTBF	FORMATTED COST
TENSION ARM	12.5-45 IPS	800 BPI 20M BYTES 1600 BPI 40M BYTES	10^9 10^{10}	3600-6000 HOURS	$3500
VACUUM COLUMN	45-125 IPS	800 BPI 20M BYTES 1600 BPI 40M BYTES 6250 BPI 156M BYTES	10^9 10^{10} 10^{11}	2000-5000 HOURS	$5000
STREAMING	25-100 IPS	NO 800 BPI AVAILABLE 1600 BPI 40M BYTES	10^{10}	7000 HOURS	$2000

Fig. 4. Summarizing *the price/performance characteristics of available tape categories.*



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CIRCLE NO. 101 ON INQUIRY CARD

A Winchester drive coupled with the ½-in. streaming tape drive and a common controller can appear as an addressable subsystem.

accomplished must reasonably match the capacity of the total disk and have transfer rates high enough so that the time required for the file save, restore is not excessive. The best answer is streaming tape.

Where tape fits in

Floppy disks now serve in backup and variable data roles for systems with capacities of less than 5M bytes. Cartridge tape serves as backup for systems with disk capacities in the 10M- to 20M-byte range, in which IBM compatibility is not an issue. Today, ½-in. (start/stop) tape is found on mid-sized and higher-capacity systems.

With the introduction of fixed Winchesters, cost per megabyte is decreasing, and traditional start/stop tape drives no longer are attractive in size or price, kindling increasing interest in the streaming ½-in. tape technology. Market indicators suggest that the backup issue can be divided into the following categories for the near future:

- Systems that require IBM interchangeability, for which the backup solution is the traditional ½-in. tape drive or the new streaming ½-in. drive. But if interchangeability with a host system is not a predominant factor, the backup can be another technology, such as cartridge or floppy disk.
- Systems with main storage greater than 20M bytes, for which the better solution for long-term cost-effectiveness will be ½-in. streaming tape.
- Systems with main storage of less than 20M bytes, for which other technologies, such as floppy disks or ¼-in. cartridges will prevail.

Factors to consider

The cost of a backup device will continue to be debated. Some designers insist that it should be approximately ⅓ the cost of a Winchester drive, while others are more realistic in saying that it should be ½ or possibly ¾ the cost of a Winchester. If the backup device is used only for redundancy backup or archival storage, the 50-percent estimate is desirable and obtainable. When comparing the costs of different technologies, however, designers must compare, as nearly as possible, all costs involved with each technology. The extra cost of power supplies, formatting electronics or hardware to mount the device must be anticipated and calculated in the total cost of the backup device.

Nor can the designer overlook the cost of media or operator time to use the device. The time required to offload the disk for backup is greatly debated, although most users will accept 15 minutes. A system with a 5M-byte disk and one with a 160M-byte disk require

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CIRCLE NO. 103 ON INQUIRY CARD

The time required to offload the disk for backup is greatly debated, but most users will accept 15 minutes.

very different hardware, transfer rates and rewind times to meet 15 minutes. The expected increase in the use of disk drives with capacities higher than 160M bytes will have increasing impact on the choice of a backup device, making ½-in. streaming tape units even more appealing.

Hardware vs. software solutions

Systems designers prefer hardware solutions to their backup requirements because software solutions, such as transactional backup techniques, require extensive changes to existing software. But without a cost-effective hardware solution, many system designers have opted for software solutions that enable them to use floppy-disk or cartridge drives even though those choices aren't considered to be the best system solution. With the ½-in. streaming tape drive, designers have hardware solutions for disk backup.

Why is tape still so popular?

Tape remains popular because its high data capacity, its low-cost medium and its very high reliability add up to an appealing cost per byte of storage. A ½-in. reel of tape stores as much as 46M bytes and costs only about $9, when data is recorded in the phase-encoded mode. Moreover, the system cost per bit for magnetic tape is considerably lower than that of any other technology (Fig. 2).

Fig. 3 indicates that the average reliability for tape recorded in the phase-encoded mode is one hard error in 10^{10}; with GCR recording, the number becomes a remarkable one in 10^{11}. This translates into just one unrecoverable error in more than 200 reels of tape for phase-encoded and 500 reels for GRC . Among competitive technologies, only Winchester disk drives can match this error rate—and that's on a nonremovable sealed medium.

The low cost of the recording medium in ½-in. tape systems must be weighed, however, against substantial hardware costs. Most high-speed vacuum-column drives, including formatting electronics, cost more than $5000; GCR systems are even more (Fig. 4). This cost can be reduced to about $2000 in new tape systems, which are designed for high-speed, disk-dump or variable-data applications, and do not have the rigid start/stop requirements of ½-in. tape drives. ■

L.D. Hemmerich is marketing vice president of Cipher Data Products, Inc., a San Diego manufacturer of ½-in. tape.

Disk-to-disk backup in a very compact disk drive.

The D100 family of compact disk drives is specially designed for OEMs and system builders. Model D140 includes a 10MB fixed platter in addition to the 10MB removable cartridge also used with the D120. In addition to disk-to-disk backup, the D100 family offers a surprising list of advantages.

High Capacity Storage: The D160, which uses a sealed module (non-removable) that includes thin-film integrated heads and carriage, offers up to 120MB of preformatted storage.

Small Size: Occupying approximately one-third the volume of conventional drives, Models D120 and D160 measure 5.6″ x 12.2″ x 21.8″. Model D140 is slightly taller at 6.7″.

Innovative Cartridge: Both D120 and D140 models use a flat, thin (11″ square by .9″) self-ventilated cartridge weighing only 2.8 pounds.

Common Interface: The transfer rate is 920 kilobytes/sec. for all units. The same controller handles D120, D140, D160, or any combination of the three models. One or more D160s in conjunction with a D120 provide a fixed data base with a high-throughput-10MB load-dump yielding twice the operating flexibility at half the size of conventional single-spindle drives.

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CIRCLE NO. 106 ON INQUIRY CARD

Color graphics information systems boost productivity

DAVID FRIEND, Friend Information Systems

Making sense of the data is more than half the battle, and these systems help executives make faster, better decisions

Color graphics systems are addictive. Once you are accustomed to them, nothing else will do, because they increase personal productivity. Transmission of information from the computer to the user increases so dramatically that the tedium of wading through written reports is replaced with a higher level of intellectual activity—depth of understanding, creative interaction with the data and conceptual problem solving. Intelligent use of these systems also partially alleviates the frustration of knowing that it is physically impossible to review enough data to avoid making any serious errors.

The result of increased personal productivity is increased organizational productivity. Hence, the emergence of computer graphics systems for business may prove to be as significant to business productivity as the development of the computer itself. It is certainly the most promising prospect for controlling the information explosion of the last decade.

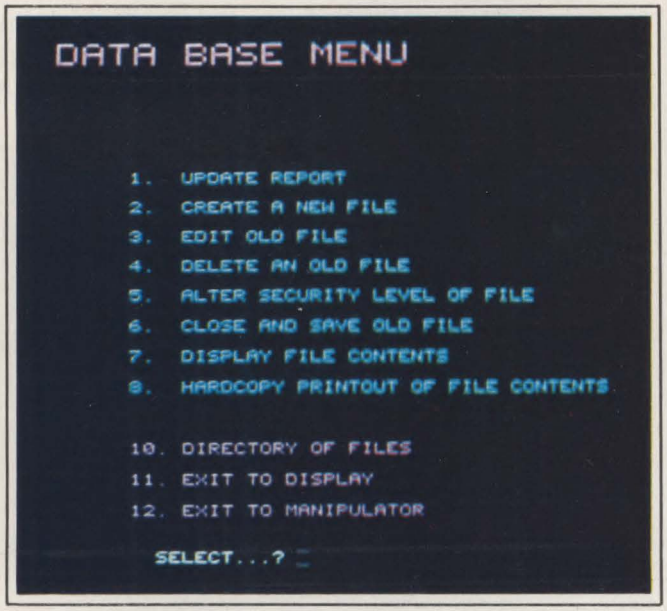


Fig. 1. Menu-drive systems *use menu displays, such as this one, to guide the user through selection and operation of functions.*

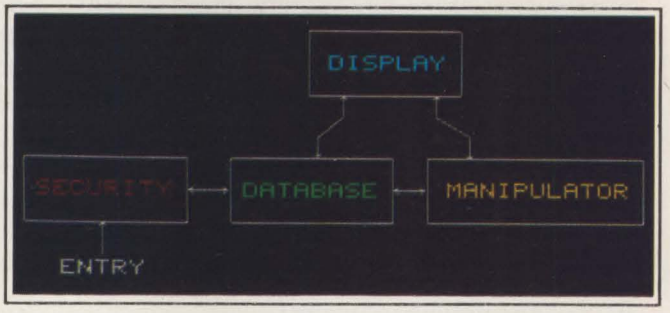


Fig. 2. The basic software *for a graphics information system includes programs for security, data base management, data manipulation and graphics display.*

Applying the 80/20 rule

The first step in designing a color graphics information system is to find out what information is really needed—a major problem in most organizations. Executives often spend much of their time reviewing large amounts of data to make relatively few decisions. About 80 percent of the decisions can be made with about 20 percent of the information, so one way for a manager to increase his efficiency is to cut back the amount of information he receives and focus on the important 20 percent of core information.

Unfortunately, management information systems grew up in an era in which computers were the province of specialists and technologists. As a result, most such

The emergence of computer graphics systems for business may prove to be as significant in improving personal and business productivity as was the development of the computer itself.

systems overwhelm executives, who have to plod through masses of reports in search of the crucial data.

Limiting the data base is probably the most difficult initial step in designing a system. No matter how much authority an executive has or how high he ranks, it is difficult to break through the notion that access to enormous detail is not in his best interests, as far as personal productivity is concerned.

In my company, we start by gathering all the executive's existing information sources, including all the reports he normally receives, computer printouts and memos from operating staff. We go through each report and circle the items that are usually of interest to the client. Then we list all the sources of verbal reports, including weekly briefings, meetings and telephone conferences. Again, we circle all the quantitative information of interest to the client. Similarly, we analyze any other sources of information the executive uses—newspapers, magazines and wire services. Finally, we review the entire list, trying to eliminate as much as possible. I usually ask an executive to pretend he has to operate with only half this information and to choose the half to be discarded. We usually throw out at least 25 percent of the reports. Many of these will creep back into the system later, but it is easier to add files than to delete existing ones; once a file is in the system, it is likely to remain there.

The need for quick response

Another factor in designing a hands-on system is the need for immediate answers. Many managers, especially top managers, consider their corporate information systems to be of little immediate use to them. They believe their staff researchers and analysts emphasize technical features and elegance of method over speed, conciseness and flexibility. Managers need to know at once—or at least within a few days—the impact of changing variables or assumptions.

The reaction time of an information system tends to be inversely proportional to the amount of data stored in it. Most individuals in an organization require about the same amount of information to do their jobs effectively, but each requires different information. For instance, the Midwest sales manager might be interested in the performance of his top accounts in Kansas, where the company president wants inventories, total sales, capital production, expenses and gross margins.

Traditionally, management information systems have tried to be all things to all people. A system that effectively serves a production supervisor can hardly be expected to provide the "big picture" to the president efficiently. The president doesn't have time to look at everything. He needs a small, dedicated system that he can operate himself.

Color graphics to the rescue

The whole point of color graphics information systems is that they can cut through details to show relationships and trends that would be overlooked in simple numerical data. Subtle movements that would be obscured in a numerical table often become obvious when plotted in an appropriate color graphics format. And there are many easy-to-use statistical tools, such as smoothing functions, regressions, curve-fitting and trend lines, that can help an executive isolate and view clearly the not-so-obvious trends he sees in displays.

Computer graphics, and color graphics in particular, can help spot trends earlier and increase an executive's information throughput. A color graphics information system lets him see at a glance when there is some change in a trend or when data departs from expectations; it helps him see the exceptions, rather than all the data. And early identification of a trend can mean the difference between success and failure in a competitive market.

Every business depends on the accuracy of its predictions. Forecasting leads to planning in which the company's resources are committed to take advantage of the predicted events. The clues are always there, but they may be hard to find.

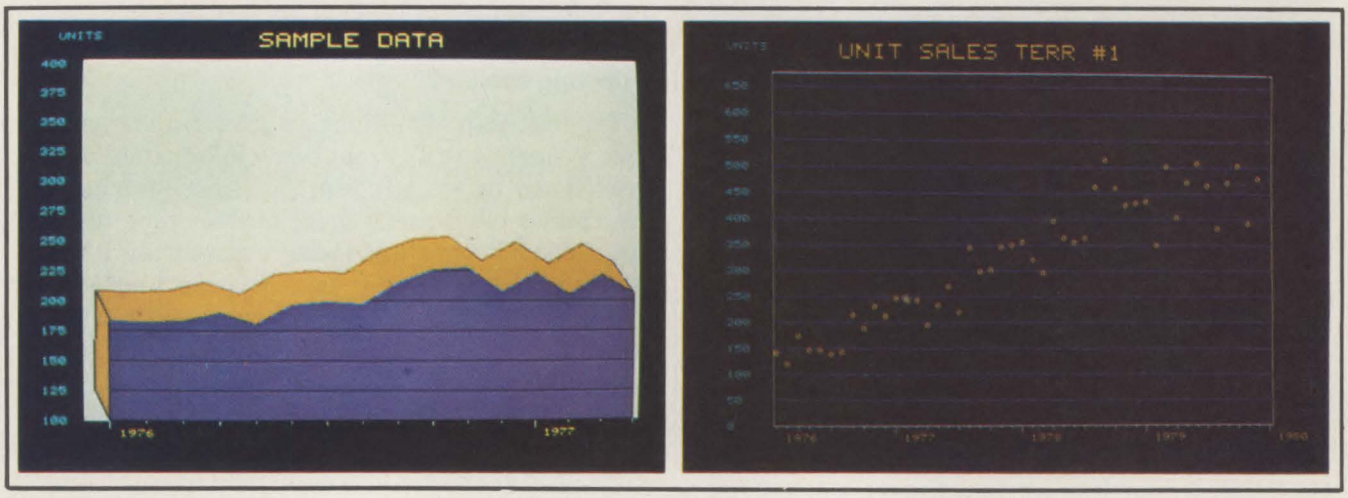
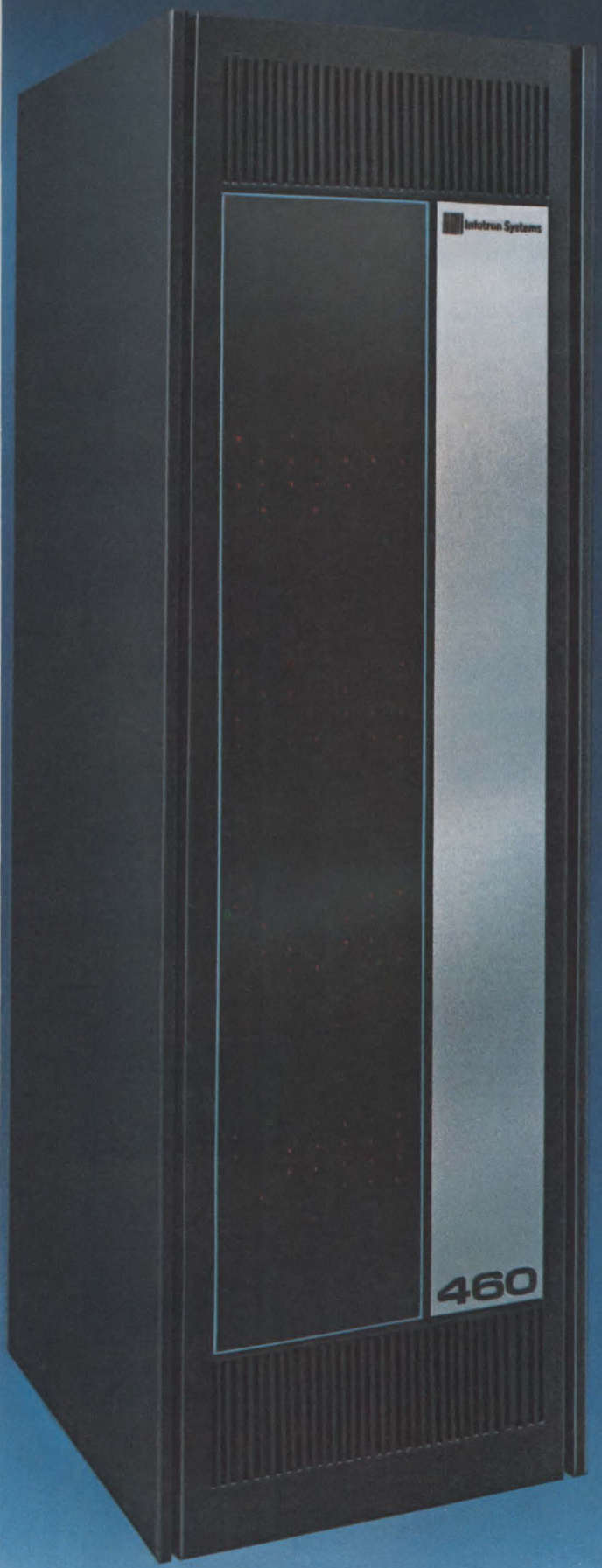


Fig. 3. Display types *range from very simple scatter graphs (right) to sophisticated 3-D displays (left).*



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The TL460 is not limited to certain data types or speeds either. Any combination of synchronous and asynchronous inputs from 110 to 19,200 bps is perfectly okay. To help guarantee good service, the TL460 provides a wealth of statistics such as successful and unsuccessful access attempts, line, port and user IDs, time in queue, etc.

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Unfortunately, management information systems grew up in an era in which computers were the province of specialists and technologists.

Requesting and finally receiving a report is a slow process—probably the slowest interactive information system ever devised. Yet is is now the primary source of information for top managers. But if a manager is to gain insight into the crucial data relating to his responsibilities, he must be able to interact directly with that data in a much faster and more responsive manner. He needs tools that enable him to analyze data in much the same way a chemist analyzes a specimen—following clues and adjusting procedures until an accurate picture emerges. Some people have trouble interpreting numbers, because they are abstract symbols with no physical relationship to the quantities they represent. Graphics formats, on the other hand, convey quantitative data as patterns in a physical space or dimension. Because the human mind is the best available pattern-recognition computer, a color graphics computer should provide the brain with pattern-rich images.

A high-performance information system has to be tailored to a user and job function. No "stock" or "canned" system can perform well for a wide range of individuals. There are too many cognitive styles among managers. An important step in designing a color graphics information system is to test and understand the prospective user's cognitive style and then to design the interactive programs and displays accordingly.

We usually offer a variety of graphics formats on our systems, knowing that customers will eventually ask for one or more of the formats to be expanded and modified. A user who likes bar graphs will get an extensive bar-graph-generating program; others may prefer line graphs or more exotic displays. Because most people have never had experience with flexible and sophisticated graphics communication systems, it takes time for them to develop their own styles of using such systems. It is important, therefore, that the ability to modify and extend the systems be built into

PROBLEM SOLVING WITH COLOR GRAPHICS

Mr. Smith, a marketing vice president in a medium-sized manufacturing company, receives new sales projections from his five regional sales managers. Smith is responsible for giving his top management a total sales projection, on which the company will base its inventory purchases and production plans. It is crucial to the company's growth that this projection be as accurate as possible—certainly better than the competition's.

Smith's color graphics information system already has files for the actual sales history of each product by sales territory, as well as for last year's projections. His assistant now creates files for the new sales projections.

Smith decides that he will look at the projections for each territory by product to see if they conform with past actuals. Starting with Territory 1, he plots the recent history of the first product's sales by selecting a scatter graph and calling for the file containing this information.

Next, he squeezes the horizontal scaling a little to make room for one year of projected sales, which are added as a line graph (Fig. 4).

At first glance, the projections appear to be in line with recent data. But Smith thinks he sees a flattening of the sales in the last year, even though they are still increasing. He decides to take a closer look.

Going to the manipulator, he asks for a smoothing of the actual sales and for a long-term trend line on the actual sales. When these are plotted, he sees that the projections fall nicely over the trend line, but that a distinct jump occurs between the smoothed actual sales and the projections (Fig. 5). Furthermore, the smoothed actual sales start to fall consistently below the trend line. This indicates that the projections may be too optimistic and that sales of this product line are slowing.

Smith returns to the manipulator and asks for a trend line on only the last 12 months' sales. He plots this, along with the smoothed projections and the long-term trend line. He's surprised to see that the last 12 months' trend is actually flat, or even down slightly. The sales projections now appear to be far out of line with the recent trend line.

The next question is whether the problem lies just with this territory or is symptomatic of a larger problem with

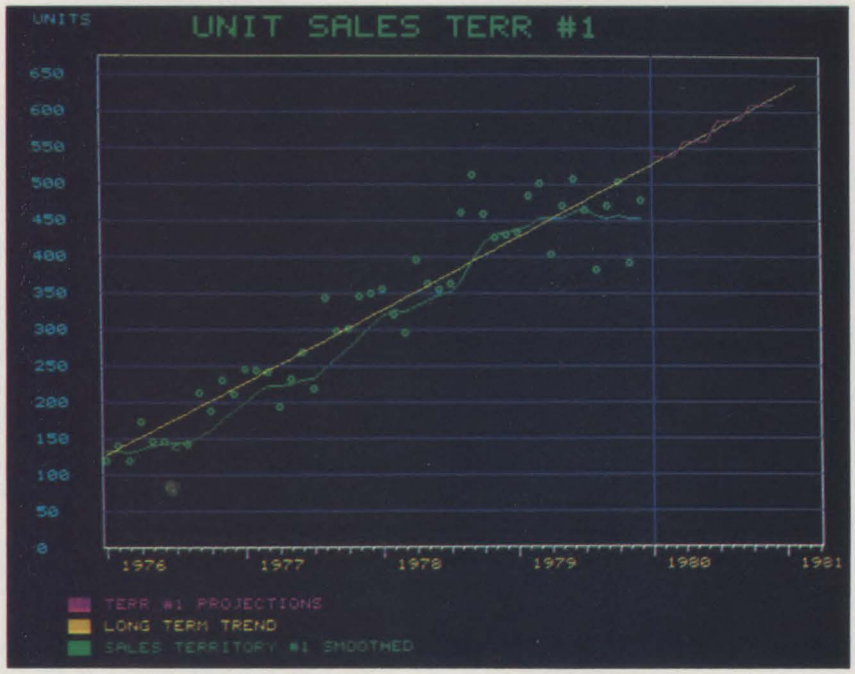

Fig. 5. A scatter plot *of actual sales, with smoothed actual sales and a long-term trend line overlaid in different colors.*

the software structure, because changes almost always occur.

Methods of interaction with the system can also vary. The systems we design are either menu-driven (Fig. 1) or language-driven. A language-driven system tends to be a little faster to operate and produces a tighter interface between the user and the display. However, language-driven systems are more intimidating to a nontechnical user because they employ unfamiliar symbols and words. Futhermore, to run the system efficiently, the user must memorize all the system commands. These are strong disadvantages for systems that are used infrequently by several different persons.

A menu-driven system is slower, because it is constantly bouncing from menu to menu, but is self-teaching. It is ideal for systems that are not used regularly, or where infrequent use by many people is the norm.

Sometimes an executive initially requests a menu-driven system because of its apparent simplicity. He later finds himself using the system much more frequently than he had envisioned. Once familiar with the operation of all the system's functions, the executive may decide to switch to a language-based system to enable more rapid operation. Such language-based systems should be designed in close consultation with an executive, who is usually trying to get a limited number of operations to respond very quickly.

A typical system

A typical color graphics management information system consists of a stand-alone microprocessor-based color graphics computer, such as those manufactured by ISC, Chromatics, Ramtek and others, plus floppy- or hard-disk storage, a color hard-copy printer and perhaps a large-screen projection TV for group presentations.

Larger systems incorporate minis for data base management and an intelligent color terminal for creating displays. Any of these systems can be interfaced with the client's main data-processing computer, although we discourage this practice. The difficulty of interfacing the color graphics information system to the company's existing computer is often greater than that of designing the color graphics system itself. The effort may also be totally out of

the product itself, so Smith looks at the sum of all the territories. Rather than simply add all the territories' sales together, he calls for a display that shows the relative contributions of each territory in a bar-graph format (Fig. 6). This display should tell him something about the performance of other territories, while giving him a picture of the entire product line.

A look at total sales shows two things immediately: first, the short- and long-term trend lines exhibit the same behavior as those of Territory 1, and second, Territory 2 sticks out because of its growth relative to the other territories. Because growth in the product line has been almost zero through the last 12 months, the significant growth of Territory 2 sales means that other territories must be doing worse than the product line. This is quickly confirmed by drawing the short-term trend lines for all five territories.

Further inquiry reveals that the growth in Territory 2 was the result of an unusual and nonrecurring purchase by one large customer. Smith decides to take Territory 2 out of the total and look at the trend, which he finds to be already slightly down. Even though this product line has shown consistent growth for the last four years, it now appears to be headed into trouble. With the manipulator, Smith differentiates the total sales to get a graph of the rate of sales growth. This graph reveals that a fairly consistent, downward trend in sales growth began approximately 18 months ago. Plotting a trend line of the rate of sales growth shows the product heading into serious decline.

Integrating the rate-of-growth trend line produces a new sales projection graph, which shows sales of the product line declining in the next 12 months, rather than increasing as in the sales managers' projections. Smith decides to cut the projections back to a level consistent with these forecasts and adopts a marketing strategy appropriate for a mature product.

All products have life cycles that eventually trend downward. The problem is to spot the turnaround with enough lead time to adopt the right marketing strategies for extending the product's life and to save the company from wasting resources by tying up capital in excessive inventories.

In this example, Smith was able to gain enough insight into the data to accurately assess the product's short-term sales trends and to save his sales managers a demoralizing error in judgment.

Fig. 6. A bar graph *showing relative sales over time in the five territories.*

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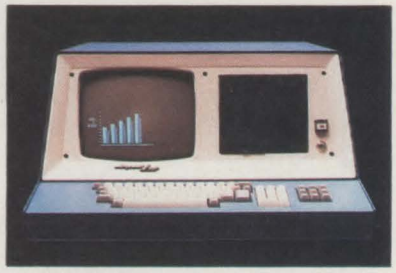

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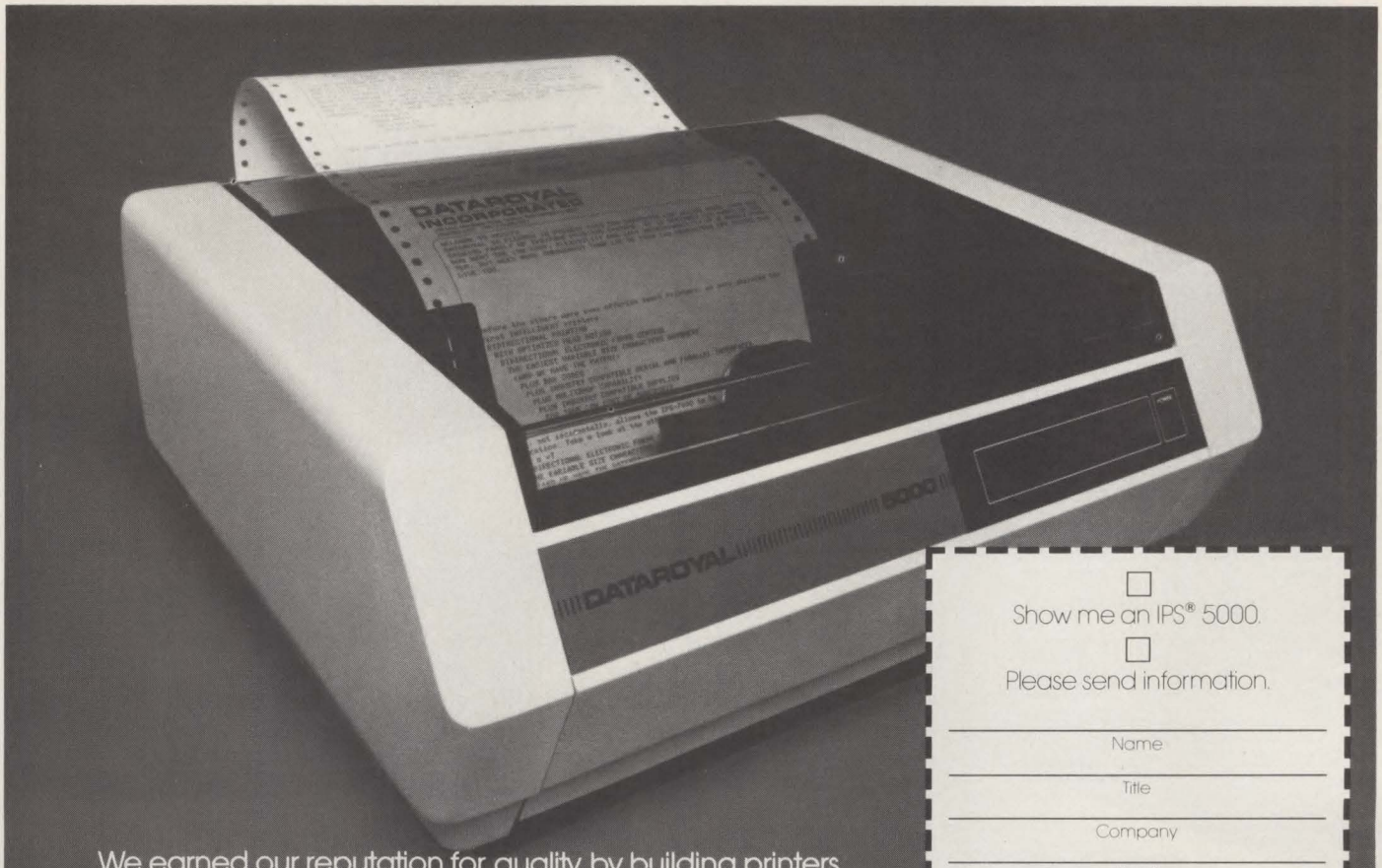

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The first step in designing a color graphics information system is to find out what information is really needed — a problem in most organizations. Limiting the data base is probably the most difficult initial step in designing a system.

proportion to the labor saved over some form of manual data entry performed by the executive's secretary or assistant, or perhaps by the executive himself, who may find the few hours a week spent in the task very informative. In addition, such tie-ins encourage nonessential data to creep into the local data base.

Color graphics information systems cost about $15,000 to $50,000, including hardware and software, with a typical one costing $35,000. A multistation mini-based system may cost more. Typically, the computer will cost from $8000 to $25,000, depending on resolution, memory size and disk storage. Prices for hard-copy printers are about $10,000 for a color line printer to about $25,000 for a color Xerox with a data interface. Software development runs from $5000 for a relatively simple "standard" system to $30,000 or more for systems requiring much custom design.

Software

The basic software of a typical color graphics information system comprises four programs, which handle security, data base management, manipulation and statistics, and displays (Fig. 2). Because much of the information stored in these systems is highly sensitive and because the displays can transmit in just a few moments so much information about a company's past performance and future plans, most systems should have a comprehensive security system. In a typical installation, there are three or four levels of security. When a data file is created, a security level is assigned that limits access to that file. Thus, it is possible to create files that require one security level for viewing or editing and a lower security level for appending new data. This permits companies to assign clerks to keep the data base current without giving them access to entire files or to the displays.

Another valuable security technique is to set up the data files so that they remember who accessed them most recently and on what date, providing a temporary trail of each person who uses the system.

In a microcomputer-based system, all the files are probably time-series files: two-dimensional arrays with data values along one axis and time along the other. This is the simplest form of data storage and handling for a computer of this size. And while other programs in the system can create cross-sectional displays from the data files, almost all users of these systems are interested in how certain variables are performing over time. The user gets rapid access and high flexibility in manipulation of time-series data at the expense of somewhat more cumbersome access and slower response for cross-sectional data, which is the best compromise for typical executive decision-making.

The biggest problem is to keep the data base limited to essential information. If the data base grows, the system's response time will deteriorate, and its advantage as an interactive tool will diminish. The technical problems associated with managing a larger data base are not the only reason for keeping it small. A user can easily remember how to find his way around in a small data base; he will remember where certain data trends were starting to emerge and will watch them closely. It's comparable to having a dozen report binders on a bookshelf versus wandering into a vast library to look for something. The very fact that only certain information is readily available results in greater use and understanding of that information.

A data base program must have facilities to create, edit and append files. Nearly all the data executives need to make effective decisions already exists in some report available in the organization. Once the reports and the line items of interest have been identified, and a corresponding file started, the system creates update reports telling the user what files require updating. When a file is created, it is specified as being daily, weekly, monthly, quarterly or yearly. From that time on, the file will appear on the update report each time new data is due and will remain on the report until the file has been updated. This update report is the user's assurance that the data files are current and speeds the clerical job of keeping files up to date.

The manipulator is a collection of statistical programs. The common features of a manipulator include software for smoothing data, forecasting, setting confidence limits, lagging and leading data, calculating averages, means and other statistical data and performing trend analysis. Again, programs should be chosen or designed to meet the user's requirements.

The manipulator is entered from the data base program or from the display program. A menu enables the user to select the type of statistical operation desired; the system then prompts the user to enter the names of the data files. Results can be stored temporarily in work files or permanently as data files.

The display program, which enables computer to "talk" to the user graphically, is the heart of the system. Displays include a wide selection of bar graphs, line graphs, scatter graphs and specialized displays, such as 3-D perspective bar graphs and line graphs, 3-D pie charts and combinations (Fig. 3).

In an interactive system for executives, speed is of the utmost importance, so the computer performs data scaling and color selection automatically. However, a manual override menu can "hide" behind each graph, enabling the user to change scaling, colors and format and add remarks. These changes can be made a permanent part of the data file, so that each time it is graphed, the same new format will appear.

Graphs can easily be overlaid for comparison, with the scaling and color selection of the overlays forced to

A valuable security technique is to set up data files so they provide a temporary trail of each person who accesses the system.

conform to those of the first file put on the screen. It is possible, for instance, to graph raw data as scatter displays overlaid with different-colored line graphs representing other data.

And any display can be saved on disk as a "slide." If an executive sees something he wants to recreate later, he saves it as a slide by giving the display a name. A slide-show program (part of the display software) enables him to order previously stored slides and display them in rapid-fire sequence, as though he were using a slide projector. If an office has several color computer systems, but only one hard-copy printer, slides can be brought to the printer on a floppy disk and reproduced.

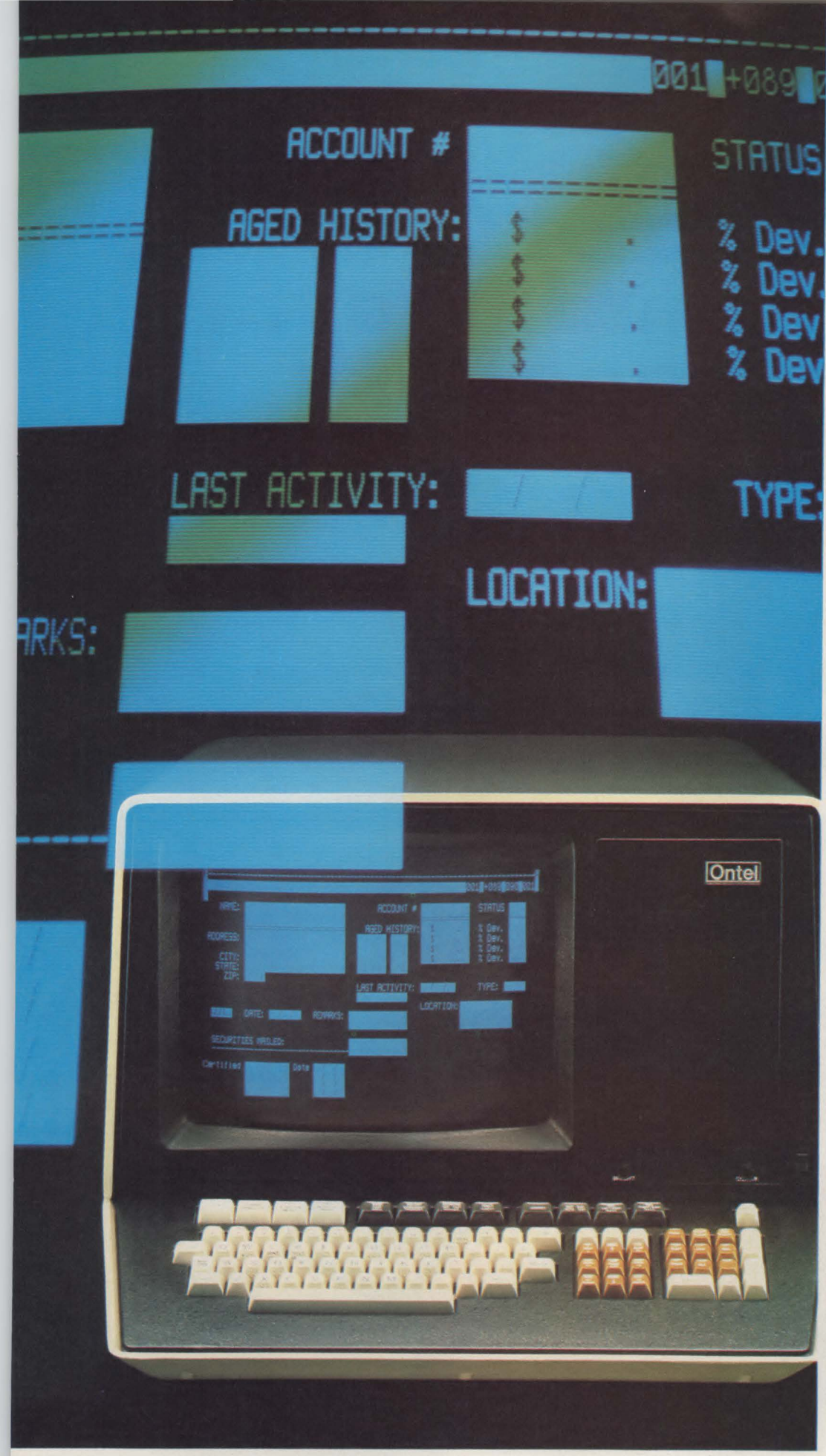
The future

Data processing will continue to be a highly technical and specialized field, but executives will not try to get an information systems manager to assume the perspective of a general manager. The executive will turn instead to personal use of small dedicated information and decision support systems. Eventually, most of these systems will incorporate color graphics displays.

Speed of interaction will improve dramatically as small computers take advantage of new bus architectures that enable faster access to larger amounts of on-line memory, thereby reducing the number of relatively slow disk transactions. The new small Winchester disks and bubble memories will help to enlarge the data base while reducing response time. And the color graphics systems themselves will evolve new ways to get images on the screen in a flash. When a system is in constant use, it is annoying to wait even one or two seconds for a display to be refreshed. A busy executive may replot data 20 or 30 times before he gets the format he wants. For graphics information systems, data precision is not usually a problem. Memory access time and size of directly addressable memory, however, are major considerations. ■

All display photos are courtesy of Chromatics, Inc., and Dunn Instruments, Inc.

David Friend is president of Friend Information Systems, a Boston-based company that specializes in custom design of graphics information systems.



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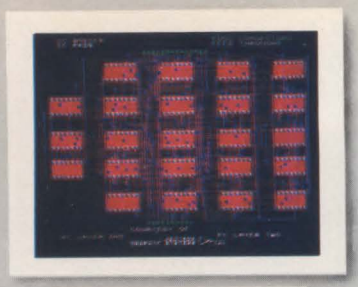

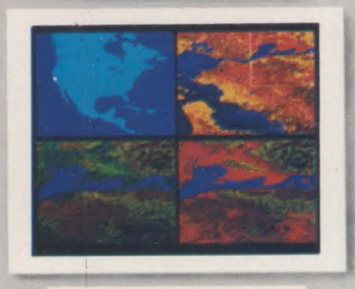

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Power protection for micro-based systems

DAVID KEMP, Sola Electric Co.

Micro/mini regulators provide an inexpensive way to protect small microprocessor systems against noise and voltage fluctuations

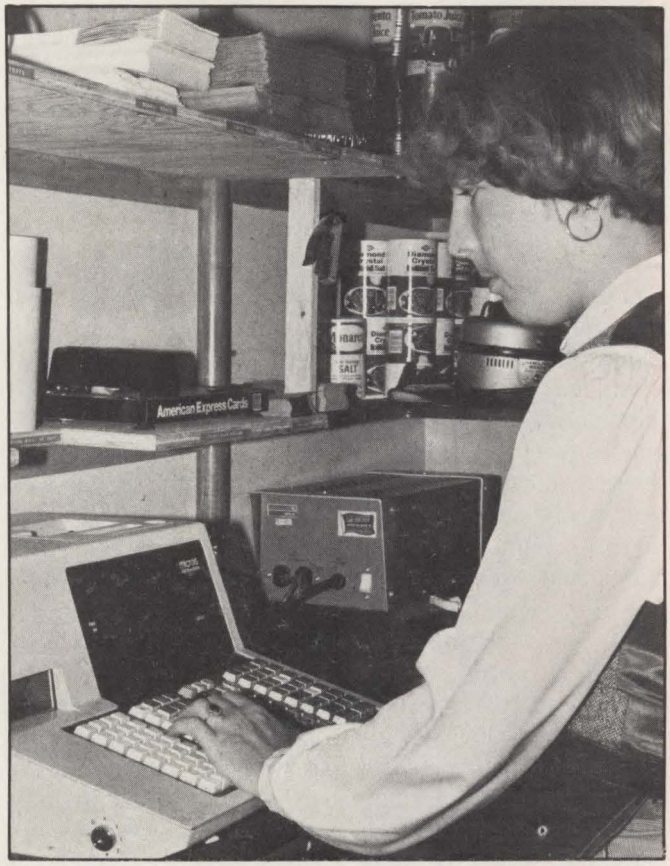
Microprocessor-controlled systems, despite their many benefits, are often victims of their own complexity. Their miniaturized digital circuitry simply will not function properly when subjected to electrical noise and line voltage fluctuations. Although these common AC power problems have long existed, they present little difficulty for earlier, less-sophisticated electrical equipment. But for microprocessor-based equipment, such as electronic cash registers, POS terminals, word processors and security and energy-management systems, these noise and voltage transients cause memory loss, system malfunction and even component failure.

Electrical utilities are often blamed for power problems, but most difficulties affecting microprocessor performance are generated downline from the major substations. There's little the utility can do about this. Expensive equipment has been developed to protect large, computer-based systems, but such equipment is not practical for a small-system owner. Also, depending upon the type of power problem at fault, these alternatives may be unsuccessful. Only recently has low-cost equipment been designed specifically to protect small microprocessor systems against both noise and voltage fluctuations.

Protecting the power line

With microprocessor chip sales expected to top $30 billion annually within the next 10 years, there's little doubt that small digital systems will move into every type of business. As power plants are built and existing energy resources are stretched thinner, the quality of electrical power will deteriorate further. Small systems users are, then, going to need power protection to keep their advanced electronics operating properly. Micro/minicomputer regulators offer a simple, practical way to bring big-system protection down to a small-system application.

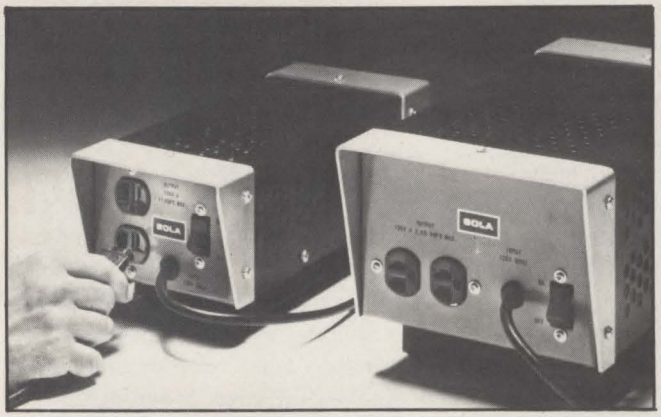
Other available solutions to problems include dedicated lines and ultra-isolation transformers. A dedicated line, which is a separate circuit installed to service only the microprocessor, is intended to bypass most voltage fluctuations generated by nearby electrical equipment. But the line cannot provide clean power because noise and voltage spikes or dips farther up the line will still be passed through to the machine. The dedicated line will not clip transients, attenuate noise or compensate for lack of voltage at its source. Further, a dedicated line can cost as much as, or more than, the system it services, making it unappealing to small-system users.



The MICROS *electronic cash register is protected against noise and voltage fluctuations by regulator, in background.*

The micro/minicomputer regulator is just as economical as the ultra-isolation transformer, but is designed specifically for microprocessor-based equipment.

A second solution is an ultra-isolation transformer. Although less expensive than a dedicated line, this device also has certain limitations. Its basic function is to prevent line-to-ground leakage, including common-mode noise. It cannot, however, suppress the more serious transverse-mode noise and cannot regulate voltage. Any equipment being fed by an ultra-isolation transformer will still be subject to over-voltages, brownouts and transient faults.



The **Sola** *micro/minicomputer regulator is available in portable or hard-wired models with power ratings as high as 60 amps.*

The micro/minicomputer regulator is just as economical as the ultra-isolation transformer, but is designed specifically for microprocessor-based equipment. Unlike passive dedicated lines, it responds to line problems and corrects them.

Noise problems

The most disruptive power problem for small systems probably is electrical noise. The familiar sinusoidal waveshape of an alternating current is characterized by its amplitude (voltage level) and frequency (normally 60 Hz). Noise, however, defined as high voltage, high frequency interference, can alter this waveshape and cause microprocessor malfunctions. Electrical noise is generated by any equipment containing an electric motor, including elevators, hair dryers, lights, thermostat-controlled heaters, neon signs and electric coffeepots. In addition, microwave ovens broadcast a form of electrical noise. Microprocessors, then, exist in electrical environments that are, by definition, noisy.

Noise is generated along the conductive path of the power line either by radio frequency interference (RFI) or by electro-magnetic interference (EMI). RFI is generated by radar, microwave and TV transmissions; spark gaps; off-line arcing; and lightning. These produce noise on AC lines through capacive coupling or inductance. Electronic equipment housing can be shielded from this noise by special coatings that will not pass these wavelengths into the system. Many power cables and data transmission lines, however, are not shielded and can act like receiving antennas to provide a path for this noise into equipment circuitry.

EMI is produced by the normal operation of on-line switches, relays, switching SCRs and triacs, found in air conditioners, electric typewriters, fans and sump pumps. It is virtually impossible for a microprocessor-based system that shares a circuit with other electrical equipment to escape such noise.

Noise on AC lines is measured as a potential between hot line and neutral (transverse-mode) or hot line and ground (common-mode). Both types of noise must be attenuated for an electronic system to function properly.

Voltage fluctuation problems

A related power problem is voltage fluctuation. Voltage fluctuations can be either short-term transients—both spikes and dips—or longer-term brownouts and overvoltages. Transient surges and dips are caused by changes in load along the power line and occur frequently when electrical equipment is switched on or off. Brownouts—voluntary voltage reductions by utilities—and overvoltages are less common, but also potentially damaging to electronic circuitry.

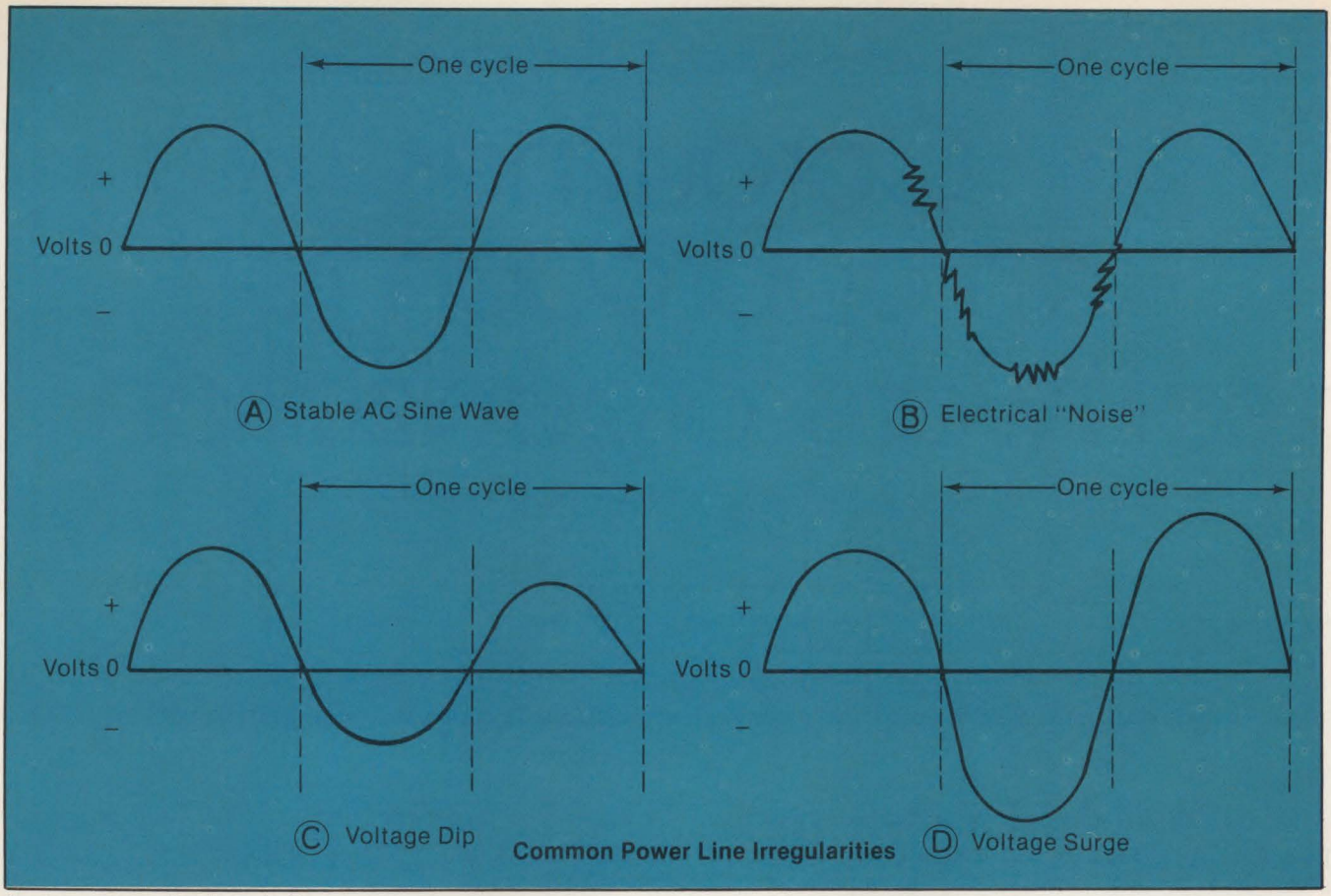
Unwanted voltages and frequencies can be erroneously interpreted by a microprocessor component as valid electrical pulses. This may cause the component to switch on or off when it shouldn't, and the performance of timing circuits will be affected. In addition, programs execute improperly because it is difficult to distinguish between noise-related errors and faulty programming. Many hours can be spent chasing down program glitches when noise is the real culprit.

Noise not only affects component operation, but also alters data stored in a system's memory, which employs "latches" to store data in the form of electrical pulses. A latch remembers the last signal at its input until a new signal is fed to it. Thus, if a data bit is changed from a "0" to a "1" because of a noisy input, it will not revert to its former state once the interference has passed. If noise is not attenuated in some way, it can sweep through a system memory, changing latched signals at random. The lost data can never be retrieved, and if no record has been kept of memory contents, valuable information is destroyed.

Voltage transients present similar problems in computer operation, but may be much more damaging. Short-term transients have the same effect as noise, except in extreme cases when transient spikes are chronic or of longer duration, and semiconductors may burn out completely.

Clean power

Noise and brief voltage fluctuations on a power line affect the performance of an analog circuit only temporarily. Current output will return to normal. In motor speed control, high-frequency noise and tran-



Common power *line irregularities.*

sients may pass through the system so quickly that the effect on motor speed may be too small to notice.

However, the greatest benefit of a digital circuit—high-speed operation—becomes a liability when noise and voltage transients are present. Noise lasting only a few microseconds may not be noticed in an analog circuit, but for a digital system switching in the nanosecond range, bursts become an acute problem.

Brownouts, which are relatively lengthy voltage drops, are more of an inconvenience than a real problem. Most systems can tolerate long-term voltage variations over a certain range (+5 −10, for example). To protect against drops in voltage levels below this range, most microprocessor systems use a power-down procedure, enabling a machine to protect its memory by activating a battery backup. When power returns to operating level, the microprocessor resumes operation at the point of interruption.

Difficulties arise, however, when voltage fluctuations pass back and forth through the low-voltage limit programmed into the machine. The processor may then sporadically activate and deactivate its brownout contingency program. In the process, the machine powers up and down rapidly, losing memory contents and possibly damaging peripherals, such as floppy disk systems.

Noise attenuation and voltage regulation

The micro/minicomputer regulator protects digital circuits against fluctuations and noise. It's built around a constant voltage sinusoidal (CVS) transformer, which is modified to achieve superior attenuation of transverse-mode noise to 60 dB and common-mode noise to 120 dB. It also compensates for line voltage changes and brownouts, adjusting output automatically to hold voltage within ±3 percent of nominal, through input voltage fluctuations as great as ±15 percent. In severe brownout conditions, with line voltage as low as 60 percent of nominal, the regulator's output voltage will remain within NEMA specifications of ±5 percent −10 percent of nominal.

The regulator provides added protection through current-limiting circuitry. If a short-circuit occurs, output current is held within 200 percent of rated value, permitting the unit to operate indefinitely, with no damage. The voltage regulator requires no modifications to existing equipment. It operates from any standard 120 VAC grounded outlet and provides two three-prong grounded receptacles for plug-in connection of small systems. ■

David Kemp is marketing manager at Sola Electric Co.

Coroutines: an approach to software organization

THOMAS L. HUMPHREY, American Microsystems, Inc.

. . . in which two or more separate programs alternately act as the main program in a common, shared computer environment

The coroutine approach to software organization provides an alternative to conventional hierarchical structures. It is a powerful tool in applications that require two interactive programs to alternately behave as main control programs. Examples include test drivers and other program development and testing aids, as well as certain categories of language processors. Although implementations of coroutine structures vary as a function of application and processor architecture, they are straightforward and require only minimal resources and operational overhead.

Most computer and microprocessor software program structures are hierarchical (Fig. 1). A single main program controls overall operation and invokes subordinate programs or subroutines. These, in turn, invoke lower-level subroutines, and so forth. Programs that use reentrant and recursive routines readily map into such a hierarchy.

The coroutine structure, in contrast, organizes software so that two or more separate programs alternately act as the main program in a common, shared computer environment. Each coroutine views the other(s) as subordinate. Each maintains its own register context, subroutine stack, and data environment.

The flow of control between two coroutines is shown in Fig. 2. Initially, coroutine A controls and acts as the main program. At some point, control transfers to coroutine B, which then assumes the role of main program. From coroutine A's perspective, control is transferred to a subordinate program—coroutine

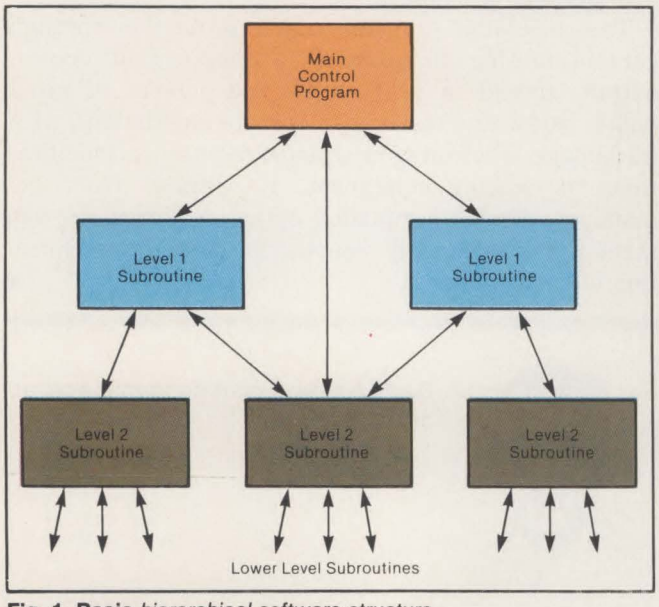


Fig. 1. Basic *hierarchical software structure.*

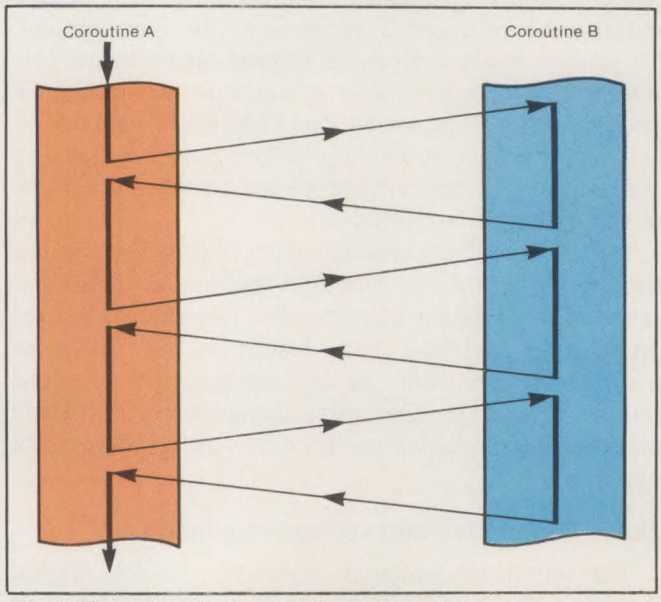


Fig. 2. Flow *of control in coroutine organization.*

B's—e.g., by a subroutine call. From coroutine B's perspective, however, control is being returned from a subroutine program—coroutine A. The situation is reversed when coroutine B transfers control back to coroutine A. Coroutine B treats the transfer as a call to a subordinate program, while coroutine A views it as a return to control from a subordinate program. Control continues to alternate between the two coroutines in this manner.

Hierarchical and coroutine software structures are not mutually exclusive. A coroutine can be hierarchically organized, and coroutines can share common subroutines and data areas. Common subroutines are a convenient way to coordinate access to shared resources, such as input/output. Shared data areas are useful for passing parameters and data between coroutines. Common subroutines and shared resources, however, must be serially reusable, and use by one coroutine must be complete before control is transferred to the other coroutine.

Coroutines may also be imbedded within a hierarchical structure. For example, a main program may

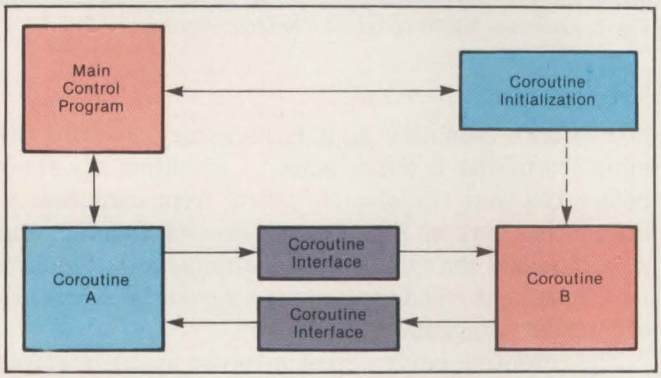


Fig. 3. Coroutines *in a hierarchical structure.*

initialize data and operational environments before invoking coroutine action (Fig. 3). Control would subsequently be returned to this main program for final processing. The main control program may call on conventional, hierarchically organized subroutines to accomplish these functions. Fig. 3 also shows coroutine interface programs, which can effect transfers of control between coroutines and perform any associated context switching.

A test driver application

An important use of coroutines occurs in the logical testing of microprocessor application programs. Many microprocessor applications are implemented as stand-alone programs designed to operate in a specific hardware configuration. But before final system testing in the target hardware environment, program operation should be tested as thoroughly as possible in a generalized, simulated environment, such as a microprocessor development system.

This is readily accomplished by coupling the application program to a separate test-driver program and operating the two as coroutines. As a coroutine, the application program behaves just like a stand-alone

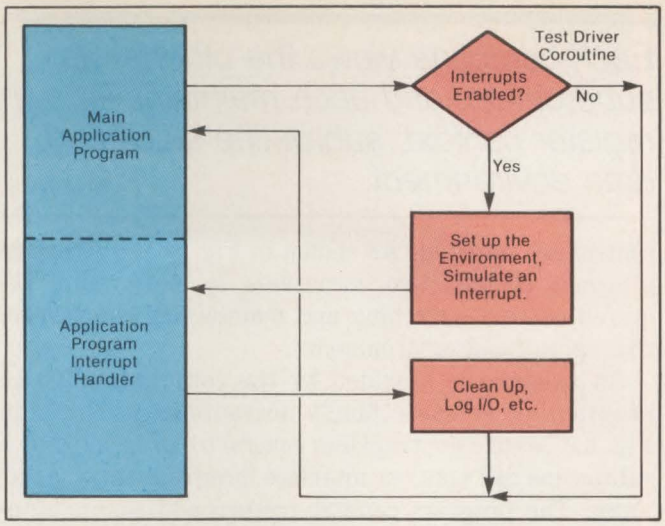


Fig. 4. Test drive *coroutine for interrupt-driven I/O.*

program, except that control is transferred to the test driver coroutine from all points in the program where inputs or outputs occur. The test-driver coroutine then accepts and validates outputs from, and simulates inputs to, the application program. The test driver may also be responsible for logging these I/O transactions for subsequent inspection and validation. A generalized test-driver program, designed to operate as a coroutine, can be used to support logical testing of many different stand-alone application programs.

Fixed test driver I/O sequences can be used to simulate specific conditions and exercise specific application program logic. Alternately, input data supplied by the test driver can be random or can be conditional on preceding application program outputs.

Microprocessor I/O is typically memory mapped—I/O device data and status registers are accessed as memory locations. This greatly simplifies test driver implementation. I/O device registers are simulated by locations in a shared memory segment. The application program accesses these locations precisely as if they were I/O device registers, while the test-driver coroutine conditions and interrogates these locations to simulate I/O device operation.

Interrupt-driven I/O can also be simulated by coupling the application program and test driver coroutines as shown in Fig. 4 and distributing transfers of control to the test driver coroutine at random throughout the application program. If a transfer to the test driver coroutine occurs when application program interrupts are masked, control is returned with no action. Otherwise, the test driver sets up an appropriate I/O environment and simulates an interrupt to the application program. Upon completion of interrupt handling, the test driver processes any outputs generated, resets the simulated environment and returns control to the application program at the initial point of simulated interrupt.

Implementing coroutine structures

A coroutine structure is readily implemented using a simple interface program through which transfers of

Each coroutine views the other(s) as subordinate, and each maintains its own register context, subroutine stack and data environment.

control are effected. As shown in Fig. 3, the interface program couples two coroutines by performing required context switching and maintaining the respective operational environments.

An example is provided by the coroutine interface program for an S6800 family microprocessor shown in Fig. 5. Coroutine A transfers control to coroutine B by a subroutine call (JSR) to interface program entry point XA2B. The program counter (return address) is automatically pushed onto coroutine A's stack. The interface program then explicitly saves the remainder of coroutine A's environment, restores coroutine 's environment and completes the transfer of control by a subroutine return (RTS) to the address previously stored in coroutine B's stack. The subsequent transfer of control back to coroutine A is accomplished in a similar fashion by a subroutine call from coroutine B to interface program entry point XB2A.

The interface program approach requires proper initialization of coroutine environments for the S6800 interface program example in Fig. 5. If coroutine action

```
XA2B    STX   XATMP      ; Save coroutine A registers.
        PSH A
        PSH B
        TPA               ; Save coroutine A condition codes.
        PSH A
        STS   XATMP+2     ; Save coroutine A stack pointer.
        LDS   XBTMP+2     ; Restore coroutine B stack pointer.
        PUL A             ; Restore coroutine B condition codes.
        TAP
        PUL B             ; Restore coroutine B registers.
        PUL A
        LDX   XBTMP
        RTS               ; Transfer control to coroutine B.
;
XB2A    STX   XBTMP       ; Inverse of program XA2B, above.
        PSH A
        PSH B
        .
        .
        .
        LDX   XATMP
        RTS               ; Transfer control to coroutine A.
;
INIT    LDX   #0          ; Intialize coroutine B index reg.
        STX   XBTMP
        LDX   #CBSTK-5    ; Initialize coroutine B stack ptr.
        STX   XBTMP+2
        CLR   1,X         ; Initialize condition codes, regs.
        CLR   2,X
        CLR   3,X
        LDX   #CBNTR      ; Initialize coroutine B entry pt.
        STX   CBSTK-1
        RTS               ; End coroutine B initialization.
;
XATMP   RMB   4
XBTMP   RMB   4

        Note: In initialization subroutine INIT, location CBSTK is
              the address of the first (topmost) byte in coroutine
              B's stack.
```

Fig. 5. S6800 *coroutine interface program.*

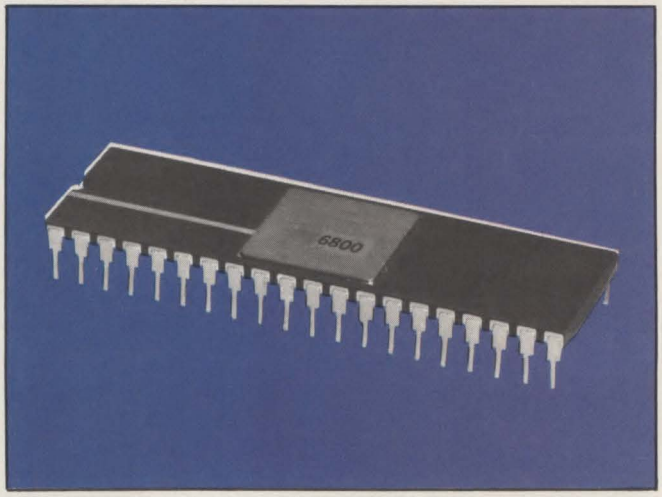
```
XFR1    COM   XTOGL       ; Complement binary toggle.
        BEQ   SFR2        ; If result = 0, coroutine B is
                          ; software interrupt source
        STS   XSTKA       ; Otherwise, switch context
        LDS   XSTKB       ; from coroutine A to B.
        RTI               ; Transfer to coroutine B.
XFR2    STS   XSTKB       ; Switch stack context from
        LDS   XSTKA       ; coroutine B to A.
        RTI               ; Transfer to coroutine A.
;
XINIT   LDX   #CBSTK-7    ; Initialize coroutine B stack
        STX   XSTKB       ; pointer value.
        CLR   1,X         ; Initialize coroutine B stack
        CLR   2,X         ; contents.
        CLR   3,X
        CLR   4,X
        CLR   5,X
        LDX   #CBNTR      ; Set initial coroutine B
        STX   CBSTK-1     ; entry point.
        CLR   XTOGL       ; Set toggle to coroutine A.
        RTS               ; End coroutine B initialization.
;
XSTKA   RMB   2
XSTKB   RMB   2
XTOGL   RMB   1
;
        ORG   $FFFA
        FDB   XFR1        ; Software interrupt trap vector.
```

Fig. 6. Alternate S6800 *coroutine interface program.*

begins with coroutine A, it is necessary to store the initial coroutine B entry point in coroutine B's stack before the first transfer of control from coroutine A. Subroutine INIT in Fig. 5 performs this function and also initializes the coroutine B environment. Subroutine INIT must be invoked by coroutine A before the first use of interface program XA2B.

The coroutine environment involved in the interface program context swap can vary with the application and with processor architecture. For example:

- Parameters and parameter-list address pointers can be passed between coroutines in registers. Contents of registers used for this purpose must be left unchanged by the interface program context swap.
- In 6800 architectures, storage locations 0 - 255



Certain locations *in the architecture of 6800 microprocessors, like this one, may be allocated between coroutines or used as shared memory.*

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Hierarchical and coroutine software structures are not mutually exclusive. Common subroutines and resources must be serially reusable; use by one coroutine must be complete before control is transferred to the other.

constitute the D-bank, and can be accessed by a special addressing mode. D-bank locations may be allocated between coroutines or used as shared memory. However, to permit unrestricted use by both coroutines, the complete D-bank context must be swapped.

- In processors with software interrupt features that are used differently by the two coroutines, the interface program must save and restore affected trap vectors.

The makeup of the coroutine environment involved in the interface program context swap also affects initialization requirements.

An alternative interface program for S6800 family microprocessors is shown in Fig. 6. In this example, a transfer of control is effected from either coroutine by a software interrupt (SWI) instruction. This causes a trap to interface program entry point XFR1 (through the trap vector in location $FFFA_{16}$ and automatically saves the return address and register-set contents in the source coroutine's stack. The source of the software interrupt is then determined by a binary toggle, and the stack pointer context is switched accordingly. A return-from-interrupt (RTI) instruction completes the transfer by restoring register set contents and the return address from the destination coroutine's stack.

This interface program approach also requires proper initialization, accomplished by subroutine INIX. As in the previous example, it is assumed that coroutine action begins with coroutine A. Subroutine INIX initializes the toggle and preloads coroutine B's stack; it must be called by coroutine A before the first software interrupt is issued.

The S6800 interface program in Fig. 6 is faster and has a shorter and simpler calling sequence than the one Fig. 5. It becomes less efficient, however, where parameters or address pointers must be passed between coroutines in machine registers, and can only be used where neither coroutine requires the software interrupt for other purposes. ■

Dr. Thomas L. Humphrey is strategy manager for microprocessors and memory at American Microsystems, Inc., Santa Clara, Calif.

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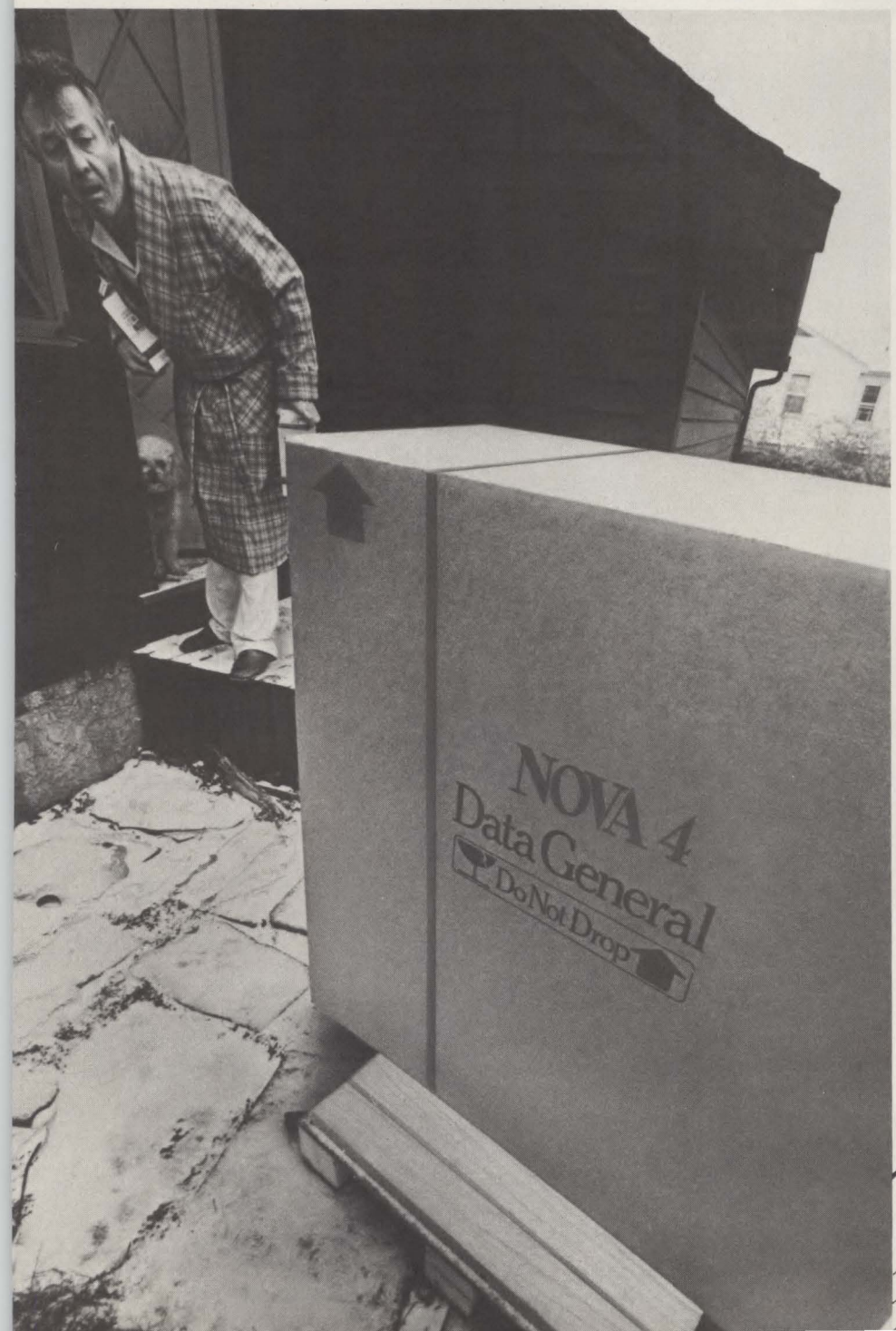

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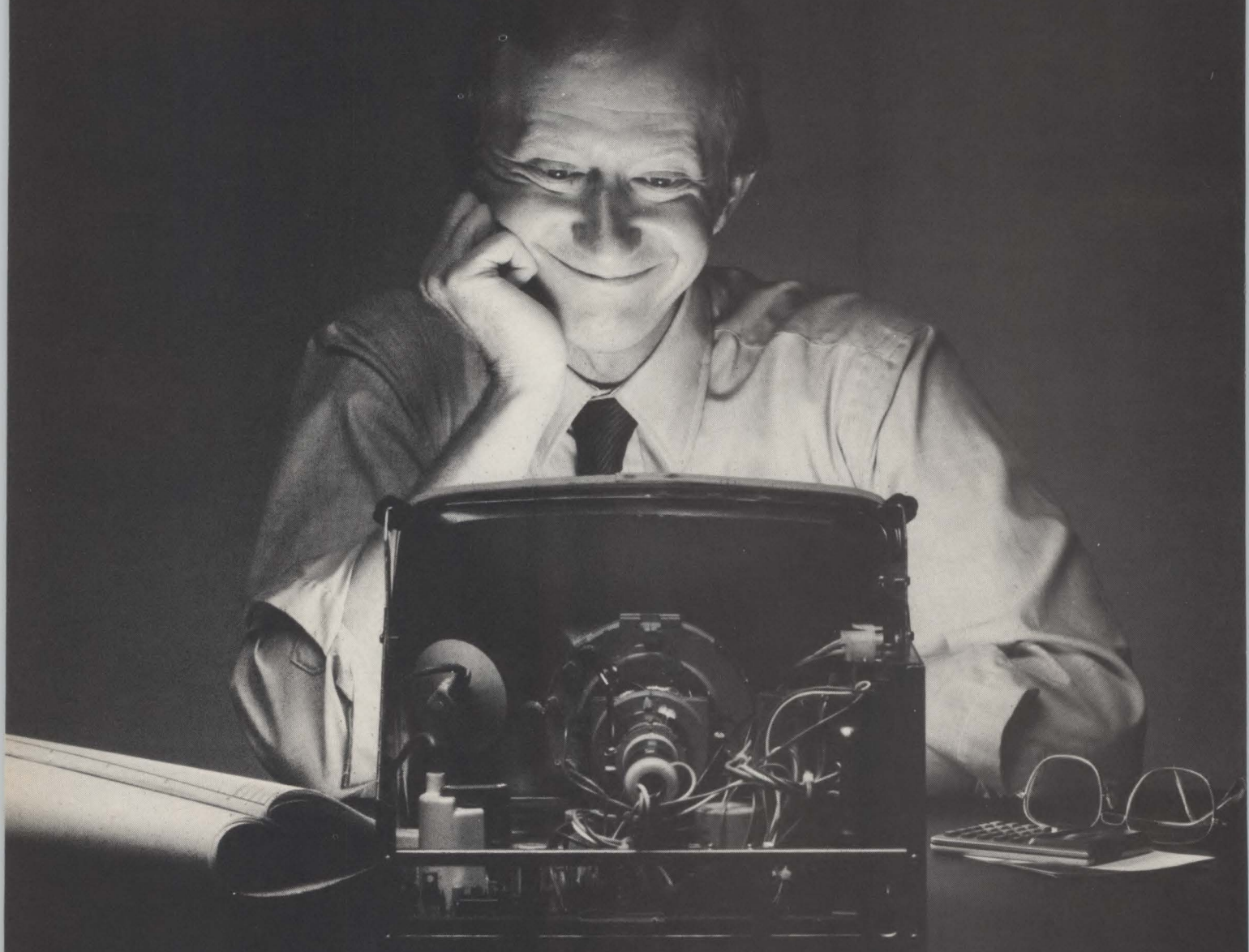

CIRCLE NO. 117 ON INQUIRY CARD

Selling to the small-business market

WALTER A. LEVY, Contributing Editor

This new market is still a frontier, and hazards exist for unwary buyers—and sellers

Both large and small suppliers of computers are vying for the attention of small businessmen—and getting it. From the giants to the small hobbyist retailers, computer suppliers want a piece of this growing market. For about the price of a large delivery truck, any small business can own at least the hardware part of a computer system, but there are still software and service problems. Buyers are buying and sellers are selling, but this new market is still a frontier, and hazards exist.

Because few of the estimated three million small businesses can develop their own software, computer manufacturers have developed a variety of marketing approaches. One approach is an alliance that would be unrealistic in any other market: IBM teaming with a two-man consulting company, for example. In addition, the industry has adopted new promotional and selling techniques, including seminars, direct-mail advertising, retail computer stores and appeals to the hobbyist.

Large companies have enough capital to invest in this

Aggressive promotion *of low-priced systems, coupled with new channels of marketing, such as retail computer stores, has prompted many small businessmen to "go shopping" for their first computers.*

Small businessmen are more concerned than large companies about the ability of a small supplier to fulfill his commitments and stay in business.

new market and can wait years for it to pay off. Large hardware vendors, for example, hope to sell thousands of $10,000 to $20,000 microcomputers and minicomputers, which often require hundreds of dollars more a month for licensed software and service. Time-sharing and data-service companies also want customers willing to pay hundreds of dollars a month for processing and occasional software support.

The small business market, however, is too widely dispersed to be easily captured by large companies. As a result, the computer industry's "third world," comprised mainly of more small businesses, is also in the market. Many systems and software houses, computer stores, dealers and consultants, for whom success is 20 to 40 annual installations each, are selling business systems. And the computer hobbyist industry is deserting its original market and turning to small businesses. Hobbyist retailers hope to substitute $5000 to $20,000 system sales for sales of $500 computer kits and $5 parts.

Neither the small computer business nor its small-business customer can survive a major financial mistake. Both must make a substantial investment—the computer supplier to develop his product and the customer to buy it. To enter this market, the small systems house or software supplier must acquire or develop a set of business application programs at a high cost—too high for any one customer to pay. The supplier must sell systems competitively, repeatedly installing essentially the same software and building a respectable base of satisfied customers, before his investment can pay off.

Profile of the small businessman

Small businessmen are usually more demanding than other customers because often their entire business operation depends on the computer. Furthermore, they are not usually systems-oriented and require more education than a large-company executive or a technically skilled industrial or scientific user. They demand that the supplier can ensure support throughout the system's useful life. Because they constantly face credit risk, business failure or breach of contract problems, they are more concerned than large companies about the ability of a small supplier to fulfill his commitments and remain in business. So the small systems supplier must establish and guard his credibility with his customers.

Because small businesses live or die on their ability to turn capital over quickly and to avoid slow collections or credit losses, they are likely to automate their basic accounting and production-control functions. Small

PROBLEMS GROW WHEN SELLERS ARE TOO EAGER . . .

J&H, a small accounting firm grossing $500,000 a year, provides its small business client base with audit, tax and general accounting services. J&H writes up the general ledger for many of its clients, posts each month's transactions to the appropriate accounts and provides a trial balance. It uses two data-processing service bureaus to support its operations—one for income tax return preparation and the other for general ledger write-up. Until recently, J&H hadn't considered buying its own computer, but it is now shopping.

Drawn by computer industry promotion of low-cost business systems, the company is ready to buy a system costing as much as $30,000, if it will handle mandatory general ledger write-up work, plan labor hours and perform engagement billing. The system would be a bargain if they could also use it for income tax preparation. Encouraged by a report that a smaller accounting firm had installed its own computer, J&H committed itself quickly.

Although convinced they should proceed, J&H officials are just beginning to explore the market and have only a faint understanding of how to buy and install a system or how to find the right supplier. The process is slow and inefficient.

The two partners involved speak to salesmen and receive presentations while continuing their normal duties. So far, they have contacted small-computer salesmen from two of the largest suppliers, which try to win the customer's confidence without imparting any specific technical or price data. After 30 or 40 hours (over two months) away from the accounting practice, J&H has accumulated only a modest inventory of facts and documents, including confusing literature and price information from both suppliers.

One major supplier furnished J&H with a six-page factual summary of its bottom-line small-business equipment and software, an oral statement of the price of a system and an explanation that a third party would provide software.

From a second major supplier, J&H received two brochures of the company's bottom-of-the-line small business computer and the next highest model in the line. It also received a third brochure that describes a general ledger software package marketed by a third-party firm 3000 miles away, but which provides no price, terms or software environmental data; a vague statement about equipment price and third-party software costs; and a confusing explanation of the relationship between the equipment supplier and the software supplier. To add to the J&H officials' confusion, the equipment salesman also informed J&H of an income tax preparation package on his computer from a prestigious "Big 8" CPA firm. To a small firm, this was an exciting prospect, so J&H contacted the "Big 8" firm and received a sales call and a presentation. Unfortunately, the firm didn't have a package. It was merely interested in developing one on a custom basis, and tried to involve J&H in a $100,000 consulting engagement.

The J&H situation results partly from inexperience in the computer market, but the customer is entitled to be properly served without becoming expert. The company is going to buy a computer sooner or later—if the industry figures out how to present an understandable and realistic procurement plan.

businessmen, then, typically buy computer systems for order-processing, invoicing, accounts receivable and inventory control functions.

This basic set of functions—which IBM has dubbed BICARSA for basic inventory control accounts receivable sales analysis—is also the dominant generator of paperwork, and the ability to computerize it, even in small businesses, can reduce costs. If a business can justify a computer system for the BICARSA functions, it would probably be willing to pay slightly more for a system that would enhance its entire accounting system by adding general ledger, accounts payable and payroll functions.

Small businesses also acquire computer systems for production, dispatching, mailings and a variety of non-accounting functions. Some examples illustrate this trend:

- Fuel oil companies maintain customer consumption records based on "degree-day" calculations and automatic delivery schedules.
- Membership organizations and direct-mail advertising companies maintain records and mailing lists and produce mailing labels.
- Small accounting firms perform general ledger accounting, maintain billing records and regulate staff availability.
- Contractors prepare quotations, generate price data from standard work units, develop labor/hour estimates and determine materials requirements.

The equipment required to support these functions is modest. Most small business applications lend themselves to transaction-oriented data processing that can be economically implemented on a mini- or microcomputer that includes a single data entry work station, a serial printer and enough diskette or disk space to store the main account file and the application programs. In a typical BICARSA installation, the system is loaded with programs for order processing, with stock availability and customer files on-line. The operator enters orders as they reach the office, checks and commits stock and interactively verifies customer identity and credit status. System capacity depends on the operator's ability to enter 100 to 200 orders at a work station in an eight-hour day.

Xerox Corp. recently *opened its first retail outlet in Dallas. Plans for six other stores are under way.*

The least expensive microcomputer on the market can handle an accounting system with these characteristics. Small systems houses and computer stores furnish hobbyist-grade equipment that costs about $8000, including a printer. Thus, they establish a market bottom against which larger or older products must compete.

Single work station application programs do not require sophisticated operating systems. The software provided in the typical hobbyist microcomputer, which

. . . AND WHEN BUYERS ARE UNDERFINANCED

Compared to J&H, SPT Metal Fabricators is a giant. The company fabricates metal components from raw stock and supplies its large customers with a combination of standard repeat-order and custom parts. With a rapidly growing annual volume that now stands at $30 million—3000 quotes and 1000 orders a month—SPT's controller is seriously considering a computer. He believes a system will improve the company's billing and collections and reduce clerical costs. The company has difficulty maintaining its raw materials stock at the right level because much of it is imported, and leadtimes on new orders are much greater than those from more expensive domestic sources. He is convinced that materials consumption planning could be greatly improved by computerizing the process of preparing quotes, and by using the data to generate materials requirements forecasts.

S.P., the controller, has been contacting several small-business turnkey system suppliers for about a year. Because S.P. is well-educated and has several years of experience in a large public accounting firm and a strong grasp of systems planning, he knows enough about the industry to deal easily with suppliers. He has realistically estimated system and installation costs. But S.P. has just one problem—his company has no money.

Although SPT is growing rapidly, it is undercapitalized and recently modernized its plant at great expense. The company needs to build up working capital before the controller can make further investments. S.P. is planning a $50,000 to $75,000 general-purpose accounting system with special materials planning abilities, but he won't be able to fund it for a year or two.

So S.P. is trying to find less expensive short-term solutions. The company owns a rather old minicomputer with a teletypewriter used as part of a metallurgical laboratory facility. S.P. has asked the vendors to enhance the older computer so it can perform accounting functions during the day shift, thereby reducing his costs. (The laboratory work can be done on the night shift.) For a simple quotation-preparation and a materials forecasting program, he is also considering a hobbyist-grade microcomputer, cabled to share the existing teletypewriter.

The situation at SPT is typical of one that frustrates suppliers: all external signs indicate a solid prospect, but several small companies are consuming resources in search of the order. But the buyer is unable to buy a system, and in his search for temporary measures, he is drawing vendors into a lengthy and unproductive relationship.

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As a tool for the small businessman, the computer must solve specific problems in tangible ways.

comprises a ROM-resident BASIC interpreter and an interactive monitor, is quite sufficient. If the application requires several work stations, much printing overlapped with operator data entry or bulk loading of input data, the system will require larger equipment and a multitasking operating system and will cost upwards of $20,000.

Computer as tool and investment

The typical system buyer is the owner-operator of a business that grosses $1 million to $25 million a year. He will probably lack EDP experience, a technical education and an appreciation of systems and procedures beyond the specifics of his daily operations. He won't have the time to get involved with the system's installation, but he will have a firm idea of which business problems to solve with a computer and how much money he can spend on one. In these respects, the small businessman is distinct from the large-company middle manager, engineer or scientist. He hopes the computer he buys will be an easily maintained tool and a sound business investment.

As a business tool, the computer must solve specific problems in tangible ways. A small businessman is likely to buy a system because it will not require much operation dislocation or staff training—not because of its "capability" or "better management information." As a facility, the computer should require minimum maintenance. The buyer requires the supplier to respond promptly to service calls. He also needs a single source of service for the computer, the printer and the software.

Many factors prompt a small businessman to shop for a system (see accompanying stories), but the biggest is aggressive promotion of low-priced systems, coupled with new channels of marketing, such as computer stores. While this kind of marketing produces sales, it also draws many "shoppers"—businessmen whose curiosity has been aroused by claims of low-priced systems, but who are not yet ready to buy. Before he feels comfortable with the prospect of his own computer system, such a buyer browses in his spare time for about a year, reads literature, goes to sales seminars and spends time with potential suppliers. Even when

THE KEY: DEVELOPING CUSTOMER CONFIDENCE

Two vendors are competing for a small-business system order. Vendor A submits an elaborate custom-written proposal after six sales calls and a site survey. Vendor B submits a letter proposal plus a brochure in response to a telephone call—and gets the order.

Why? Vendor B's letter essentially said the following: "Our system is installed in 50 companies similar to yours. Here are six references of satisfied customers. This is our standard price. These are our standard terms."

Customer confidence is the key ingredient. Vendor B's brief business-like letter told the customer everything he needed to know and gained his confidence. Small-business system suppliers must understand this and adjust their marketing methods accordingly if they are going to be successful. Three factors are key to achieving customer confidence:

Clear communications: Literature and proposals must be clear and understandable. The vendor must understand the customer's industry and problems, and demonstrate this fact. Essential facts about computer technology must be communicated at the right level: not too technical, not too simple. The rights and responsibilities of buyers and vendors should be clearly explained.

Here are three examples of how a vendor might describe the disk drives furnished with his system.

Bad: "We offer a 256K-byte IBM-compatible software-formatted floppy-disk drive." (Too technical.)

Better: "Our low-cost disk drive will store 100 customer files." (Customer understands.)

Best: "Our low-cost floppy-disk drive has a physical storage capacity of 256,000 characters. It can hold as many as 100 customer files, each holding an average of 10 transaction records." (Customer understands and can make informed comparisons.)

Reasonable business policies: The vendor's approach to marketing and supporting his product must recognize both the legitimate needs and expectations of an unsophisticated customer and the realistic limits of the vendor's resources. The customer must gain confidence that the vendor is reasonable and reliable and that, having contracted for a system, he will not discover unpleasant surprises.

Vendors should avoid any marketing techniques that cause a buyer to feel that a product's capabilities or true costs were understated to gain an order, or that pricing was arbitrary or sensitive to the buyer's apparent eagerness or ability to pay. The cost of add-on features should not be out of line with their cost as part of an initial order. Vendors should bend over backward to stress the importance of the user's participation in system installation and conversions, regardless of how well the vendor may feel he is protected by contract terms. This will assure a successful installation and a happy customer.

An efficient relationship between vendor and customers: The vendor's selling and promotional efforts must be realistically scaled to the price of the product and the buyer's budget. Small businessmen, as one-time buyers of computers, must be able to understand the limitations of the vendor's marketing resources and be realistic in their expectations.

The vendor of a turnkey system selling for perhaps $25,000 can afford to budget $2000 to $3000 per system for the cost of sales. Such a budget barely covers the cost of one or two sales calls and a proposal, particularly if out-of-town travel is involved. Vendors must learn to qualify buyers inexpensively, limit their costs for "missionary work" and education and close orders for standard systems at standard prices. Buyers should cooperate in the sales effort by doing their homework and being prepared to act if a reasonable proposal is received. Experienced vendors have learned to provide interested buyers with survey forms and self-instruction sales aids.

Before he feels comfortable with the prospect of his own computer, a buyer may 'browse' in his spare time for about a year.

he makes a firm commitment to buy a system, the procurement competes with other demands for capital up to the moment he signs the contract.

Under these conditions, the buyer's ability to discover what the market has to offer is severely limited. He will probably sporadically contact one of the obvious "biggies" such as IBM or Burroughs Computer Corp., a nearby computer store, a minicomputer dealer/systems house or a system supplier referred by a trade association or by a large supplier. He will probably quickly understand the concept of turnkey

Xerox Corp.'s "supermarket *for the office" carries a variety of copiers and word processors, as well as small computers produced by other manufacturers.*

systems because it corresponds precisely to his needs. He may, however, become frustrated at his inability to get turnkey systems from blue-chip equipment vendors, to understand the responsibilities and proposals of hardware suppliers or to understand the significance of standard application programs and consultants. The buyer probably will learn enough about hardware to define configurations and make comparisons on the basis of price and nominal specifications, such as memory size and printer speed, but he probably will not learn much about software.

Buyers often seek advice from accounting firms, from other businessmen who own systems or from consultants. And when they do, it can be a problem. If the accounting firm is small, for example, it may be no more knowledgeable than its client, and reluctant to share a risky decision. Another businessman may describe only his own experiences to the prospective buyer, but not give much advice. And an independent consultant's fees would probably be too large in relation to the system's price to be acceptable or worthwhile. A businessman shopping for a $25,000 system, for example, is unlikely to want to pay a consultant's fees of $2000 to $5000 for the one or two weeks required to survey the business, locate a few competitive suppliers, develop a simple request for proposals and make a recommendation, even though the businessman may fruitlessly spend more of his own time trying to manage the same process. A consultant who comes in for only one or two days can do little more than collect a few simple statistics about the business and recommend one or two qualified systems houses.

The relationship between small businessmen buyers and consultants has not yet matured enough to be effective. When it does, independent consultants, acting as advisers or representatives, will be quite valuable to the small businessman. Suppliers also benefit from consultants because they reduce the burden of educating buyers.

All branches of the computer industry recognize the importance of educating the buyer. Many suppliers offer seminars and publications that combine product exposure with some advice. Independent consultants and training firms also provide seminars and publications that usually present an overview of EDP technology and guidelines about how to procure a system. People with substantial experience in EDP frequently develop and present these seminars. Sometimes, however, they fail to recognize the "smallness" of the buyer and present advice in overly sophisticated terms. Seminar teachers make another common error when they tell the small businessman to prepare and elaborate a demanding request for proposal (RFP) full of questions with answers he wouldn't understand.

The "shopping" phase of a small business system procurement, then, is most critical for both buyers and suppliers—buyers because of the necessary education to be acquired, and suppliers because of the expenses and risks of a lengthy and tenuous relationship with a new customer. There are no heroes in this market—a lot of vendors and buyers are wasting each other's time and money with unrealistic expectations. For a small systems house or software supplier in this market, a qualified buyer is indispensable. ■

Walter A. Levy is president of Edgewood Computer Associates, Inc., a consulting firm specializing in data communications, distributed processing and minicomputer applications.

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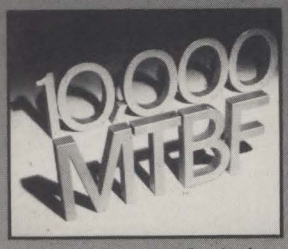

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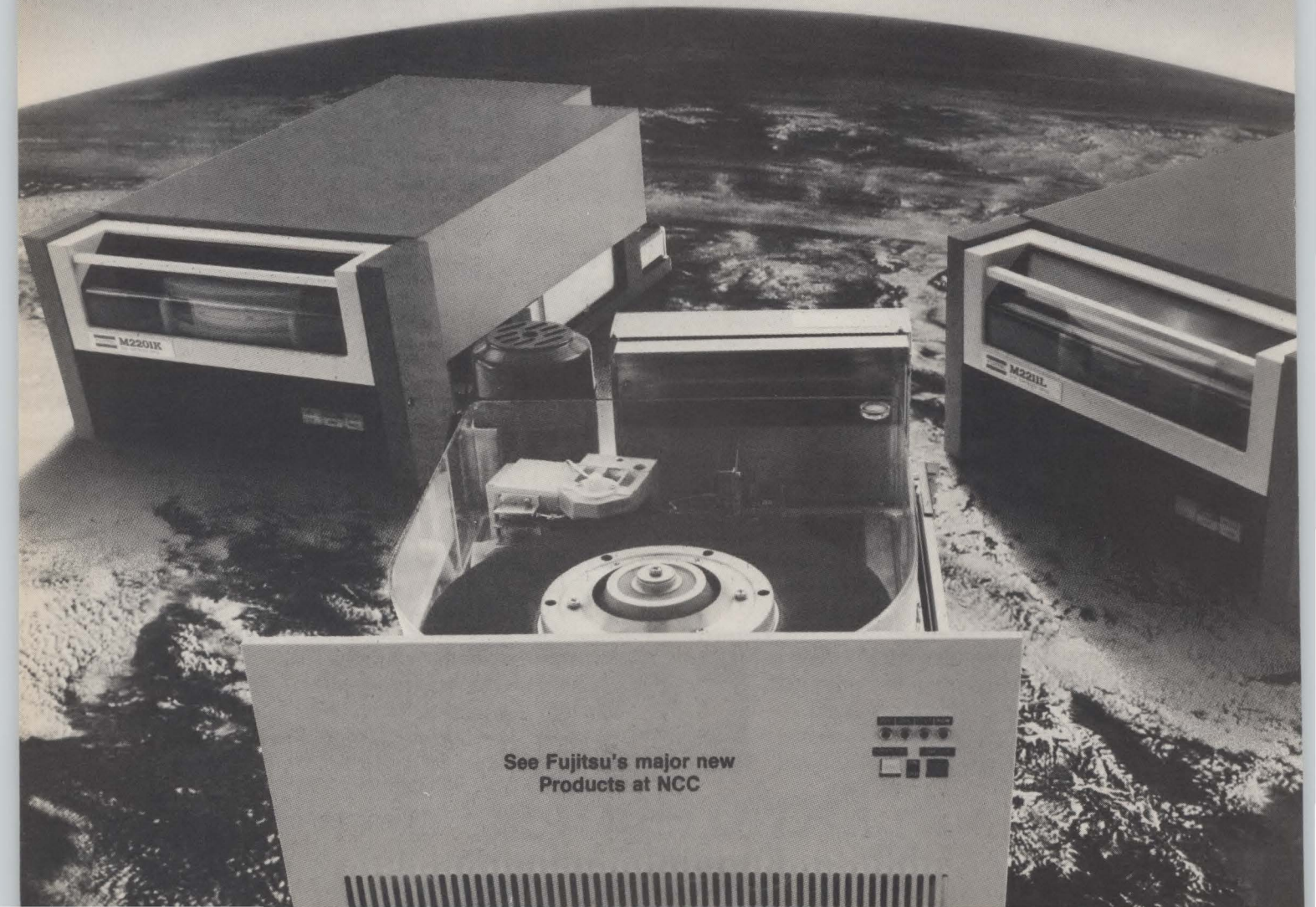

Applying CBASIC to accounting systems

Two books provide efficient programs for updating and maintaining accounting data

GENERAL LEDGER—CBASIC and ACCOUNTS RECEIVABLE & ACCOUNTS PAYABLE—CBASIC, By Lon Poole with Mary Corchers, Martin McNiff and Robert Thomson, Osborne/McGraw-Hill, Berkeley, Calif., 1980, $20 each (paper).

Reviewed by
Eileen F. Hemenway

Whether a business is small or large, accounting chores are handled more easily and accurately with a well-designed and well-implemented automated accounting system. These two books provide a complete set of programs for computerized general ledger and accounts payable/accounts receivable systems.

The books, developed from Adam Osborne's earlier business software books of the same title, include programs written in CBASIC, Version 2. These programs will run on any 8080/Z80 microcomputer with the CP/M operating system. They have been converted so they can be used on a wide variety of computers, such as Apple II, TRS 80 and IBM 5110.

Business software users know that no matter how professional the business software is, there occasionally is a need for a feature in a system that is unique for a particular organization. It then becomes necessary to modify one or more of the programs. Although the programs in these books are general-purpose, the authors recognize the need for customizing and devote an entire chapter to it.

General Ledger contains eight application programs and eight support modules, of which seven are common subroutines.

Some characteristics of general ledger that are provided with the program in the book include:

- user-established and user-maintained charts of accounts,
- user-selected headings, totals and subtotals for financial reports,
- flexible report formats for balance sheet and income statements,
- user-established fiscal year ending month,
- posting to the general ledger from outside the programs via an external posting file,
- audit trail printout for account balance changes,
- monthly, quarterly and year-end balance sheet and income statement,
- addition, deletion and modification of accounts,
- adjustment of account totals when balance errors are detected and corrected,
- printout of current account balances for selected accounts.

A chapter called "User's Manual" includes flow charts and detailed instructions for using the system's programs, explanations of the program's purpose and information on handling error-recovery and exceptional processing. In addition, samples of CRT screen images and printed reports are included.

Another chapter, "Management Guide," provides an understanding of what the programs can do and when they should be used. It discusses posting from the accounts receivable and payable, as well as a cash journal. Although the programs are designed to detect errors in processing and to report them, they cannot detect posting to an incorrect account or posting of an incorrect amount, so they provide an update report that can be used for error detection and correction.

A companion publication to the general ledger book, *Accounts Payable/Accounts Receivable*, provides a business with the ability to accumulate information for current assets and liabilities on a balance sheet. The book contains 22 application programs and 14 support modules; 13 are common subroutines. The system permits the option of generating files for posting to the G/L system.

"Receivables" generally refer to customer accounts, and "payables" to vendor accounts. Because both directly affect the cash flow of a business operating cycle, they must be accurate and up-to-date.

The programs in this book offer a system that supports processing and analyzes business cash flow, using an invoice as the primary source of data.

The programs for accounts payable provide the means to keep

track of vendor purchases and credits and to calculate vendor payment amounts. Program features include:

- maintenance of vendor and invoice system files,
- maintenance of vendor activity totals,
- flexible check calculation check writing on preprinted forms,
- aging summary for open items aging analysis—30/60/90 day or user basis,
- invoice distribution to 11 different general ledger accounts,
- check register printout.

Invoices, debit memos and credit memos are maintained as separate records on the systems ledger, which is the invoice file of closed (paid) and open (unpaid) items.

An important provision is available for entering prepaid invoices—items that were paid with handwritten, rather than computer-calculated, checks. When the prepaid check data is entered into the computer, the programs ensure that the check amount is posted to the appropriate vendor and general ledger totals. Transaction processing also ensures that correct totals are maintained for vendor and general ledger. A transaction that deletes or modifies an existing invoice causes the programs to require any corresponding changes for account distribution.

A record for each vendor is kept on a vendor file, where each vendor is assigned a six-character code. For payment, a specific vendor number or a vendor number range can be specified. The book includes three programs to handle check-processing requirements:

- check calculation
- check register
- check writer

Check calculation processing contains a restriction on the check date—it may not be more than seven days earlier or later than the file date that is maintained on the system's general-information file.

The check-calculation program adds the total invoices and debit memos for payment and subtracts any credit memos. This sum is added to the current year purchase (activity) total in the vendors record, which provides a record of how much was paid any vendor to date.

The check-writer program provides check protection by printing the dollar amount in English and in numerals. Although negative check amounts will not print, zero check amounts will print in order to include the paid invoices on the check register.

A high volume of invoices for payment to any one vendor may necessitate the production of several checks because the programs will permit a total of only 25 detailed items to be included for each check.

The ability to partially pay invoices exists, but requires interactions with four programs. Year-end reports are provided, as well as the option of establishing a new last year's total in the vendor records. The current-year accumulator can then be reset to zero, preparing the system for generating new purchase totals for the current year.

The ability to process and maintain data for customers is provided with the accounts/receivable programs. Among the features included are:

- system files for customer, invoices and tax codes,
- the ability to enter invoices at any time,
- provision for progress billing reporting on billed invoices, open and closed items,
- statement output to preprinted form,
- aging analysis of open items.

Customers are identified by a six-character code and have one record each on the customer file. Each record contains the current total for purchases and the previous year's totals. Companies that are both vendor and customer must be assigned both vendor and customer numbers, which can be the same. The system's year-end procedure will reset the values in these total fields by moving current to prior and resetting current to zero.

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BASF

CIRCLE NO. 124 ON INQUIRY CARD

For each invoice, credit memo and debit memo issued a customer, there is a separate record on the invoice file. The programs in this book enable the listing of invoices and optional deletion of paid invoices. The list provides an up-to-date account of all invoices on file, by category, with an aging analysis of open times.

The statement-preparation feature enables the program to list customer open items in invoice number order. Each item will be aged as current (less than 30 days old) or past due.

For long-term projects, the progress payment feature provides the ability to request the progress due date and the billing amount. Payments can be entered after the invoice has been billed, provided there is a non-zero balance. When payments are greater than the balance due, analysis and adjustment of payment entries are required. Progress balances are aged on a 10-day basis.

Automatic calculation of sales tax, using the rate in the tax code file, is also provided. As many as nine rates can be specified, where each rate has a general ledger account associated with it. In this way, the appropriate tax account can be determined for posting.

The general ledger accounts affected by the accounts/receivable programs include:

- cash
- shipping
- travel
- sales tax accounts

Program modifications may be required.

In summary, the programs for the three systems provide an efficient and time-saving means of maintaining and updating accounting data. The extensive systems and program documentation is excellent. The programs work more efficiently when time is spent to understand what they can do and how they do it.

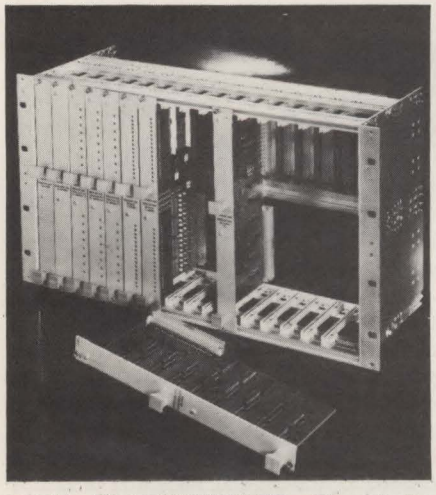
(Eileen F. Hemenway is a co-founder of Hemenway Associates, Inc., a Boston-based software house specializing in language translators.)

VOICE-RESPONSE SYSTEM. The BT-2 is a stand-alone voice-response system that communicates messages, instructions, questions, answers and alarms in natural human sentences or phrases. Based on a DEC LSI-11, the RS232C-compatible system uses telephone-quality male or female speech for responses that are not computer-synthesized. There is no limit on word or phrase length. The standard system supports eight channels of speech output and approximately 30 words and can be expanded to support as many as 64 input and 64 output channels and 256 words. Price is $7000 for the standard system. **Perception Technology Corp.,** Winchester, Mass.

Circle No 261

SMALL BUSINESS COMPUTER. The BC-5000 desk-top computer, intended for use as a small business computer or an intelligent terminal for distributed data processing, includes two 1.2M-bit double-sided, double-density floppy-disk drives. The system's one-touch keyboard uses an exchangeable cartridge that stores 24 pages, each containing 96 item keys, 48 function keys and status lights. A simple command will select a page automatically in less than 1 sec. Each key has a customized legend. When pressed, each key supplies user-specified information to the computer; a single keystroke can generate a character, word, line or page of information. **Panasonic,** Secaucus, N.J.

Circle No 262



16-BIT MICROCOMPUTER. The Series 990E 16-bit microcomputer system, designed for process control, industrial equipment and machine control and quality-control test instrumentation applications, is compatible with Texas Instruments' 990 Series computers and 5TI programmable controllers. The 990E includes a TMS-9900 CPU and 20 digital and analog interface boards. The system is expandable to 4096 I/O lines on as many as eight chassis, each with a 16-slot motherboard. Each circuit board is securely fastened to the chassis to prevent walk-out. Separate bus and I/O connectors prevent electrical or programming mishaps. **Erni & Company,** Northbrook, Ill.

Circle No 263

BUSINESS SYSTEM. The Chieftain Business System, a multi-user system based on the vendor's Chieftain microcomputer, includes 64K bytes of main memory and a DCB-4 disk controller capable of handling four 8-in., 1M-byte floppy disks. Optional hard disks provide 10M bytes of fixed and 10M bytes of removable storage that can be accessed by as many as four users. The system's 6809 microprocessor is said to enable it to run BASIC programs more than two and one-half times as fast as comparable 6800-based computers. Prices range from $5000 to $8400 in single-unit quantities; the hard-disk and multi-user options cost an additional $8500. **Smoke Signal Broadcasting,** Westlake Village, Calif. **Circle No 264**

WORD- AND DATA-PROCESSING SYSTEM. The "minichester" turnkey system, which can be used for both word and data processing, incorporates a DEC LSI 11/2 processor running under the RT-11 operating system, double-density floppy drives, a CRT and a printer. The system comes with word-processing and data base-management software and a business software package for accounts receivable, accounts payable, order entry, inventory, invoicing and general ledger. Payroll is available as an option. Price for the "minichester", including 64K bytes of memory and a training seminar, is $14,950. **ABC Computers, Inc.,** Tahoe City, Calif.

Circle No 265

CADD SYSTEM. The model 1010 computer-aided drafting and design system is a stand-alone, interactive graphic station, incorporating a DEC LSI 11/23, an 8086 microprocessor and a hard disk. The three-dimensional system can communicate via hard-wired or dial-up lines, and can operate remote plotters. The system also supports text editing and programming functions. Prices start at approximately $50,000. **Interactive Computer Systems, Inc.,** Baton Rouge, La. **Circle No 266**

COMPUTER-ASSISTED RETRIEVAL SYSTEM. The Excalibur management system for computer-assisted retrieval of microfilm can store and retrieve 56 million to 3.5 billion characters of cross-referenced information. Any record can be accessed in less than 6 sec. The basic system consists of a minicomputer with 128K bytes of main memory, two 28M-byte disk drives, one video display terminal, a 16mm data-entry camera, a retrieval unit and software. The system, which can also index paper files, costs $98,500. **Bell & Howell, COM Products Division,** Newport Beach, Calif.

Circle No 267

OFFICE AUTOMATION SYSTEM. The Series 1000 office work station, a 16-bit microprocessor-based unit, combines word processing, data processing and data communication capabilities with a program-development software system. The standard system, designed around Intel's Multibus, includes a console with a 15-in. CRT and a 56-key detached keyboard plus a separate cabinet housing two single-sided, double-density 8-in. floppy-disk drives. The console also contains the system's CPU, 64K bytes of memory and I/O and communication controllers. **Artel Corp.,** Palo Alto, Calif.

Circle No 268

TRAFFIC ENGINEERING MANAGEMENT SYSTEM. The ATEMS-85 automated traffic engineering management system, designed to provide computational, analytical and graphics capabilities for traffic engineers, automates preparation of time-space diagrams and other calculations. The 8085A-based turnkey system also analyzes existing and future multiphase arterial systems and simulates problem intersections by evaluating delay emissions and fuel consumption. ATEMS-85 includes 64K bytes of RAM, 500K bytes of disk storage, a Qume daisy-wheel printer and a Hazeltine 1520 CRT terminal with a standard ASCII keyboard. Prices start at $29,000. **ATEMS Computer Systems,** Fullerton, Calif. **Circle No 269**

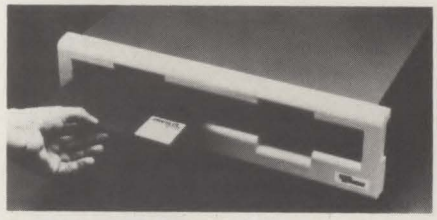
New Products

disk/tape

DISK STORAGE SUBSYSTEMS. The 6100 Series of disk storage subsystems for Eclipse, Nova and microNova computers incorporates a Winchester-disk drive, along with a floppy-disk drive for high-capacity file transfer and backup. Said to be the first such subsystems from a major minicomputer vendor, they are available in three models: a 25M-byte Winchester with a 1M-byte floppy, a 25M-byte disk only and a 12.5M-byte disk with a 1M-byte diskette. Single-unit prices for the 6100 Series range from $7300 to $10,200. **Data General Corp.,** Westboro, Mass. **Circle No 270**

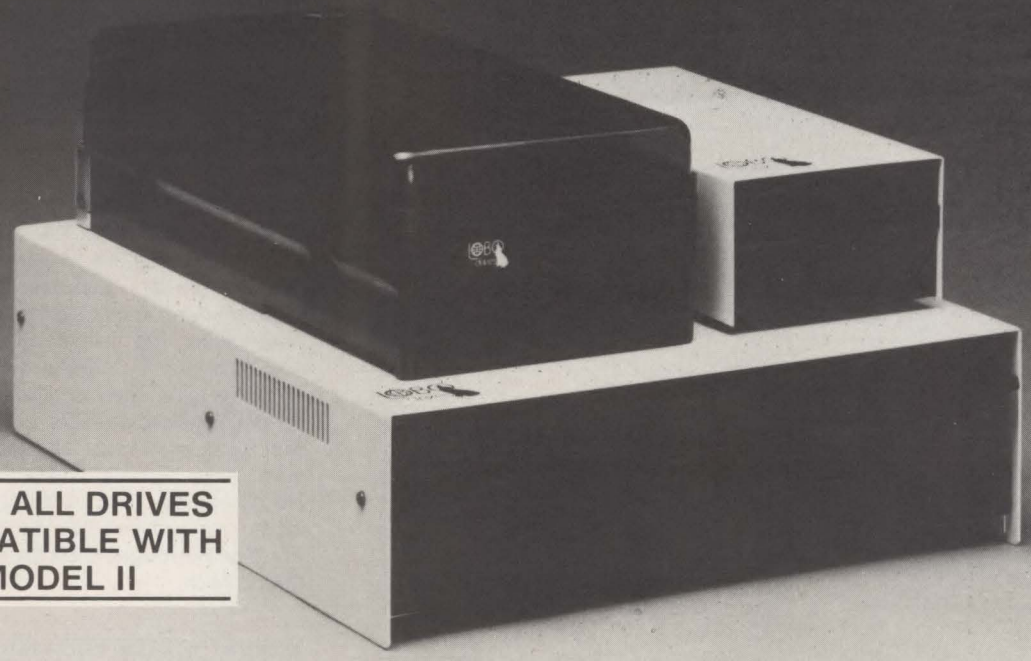
SA4000-BASED SUBSYSTEM. The RX-50 disk subsystem uses single or dual Shugart SA4000 14-in. Winchester drives for 13M to 52M bytes of mass storage and an 8-in. floppy-disk drive for program loading and file backup. Also included is an MC6800-based controller with two 8-bit parallel data buses and handshake control logic that enables the user's system to pace data transfer, eliminating the need for DMA capability on the host processor. Prices for a 13M-byte system start at $6990 in single-unit quantities. **RX Electronics, Inc.,** St. Paul, Minn. **Circle No 271**

VIDEO TAPE BACKUP FOR WINCHESTERS. The MIRROR backup subsystem for 8-in. Winchester-disk drives employs standard video cassettes with a total capacity of 100M bytes. The entire 10M-byte capacity of the vendor's 8-in. hard disk can be transferred to a MIRROR cassette in less than 10 min. without operator attention. The MIRROR subsystem costs $790; a complete system, including a commercially available video cassette recorder, can be assembled for less than $1500. **Corvus Systems,** San Jose, Calif. **Circle No 272**



FLOPPY-DISK DRIVE SYSTEM. The DSD 480 8-in. floppy-disk drive system—said to be the first to be compatible with all DEC and IBM diskette formats—has a capacity of 1M-byte per double-sided diskette, for a total of 2M bytes of on-line storage. The system, which is said to have twice the capacity of other DEC-compatible floppy hardware, provides a method of transferring data and programs between DEC and IBM systems. Features include a built-in hardware bootstrap, off-line diskette formatting and a library of built-in, user-selectable diagnostic routines. The system is packaged in 5¼-in.-high, 19-in.-wide chassis and costs $4495 in single-unit quantities. **Data Systems Design, Inc.,** Santa Clara, Calif. **Circle No 273**

NEW FROM LOBO:



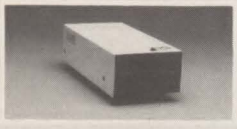
NOW! ALL DRIVES COMPATIBLE WITH MODEL II

An Entire Family of Disk Drives for APPLE, TRS-80*, and S-100 Computers

Only LOBO DRIVES offers you an entire family of fully-compatible disk drives to select from. Whatever computer you're using, APPLE, TRS-80, or S-100, you can add a LOBO drive now, with the peace-of-mind of knowing there's a whole family of drives available when you're ready to expand.

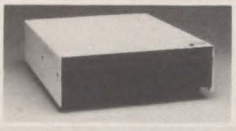
And every drive you order comes complete with chassis and high reliability power supply. Each drive is 100% calibrated, burned-in, and performance tested on either an APPLE, TRS-80, or S-100 computer before it's shipped. We are so proud of our drives . . . our quality, reliability, and performance, that we back-up every drive with a one year, 100% parts/labor warranty.

400 SERIES FLOPPY DISK DRIVES



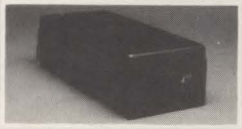
Meet our low-cost 5.25-inch mini drive that records data in either hard or soft sectored format. It is available in single or double density configurations, with a total storage capacity of 220K bytes.

800/801 SERIES FLOPPY DISK DRIVES



Here is our dual 8-inch Floppy disk memory unit. It records and retrieves data on standard 8-inch diskettes to provide 800K bytes of data storage unformatted, or 512K bytes in IBM format per drive. It is also available with double-sided, double-density capabilities, for a maximum storage capacity of 1.6 Megabytes.

7000 SERIES HARD DISK DRIVES



The latest member of our drive family, the Series 7000 is an 8-inch, 10 Megabyte Winchester Technology, hard disk drive. It is fully hardware/software compatible and comes complete with disk controller. Now you can have the convenience, speed, reliability, and all the storage capacity you need.

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☐ 8-in. Floppy drive
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Double sided
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☐ Double density expansion interface

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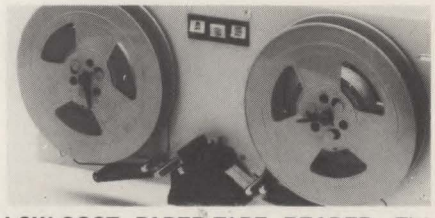
CIRCLE NO. 127 ON INQUIRY CARD

New Products

14-IN. WINCHESTERS. The FD 210 series of 14-in. Winchester-disk drives, available in 20M-byte (FD 211) and 80M-byte (FD 214) capacities, are interface-compatible with the vendor's MD 122 6M-byte dual floppy-disk drive. The FD 210 drives include parallel interfaces, plus microprocessor controllers to perform asynchronous file searches, confidence/diagnostic tests, CRC generation and other tasks normally handled by the host processor. OEM prices are less than $3000 for the FD 211 and less than $4000 for the FD 214. **The Burroughs OEM Marketing Corp.,** Detroit, Mich. **Circle No 274**

MEMORY SYSTEM FOR EXORCISOR. The Storage Demon provides users of Motorola 6800 EXORciser systems with as much as 10M bytes of hard-disk memory. The Demon includes a controller, an IMI 7710 Winchester-disk drive and a disk operating system. Price in single-unit quantities is $6995. **Software Dynamics,** Anaheim, Calif. **Circle No 275**



LOW-COST PAPER-TAPE READER. The RR7155 paper-tape reader operates at 200 cps in an asynchronous or synchronous read mode or at 400 cps in a tape-positioning mode. Intended for the computerized numerical-control and program-loading markets, the unit is 5½-in. high and mounts in a 19-in. rack. An optional add-on fanfold tank assembly is also available. The RR7155 reader costs $657 in OEM quantities. **Remex Division, Ex-Cell-O Corp.,** Irvine, Calif. **Circle No 276**

PAPER-TAPE READER. The model 612 paper-tape reader can read five- to eight-level tape and can transmit seven to 11 frames per character at 50 to 9600 baud. Other features of the stand-alone device include starting and stopping on character at all speeds, choice of manual control or X-on and RS232, current-loop or parallel outputs. Both desk-top and rack-mount versions are available. Price is $656 to $854 in single-unit quantities. **The Addmaster Corp.,** San Gabriel, Calif. **Circle No 277**

DEC controls DEC.

The companies at right control the disk and tape drive market.

And we've got the controller-formatters that put the two together.

No matter which of these 13 companies are selling you a disk or tape drive for you to integrate into your DEC-based system, you're going to need a controller.

Which one? Ask your peripheral salesman. Chances are he'll recommend Emulex.

1. Ampex 2. Century Data Systems 3. Cipher Data 4. Control Data 5. Fujitsu 6. Kennedy 7. Memorex 8. Okidata 9. Perkin-Elmer 10. Pertec 11. Priam 12. Storage Technology 13. Telex

These 13 men have a controlling interest in DEC

It should come as no surprise that the leading tape and disk drive manufacturers have a strong interest in our family of software transparent micro-programmed controllers for PDP-11 and LSI-11 cpu's. Or that they recommend our products. They do it for purely selfish reasons. With an Emulex controller, integrating their drives into your DEC system is predictably fast and easy.

You win. They win. And we win.

And victory has never been so sweet. Or easy. Emulex controller boards slide directly into available slots in your cpu backplane. No modifications, no dangling wires, no ancillary power supplies, no "boat anchor" black boxes. Simple. And reliable.

All of our controllers are fully transparent to the cpu hardware and software, insulating you from system revisions. Because they're fully compatible, just plug them in, and you're running DEC diagnostics and operating systems in minutes. Plus we give you added features: automatic self-test, built-in pack formatting, programmable bandwidth control—and more.

It makes no difference which DEC-11 series cpu you're using, or what storage device. We support 59 different drives from these 13 manufacturers. Including all the latest varieties of 14-inch SMD and Winchester class disks; NRZ, PE, NRZ/PE and GCR tapes. And we're adding more all the time.

So when your disk or tape drive salesman calls, tell him you can't control yourself. Without Emulex. Or call or write for our free Buyer's Guide, today.

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EMULEX

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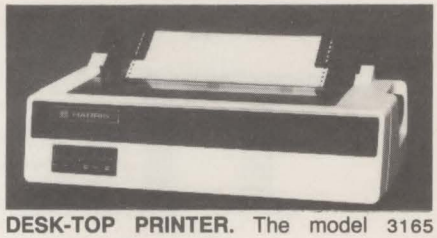
CIRCLE NO. 130 ON INQUIRY CARD

New Products

printers

SMALL BUSINESS PRINTER. The model 737 printer for small businesses produces letter-quality characters in a 7 × 8 dot matrix at 10 or 16.5 cpi or in an N × 9 dot matrix for proportional spacing. An adjustable nine-wire free-flight print head prints true lower-case, descending characters, underlines, superscripts, subscripts and expanded print. The unit accepts stationary, 80-column roll paper and 80-column fanfold pinfeed paper. Price is $995, with OEM discounts available. **Centronics Data Computer Corp.,** Hudson, N.H. **Circle No 278**

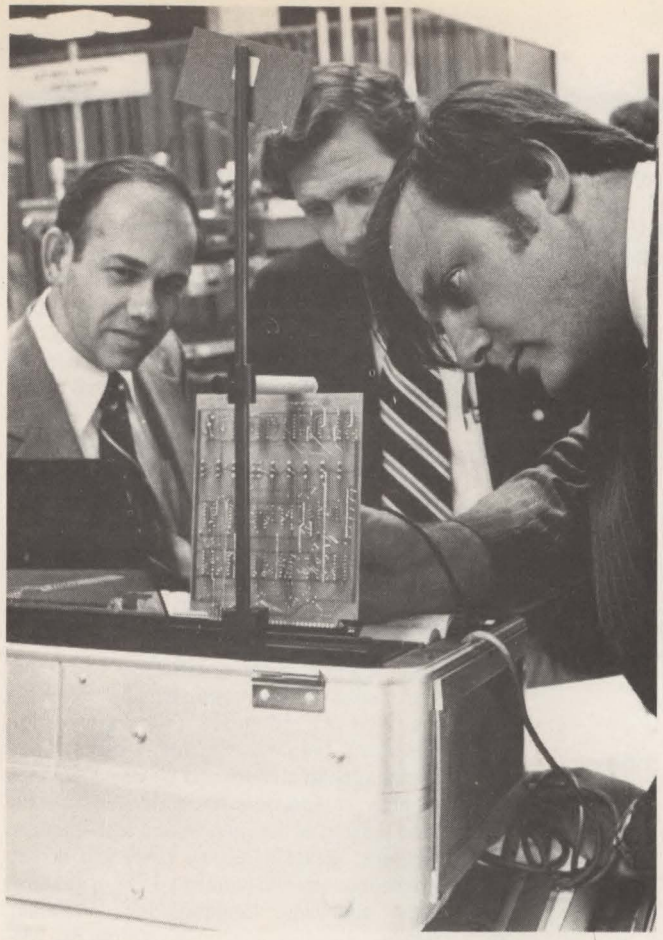
WIDE BELTBED PLOTTER. The model 970 plotter, intended for applications such as mapping, computer-aided design and drafting and engineering design, is said to provide the capabilities of a large flatbed unit at 25 to 50 percent lower cost. The plotter draws as fast as 30 ips with 2G acceleration and a resolution of .00049 in. in as many as four colors and line widths. The system, which includes interfacing for most minicomputers and mainframes, operates in on-line, off-line and remote time-sharing environments at speeds as high as 9600 baud. Price is less than $51,000. **California Computer Products, Inc.,** Anaheim, Calif. **Circle No 279**



DESK-TOP PRINTER. The model 3165 bidirectional printer improves medium-volume throughput for the vendor's model 8000 interactive terminal systems by seeking the shortest path to the next line of data. The unit prints 64 upper-case ASCII or EBCDIC characters at 120 cps in a 7 × 7 dot matrix or 96 upper- and lower-case characters in 7 × 9 dot matrix. The 3165 accepts six-part forms as much as 17.3 in. wide and prints 132-column lines at 10 cpi. Vertical spacing is 6 lpi; paper slew rate is 8 ips. **Harris Corp.,** Data Communications Division, Melbourne, Fla. **Circle No 280**

LOW-COST PRINTER. The DIP-84 impact printer, intended for use with mini- and microcomputers in data-processing and personal-computing applications, prints at 100 cps in a 7 × 7 or 14 × 7 dot matrix. Features include a 96 ASCII upper- and lower-case character set, bidirectional printing and operation with roll or fanfold paper 2.5- to 9.5-in. wide. The unit's tractor-feed mechanism is controlled by a stepping motor. OEM price is $575. **DIP, Inc.,** Boston, Mass. **Circle No 281**

PRINTER/PLOTTER FOR NCR 8200. The T-8200 impact dot-matrix printer/plotter system for use with NCR 8200 minicomputers is said to provide, for half the price, more capabilities than the NCR band printer. The software-selectable unit, which can be used in business applications for graphs, bar code symbols and labels, plots 60 × 72 dots per in. at 33 in. per minute. Other features include a 96 ASCII upper- and lower-case character set, a static eliminator, a forms-length switch accommodating one to 99 lines and a self-test switch. Price is $7630 including a pedestal, a paper basket and a common trunk interface. **Trilog, Inc.,** Irvine, Calif. **Circle No 282**



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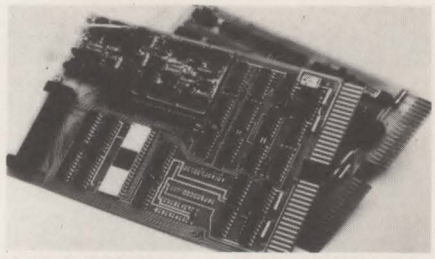
CIRCLE NO. 132 ON INQUIRY CARD

interfaces and controllers

FLOPPY-DISK DRIVE CONTROLLER. The model 8272 floppy-disk drive controller, which interfaces as many as four double- or single-sided drives to a microprocessor, is claimed to offer hardware manufacturers parts count reductions as great as 20-to-one compared to conventional controller boards. The 40-pin 8272 is compatible with both the IBM 3740 single-density and System 34 double-density formats. Prices start at $38.10 in 100-lot quantities. **Intel Corp.,** Santa Clara, Calif. **Circle No 283**

SINGLE-BOARD SMD CONTROLLER. The model 3211 single-board disk controller, which emulates the DEC RM-02, interfaces any DEC PDP-11 minicomputer to as many as four SMD or SMD-compatible drives in any mix of capacities. Designed to mount in a single SPC slot, the controller directly accesses memory for all read/write block transfers. A 32-bit ECC detects single-burst errors as much as 22 bits long and corrects burst errors up to 11 bits per sector. The model 3211 requires only one Unibus load and may be strapped to any interrupt priority level, interrupt vector address and device register address. Price is $3950 in single-unit quantities. **Ball Computer Products,** Sunnyvale, Calif. **Circle No 284**

GRAPHICS DISPLAY CONTROLLER. Intended primarily for the OEM and system-builder markets, the microprocessor-based Lexiscope 4000 video display controller for Data General Nova and Eclipse computers can emulate standard display terminals as well as generate moderately high resolution graphics. Separate graphics and alphanumeric cursors and display memories enable independent programming, display and erasing of the graphic and alphanumeric screens. Graphic display resolution is 560 (horizontal) by 500 (vertical). Price is $2200 in OEM quantities. **Lexicon, Inc.,** Waltham, Mass. **Circle No 285**

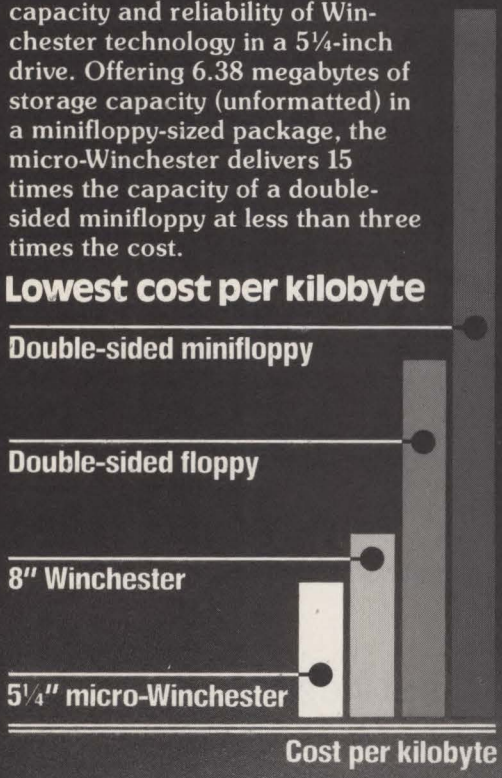


Q-BUS-COMPATIBLE INTERFACES. The model 11-0011 Q-bus-compatible interface enables DMA block transfers between as many as 255 LSI-11 microcomputers over a single coaxial cable as much as 32,000 ft. long. The network can be operated point to point or as a multidrop party line, using the SDLC communications protocol. The unit is packaged on two half-quad boards that plug directly into all LSI-11 backplanes. A one-megabaud model 30-0078 coaxial cable modem on one of the boards serves as the data transmitter and receiver. Price is $970 in quantities of 100. **Computrol Corp.,** Ridgefield, Conn. **Circle No 286**

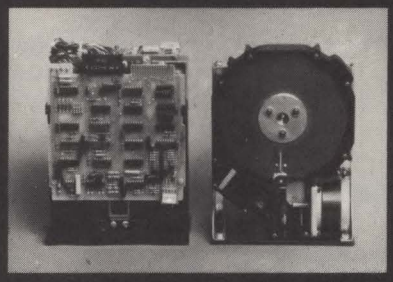
DISK ADAPTOR FOR TRS-80. The DC-504 Model II adaptor enables users of the vendor's DC-500 controller to attach as many as four 2.5M- to 20M-byte cartridge-disk drives to a TRS-80 microcomputer. Claimed to be the first product of its type, the DC-504 adaptor with a DC-500 controller and all cables costs $1500 in single-unit quantities. **Cameo Data Systems, Inc.,** Anaheim, Calif. **Circle No 287**

Al Shugart delivers the first 5 1/4-inch micro-Winchester

The developer of the original OEM floppy has done it again. He has packaged the performance, capacity and reliability of Winchester technology in a 5¼-inch drive. Offering 6.38 megabytes of storage capacity (unformatted) in a minifloppy-sized package, the micro-Winchester delivers 15 times the capacity of a double-sided minifloppy at less than three times the cost.



The perfect marriage– Minifloppy and micro-Winchester



Use micro-Winchester with a minifloppy. Get Winchester's faster access time and data rate. Average access time is 170 milliseconds, almost twice as fast as the minifloppy's 298 milliseconds. Data rate? In one second, the micro-Winchester transfers five megabits compared to the minifloppy's ¼ of a megabit. Save your minifloppy for low-cost backup and system I/O.

It's easy to integrate micro-Winchester with your existing minifloppy-based system. Like the minifloppy, the micro-Winchester has dimensions of 5¾" by 3¼" by 8". It uses the same voltages (+12 and +5) and requires no A.C. power.

The micro-Winchester is real. You can see hard-tooled production models while at NCC. For an invitation and a comprehensive technical brochure, check our readers' service number or call Finis Conner.

Shugart Technology

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CIRCLE NO. 134 ON INQUIRY CARD

New Products

INTELLIGENT CONTROLLER FOR IEEE-488 BUS. The MSC-1088 single-board controller, intended primarily for use in small-business systems and microcomputer-based instrumentation, interfaces the IEEE-488 bus to as many as two Shugart Associates SA4000 series Winchester drives. Features include error checking and correction (ECC), write protection, automatic and head cylinder switching, relative addressing, automatic seek to alternate tracks and verification of disk positioning and buffer data. Price ranges from $2650 in single-unit quantities to less than $2000 in OEM quantities. **Microcomputer Systems Corp.,** Sunnyvale, Calif. **Circle No 288**

INTELLIGENT COMMUNICATIONS CONTROLLER. DIOS (DMA I/O Subsystem) is an intelligent communications controller that provides DMA facilities between main memory and the vendor's hardware communications adaptors. DIOS is available in two versions. The first supports BISYNC and asynchronous protocols; the second version, intended for users with concurrent data communications requirements, also supports character-synchronous protocols and the bit-synchronous protocols, such as SDLC, HDLC and ADCCP, which require zero-bit insertion/deletion. Other features include support of data rates as high as 56 kilobaud per line, for peak throughput of 100,000 cps. DIOS costs $6000 or $7500, depending on the version selected. **Perkin-Elmer Computer Systems Div.,** Oceanport, N.J. **Circle No 289**

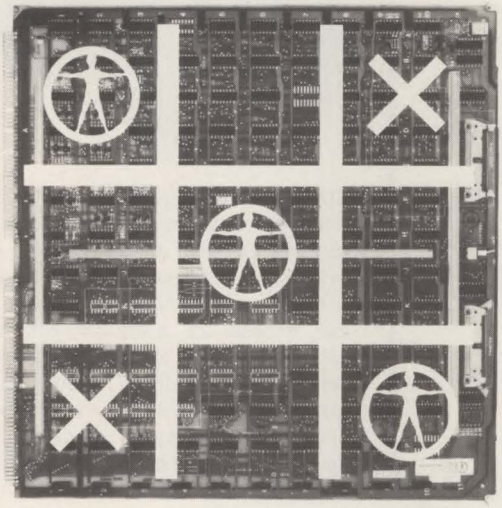
PRINTER CONTROLLER. The DLP-11 printer controller provides interfaces for Dataproducts, Centronics and DEC LA-180 printers. An on-board switch-selectable long-lines option enables data transmission to a printer as much as 3000 ft. from the computer. The controller has an exclusive self-test capability that simplifies installation and maintenance. **Datasystems Corp.,** San Diego, Calif. **Circle No 290**

services

COMPUTER-BASED MICROPROCESSOR COURSE. This course enables those with no previous computer experience to learn the principles of microprocessors through a computer-based education program. Called "Microprocessors: A Short Course," the training takes place by means of Control Data Corp.'s PLATO system. The course is held at television-like terminals at one of 20 Control Data Institutes or at terminals installed on the premises of the user's employer. Approximately 25 percent of the time in the course is spent on using the PLATO terminals, 55 percent on individual study using texts and 20 percent in the laboratory. Prices start at $595. **Control Data Corp.,** Minneapolis, Minn. **Circle No 291**

ENGINEERING SERVICES DATA BASE. The Design Professions Technical Specialties Index (DPTSI) data base—the result of a recently announced agreement between the National Society of Professional Engineers (NSPE) and Control Data Corp.—is a mechanism for finding engineering talent and solving engineering problems. The index is open for subscription to individual engineers; engineering, construction and industrial firms; universities; and government agencies at a cost of $60 per unit for NSPE members and $75 for nonmembers. **Control Data Corp.,** Minneapolis, Minn. **Circle No 292**

Choosing a Line Printer Controller is more than a game.



Doing what you did the last time isn't always the best move. Not when the wrong choice can mean delivery delays or weeks of expensive down time.

The next time you specify a Line Printer Controller for your DEC or Data General system or one that emulates them, consider these factors:

Self Testing

This is a unique Datasystems feature. It allows you to verify controller, cable and printer operations.

12 Month Replacement

Another feature unique to Datasystems units. After testing in the host computer, we warranty immediate replacement for one full year.

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All Datasystems units are functionally operational with any DEC or Data General system or systems emulating them.

Quality Assurance

Datasystems units use only high quality components and are subjected to a 48-hour burn-in before delivery.

Simple Installation

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Software Transparent

Datasystems controllers are totally transparent to the host computer's operating system and diagnostics.

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Take the gamble out of your selection process. For more complete information on prices, features and delivery of Datasystems' line printer controllers write or call us today.

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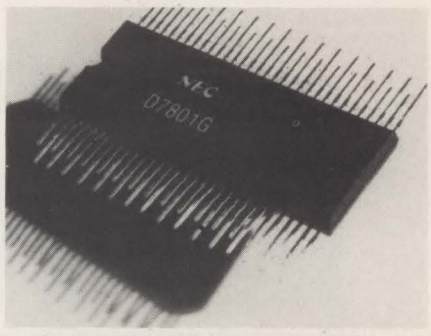
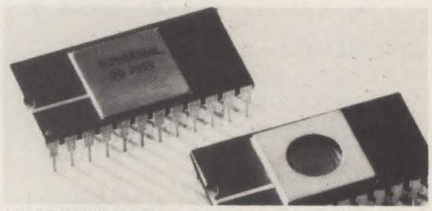
components



SINGLE-CHIP MICROCOMPUTER. The μPD7801 8-bit single-chip microcomputer contains 4K bytes of ROM, coupled with 128 bytes of on-chip RAM and two 8-byte register banks. It uses an 8080A-compatible bus and can access an additional 60K bytes of external memory. The μPD7801's instruction set (a combination of 8080A, Z80A and μCOM-4 instructions) provides block moves and nine addressing modes. Software development is via cross-assemblers that run on the vendors PDA-80 and Intel's MDS-200 series development systems. The 64-pin device costs $20 in volume. **NEC Microcomputers, Inc.,** Wellesley, Mass. **Circle No 293**

HIGH-SPEED ANALOG MULTIPLEXOR. The HI-516 16-channel analog multiplexor, intended for use in high-speed data acquisition systems such as those found in avionics, electronic warfare and industrial process control, can be used in single-ended or differential modes. Said to be the fastest monolithic analog multiplexor available, the device has an access time of 90 nsec. and a typical settling time of 800 nsec. Price is $61.37 in evaluation quantities. **Harris Semiconductor Products Div.,** Melbourne, Fla. **Circle No 294**



64K EPROM. The MCM68764 64K-bit EPROM, which is compatible with Motorola's 8K to 64K memory series, comes in a 24-pin package. Access time is 450 nsec.; power dissipation is less than 880 mw in the active mode and less than 140 mw in the standby mode. Prices start at $164 in 100-lot quantities. **Motorola Semiconductor Products, Inc.,** Austin, Texas. **Circle No 295**

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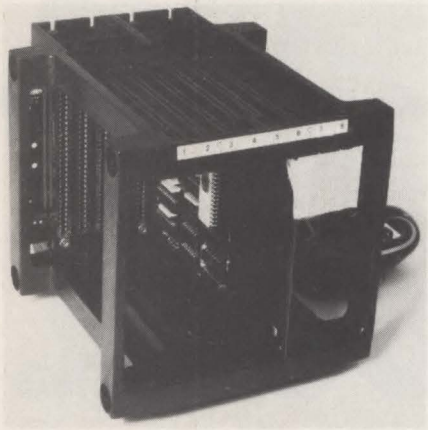
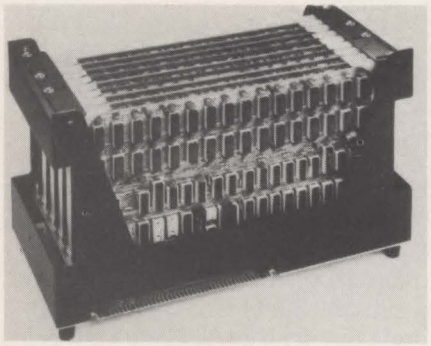
New Products



CARD RACKS WITH STD-BUS MOTHERBOARDS. The CR family of card racks contains STD-Bus motherboards and card edge connectors. Designed to hold all standard 4½- × 6½-in. STD-Bus integrated circuit cards, the racks are available in four-, eight- and sixteen-slot configurations. Open end panels and convection cooling promote long card life and high reliability. Prices range from $120 for a four-slot rack to $195 for a 16-slot version. **Pro-log Corp.,** Monterey, Calif. **Circle No 296**

FLOPPY-DISK DRIVE CONTROLLER CHIP. The 8272 floppy-disk drive controller chip, which interfaces as many as four single- or double-sided drives to a microprocessor, is compatible with both IBM 3740 single-density and System/34 double-density drives and their FM and MFM recording formats. The device can operate at 8 MHz. Price is $38.10 in 100-lot quantities. **Intel Corp.,** Santa Clara, Calif. **Circle No 297**



MULTIBUS CARD CAGE. The SBC 609 nine-slot card cage for Intel's iSBC-80 Multibus fits in the same space and has the same mounting configuration as two Intel four-slot card cages. The SBC 609 maintains the standard .6-in. card spacing, while providing for one two-level wirewrap card. Price is $410 in single-unit quantities. **Electronic Solutions, Inc.,** San Diego, Calif. **Circle No 298**

8-BIT MULTIPLYING DAC. The DAC-08 multiplying D/A converter is designed for use in 1-μsec. A/D converters, servomotor and pen drives, waveform generators, audio encoders and attenuators and CRT display drivers. The 8-bit monolithic device consumes 33 mW of power and interfaces to all popular logic families. High-swing, adjustable-threshold logic inputs provide full noise immunity. Prices in quantities of 100 start at $2.75. **Signetics Corp.,** Sunnyvale, Calif. **Circle No 299**

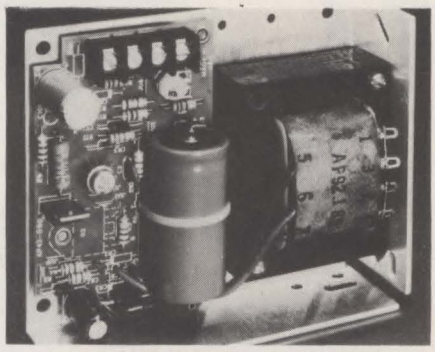
CRT MONITOR. The HR-1500 CRT display monitor can display more than 1920 characters in either white or green phosphor. The unit provides 400 active raster lines with a horizontal scan rate of 25 kHz, vertical step scan and dual intensity. The 15-in. nonreflective screen uses an etched, bonded faceplate to eliminate glare. Prices start at $260; a complete package with a monitor, cabinet and power supply costs $550. **Telex Computer Products, Inc.,** Tulsa, Okla. **Circle No 300**

EMITTER COUPLED LOGIC RAM. The DM10414 256-bit RAM, which uses emitter-coupled logic, has maximum and typical access times of 12 and 7 nsec., respectively. Packaged in a 16-pin ceramic DIP, the device is compatible with Fairchild 10414 and Motorola 10142 ECL RAMs. An unterminated emitter-follower output enables wired-OR interconnection in multiple-RAM arrays. The DM10414 costs $10.65 in 100-lot quantities. **National Semiconductor Corp.,** Santa Clara, Calif. **Circle No 301**

MONOLITHIC ADC. The TEC-1007J-M video-speed A/D converter is guaranteed to operate over a case-temperature range of −30° to +125°C and is available certified to any of the MIL-STD-883B environmental test conditions. Intended to replace discrete and hybrid circuits in high-performance military radar and image-acquisition systems, the 8-bit monolithic device can perform 30 million conversions per sec. while drawing only 2.5W of power. The TEC-1007J-M is packaged in a standard 64-pin DIP. Price is $781 in 100-lot quantities. **TRW LSI Products,** Redondo Beach, Calif. **Circle No 302**

power supplies

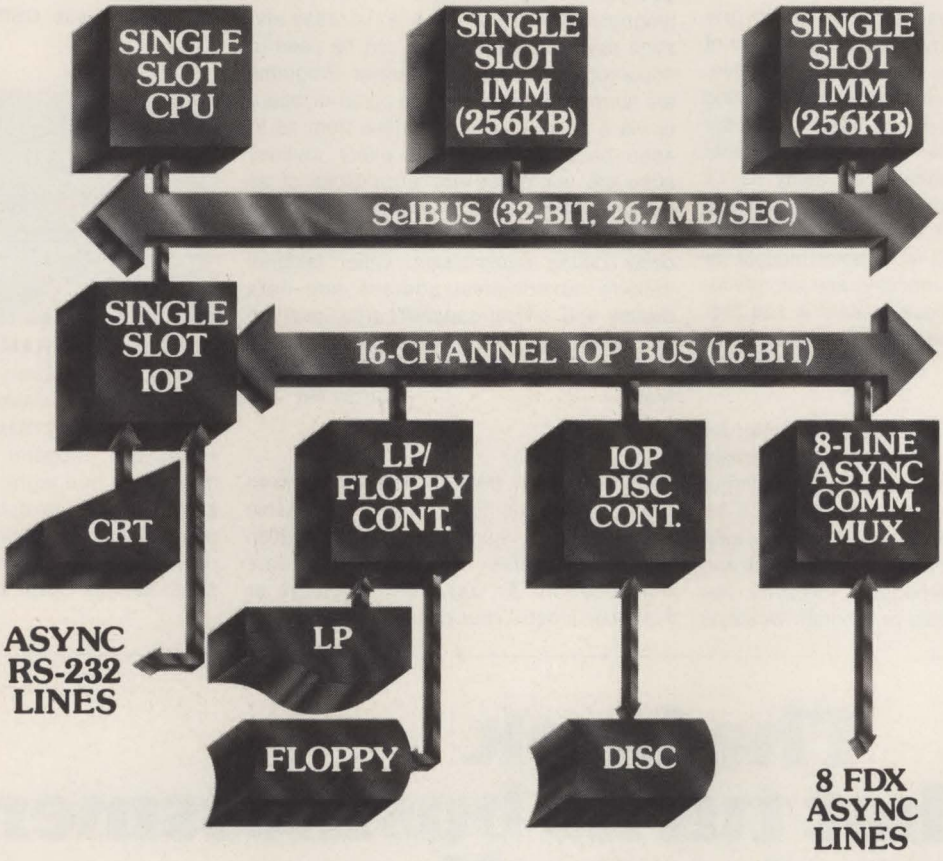
WINCHESTER POWER SUPPLY. The CP384 multiple-output DC power supply, designed specifically for Winchester fixed-disk drives, can handle most drives now on the market, including Shugart's SA1000 and SA4000 Series, the Century Marksman and the Micropolis Microdisk 1200 Series. The CP384 also provides power to operate the controllers offered by each manufacturer for its drives. Price is $120 in quantities of one to nine. **Power-One, Inc.,** Camarillo, Calif. **Circle No 303**



OPEN FRAME POWER SUPPLIES. The EAPS "U" series power supplies operate from 103V-130V/206V-260V/AC, 47-63 HZ inputs and provide DC outputs of 5V at 3A, 12V at 1.6A, 15V at 1.5A and 24V at 1A. Regulation for all devices is ±0.05 percent for line and ±0.1 percent for load; ripple is 5 mV peak-to-peak maximum. The units are no larger than 4 × 4.87 × 2.07 in. and cost $23.25 in single-unit quantities. **Adtech Power, Inc.,** Anaheim, Calif. **Circle No 304**

CONTROLLER AND POWER MODULE. The model 8960/2 controller and power module for EIA interfaces drives eight of the vendor's model 8906, 8909 or 8914 two-channel interface switching and monitoring modules. The unit includes power-supply redundancy with an audible alarm to indicate the fallback mode. The model 8960/2 enables a simultaneous switching of as many as 160 channels to A or B by a master A-B switch, computer command or the vendor's model 8930 remote control panel. The device costs $650. **International Data Sciences, Inc.,** Hallandale, Fla. **Circle No 305**

A low-end 32-bit mini designed for the OEM. Introducing CONCEPT/32™



The trouble with most small minicomputers is that they started out as big minis and were simply scaled down. Same functionality. Similar performance. Lower cost. (You've seen the ads). If you're an OEM, you also know those "minis" retained all their complexity. Big mini interfaces. Expensive memory. Costly device controllers. Complex architecture. A big machine, in a cumbersome cabinet. Functionality? Sure. But with all the problems still there for you to solve with your bucks.

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New Products

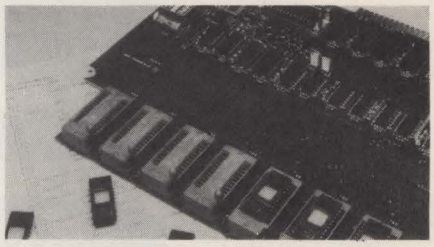
design aids

MC68000 DEVELOPMENT SYSTEM. The EXORmacs development system for the Motorola MC68000 comprises a microcomputer chassis with a basic complement of functional modules, an intelligent CRT terminal, a 132-column printer, 128K bytes of RAM and a 1M-byte dual floppy-disk drive. Software includes an advanced operating system, a symbolic-debug assembler/editor and a Pascal compiler. The system's internal card cage accommodates as many as 11 additional functional modules, enabling installation of extra interfaces, more than 1M-byte of RAM and an adaptor module for use with EXORciser modules and micromodules. Price for the basic system is $28,775. **Motorola Semiconductor Products, Inc.,** Phoenix, Ariz. **Circle No 306**

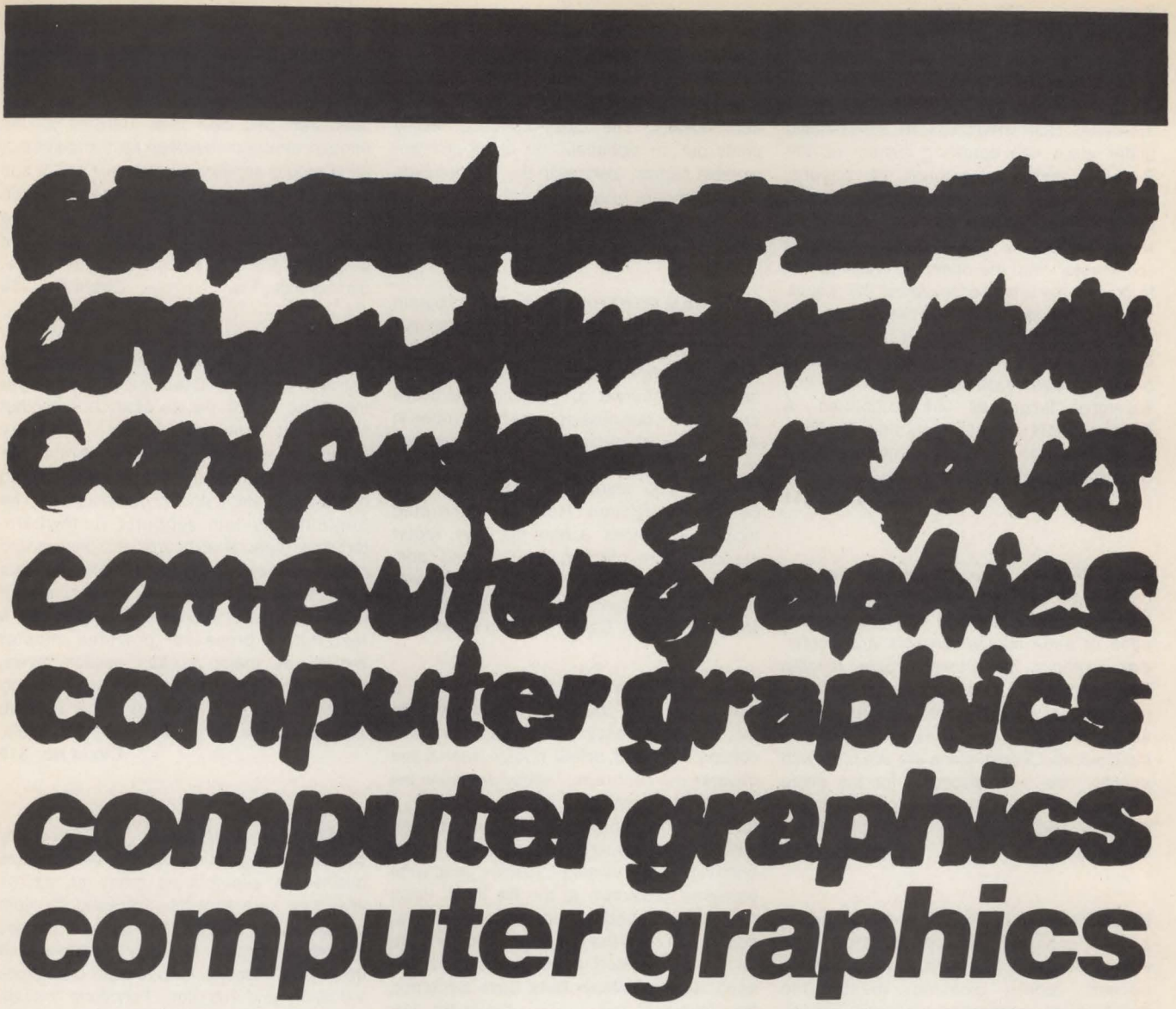
8088 ICE. The ICE-88 in-circuit emulator for use with Intellec microcomputer development systems facilitates testing and debugging of products based on the 8088 8-bit microprocessor. Features include breakpoints, display of parameter values, trace and disassembly. All debugging functions can refer to data, variables or program locations by symbolic names, eliminating the need to keep track of absolute addresses. The ICE-88 emulator module costs $5500. **Intel Corp.,** Aloha, Ore. **Circle No 307**

EPROM PROGRAMMER. The model 80 programmer for 2758, 2516, 2716, 2532 and 2732 single-supply EPROMs can be used to make copy EPROMs from a master. Programs are normally entered from the panel keyboard or via a serial interface at rates from 75 to 4800 baud. Serial error-recovery routines store the addresses and error types of as many as 32 locations where bit or character overruns, parity errors or illegal characters occur during transmission. Other features include hexadecimal address and data display and editing capabilities for insertion and deletion of data with resequencing prior to programming. **SMR Electronics,** Medfield, Mass. **Circle No 308**

PROGRAMMER PANEL. The model 7140 programmer panel for MAP array processors provides direct visual access to information normally available only through software interrogation. An assembly-language or FORTRAN programmer can use the panel to inspect the status of input and output queues, as well as program counter information for individual internal AP processors. Single-step control of the CSPU simplifies debugging of control and nonarray functions, and all system flags can be monitored for condition. The model 7140, which mounts in a 19-in. RETMA rack, costs $1500. **CSP, Inc.,** Billerica, Mass. **Circle No 309**



EPROM PROGRAMMER BOARD. The model ZX-908 MULTIBUS-compatible programmer board is available in versions for Intel 2716, 2732 and 2732A EPROMs. The board, which can program 16K bytes in one operation, has eight zero-insertion-force EPROM sockets. An optional cabinet with a 5V power supply and cables enables stand-alone operation of the ZX-908 with an MDS. Price is $450. **Zendex Corp.,** Dublin, Calif. **Circle No 310**



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New Software

TRANSACTION PROCESSOR. RTP, running under IBM's RPS operating system on the Series/1, facilitates creation of screens, record formats and inter-program flow. Entered data is validated based on stored record definitions. If RTP detects errors, it "converses" with the operator, enabling him to correct the errors or to cancel the record. The meaning of each function key on the user terminal may be fixed for an entire session, or it may depend on the context of the screen being displayed. COBOL, PL/1, FORTRAN and assembly languages are supported. A license costs $7000, including training, documentation and maintenance. **Data Structures, Inc.,** New York, N.Y.
Circle No 311

UCSD PASCAL. The UCSD Pascal Adaptable System, an extension of UCSD Pascal, runs on microcomputers using 8080, Z80, 6502, 6800 or 6809 microprocessors and floppy-disk storage. Extensions enable random accessing of disk files, separate compilation of individual program modules, linkage of assembly-language routines and interactive input/output. License plans are available with quantity and OEM discounts for the entire package and for selected components. **Softech Microsystems, Inc.,** San Diego, Calif. **Circle No 312**

PROGRAMMING UTILITY. SPEED, written in BASIC, consists of approximately 100 subroutines and programs that handle file access, record blocking, master file maintenance, transaction entry/edit, inquiry, sorting and report printing on Wang 2200 VP and MVP computers. Fixed-length records of any size can be used and a file locaton index enables files to reside on any disk without program changes. SPEED supports direct and hashed random access. Files can be accessed sequentially by key or sorted on as many as seven fields. Reports can be printed immediately, added to a report stack for overnight printing or—on the MVP—printed in background mode to free the terminal. A perpetual license costs $3750 per CPU. **The Office Manager, Inc.,** Seattle, Wash. **Circle No 313**

CROSS ASSEMBLER. The XMACRO-86 cross assembler assembles 8086 code on 8080 or Z80 development systems running under the CP/M, ISIS-II or TEKDOS operating system. Assembly rate is 1000 lpm. Features include relocation, macros, conditional assembly and listing and loader control. Supplied with XMACRO-86 are the LINK-80 linking loader and CREF-80 cross reference facility. LINK-80 enables several programs to be loaded with one command; external references between modules are resolved autcmatically. The cross-reference facility prints out an alphabetic list of all program variable names, along with the line numbers where they are referenced and defined. The package costs $300. **Microsoft,** Bellevue, Wash. **Circle No 314**

PROGRAM GENERATOR. A BASIC program generator, claimed to increase programmer productivity by 300 percent, uses a predefined data dictionary and a question-and-answer format to generate interactive programs for business applications. Written in BASIC, the system provides file-maintenance or report programs directly, as well as the structure and standard routines for more complex programs. Routines generated include I/O handler, screen manager, report section, error handler, inquiry, and add, change and delete functions. The package eliminates user coding of subroutines. **Quest, Inc.,** San Rafael, Calif. **Circle No 315**

DATA BASE MANAGEMENT. HDBS, a hierarchical data base management system for the Z80, 6502 and 8080, includes commands to add, delete, update, search and traverse the data base. Users can define set relationships between record types in a number of different ways, including sorting on various keys and FIFO, LIFO, NEXT and PRIOR orderings. The system provides read/write password protection at the file level. HDBS routines are callable from BASIC, FORTRAN, COBOL and machine language. Price is $250 for the Z80 version, $325 for the 6502 and 8080 versions. **Micro Data Base Systems, Inc.,** Lafayette, Ind. **Circle No 316**

DISK OPERATING SYSTEM. The I/OS disk operating system is designed for 8080, 8085 and Z80 disk-based CPUs. A library of terminal-, device- and disk-driver modules is used to tailor I/OS to specific hardware configurations. File capacity exceeds 268M bytes on as many as 15 drives. Features include print spooling, autostart and capability to disable user abort sequences. Utilities include a symbolic debugger, a text editor, directory status, disk-copy and file tranfer programs, disk and memory diagnostics and a printout formatting facility. Price is $150, plus a nominal dealer configuration fee. **InfoSoft Systems, Inc.,** Westport, Conn. **Circle No 317**

CPM/IBM CONVERSION. The CPM/IBM Translator, a diskette utility for 8080- or Z80-based CP/M systems, converts 8-in. diskettes from CP/M files to IBM data sets and vice versa. A user can initialize diskettes to IBM 3740 Data Recorder and 3540 I/O Unit specifications, display sectors in ASCII, EBCDIC and hex dump formats and manipulate IBM directories and data sets. Transfer options enable conversion between ASCII and EBCDIC, CP/M record and IBM sector ,CP/M sector and IBM sector, as well as upper-case translation and nongraphic character conversion. The utility can also handle multiple diskette IBM data sets. Price is $145. **Genus Software,** Jacksonville, Fla. **Circle No 318**

APPLICATION DEVELOPMENT. The Advanced Application Development System for the Radio Shack TRS-80 Model II computer includes a data base handler, a display control monitor, indexed-sequential file support, a BASIC compiler - interpreter, an operating system and documentation. The operating system supports Spinwriters, terminals, special keyboards, line printers and plotters. A screen manager performs data entry, editing, titling and menu creation/update. To assist in document preparation, a text output processor provides chapter breaks, as many as four section levels, pagination and titling and can automatically generate a table of contents. Price is $595. **The Software Firm, Inc.,** Denver, Colo. **Circle No 319**

INVENTORY CONTROL. This inventory control package for small- to medium-size businesses supports as many as 32,767 inventory item records, accessed by item number. An "auditability option" creates hard-copy records of stock additions and depletions. Reports include Item List, Stock Valuation and Reorder. Functions include adding to and depleting from stock, deleting items no longer carried, adding new items to stock and keeping track of quantities on hand, quantities on order, quantities back-ordered and inventory values. The package runs on microcomputers using the CBASIC2 language under the CP/M operating system, with dual floppy-disk drives and 48K bytes of user memory. **Structured Systems Group,** Oakland, Calif. **Circle No 320**

MASTER CATALOG. This Master Catalog Program keeps track of files on diskettes in use on a microcomputer running under the CP/M operating system. The program produces a listing of file names in alphabetical order, with the name of the disk containing each file. A SUBMIT command can be used to list directories of selected diskettes. The package also includes a program that sorts the directory in alphabetic order, and other programs list the directory in three or four columns, showing each file's size and the available space left on disk. Source and object programs with instructions cost $10. **Elliam Associates,** Woodland Hills, Calif. **Circle No 321**

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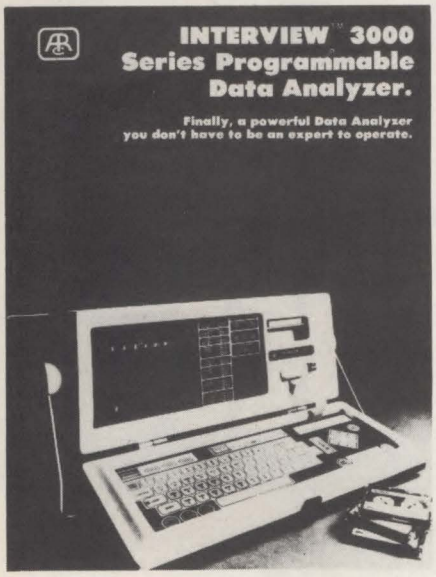
CIRCLE NO. 141 ON INQUIRY CARD

New Literature

CUSTOM DISPLAY TERMINALS. The 5100S and 5100E custom display terminals are detailed in a brochure. The publication describes the standard and optional specifications of the 12-in. 5100S and the 15-in. 5100E. The brochure also includes photos and a comparison chart that lists character number, screen format, character set, interface options and other characteristics of the two systems. **Data General Corp.**, Westboro, Mass. **Circle No 322**



DATA ANALYZER. The INTERVIEW 3000 series of programmable data analyzers is detailed in a brochure. The publication explains the system's self-teaching displays, color-coded keyboard and nonsequential programming. The booklet also covers the use of training tapes for async, bisync and bit-oriented protocols. **Atlantic Research Corp.**, Alexandria, Va. **Circle No 323**

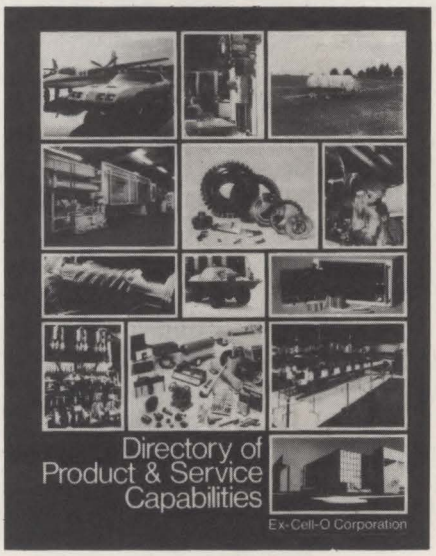
POWER TRANSISTORS. The 1030/1090 MHZ NPN power transistors are described in a data sheet. The literature details typical amplifier lineups for the transistors, which are designed for transponder/interrogator avionics applications. The publication also includes diagrams on device dimensions and physical characteristics. **Acrian, Inc.**, Cupertino, Calif. **Circle No 324**

DESIGN AND MANUFACTURING SYSTEM. The DDM (design, drafting and manufacturing) system, a computer-aided graphics system, is described in a brochure. The 16-page booklet details the process of computer-aided geometry construction, model documentation and manufacturing. The catalog also lists the system configuration and explains finite element analysis, design analysis language, hidden line removal and drawing layout capabilities. **Calma**, Sunnyvale, Calif. **Circle No 325**

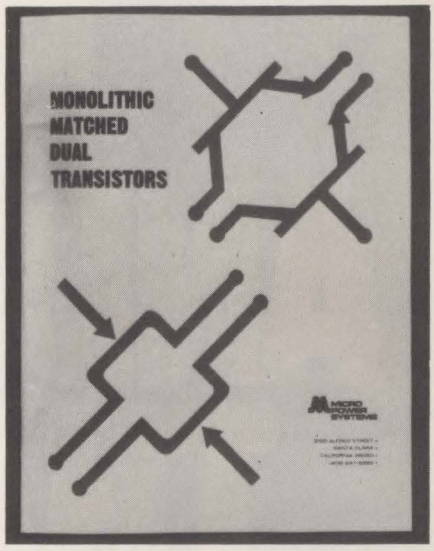
DATA COLLECTION SYSTEM. The MICRCOM, a dedicated remote MICR data collection system is detailed in a booklet. The illustrated publication lists the system's probable applications, which include banks and holding companies with remote branches and service bureaus that provide correspondent services. The booklet also details software and hardware, configurations and peripherals and the system's document entry, proof and transit and communications subsystems. **Honeywell Information Systems**, Waltham, Mass. **Circle No 326**

VIDEO DISPLAY TERMINAL. The DASHER D/100 and D/200 video display terminals are detailed in a brochure. The pamphlet describes the design and compatibility characteristics of the system, which is intended for use with the vendor's commercial systems, Nova, microNova and Eclipse computers. **Data General Corp.**, Westboro, Mass. **Circle No 327**

DATA BASE MANAGEMENT SYSTEM. The RTFILE user-oriented data base management system is described in a pamphlet. The four-page publication covers file management, creation, CRT screen format management, data management and report generation capabilities. **RDA, Inc.**, Beltsville, Md. **Circle No 328**



PRODUCTS AND SERVICES. A listing of products and services is provided in a directory. The four-page catalog includes information on the vendor's aerospace components, agricultural equipment, automotive components, contractors' equipment, electronics, gear and power transmission, metal-working equipment, ordnance, packaging systems, plastics and woodworking equipment, precision manufacturing and quality assurance equipment. The brochure also lists the addresses and phone numbers of offices that have product information. **Ex-Cell-O Corp.**, Troy, Mich. **Circle No 329**



MONOLITHIC MATCHED DUAL TRANSISTORS. Monolithic dual PNPS, NPNS and N Channel J-FETS are described in a catalog. The 44-page booklet details specifications, performance and parameters, including matching characteristics, high gain values, power dissipation, low output capacitance, log conformance, drift, noise and transconductance. The catalog also provides product comparison charts and tables and drawings showing lead and bonding pad designations. **Micro Power Systems, Inc.**, Santa Clara, Calif. **Circle No 330**

INTERCONNECT SYSTEM. The Multi-Term Interconnect System line of insulation displacement connector products is described in a catalog. Products listed include ribbon cables, bonded cable and bonded twisted pairs, assembly tooling and interconnect assemblies. The 24-page, illustrated publication details the electrical and mechanical specifications of header and socket connectors, DIP and PC connectors, edgeboard PC connectors and other products. The catalog also discusses dimensional data and parts numbering. **Stanford Applied Engineering, Inc.**, Santa Clara, Calif. **Circle No 331**

MICRONOVA SYSTEMS. The microNova line of chip-level processors, single-board computers and microcomputers are detailed in a brochure. The 20-page publication discusses the systems' peripherals, industry-standard communications, comprehensive development and runtime software. **Data General Corp.**, Westboro, Mass. **Circle No 332**

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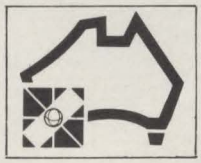

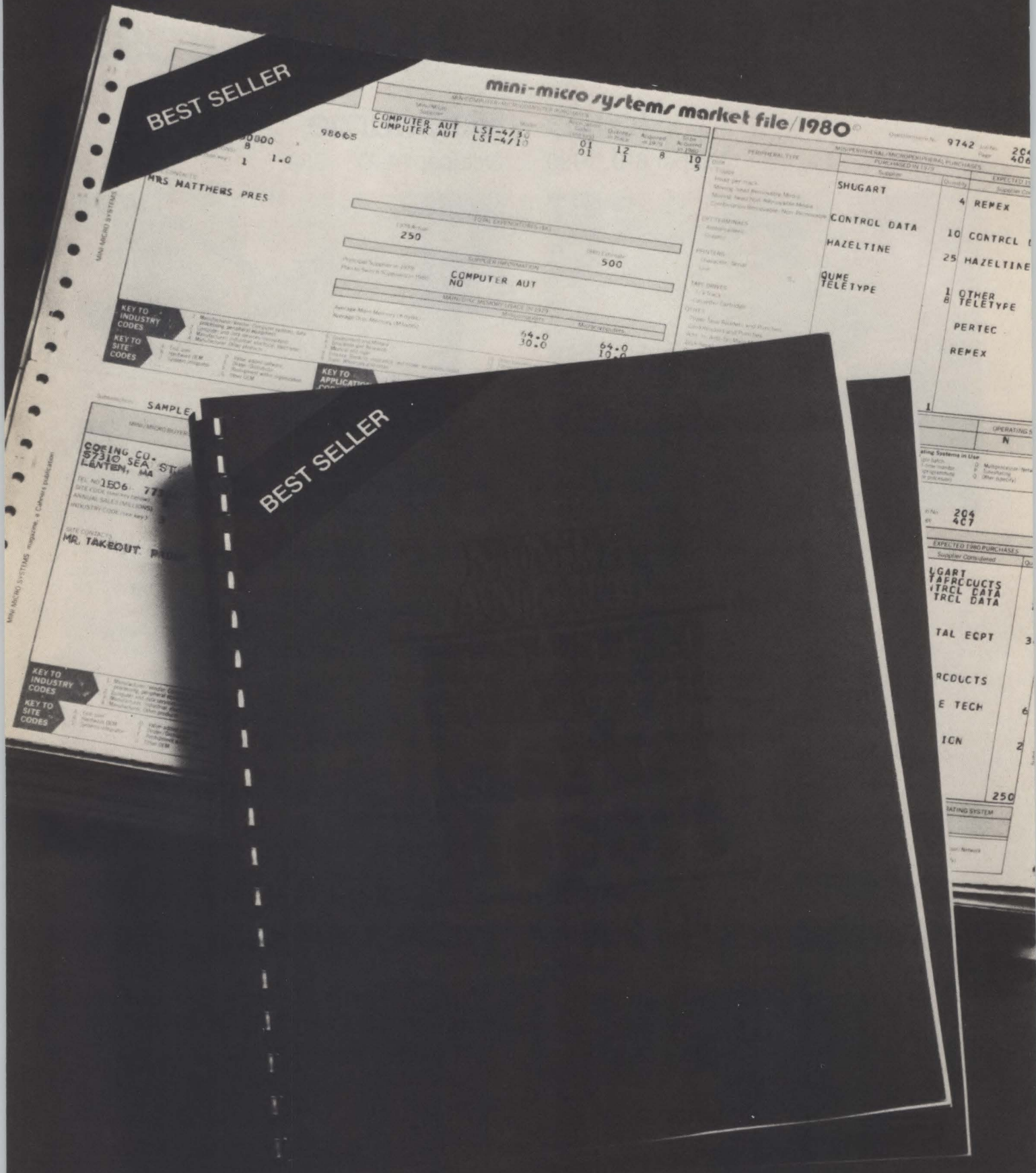
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1979 purchases	1980 buying plans		1979 purchases	1980 buying plans	
20,915	25,481	Minicomputers	56,439	69,099	Floppy disk drives
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58,965	71,676	Alphanumeric CRT terminals	38,762	48,709	Printers and teleprinters
4,882	6,993	Graphic CRT terminals	3,126	3,528	Data acquisition systems
6,002	7,451	Open reel tape drives	19,493	24,918	Modems
3,566	6,461	Tape cassette and cartridge drives			

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The CPU employs three micro-processors, the 6502, the Z-80 and the 6800. And the processor bus has been designed so new, more powerful micros (like 16 bit CPU's) can be added to the system later on.

There are also 10 open slots in the basic C3-C. The system supports up to 768K bytes of memory, in a multi user configuration.

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For those who require even more hard disk storage, Ohio Scientific offers another microcomputer in the C3 Series, the C3-B. Its specifications are the same as those of the C3-C. However, the C3-B offers a 74 Megabyte Winchester drive.

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