Mini-Micro Systems

A CAHNERS PUBLICATION

MARCH 1981

DATA COMMUNICATIONS: 'Private' packet switching

Local coax networks

Rolm's digital CBX

We've got your number in 1981. It's 6450.

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The ¼" cartridge recorder that thinks it's a ½" tape deck.

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CIRCLE NO. 136 ON INQUIRY CARD

Model 6450 shown in service position.

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If you would like more information on the Models 785 and 787 Portable Data Terminals, contact the TI sales office nearest you or write Texas Instruments Incorporated, P.O. Box 1444, M/S 7884, Houston, Texas 77001 or phone (713) 373-1050.

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CIRCLE NO. 1 ON INQUIRY CARD

INTRODUCING

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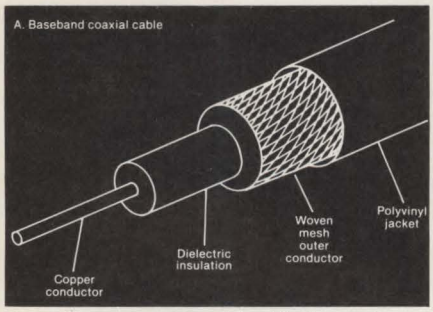
CIRCLE NO. 2 ON INQUIRY CARD

Rolm Corp.'s computerized digital-telephone system integrates voice and data communications (see p. 34). Cover photograph by Curt Fisher, design by Bonnie Butler, courtesy of Rolm Corp.

Page 50 . DG's de Castro takes a look ahead



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VBPA ABP

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BEST PICTURE OF 1981.

It's easy to see why our new CIT-101 video terminal stands out. Along with plug-compatibility to the DEC® VT100 and other 132-column models, you get the best picture on today's video scene.

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Your operators are also helped by our "no-scroll" key status indicator, a set-up mode dictionary display, plus an unrestricted 9600 BAUD transmission. So instead of making do with last year's show, pick the 1981 winner for best picture. The CIT-101 by C. Itoh. Just contact our exclusive representative and find out how fast we can be: ACRO Corporation, 18003-L Skypark South, Irvine, California 92714; Telephone (714) 557-5118.

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Breakpoints

MODCOMP SETS SIGHTS ON VIEWDATA MARKET

Look for Modular Computer Systems, Inc. (MODCOMP), to enter the embryonic U.S. viewdata market next month. As its initial offering, the Fort Lauderdale, Fla., computer maker plans to announce a family of turnkey viewdata systems at the Viewtext '81 conference in Alexandria, Va., which will be held April 23 to 24. The as-yet-unnamed systems will include software, processors, memory, mass-storage devices and information-provider terminals. The only hardware not included in the Modcomp systems will be the information-user terminals, says Scott McClary, business manager for communications at Modcomp. Although prices on the systems have not been set, McClary says that an entry-level system that supports 100 information-user terminals will start at about $250,000.

SEAGATE MICRO-WINCHESTER GAINS A SECOND SOURCE

Seagate Technology was first on the market last spring with a 5¼-in. Winchester-disk drive. Now the Scotts Valley, Calif., firm is about to score another market coup by becoming the first micro-Winchester maker to gain an alternate source for its product. On March 20, Texas Instruments Inc. will unveil its own version of the Seagate ST500 drive, for which it received manufacturing rights from Seagate. The TI version has the same specifications as the Seagate unit and appears to be comparably priced at $1490 in single-unit quantities. Initial deliveries are slated to begin in the second quarter, a company spokeswoman says.

PERKIN-ELMER TO ENTER WINCHESTER-DISK MARKET, ADD TWO SUPERMINIS

Perkin-Elmer Corp. will enter the Winchester-disk market in early May with an 8-in. cartridge disk drive that was developed in-house at its memory products division, Garden Grove, N.J. Positioned against Control Data Corp.'s Lark, the drive contains 16M-byte fixed and 16M-byte removable disks. OEM pricing has not yet been determined. Two 32-bit processors are also waiting in the wings at the company's computer systems division, Oceanport, N.J. The model 3230, to be announced this month, is a mid-range supermini with 8M bytes of memory. Priced between $36,000 and $100,000, it will compete with Digital Equipment Corp.'s VAX 11/750 and 780. A second processor, code-named "Schooner," will follow in early May.

FIXED/REMOVABLE MICRO-WINCHESTER IS UNDER DEVELOPMENT

The industry's first 5¼-in. fixed/removable Winchester-disk drive could be available in evaluation quantities from Santa Barbara, Calif., start-up DMA Systems Corp., by year-end. Tagged the Sage 55, the drive will offer 5M bytes of fixed storage tied to a 5M-byte disk cartridge. The drive will fit the cut-out dimensions of Shugart Associates' SA450 minifloppy, but will be several inches longer in order to accommodate an actuator driven by a linear voice-coil motor. The drive will use an embedded servo, and will incorporate a proprietary DC spindle motor. Production versions are scheduled for the second quarter of 1982.

BUBBLE CASSETTE EXPECTED FROM INTEL BY YEAR-END

Further details have emerged concerning Intel Corp.'s upcoming bubble memory cassette system (see "Removable bubble memories move into new markets," p. 49). Intel expects to begin delivering the 1M-byte bubble memory cassette the second half of the year. Called "Plug-A-Bubble," the cassette incorporates the Santa Clara, Calif., firm's 7110 1M-byte bubble device, the 7220 bubble controller and associated support circuitry in a ruggedized metal case not much larger than a paperback book. The cassette holders, which plug the device into the host systems, are also included. An interface to Intel's SBC board-level computer product family is optional. Price will be about $3000 in 100-unit quantities.

ZILOG ANNOUNCES 16-BIT μP DEVELOPMENT SYSTEMS

Zilog Corp. has introduced its first 16-bit μc-based development system. Called Z-Lab 8000, the new system incorporates Zilog's 16-bit model Z8001A processor and is controlled by an enhanced UNIX-type operating system, which Zilog has dubbed "Zeus." The system, which

will support Zilog's Z8000 and Z8 processors initially, comes in two versions: the model 20, which accommodates as many as four users, and the model 30, which supports 16 users. Prices start at $27,000 and $33,900 for the models 20 and 30, respectively. System software, including the Zeus operating system, high-level languages (Pascal, C, PLV-SYS), assemblers and utilities, is priced separately at $2000. Deliveries will begin in November.

INTERMETRICS ENTERS μC SOFTWARE MARKET

Looking for new markets to conquer, Intermetrics Inc. will introduce its first non-custom software product this month. Until now, the Cambridge, Mass., firm has specialized in developing custom software—notably high-level languages—for large industrial and governmental clients. The company's first non-custom product is a Pascal compiler that runs on a minicomputer and produces code for 16-bit μcs. Initially, the new cross-compiler will run on DEC PDP-11 series minicomputers under RSX-11 or UNIX operating systems, and will support Intel 8086 μcs. However, Intermetrics plans to add support for the Motorola 68000 this fall, and is considering rehosting the compiler to other minicomputers such as the Data General Eclipse, says Ron Cole, director of Intermetrics' software systems division, which was recently formed to market the company's non-custom products. The compiler will sell for about $15,000, Cole says.

ADDS WILL UNVEIL LOW-COST CRT TERMINAL

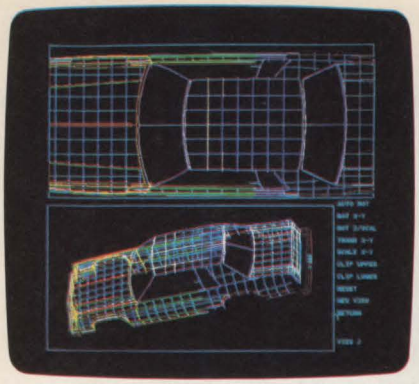
Moving to expand its market at the low end, Applied Digital Data Systems, Inc. (ADDS), will introduce its least expensive CRT terminal this month. Called Viewpoint, the new terminal will sell for $650 in single-unit quantities. That price includes a two-position tiltable screen, an 80-line × 24-character display capacity and six switch-selectable international character fonts—features usually associated with more expensive terminals, an ADDS spokeswoman says. Targeted at OEMs, the new terminal will be available in quantity immediately.

SONY READIES PERSONAL BUSINESS COMPUTER

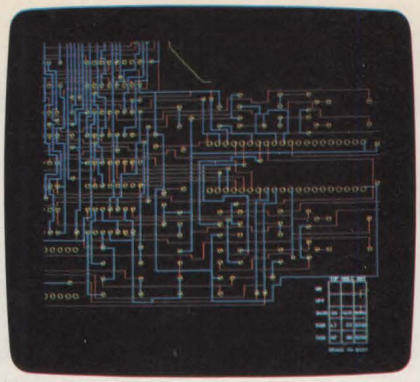
Sony Corp. will continue its expansion into the U.S. office electronics market next fall, when the Japanese electronics giant is expected to introduce the first member of a family of personal computers for businessmen. The Z80-based system will include a CRT monitor, keyboard, 64K-byte memory, RS232 interface and as many as four 437.5K-byte microfloppies, an industry source says. The system is expected to sell for less than $2000—a price that would put it squarely in competition with Apple Computer Inc.'s mainstay, the Apple II. Although the system is being developed primarily in Japan, some work is also being done at Sony's new technical design center in Paramus, N.J. Sony initially entered the U.S. market in December, when it introduced a stand-alone word-processing system and a 3½-in. floppy-disk drive.

NATIONAL REVEALS NS16000 SAMPLING SCHEDULE

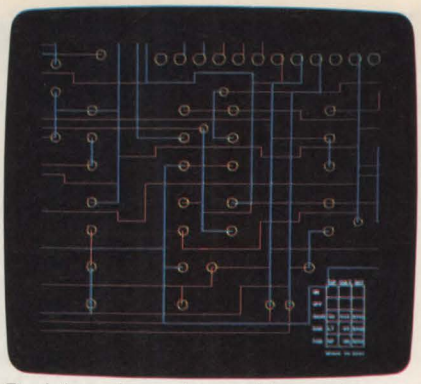
National Semiconductor Corp. has laid out a schedule for availability of samples of its NS16000 16-bit μp and associated peripheral chips. The schedule for this year is as follows. Second quarter: model 16032 CPU chip and model 16201 clock chip. Third quarter: in-circuit emulator for the 16032 CPU. Fourth quarter: model 16016 CPU chip (supports both 8080 and NS16000 native code), model 16082 memory management unit and model 16202 interrupt control unit. Although National hopes to be producing the 16032 CPU chip in limited quantities by year-end, the company does not expect to be in full production until 1982, says Richard Sanquini, director of National's μp group. In addition, he says, a resident development system will not be available until June, 1982, although cross software for the 16032 will be available as early as the second quarter of this year.



Megatek's new Whizzard 6250 raster system makes advanced computer graphics more economical than ever.

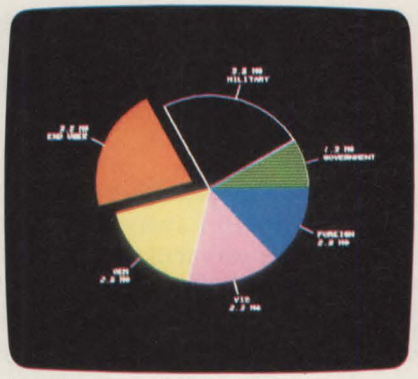


You can define your image in a 4096 x 4096 virtual space, with up to eight colors.

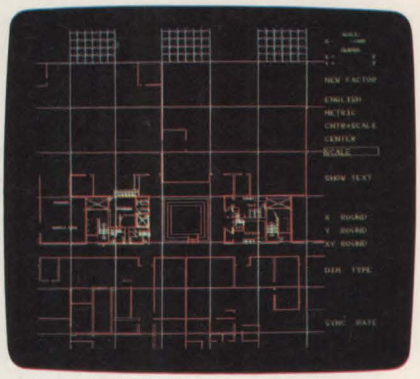


Real-time dynamics enable you to pan throughout this space, then zoom in with true scaling for added detail.

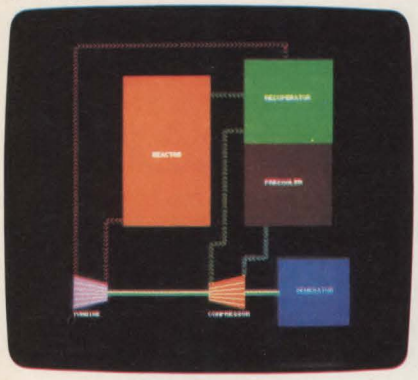
And our new system introduces you to low-cost, FORTRAN-based WAND software.



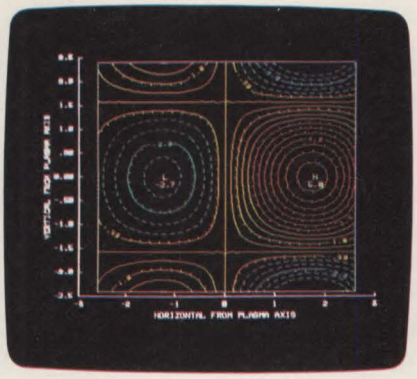
The Whizzard 6250 harnesses the power of Megatek technology for your business applications...



...for new flexibility in architecture and drafting...



...for an added dimension in process control...



...and wherever a visual presentation makes data easier to understand.

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The 6250 has its own version of easy to use WAND software. It's upward compatible to WAND 7200, software for our family of advanced systems and terminals.

MEGATEK

MEGATEK CORPORATION

The new Whizzard 6250 is the perfect starter system for end-users. OEM configurations are available too. Imagine all the possibilities. Better yet, write for all the facts. Megatek Corporation, 3931 Sorrento Valley Blvd., San Diego, CA 92121. 714/455-5590. TWX 910-337-1270. Megatek International/Europe 11 Woudstraat, 4031 JA Ingen, The Netherlands. Telephone: 31 3443-2800. TWX 70619.

CIRCLE NO. 4 ON INQUIRY CARD

Breakpoints

SHUGART READIES NEW 8-IN. WINCHESTER

Shugart Associates reportedly will introduce a new family of 8-in. Winchester-disk drives in the fourth quarter. The SA1000F series will include a single-platter, 10M-byte drive; a dual-platter, 21M-byte version; and a three-platter, 34M-byte drive, industry sources say. The drives will be an upgrade path for users of the company's 5M- and 10M-byte SA1000 8-in. Winchester. But the SA1000F will be more than an enhanced version of the earlier drive. The device will incorporate a voice-coil motor and track-following servo, instead of the low-cost stepper motor drive actuator used in the SA1000. Use of this design could push track densities to the 500-track-per-in. range and storage capacities to 7M bytes per surface. All three drives will be compatible with Shugart's SA1400 controller. Production models will be available during the first quarter of next year, sources say, but prices have not been set.

NIXDORF ADOPTS ETHERNET

Nixdorf has become the second major computer manufacturer to adopt the Ethernet office-communications network standard, developed jointly by Xerox, Intel and DEC. Hewlett-Packard adopted the standard last fall. Nixdorf will use Ethernet in-house for communications among its own data- and word-processing systems, and office equipment supplied by outside vendors. Ethernet will also give the company access to public TWX and Rapifax services and circuit-switching and packet-switching networks. According to company sources, Nixdorf will implement Ethernet in both its North American and European facilities as soon as LSI chips can be supplied by Intel.

RANDOM DISK FILINGS

IBM reportedly is on the prowl for 5¼-in. floppy-disk drives to augment production at a recently established Florida facility. According to one source, the mainframe giant is looking for more than 300,000 drives to be delivered over three years . . . Also at **IBM**: reports are circulating that an upgrade for the firm's line of 8-in. floppy-disk drives is being readied at the company's Rochester, Minn., facilities. One source says the new drive, code-named "Bright," will use a chromium-dioxide-coated media to double both bit and track densities without redesigning the drive actuators.

Look for a single-board disk/tape controller from Anaheim, Calif-based **Rianda Electronics, Ltd.,** to appear this month. Priced at $4500 in single-unit quantities, the controller will emulate existing hardware equipped with storage module drive (SMD) interfacing and will handle 8- and 16-in. Winchesters as well as ¼-in. tape cartridge drives . . . Evaluation versions of an intelligent Z80A-based controller for **SLI Industries'** "Cheyenne" 8-in. Winchester could be available by mid-year, say sources at the Woodland Hills, Calif., peripherals house.

First product offering from newly formed **TECSTOR** will be a 160M-byte, 14-in. Winchester designed as a replacement for DEC's recently announced 124M-byte RM80. Formal introduction of the new TECSTOR drive could come at the National Computer Conference, with production hardware planned for sometime this year. The new company will be located in Orange County, Calif., and will be headed by ex-**Microdata Peripherals** vice president Bud Bleininger . . . Pricing clarification: Some confusion may have arisen over the pricing listed for **Shugart Associates'** line of SA600 5¼-in. Winchesters (MMS, January, 1980, p. 20). Correct pricing in 500-unit quantities is $760 for the 3.33M-byte SA602; $980 for the 6.66M-byte SA604, and $1190 for the 10M-byte SA606.

Chatsworth, Calif., start-up **Computer Memories, Inc.,** will unveil its first offering—a 16M-byte, three-platter 5¼-in. Winchester—at the upcoming Hanover Fair, and plans to bring hardware to NCC in May. . . . First hardware from Westlake Village, Calif., start-up **Magnum** will be a ½-in., 1M-byte, 48-tpi, 8-in. floppy disk—the model 848-2. Magnum's first offering reportedly will be priced substantially lower than "standard" 8-in. floppies, and could be ready by NCC. Also in the works is a 96-tpi, 2.5M-byte version. Funding for Magnum comes from Chatsworth, Calif., peripheral vendor **Tandon Corp.**.

—John Trifari

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CIRCLE NO. 5 ON INQUIRY CARD

TI Announces E a Growin

Introducing the new DS990 Models 7, 9 & 29 with fixed and removable disk storage.

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Flexibility is not forgotten at TI. That's why each of these new DS990 computer systems feature disk storage systems with both fixed storage and a removable cartridge. Fixed disk storage allows easy access to day-to-day information, while removable cartridge disks let users change information when needed. The removable cartridge disk also provides users with a safe, easy, and inexpensive way to back-up information without purchasing another disk drive or magnetic tape drive.

Both the DS990 Models 7 and 9 combine these disks with the power and field-proven reliability of TI's 990/10 CPU. The DS990 Model 7 provides 16 fixed and 16 removable megabytes of disk storage. For greater storage capacity, the DS990 Model 9 includes a disk drive with 96 megabytes of storage — 16 removable and 80 fixed. Should you need it, a second identical disk can be added to either system on the same controller for additional storage.

The DS990 Model 29 features a new, low-profile, 60-inch cabinet and offers the processing power of TI's 990/12 CPU — the strongest central processing unit ever developed for a DS990 computer system. With one disk drive, the Model 29 provides 96 megabytes of storage — 16 removable and 80 fixed. And you can double your capacity by adding a second drive on the same controller.

New members of a proven family.

The DS990 Models 7, 9 and 29 fit right into the DS990 computer family. So you can upgrade your system at any time with a minimum of cost and effort, they're upward-compatible with the other members of the DS990 family— from the microcomputer-based Model 1 to the highly-advanced Model 30.

With proven software.

As members of TI's versatile DS990 family, the new Models 7, 9 and 29 are available

xtra Storage for g Family.

with proven software, including COBOL, BASIC, FORTRAN, RPG II and Pascal. They also have valuable time-saving software utilities, including a powerful data base management system with query and report-generation facilities as well as TIFORM, TI's uniquely efficient screen-formatting language. Word processing software is also now available to let these systems perform a wide variety of office-oriented tasks.

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FEATURE COMPARISON CHART

FEATURE	Visual 400	Lear Seigler ADM-42	Perkin Elmer 1251	ADDS Regent 60	Hazeltine Executive 80, Model 30	Beehive DM30
ANSI X3.64 Specified	STD	**NO**	**NO**	**NO**	STD	**NO**
Set-up Modes Eliminate External Switches	STD	**NO**	STD	**NO**	**NO**	**NO**
Typomatic Solid State Keyboard	STD	**NO**	**NO**	**NO**	STD	**NO**
Detached Keyboard	STD	STD	**OPT**	**NO**	STD	STD
CRT Saver	STD	**NO**	**NO**	**NO**	**NO**	**NO**
Block or Underline Cursor	STD	**NO**	STD	STD	STD	**NO**
80 and 132 Columns	STD	**NO**	**NO**	**NO**	**OPT**	**NO**
Double Size Characters	STD	**NO**	**NO**	**NO**	**OPT**	**NO**
Smooth Scrolling	STD	**NO**	**NO**	**NO**	**OPT**	**NO**
Horizontal Split Screen	STD	**NO**	**NO**	**NO**	STD	**NO**
Video Attributes Require No Display Space	STD	**NO**	**NO**	**NO**	STD	STD
8 Area Qualifications	STD	**NO**	**NO**	**NO**	**NO**	**NO**
8 Resident Nat'l Char. Sets Including Line Drawing	STD	**NO**	**NO**	**NO**	**NO**	**NO**
Programmable Non-volatile Function Keys	STD	**OPT**	STD	**NO**	**NO**	**NO**
Display of ALL Control Codes	STD	STD	STD	STD	**NO**	STD
Insert Delete Line with Push Up or Down	STD	**NO**	**NO**	**NO**	**NO**	**NO**
Insert Delete Character with Push Right or Left	STD	**NO**	**NO**	**NO**	**NO**	**NO**
Select Editing Extent to Field, Area, Line, Page	STD	**NO**	**NO**	**NO**	**NO**	**NO**
20 mA Current Loop	STD	STD	**OPT**	**OPT**	**OPT**	STD
Programmable Message Framing (non-volatile)	STD	**NO**	STD	**NO**	**NO**	**NO**
Programmable Answerback	STD	**NO**	STD	**NO**	**NO**	**NO**
Baud Rates to 19200 BPS	STD	**NO**	**NO**	**NO**	STD	STD
Independent Xmit/Receive Rates	STD	**NO**	**NO**	**NO**	**NO**	**NO**
Printer Port Independent of Communication Interface	**OPT**	**OPT**	STD	STD	**OPT**	STD
Paging	**OPT**	STD	**NO**	**NO**	STD	STD

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CIRCLE NO. 124 ON INQUIRY CARD

Intel puts mainframe power on chips

After five years of not-so-secret development in Aloha, Ore., Intel Corp. detailed its 32-bit μp family during February's International Solid State Circuits Conference (ISSCC) in New York. As expected, the Intel iAPX 432, which is based on a three-chip set and is dubbed a micro-mainframe, forsakes compatibility with earlier products in favor of a new and powerful architecture (MMS, September, 1979, p. 19).

The 432 is distinct in many ways: it is a 32-bit processor in that it uses 32-bit words, data paths and registers; it has the computing power of a mid-range mainframe; many of its applications reportedly do not exist yet; it employs an object-oriented architecture and language to support multiprocessors; it uses other Intel μps, peripheral controller chips and memories as attached devices; it embeds some traditional operating system scheduling functions in silicon; each of the three chips is housed in a 64-pin quad in-line package (QUIP), rather than the widely-used dual in-line package (DIP), and together the three chips integrate more than 200,000 devices; and various bus implementations will be announced by Intel, because bus size can vary from 8 to 256 bits wide.

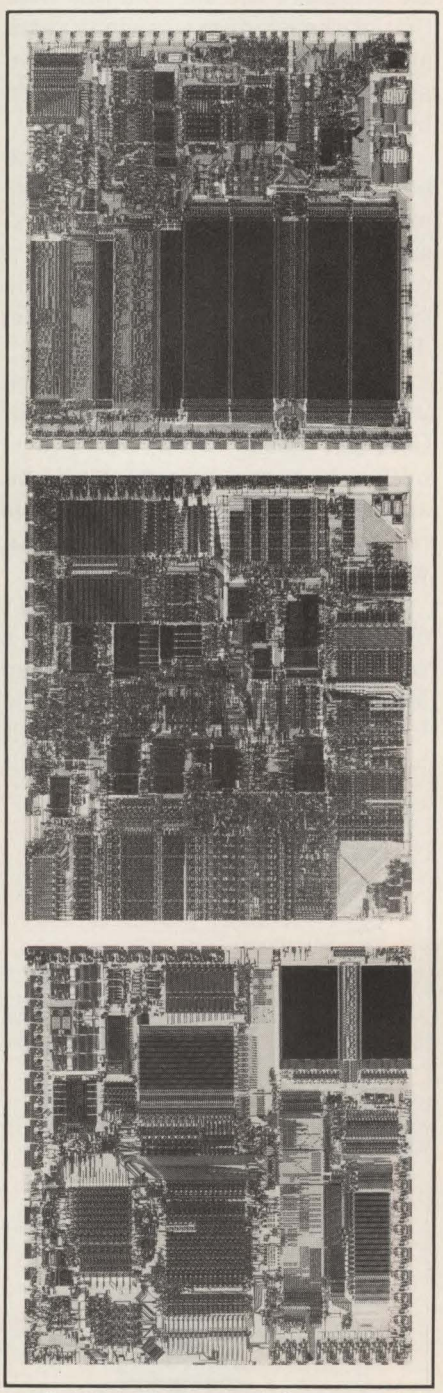
At the same time, Intel is offering a board-level product incorporating the chip set, mostly for development work. But the 432's maximum power, configuration and performance parameters will not begin to be explored until the second half of this year. The 432 family will be introduced in stages over the remainder of the year. The first two members are the three-chip set and a single-board μc.

Limited quantities of the three-chip set, comprised of an instruction decode unit, a micro-execution unit and an interface processor, are scheduled for delivery in the second quarter. Price for one set is expected to be less than $1500.

The second product is the Intellec 432/100 single-board computer, a learning tool that includes documentation and two diskettes with software. It is intended for use with the model 800 Intellec Series II or III development systems, which have 64K bytes of RAM. The 432/100 is Multibus-compatible and has an RS232C serial interface. It teaches users how to handle object-oriented architecture, which forms the backbone of the 432, but it does not include an interface processor, which is required to manage I/O and to build applications. Single-unit price is $3900, and shipments will begin this month. David Best, marketing manager at the Special Systems Operation, Aloha, says Intel already has a backlog of the evaluation units, but he does not specify how many.

Interpreting the complexity of architecture is only one of the problems potential users face. Some are also wrestling with the question of defining its performance and application. "We do not intend to replace mainframes. But the power needed for mainframe applications is moving into the μc area. We're not going after mainframe applications as they exist today, but we are trying to bring that computer power and its facilities into the μc arena to take on new applications," says Best.

"More than half of our business in five to eight years will be in applications that do not exist



Intel's iAPX 432 *micro-mainframe consists of three chips: the 43201 instruction decode unit (top), the 43202 instruction execution unit (middle) and the 43203 interface processor (bottom). Together they house more than 200,000 devices.*

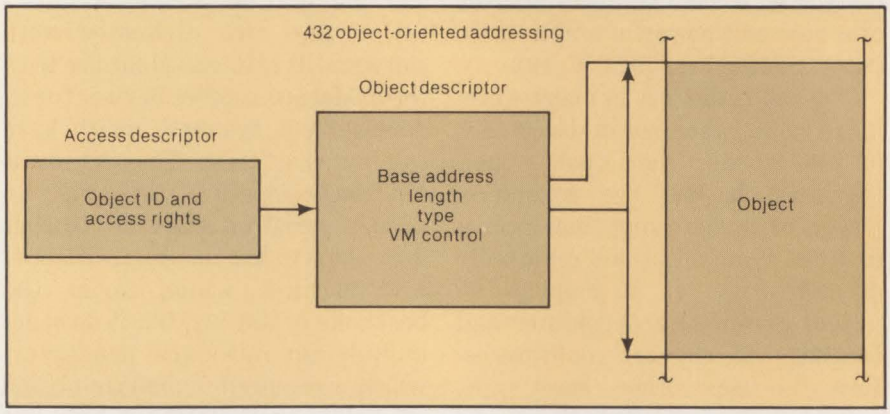
today," he maintains. He speculates that some vertical markets will include office-automation systems, computer-aided design and simulation, factory automation, pattern and speech recognition and PABX. He compares the 432's impact with that of the original μps eight years ago, which were designed for use in appliances but were readily adopted by electronic toy manufacturers.

Analysts believe the 432 will be used initially as a board-level product by small manufacturers, and then gain popularity as a component or system product. "The significance of the product for Intel depends on the time frame," explains Ken Logan, of the investment research department of Goldman Sachs, New York, who believes that impact won't be apparent for several years. "Intel is not yet in full-volume production with its 16-bit μp line."

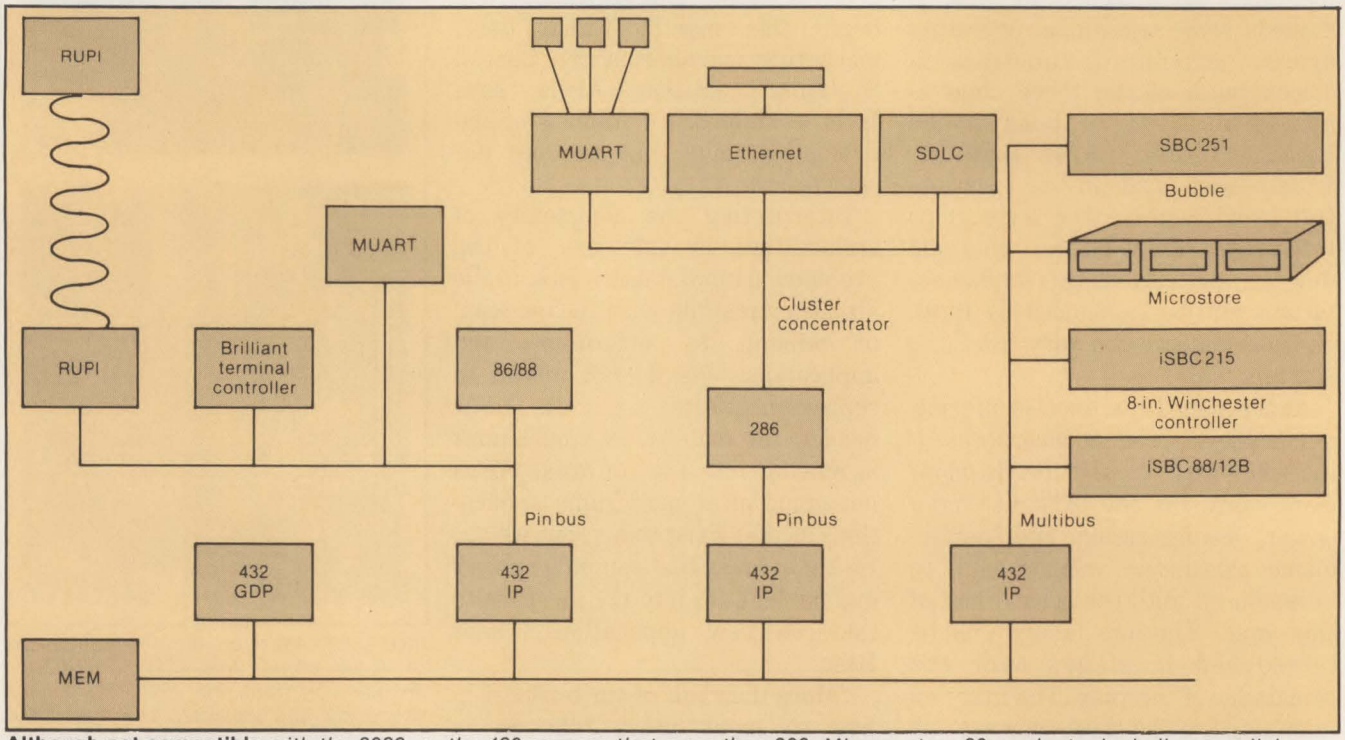
Some semiconductor market observers believe the 432 is a response to market pressure from Motorola's 68000 chip. The 68000 handles 32-bit words over a 16-bit data path, but the Intel 8086 can't process 32-bit information. However, its impact on the 68000 may be negligible, because the 68000 has a good toehold in the market, and the applications may differ. "The 432 is distinct from any other μp in that it addresses memory, fetches information and manipulates it in 32-bit chunks," says one of the system's architects.

The 432 handles 32-bit words and floating-point values of 32, 64 and 80 bits. It multiplies 32-bit integers in 6.25 μsec. and 80-bit floating point numbers in 26.125 μsec. Comparatively, the company says, 32-bit integer computation takes 16 μsec. on an IBM 370/148. When run in software, integers are computed in 40 to 60 μsec. on an 8086, about 88 μsec. on a Z8000 and 35 to 45 μsec. on a 68000. The micro-mainframe supports a logical address space of 2^{32}, which governs a system address space of 2^{40}.

At the heart of the 432 family is the three-chip set, which is based on a new architecture. The chips are manufactured using Intel's HMOS-1 process. The architecture is truly 32 bits, explains one of the system's

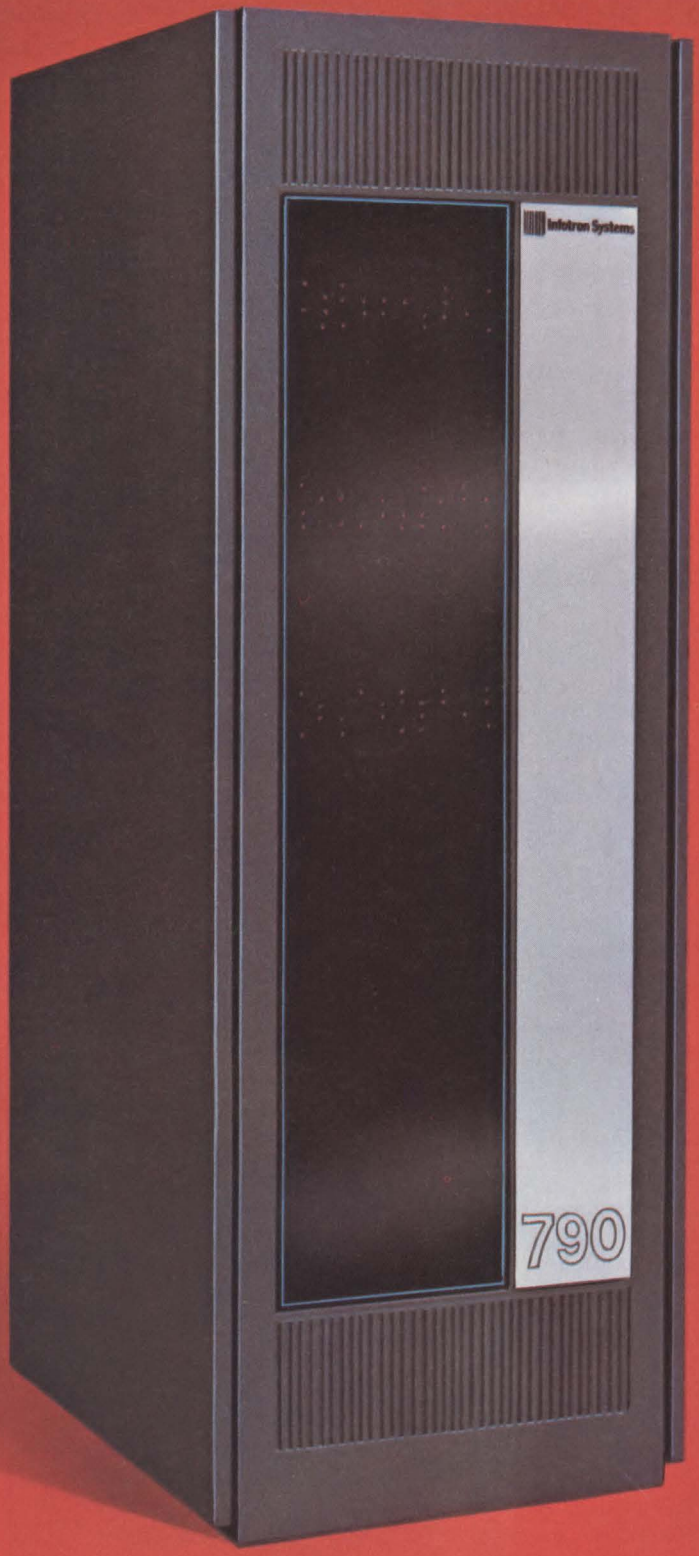


Access to software *objects is controlled by "right of access."*



Although not compatible *with the 8086 μp, the 432 ensures that more than 200 Microsystem 80 products, including parallel, attached processing and I/O subsystems, as well as future products, can be used.*

Incredible Power!



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CIRCLE NO. 7 ON INQUIRY CARD

architects, and does not stretch a 16-bit architecture to 32 bits, nor does it use two 16-bit processors back-to-back for two fetches from memory. The architecture is implemented by an internal microprogram that is encoded in 16-bit microinstructions, which are transparent to the architecture and to the end user. Later products may have wider data paths.

The chips are housed in 64-pin QUIPs developed jointly by Intel and 3M. The 432 will not fit in a DIP, and it requires the higher degree of heat and power dissipation available in QUIPs.

The first two chips—the 43201 and 43202, make up the micro-mainframe's general data processor (GDP), which is part of the processing-control system. The 43201 is an instruction-decode unit, and the 43202 is a micro-execution unit. The two communicate across an internal bidirectional microinstruction bus, which is optimized at 16 bits with buffers at both ends. Together, the chips fetch, decode and execute program instructions as fast as 200,000 instructions per sec. Adding processors to the system yields a greater number of instructions per sec. For example, six GDPs roughly equal the performance of a mid-range IBM/370 mainframe, says Best. That performance is estimated to be 2 million instructions per sec., sources say.

The third chip, the 43203, is an interface processor (IP) that links attached processors to the GDP. When adhering an attached processor, which may include an 8086 to control I/O, the 43203 acts as a middleman to communicate to the GDP via a packet bus, and to the attached processor via a subsystem bus. For example, by making the following series of attachments, a group of attached processors can expand I/O bandwidth ten-fold to a maximum of 20M bytes per sec.: peripheral to peripheral controller to Multibus to 8086 to IP to packet bus to GDP. There is no theoretical limit to the number of peripherals and I/O channels that can be attached. Practically, however,

SIZING UP THE 'MICRO-MAINFRAME'

Some potential users of Intel Corp.'s iAPX 432 micro-mainframe have expressed concern that the system is not compatible with the 8086. But others, including David Best, marketing manager at the company's Special Systems Operation, Aloha, Ore., believe the system would have limited performance if it was designed to adhere to the 8086 structure. "I'm not concerned that the 432 is not compatible with the 8086 because it is geared for different applications," says Ken Logan, of the investment research department of Goldman Sachs, New York. "Intel sacrificed performance with the 8086 to make it compatible with the 8080."

The 432's good performance is most visible through its multiprocessing capabilities. Best and potential users agree that multiprocessing is the 432's most significant feature. General data processors (GDPs) can be added without changing software to increase performance.

Performance can be changed in a manner similar to turning a knob on a stereo, explains Best. By adding multiprocessors and attached processors, a single system can become larger without requiring a new processor family. I/O processors and I/O device controllers are available in existing product lines.

Linking multiple GDPs on one packet bus so that they can communicate with one another is a smart move, say two potential users.

A ten-fold performance increase can be achieved, depending on the number of GDPs in the system. As processors are added, the work load is shared among them automatically, without requiring new instructions because multiprocessing capabilities are resident in silicon.

In a similar manner, the system programming language—Ada, the Department of Defense-sponsored language, which is similar to Pascal—operates on memory modules that are based on objects. It was chosen because it complements the architecture. Objects can be as large as 64K bytes. A module package in Ada is equivalent to a domain in 432 architecture, Best says. Each object is categorized by an object description, which can be physically addressed only by an access descriptor that holds the object's identification and access rights. Access to and operation upon objects is thus inherently controlled.

The 432 has no assembler. Ada is compiled directly into machine instructions. One software consultant compares the 432's Ada to the way Burroughs has run Algol for years. He says this is an innovative and easy approach to handling a language. Other languages that are 8086-compatible will follow on the 432. Pascal heads the list, Best says. To run 8086 software on a 432 requires a rewrite into Ada.

Ada is licensed separately and will not be available until the second half of the year. The price has not been determined. The software is being screened now for conformance with government standards (MMS, December, 1979, p. 33 and March, 1979, p. 14). The 432/100 evaluation board contains Ada-like software.

A software development system, the Intellec Series III/432, is expected during the second half of this year. It is designed to be used with a host, such as the VAX 11/780, Intellec Series III or IBM VM/CMS, that is linked to a Series III debug station equipped with an iAPX 432-based execution system.

Other planned software includes an Ada-like high-level language for the development system, a cross linker, a symbolic debugger and a multifunction applications executive package.

Best says the first board product will be available in the second half of the year. Some industry sources believe this product will indicate the success of the 432 because it will be geared for user applications. It will be introduced this summer. The board will support as many as four GDPs, as many as four interface processor/Multibus subsystems or a maximum of six GDPs or IPs.

more than 30 IPs on a bus would slow performance. Attached processors retain local memory. The packet bus can transfer from 1 to 16 bytes of data during one request or reply.

Multiprocessing is expedited by placing some software control functions in the silicon. Operating system functions, such as process scheduling and dispatching, are part of the 432 hardware. The hardware recognizes system data structures so that the processors can find their own work. Some of the policies that govern the software in silicon, such as scheduling an algorithm, remain under software control to keep the system flexible. Best claims that the "hardware" silicon operating system runs functions about 10 to 20 times faster than they could be run in software.

The IP subsystem off-loads some low-level device control and interrupt functions from the CPU to enable the CPU to be more efficient in computations. The IP acts as a memory unit to translate 16-bit information into the 432's system address space, making the 432's memory look like local memory to the subsystem.

The IP is the only semblance of compatibility with the 8086 that the 432 shows. For example, although the 432 cannot execute 8086 instructions, any μp from an 8080 upward can serve as an attached processor through the IP. "Its (the IP's) role in life is to provide the connection to current products," says Best.

"We're not trying to position the 432 as a successor to the 8086 or as a logical migration path. We set aside compatibility constraints to get a significant architecture with the 432 that will offer us new markets and applications, not a ready-made market." Best adds that a follow-on product to the 8086—the 286—addresses binary-level upward compatibility.

—Lori Valigra

BOX SCORE OF EARNINGS

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

Company	Period		Revenues	Earnings	EpS
Advanced Micro Devices	9 mos.	12/28/80	229,073,000	19,507,000	1.23
	9 mos.	12/30/79	163,376,000	16,529,000	1.10
Beehive International	3 mos.	12/31/80	9,556,063	1,023,162	.80
	3 mos.	12/31/79	5,607,158	(269,731)	(.21)
Computer Automation	6 mos.	12/28/80	38,233,000	802,000	.40
	6 mos.	12/28/79	37,994,000	1,481,000	.74
Comshare	6 mos.	12/31/80	42,572,500	1,805,100	.46
	6 mos.	12/31/79	32,612,300	2,034,400	.55
Control Data	12 mos.	12/31/80	2,790,500,000	150,600,000	8.45
	12 mos.	12/31/79	2,273,000,000	124,200,000	7.20
CPT	6 mos.	12/31/80	43,562,000	5,784,000	1.18
	6 mos.	12/31/79	26,090,000	2,825,000	.66
Cray Research	Yr.	12/31/80	60,748,000	10,900,000	.85
	Yr.	12/31/79	42,715,000	7,819,000	.63
Data General	3 mos.	12/20/80	156,000,000	13,800,000	1.29
	3 mos.	12/22/79	137,100,000	11,900,000	1.15
Datapoint	3 mos.	10/31/80	93,881,000	10,284,000	1.14
	3 mos.	10/31/79	70,560,000	7,635,000	.88
Four-Phase Systems	Yr.	12/31/80	197,187,000	5,452,000	1.06
	Yr.	12/31/79	178,736,000	16,727,000	3.25
Harris	6 mos.	12/26/80	734,195,000	54,949,000	1.79
	6 mos.	12/28/79	581,653,000	35,899,000	1.19
Honeywell	Yr.	12/31/80	4,924,700,000	293,500,000	13.13
	Yr.	12/31/79	4,209,500,000	260,500,000	11.89
Intel	Yr.	12/31/80	854,561,000	96,741,000	2.21
	Yr.	12/31/79	660,984,000	77,804,000	1.85
International Business Machines	Yr.	12/31/80	26,212,885,000	3,561,996,000	6.10
	Yr.	12/31/79	22,862,776,000	3,011,259,000	5.16
Lanier Business Products	26 wks.	11/28/80	131,061,000	9,959,000	1.34
	26 wks.	11/30/79	114,438,000	7,161,000	.97
Lear Siegler	6 mos.	12/31/80	726,428,000	33,088,000	2.07
	6 mos.	12/31/79	661,337,000	29,725,000	1.92
Memorex	Yr.	12/26/80	768,661,000	(28,978,000)	(4.42)
	Yr.	12/28/79	737,761,000	31,544,000	3.91
Monolithic Memories	3 mos.	12/21/80	22,613,000	2,734,000	.42
	3 mos.	12/23/79	12,033,000	896,000	.23
National Semiconductor	6 mos.	12/14/80	628,172,000	33,410,000	1.55
	6 mos.	12/9/79	449,347,000	23,554,000	1.15
NCR	Yr.	12/31/80	3,322,370,000	254,686,000	9.51
	Yr.	12/31/79	3,002,640,000	234,602,000	8.78
Plantronics	Yr.	11/29/80	52,721,000	3,889,000	.61
	Yr.	12/1/79	46,373,000	3,992,000	.63
Prime Computer	Yr.	12/31/80	267,637,000	31,222,000	1.07
	Yr.	12/31/79	152,943,000	16,940,000	.64
Ramtek	6 mos.	12/31/80	15,211,000	940,000	.35
	6 mos.	12/31/79	10,751,000	546,000	.28
Scientific Atlanta	6 mos.	12/31/80	120,592,000	7,882,000	.75
	6 mos.	12/31/79	85,972,000	5,199,000	.58
Tandy	Yr.	12/31/80	1,526,948,000	132,677,000	2.63
	Yr.	12/31/79	1,306,934,000	92,660,000	1.79
Timeplex	6 mos.	12/31/80	15,099,401	1,067,488	.29
	6 mos.	12/31/79	7,648,176	612,218	.20
Wespercorp	6 mos.	12/31/80	6,578,000	598,700	.45
	6 mos.	12/31/79	4,693,000	440,100	.38

Controversy hits market for local area networks

The question of which local area network scheme will dominate upcoming "office-of-the-future" applications remains unsettled, say a number of industry observers. And it may never be completely resolved, given some of the technical points that have yet to be addressed by vendors now supplying these systems or about ready to jump into the market (see "NRC adds high-speed network to product line," p.153).

So far, system designers face the possibility of dealing with at least four vendor-proposed networking standards, and more may come. They also will have to deal with the efforts of a number of standards bodies and the product offerings of independent network vendors. Getting the greatest attention now is Xerox Corp.'s 10M-bit-per-sec. Ethernet system. Next is the counter-offering sure to come from IBM and designed, observers say, to integrate IBM-driven office-automation applications with the company's already-developed Systems Network Architecture (SNA) concept as an umbrella for data-communications applications.

Also in the wind are two 100-MHz broadband CATV networks. The first is under development at Wang Laboratories, Lowell, Mass.; the second reportedly will integrate the office products marketed by Exxon Information Systems.

Exxon's plans are undefined, but one report says the company's networking plans may take two routes. First, a broadband development effort is under way at Exxon Office Systems, Palo Alto, Calif. Office Systems comprises Vydec, Qyx, Qwip and Summit Systems, an R&D spin-off of Zilog, Inc. It is Summit's charter to develop the network.

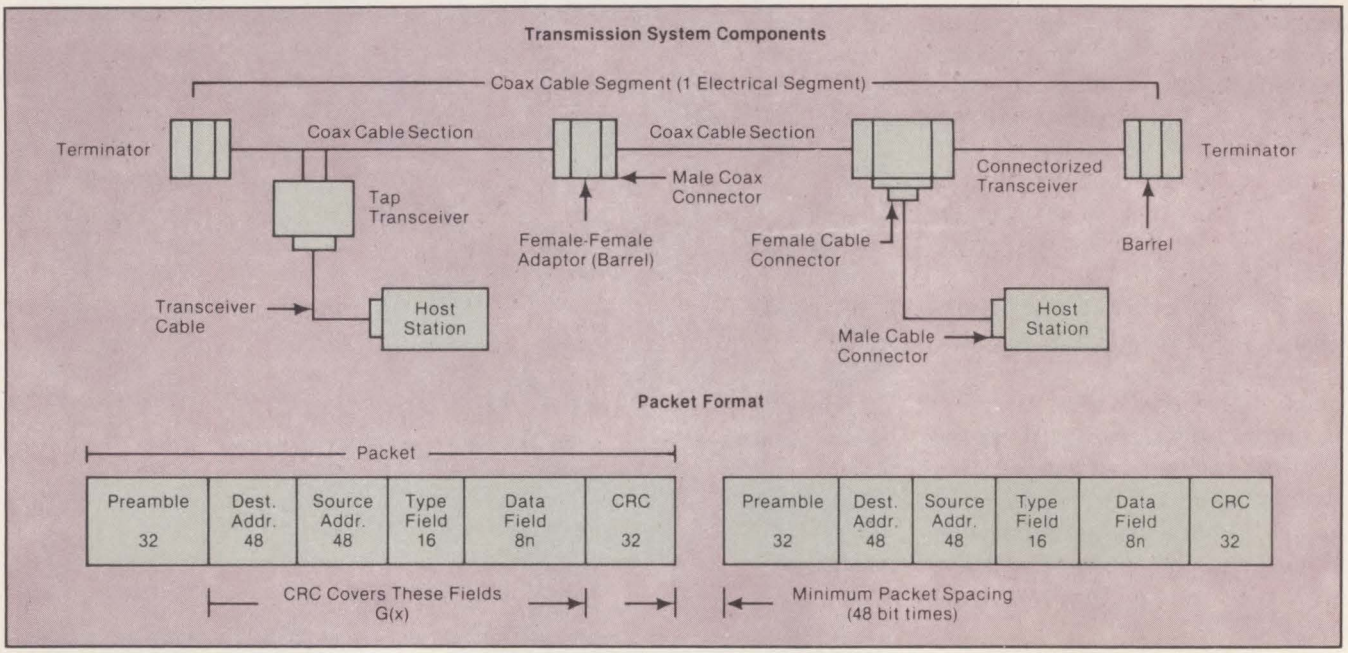
Closely monitoring the activities of these four companies are several large-scale systems vendors, including Hewlett-Packard Co., Nixdorf Computer Corp., NBI, Inc., and Vector Graphic, all of which have already made tentative commitments to Ethernet. Also casting its lot with Xerox is Digital Equipment Corp., which is participating with Intel in Ethernet (MMS, July, 1980, p. 17).

A Princeton, N.J., think tank, called Xonex, is working with the Summit group. Xonex's charter is not spelled out, but the company is known to be developing high-speed work stations and terminals, and its efforts, originally due this quarter, will not appear until later.

A second effort is under way at Exxon subsidiary Zilog Corp. that is aimed at implementing an Ethernet evironment into Zilog's existing μc systems. The Cupertino, Calif.-based semiconductor house plans to develop "gateway" hardware to enable users of Zilog's current Z-Net local area network to migrate up to Ethernet systems.

DEC's role in future Ethernet installations is uncertain. One source suggests that the relationship between DEC and Xerox may be based on the fact that DEC does not have a local area network of its own. Conversely, Xerox does not have a large installed computer and word-processing base. "The two could fit together quite well," the source adds.

Intel's role appears to be



The local area network *being developed by Xerox, Intel and DEC will be based on Xerox's Ethernet system.*

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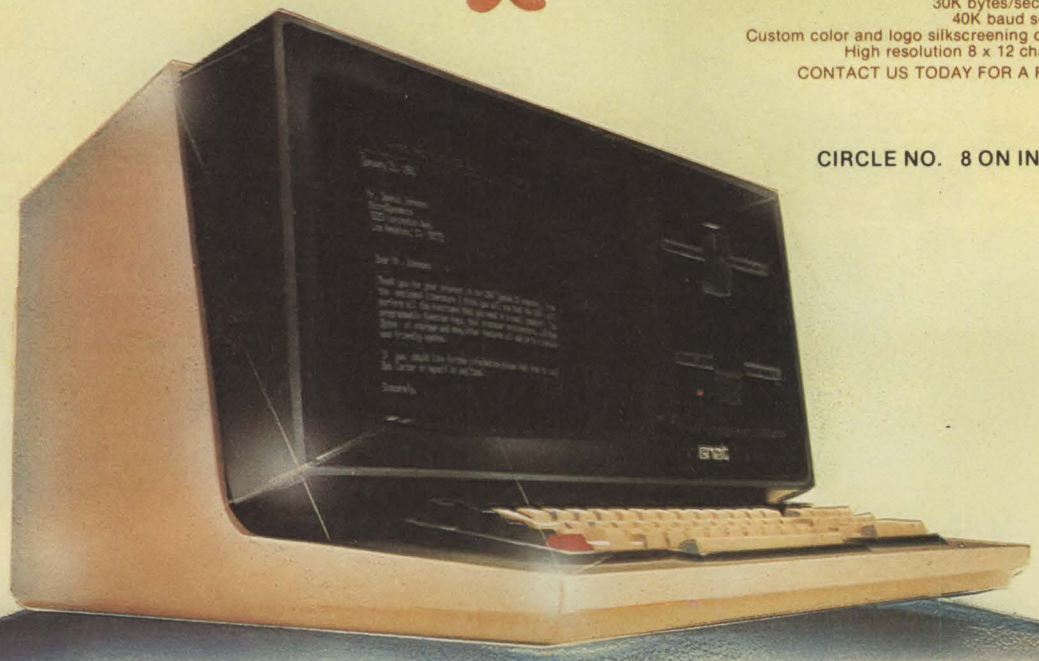

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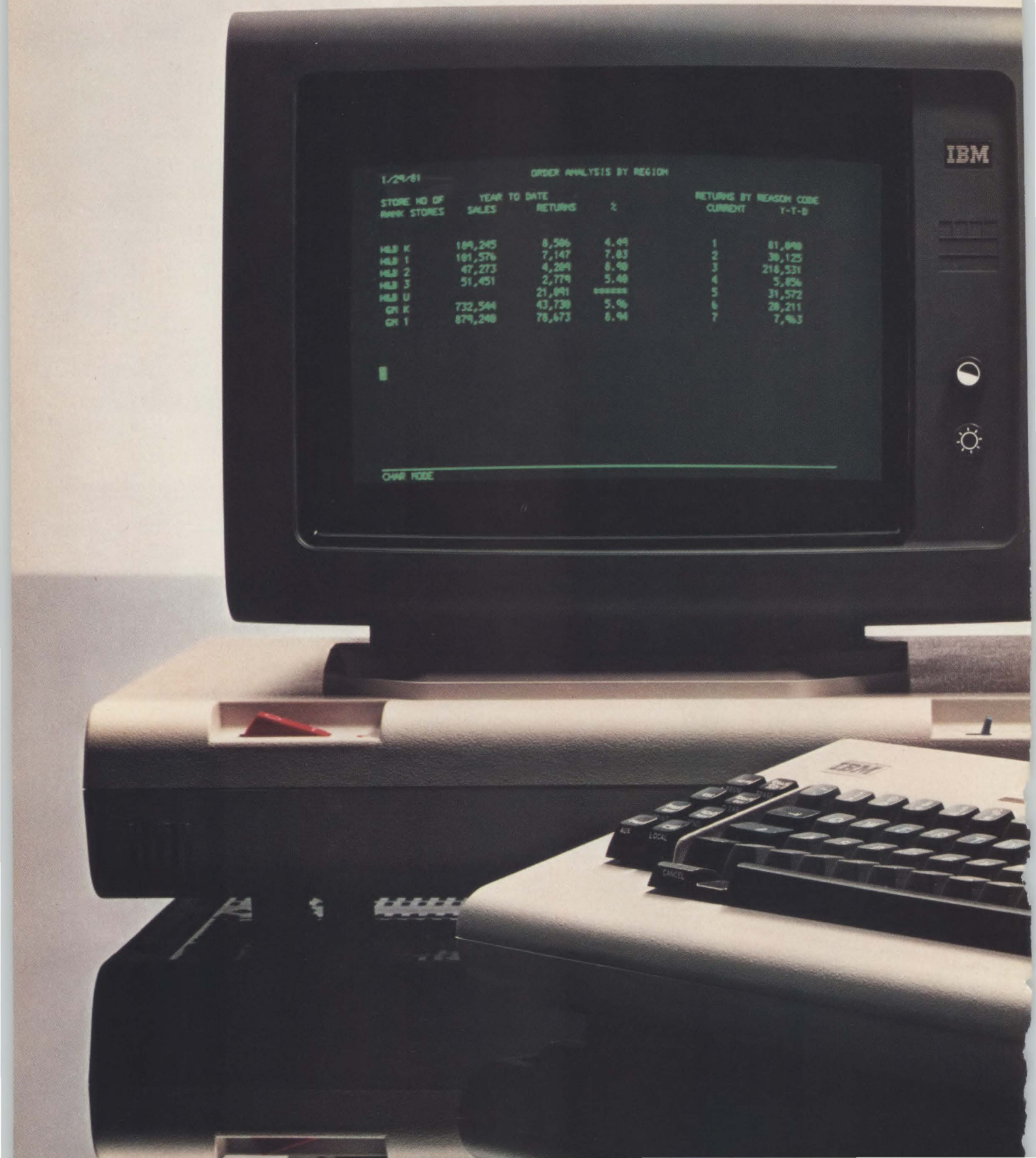

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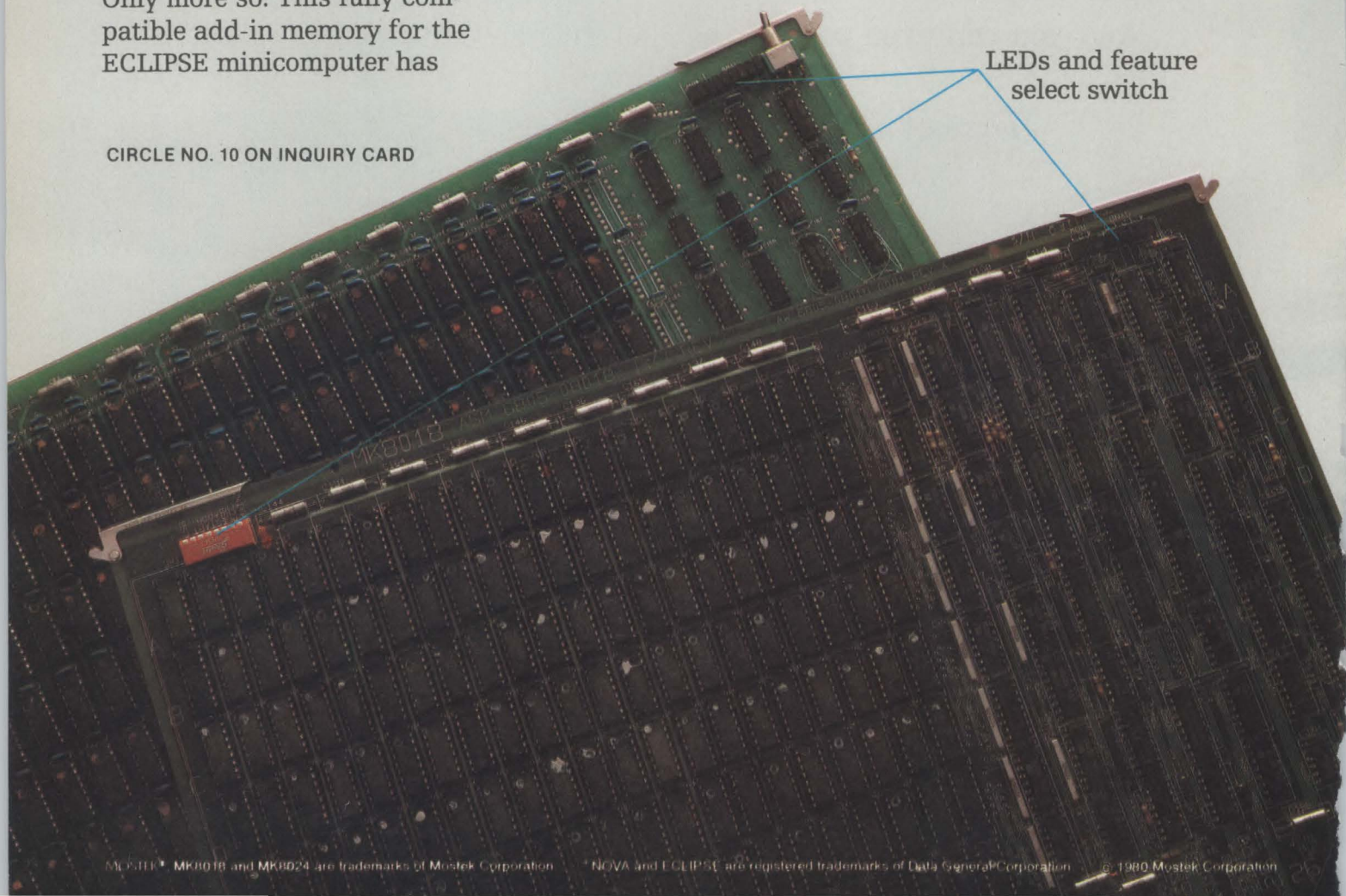

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better-defined. The company will manufacture interface chips to connect Xerox and non-Xerox equipment to an Ethernet line. The Santa Clara, Calif., company will introduce LSI products that can handle frame definition, or the format of the packet being transmitted, as well as device addressing, handshaking and line discipline. But those products are not expected until 1982. Board-level hardware could appear by year-end, says one observer. Meanwhile, Xerox is offering a conversion module to handle much of the same work.

Xerox has proclaimed its intention to promote interconnection of non-Xerox hardware to its Ethernet system, but the intentions of Wang and Exxon are unknown. IBM may not adopt such an altruistic attitude, however, and its decision concerning local area networks could indelibly stamp the office of the future for some time to come. "When you look at the companies involved here, you see that none has the motivation to go with the other," says Ken Bosomworth, head of International Resource Development (IRD), Inc., a Norwalk, Conn., research and consulting firm. "These companies want to develop their own de facto standards, and will get together only if forced."

IBM's move will entail the construction of a non-SNA-compatible local area network, Bosomworth says. "In an SNA environment, the central computer is boss," he explains. "In a packet-switching network such as Ethernet and the broadband systems others are proposing, you have carefully managed anarchy."

Bosomworth predicts that IBM will take two steps to get around internal network incompatibility. "First, it is possible to build a black box that will interface with the two networks," he says, and there are reports that the company has introduced such hardware in France and Canada.

More significant, he says, would be a casual upgrade of the existing twisted-pair connections now used in IBM's mainframe environments. "The new H-Series machines could be precursors of systems based on coax cable," he says. "We can expect that future additions to this line will be linked by broadband CATV and fiber-optic lines." IBM will also announce that this networking environment can also be used as the basis of a local area network, Bosomworth adds.

Steve Randesi, head of Computer Solutions, Inc., a San Jose, Calif., consulting firm, and publisher of the monthly SNA Report, sees no conflict from the point of view of systems control if IBM takes the route Bosomworth proposes. "SNA defines the application," he says, and both local and remote networks could use the same protocols. Randesi says IBM also has alternatives. For example, the company could use its long-awaited PABX system as the basis for a local area network. "There is also the possibility that IBM will support one of the more widely used networks, but only if a standard for local area networks is adopted, or if one of the networks now proposed becomes a de facto standard." Xerox's Ethernet could meet both requirements, he adds.

Many observers feel that any cooperation between the two companies is unlikely. IBM and Xerox have already clashed over the issue of local area network standards. An IEEE committee developing its own set of standards was caught in the middle of the two companies.

At the IEEE, the issue was the question of defining the "link-level" protocols for the proposed IEEE 802 standard. A protocol is a transmission convention, with some bits designating the beginning and the end of a message, others defining a data field and the format of a data, others for control purposes, such as addressing, etc., and others for error detection and recovery.

Two elements function at a protocol's link-level. The first deals with the handshaking conventions and the means used to address a specific device. In the Ethernet environment, addressing comprises a 48-bit address field, the first 16 bits of which define the manufacturer of the equipment, and the next 32 defining a device address.

The second component handles line discipline, which determines which device can use the networking facility, given that only one device can transmit at a time in a serial environment. Ethernet uses a contention method. If two devices try to transmit simultaneously, a "line-busy" status is generated, and both devices shut down. Each then waits a randomly generated amount

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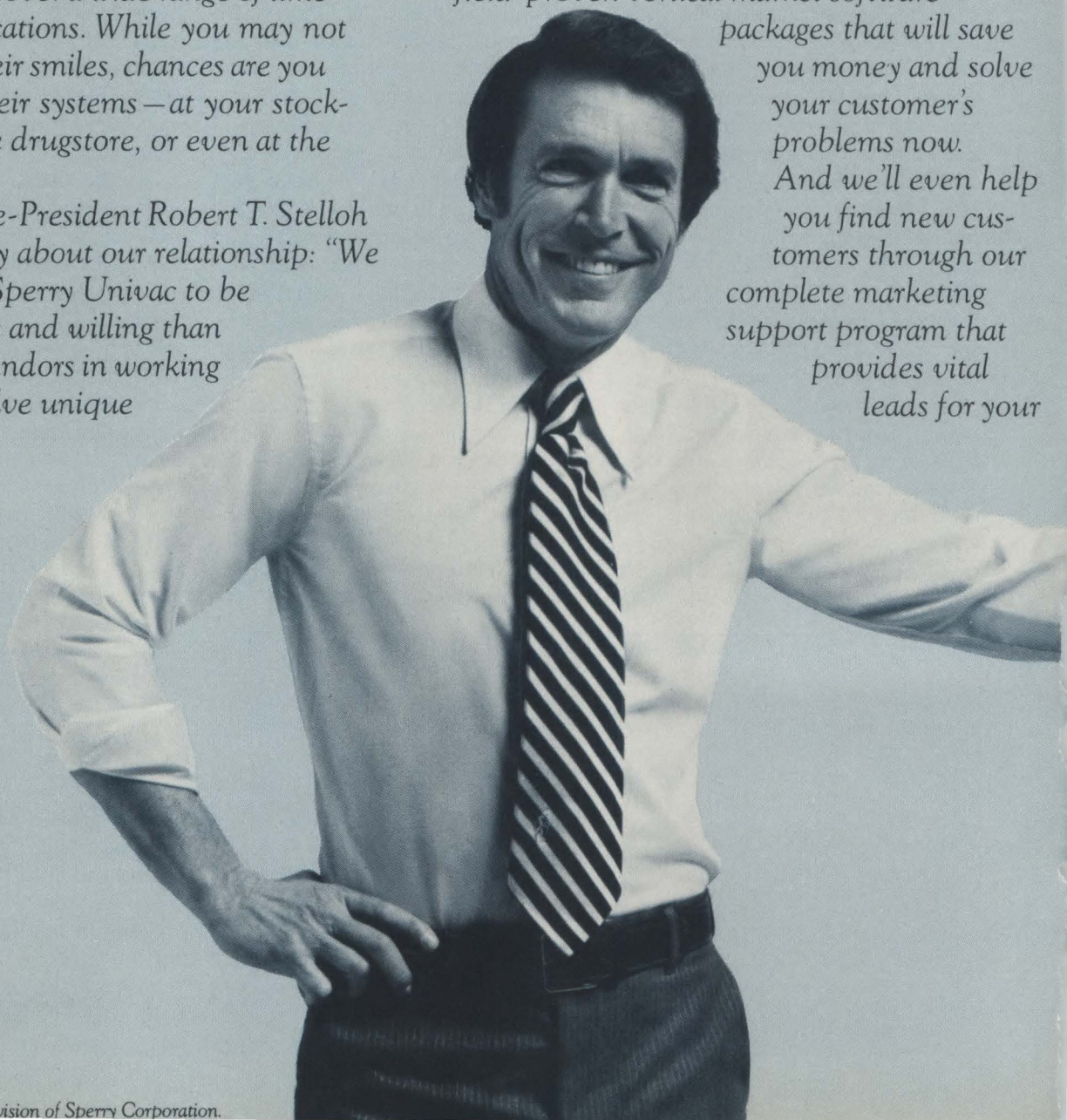

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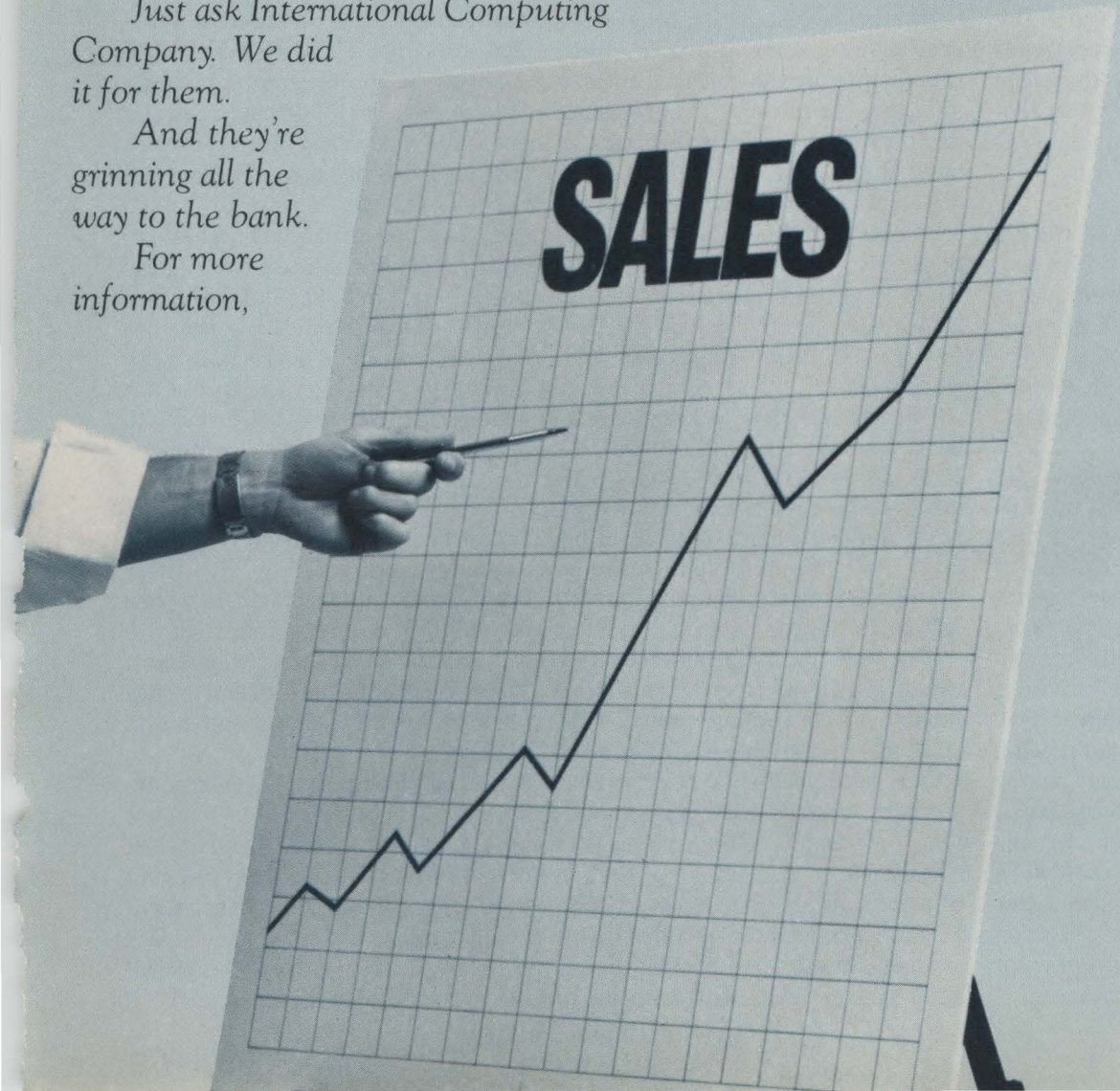

of time before attempting to transmit.

IBM has expressed interest in a "token" system originally developed for the process-control industry. One source says the term "token" comes from the New York subway system—a token is "permission" to transmit, based on a predetermined calculation.

When a device has the token, it can use the line, excluding all other devices, much like a father giving permission to each of his children to speak in turn at the dinner table.

The IEEE accepts both methods, and one observer claims that is the result of political pressure from IBM. "In effect, the committee has set two standards," he claims. "IBM does not want Ethernet to be recognized as a network standard, and the committee copped out." The split between the two companies may reflect more than commercial considerations. "IBM has a psychological barrier against any endorsement of Ethernet. The reason is simple: Xerox built it."

Another source says IEEE's decision may be opposed to its own goals of defining a hardware-transparent network. In a network designed to handle both, error control must reside in the device. IEEE has leveled a complaint about this against Xerox.

Controversy over protocols for local area networks extends upward from the link level, although in this case, the issue takes on a different hue because no higher-level protocols have yet been defined for local area networks. For example, with the exception of the link-level protocols and frame definition (the format of the data and addressing information), protocols to handle error control (the "transport" level) have not been specified. In the Ethernet environment, software within each device in the network handles error control, a situation IEEE opposes because it does not promote network transparency.

Also undefined are how tasks interact with each other (the "session" level), the formatting of the data (ASCII, EBCDIC, etc.—the "presentation"-level protocols) and how the logical-to-physical conversion is made to enable any terminal to be connected to any node.

Xerox has not yet defined these protocols for Ethernet, sources say, and another complication may hinder systems designers when they are defined. One report says Ethernet's high-level protocols may be incompatible with those developed by DEC, and those may be incompatible with H-P's offerings.

Two other groups—the International Standards Organization (ISO) and independent vendors of networking systems, such as Ungermann-Bass, Inc., Santa Clara, Calif., and Sytek, Inc., Sunnyvale—are also in the picture. ISO, represented by the National Bureau of Standards and ANSI, is preparing draft protocols that will apply to both local area networks and distributed data-processing environments using the X.25 protocol. IEEE intends to follow the ISO's Open Systems Interconnection Reference in developing its proposed 802 local area network standard.

Ungermann-Bass, with its baseband 4-MHz "Ethernet-compatible" Net/One System, and Sytek, with its System 40 broadband scheme, have defined their own protocols and see themselves not as competitors, but as complements, to Xerox, IBM and Exxon.

"We see a large market for gateways, or advanced translators capable of converting protocols at all levels," says Sytek's Ken Biba. "What ISO specifies and what SNA specifies are two wholly incompatible entities." Biba sees the installation of dedicated System 40 communications nodes that will be able to connect those systems based around SNA to those using Ethernet, and those that conform to ISO standards. Sytek will be producing such translators later this year, he says. The first will interconnect IBM hosts to X.25-based networks. Gateways linking Ethernet systems to X.25 links are due in 1982.

Charles Bass, co-founder of Ungermann-Bass, sees a similar role for his company. "We're not 100 percent tied to Ethernet," he says. "It is a very positive development as far as the office of the future is concerned, but the market will require alternatives."

Bosomworth puts it differently: "The rationale for a standard makes little sense from either a vendor or user point of view," he says. "On a local basis, incompatible local area networks will evolve." Like Biba, he sees these independent networks interconnected as required, a move that may not sit well with those engaged in promoting standards. "It has been implied that there is a need for one local area network standard," Biba says. "I know of three—and as many as six—organizations that won't adhere to one." Thus he agrees, on a local basis, de facto standards will evolve. "This is something that has happened over and over again in our industry," he says, "and that reflects the fact that at the bottom of all this lies crass, commercial motives."

The controversy over local area networks has produced confusion. "People are looking at their networking requirements in terms of finding the one system that will solve all their problems," says Bass. "That is an illusion." Users need a blending of networking capability, he says.

"Everything is application-specific," he explains. "You use baseband until the network runs out of gas, or if you have to transmit over longer distances; at that point you switch to broadband." Jack Kessler, a Newport, R.I., consultant, agrees, noting that if

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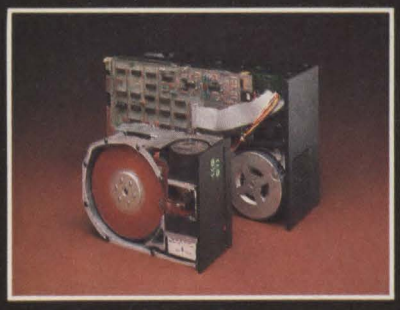

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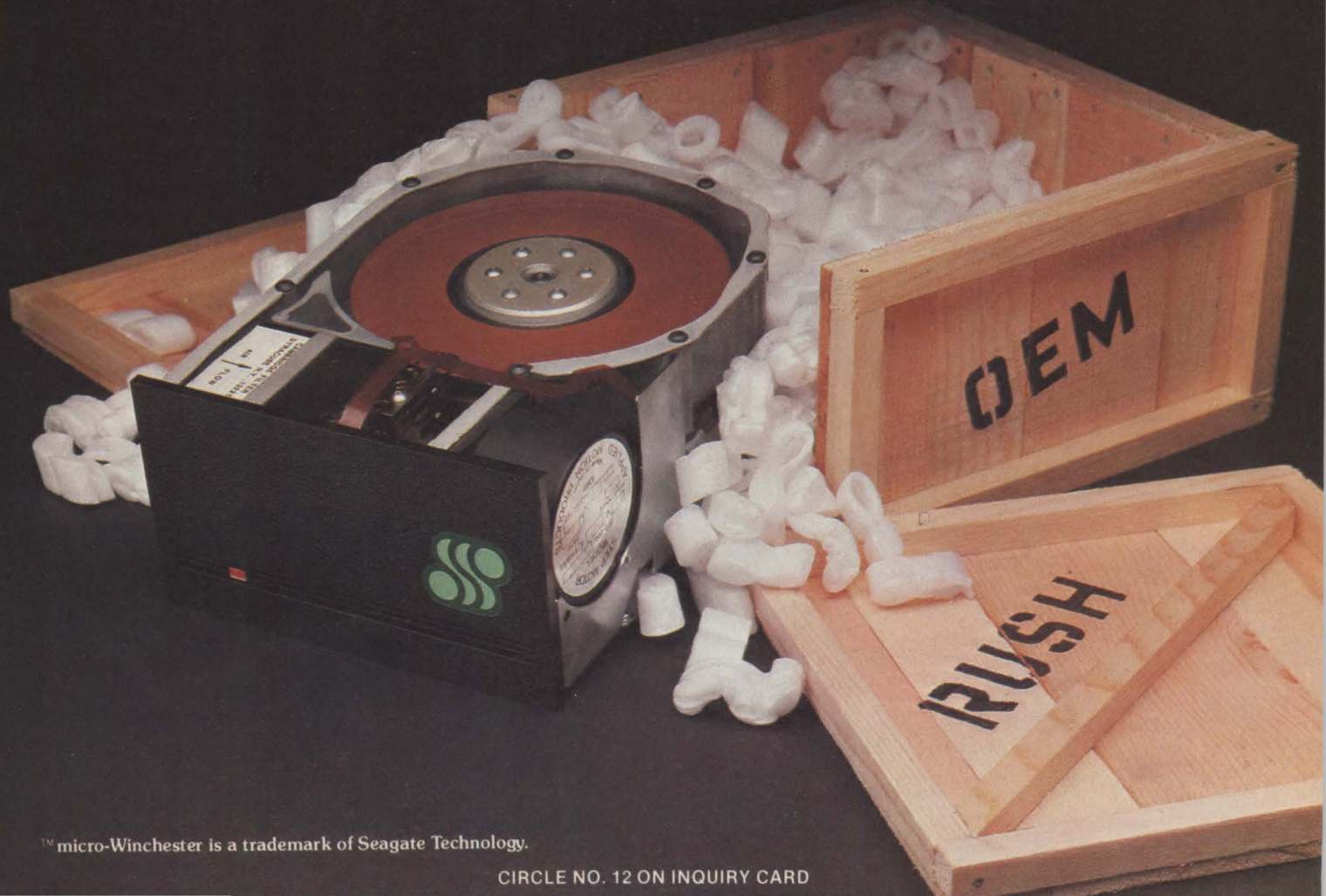

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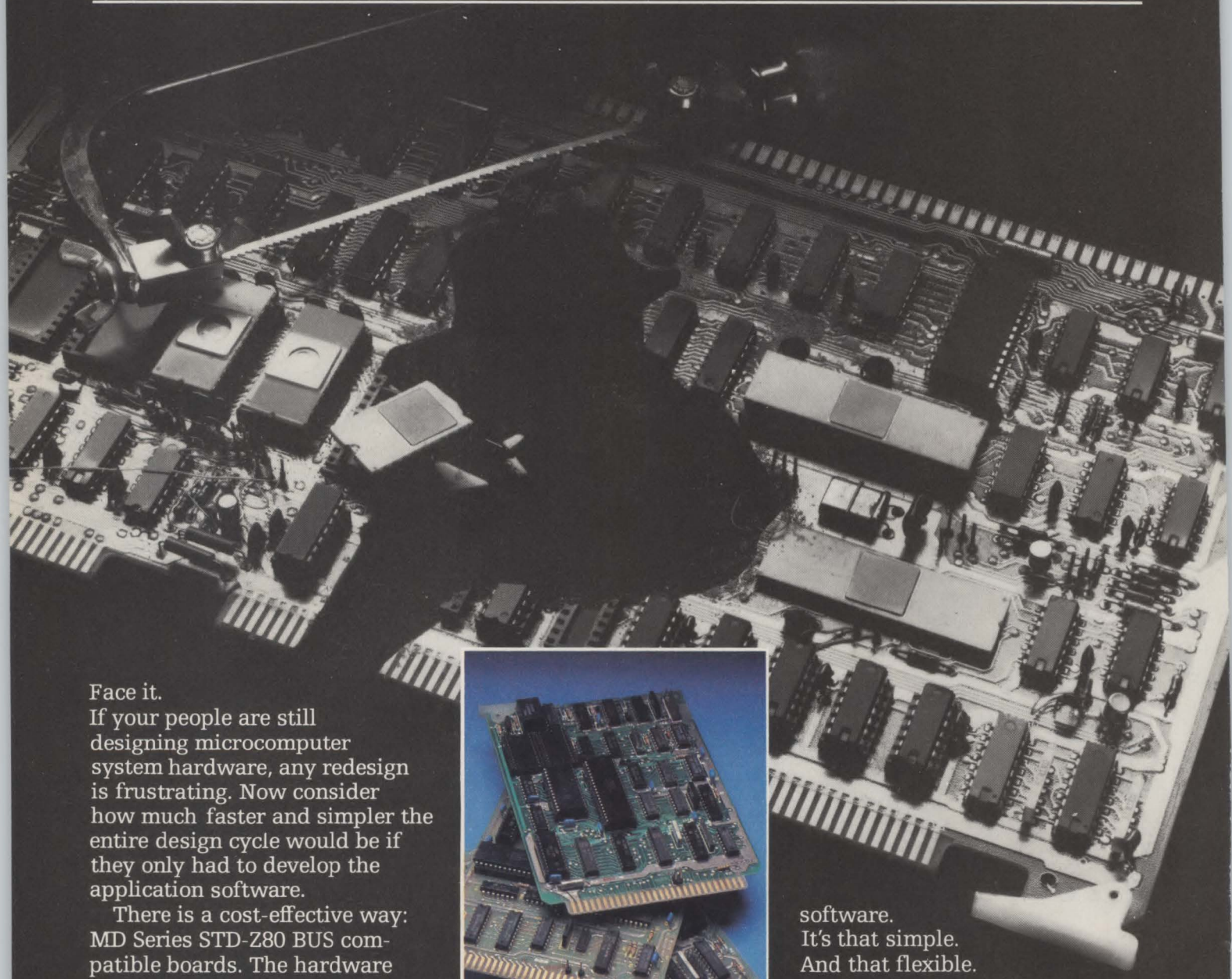

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environmental conditions change—if the cable has to be run up an elevator shaft where it could be subject to heavy doses of magnetism from the hoist motors, for example, or if the network is to be installed in the hostile environment of a factory floor—fiber-optic links should be considered.

The key element, says Bass, is how the user perceives the system. "The bottom line is that we need to provide local area networks that are not hardware-dependent, and that are completely user-transparent," he says. "The user shouldn't care what technology his network is using—baseband, broadband, fiber optics, Pony Express." *—John Trifari*

Vendors face problem of servicing networks

With local area networks expected to become widespread in the next decade, computer vendors must begin now to face the problem of how to maintain and repair them. "Vendors will have to be concerned about what it means to service a type of system that differs so greatly from those they have dealt with in the past," warned David Potter, engineering manager of Digital Equipment Corp.'s local area network development group, at a recent Communication Networks conference in Houston.

"Our service people are a little frightened at having to go out and service something that has a lot of other companies' equipment attached to it," Potter said, referring to an aspect of local area networks that could create a major service headache. If the industry standardizes on Ethernet or some other local area network scheme, Potter pointed out, mixed-vendor networks will become common. Thus, vendors will have to develop diagnostic techniques to isolate network failures caused by their own equipment from those caused by another manufacturer's hardware. Otherwise, he said, service calls could degenerate into time-wasting finger-pointing exercises.

Vendors will also have to develop ways to diagnose and repair their equipment without bringing down the rest of the network, Potter said. The reason? "Local area networks will raise users' expectations," he said. "They are going to want the network to be available all the time." As a result, users will not tolerate a service interruption to allow the repair of a malfunctioning disk drive or other system component.

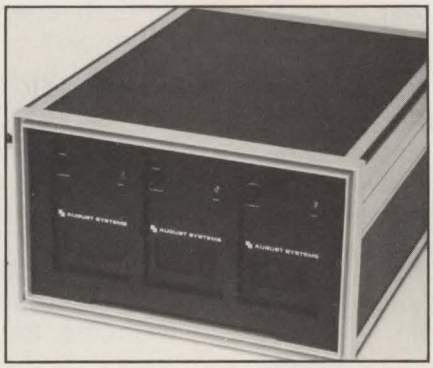
Local area networks will also create new service problems because the equipment they interconnect will be scattered around a customer's building or office complex instead of being concentrated in a single room, as with conventional systems. Potter said techniques will have to be developed for isolating equipment failures from a central point in the network. Otherwise, he pointed out, technicians could waste time running from office to office trying to track down a malfunctioning device.

In addition to new service techniques, vendors who decide to develop terminals to be used with local area networks will have to incorporate some form of network protection into them, Potter said. "Terminals will need some form of 'firewall' built into them to prevent them from accidentally destroying data elsewhere in the network while they are being repaired," he said.

—Paul Kinnucan

An industrial computer that 'can't fail'

"To err is human, to forgive, divine," goes a famous aphorism of Shakespeare's. Many industrial users would echo that sentiment when it comes to computers. With the growing reliance on computers to control industrial processes, the ability of systems to "forgive" errors caused by electrical noise or hardware failures has become increasingly important.



August Systems' BC 304 fault-tolerant computer *"forgives" errors caused by electrical noise or hardware failures in industrial environments.*

Now, a Salem, Ore., start-up has introduced a line of industrial-control computers that offers the ultimate in reliability—nonstop operation even when a major hardware failure occurs (see "Nonstop processing: how it works," p. 31). August Systems' Basic Controller series systems can achieve nonstop operation because they are "fault-tolerant," explains David Willoughby, the recently appointed president of August Systems.

Not only can the μc-based systems detect—and automatically correct—errors that would go unperceived by ordinary computers, Willoughby says, but they can also segue without human intervention to a backup processor in the event of a processor failure.

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"Actually, fault-tolerance is something of a misnomer," Willoughby says. "We really want to be perceived as offering nonstop computing to the industrial user."

A need for such ultra-reliability is emerging in industrial applications, Willoughby says, because computers are increasingly being used to govern machine tools, power plants and other equipment often representing a major portion of a company's capital investment. "Computers now control everything from the family car to nuclear plants worth billions of dollars," Willoughby says. Because computers represent the central nervous system of industrial control systems, their failure can have serious economic consequences, he points out. For example, a computer can lead to production delays. Even worse, a faulty output caused by an undetected error could wreak havoc in a rolling mill or chemical plant.

Until now, industrial users could protect their systems against the consequences of a computer failure only to a limited extent, Willoughby says. Typically, industrial users for whom reliability is paramount have replicated their main system with an identical system to serve as backup in the event the main system fails. But this solution doubles the cost of the system and is inefficient, Willoughby points out, because the backup processor is usually idle. Moreover, such systems generally do not operate nonstop because the software and hardware techniques that allow automatic switch-over are too tricky for most industrial users to develop on their own. "The basic problem is that the technology for nonstop processing has not been available from computer suppliers until now," Willoughby says.

Nonstop systems are not new, however. The National Aeronautics and Space Administration, for example, has developed such systems for use in its space-exploration missions, during which unattended computers must operate reliably in a harsh environment for years after a spacecraft is launched.

Nor is August Systems the first company to market nonstop systems as commercial products. Tandem Computers Inc., Cupertino, Calif., pioneered a line of fault-tolerant systems for on-line data processing and network applications in the mid-1970s, and as a result, has become one of the industry's fastest-growing computer makers.

But Tandem's systems are too expensive—at $150,000 to $2 million—and too powerful for many industrial-control applications, Willoughby says. A typical industrial-control system consists of a network of computers with a plant supervisory computer linked to remote controllers, which in turn

NONSTOP PROCESSING: HOW IT WORKS

August Systems uses a "voting" approach to achieve high reliability in its Basic Controller series of fault-tolerant computers. Instead of trying to build hardware that's error-free, August Systems has a committee of processors working on critical tasks, with as many as three processors cross-checking each other's computations and providing backup in the event of a processor failure.

The technique permits the correction of errors by having the system processors vote on critical results and then using the result that gets a majority of votes. Moreover, it allows nonstop operation even when a major hardware failure occurs because the healthy members of the computer committee can take over the tasks of a malfunctioning unit.

In addition, the redundant processors operate in parallel only on critical tasks. Noncritical tasks can be divided among the processors to increase system throughput. This asynchronous operation reduces the waste of processing power often entailed by redundant systems.

Tandem Computer's NonStop line of fault-tolerant systems also uses a redundant processor technique to achieve high reliability, with as many as 16 processors interconnected by a dual bus. However, the Tandem processors do not cross-check each other's computations. Instead, Tandem has built extensive diagnostic circuits into the processors to allow them to detect their own errors.

Tandem deliberately avoided the voting solution to error detection, a Tandem spokeswoman says, because it defeats redundancy, leading to one component—a voter—that cannot be redundant.

August Systems adopted the voting approach because the firm wanted to assure 100 percent "coverage" of all possible faults, says John Wensley, a company founder who is now board chairman. Wensley also says that the voting technique reduces the cost of building a fault-tolerant system because it can be implemented in software, thus allowing the use of off-the-shelf general-purpose hardware. He claims full fault coverage is not possible with the Tandem approach because there are errors that a processor cannot detect by itself, such as faulty input.

Wensley concedes that the August Systems computers do use a single hardware voter for critical output commands. But he claims that at least two components must fail to cause the voter to operate incorrectly.

The software-implemented fault tolerant (SIFT) technique used by August Systems was originally developed by SRI International for the National Aeronautics and Space Administration as part of a technology transfer program to encourage the development of fuel-efficient commercial aircraft for the 1980s. The energy-efficient aircraft envisioned by NASA will be less aerodynamically stable than present planes, and hence will have to rely on computers to keep them on an even keel. Such an application entails an automatic flight control system that can survive even a major failure in hardware. SRI International was given a contract in the early '70s to develop a prototype fault-tolerant computer system for the NASA Energy Efficiency program.

govern individual device and process controllers. Although the Tandem systems might find a niche as plant-wide supervisory systems, they are overkill, Willoughby says, at the lower levels of the industrial-control hierarchy, where the ability to operate unattended in a harsh environment with great reliability is more important than raw processing power.

It is at this level in the industrial-control system hierarchy that August Systems has aimed its Basic Controller series of nonstop computers. "We wanted to develop a line of fault-tolerant controllers that were packaged in a form that the industrial user is accustomed to and were inexpensively priced," Willoughby says.

The Basic Controller series comprises three standard models, the BC 104, 204 and 304, which incorporate one, two and three processors, respectively. The basic BC 104 contains an Intel 8086 16-bit μc with memory and I/O subsystem, and this basic configuration is replicated once in the model 204 and twice in the 304.

The series increases in reliability as the number of processors increases—a result of the voting technique used by August Systems to achieve fault-tolerance. The model 104, intended for use in applications where reliability is not critical, has no fault-tolerance. The two-processor model can detect errors, but it cannot correct them. In the event of an error, however, the computer can re-try a task or halt to prevent a faulty output from causing damage to the device it controls. The three-processor model can correct—as well as detect—errors, thus enabling the computer to continue to operate normally even when a failure occurs.

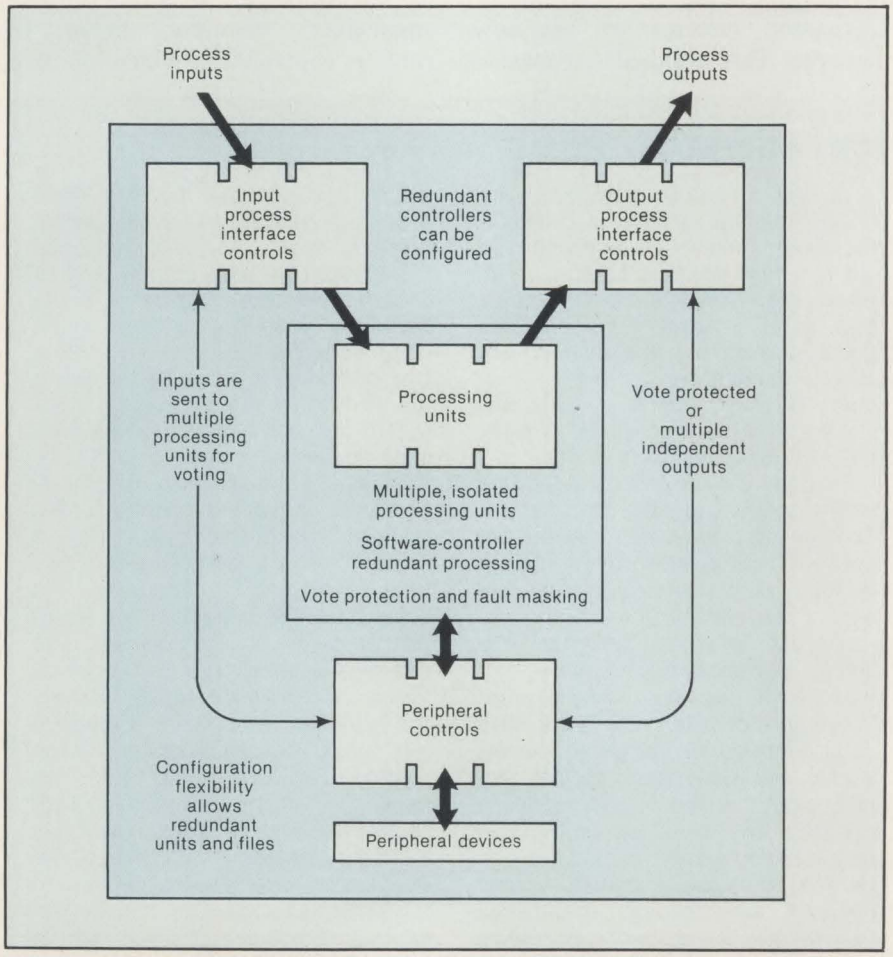
August Systems plans to expand this product line with models having as many as five identical processors. These systems will not only be more reliable, a company source says, but will also be more flexible because they will allow automatic reconfiguration of systems having the processors attached to different peripherals.

Prices of the Basic Controller series start at $10,000 for a BC 104 with 32K bytes of memory. A typical BC 304 with 128K bytes of memory sells for $25,000.

Although August Systems plans to market the series directly to sophisticated end users, its primary thrust will be aimed at third-party firms that will add applications software and re-sell them to end users. The company already has one OEM customer—a California systems house that is developing a nuclear power plant control system.

August Systems was founded two years ago by three former employees of SRI International, a Menlo Park, Calif., high-technology research and consulting firm. The technology on which the fledgling company's fault-tolerant systems are based was originally developed there as part of a NASA project to encourage the development of energy-efficient commercial aircraft. The three founders—John Wensley, Maurice Mills and Robert Wing—serve as board chairman, vice president of advanced development and vice president in charge of administration, respectively. All three were involved in the NASA project at SRI International, which Wensley headed.

Preparing for a period of rapid growth, August Systems has recently strengthened this management team with the addition of Willoughby as president and Robert



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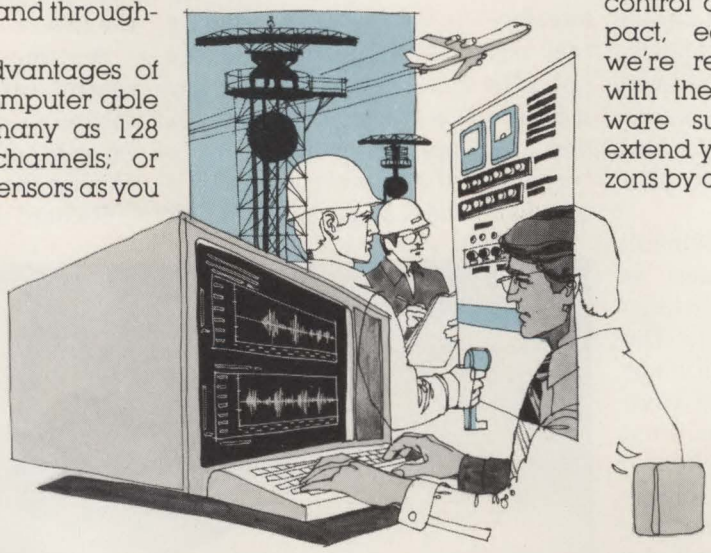

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Gardner, a Philadelphia computer consultant and former Burroughs Corp. executive, as marketing vice president. Willoughby, who was hired for his managerial expertise, is no stranger to start-up operations, having been president of Axxa Corp., an advanced electronic office systems firm spun-off by Citicorp last year. Willoughby left the firm along with other Axxa top management in a dispute with Citicorp over the degree of autonomy from the bank that the spin-off was to be allowed.

In addition to strengthening its management team, August Systems has also obtained more than $2 million in venture capital to finance its entry into the industrial control market. The company's three venture capital backers include Innoven, a New Jersey venture capital firm that has backed several highly successful high-tech start-ups, including Cray Research and Ramtek Corp. —*Paul Kinnucan*

Rolm's digital CBX mixes voice, data communications

A computerized digital-telephone system, said to integrate voice and data communications, has been introduced by Rolm Corp. The Santa Clara, Calif., maker of MIL-spec minicomputers and computerized private-branch-exchange telephone (CBX) systems says its CBX, with the data-communications feature, will allow voice and digital communications between terminals, computers and other transmission facilities, on-site or off-site, at speeds as high as 19.2K bps for less than the per-connection cost of a 1200-bps modem.

Using a technique called submultiplexing, the system handles as many as 40 data connections at 2400 bps through a pair of time slots. The company says neither quality nor performance of the data and voice communications is sacrificed when transmitted simultaneously.

Jerry Tomanek, Rolm's office-automation manager, calls the system "the first step toward the office of the future." He says it allows a user to access an information system via a single device and provides an experimental vehicle for determining office-system needs. "It may be that an office doesn't need electronic mail, for instance," says Tomanek, "but a manager may want to try it. The Rolm system provides the means to develop a pilot system." He adds that the system will support all features of office automation.

Rolm's data-communications feature uses the firm's CBX as the central switching device. A new release of CBX software and three other components comprise the system.

One component is "data terminal interface" (DTI)—a desk-top device that connects a terminal and the CBX. The unit can be used with any asynchronous terminal, computer port, modem or multiplexer to transmit data over standard telephone wires at 110 bps to 19.2K bps at distances as far as 5000 ft. from the CBX. The DTI has a standard RS232C interface.

The second component of the system is a data line interface (DLI)—two PC boards mounted in the CBX cabinet. Each DLI supports 16 data lines, and each channel operates at a data rate independent of the others.

The DLI provides the interface and control capabilities for full-duplex data communications before connection to the time-division multiplexing bus for switching by the CBX.

A time-division multiplexing control card installed in the CBX cabinet expands the traffic-carrying capacity of the CBX by submultiplexing the data connections.

Richard Moley, vice president of

Rolm Corp.'s CBX, *with a new data communications feature called submultiplexing, allows voice and digital communications between terminals, computers or other facilities.*

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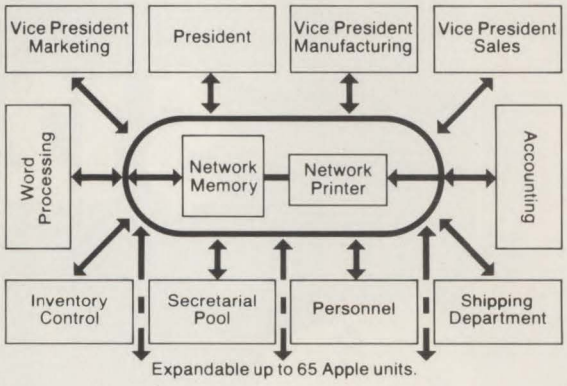

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EPI's STR-610 is a compact, low cost digital recorder that's ideal for use with POS terminals, smart CRT terminals and as a general peripheral for mini/microcomputer-based systems. The 610's recording density is 800 bpi for a capacity of 168K bytes/track, using a two-track 3M DC-100 mini-cartridge. Formatting is ANSI Standard and interfacing is parallel, with a variety of options. Price: $280 in quantities of 1,000. **The STR-LINK III** is a high-speed (9600 baud), portable program loader that uses the STR-610's drive system and shares the same specifications. It is used as a field service tool for diagnostic work or as a peripheral in a mini/microcomputer system. STR-LINK III uses a serial RS-232 interface for data communications or data terminal applications, and it can be controlled through RS-232, ASCII control codes, or manually. Price: $1,615 in single quantity.

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Submultiplexing provides maximum flexibility, capacity and efficiency in switching integrated voice and data. The time slots used for a single telephone conversation can now be subdivided, or submultiplexed, to transmit 40 simultaneous, 2400-bps data connections through any Rolm computerized business telephone system (CBX) equipped with the new data-communications feature.

Submultiplexing, an enhancement of the CBX time-division multiplexing process, digitizes all voice signals so that more than one two-way conversation can travel in the same time slot at 144K bps. Two of the CBX's 384 time slots are required for each voice transmission. With submultiplexing, the dedication of 16 time slots individually divided into 40-position fields provides as many as 640 data connections or 320 simultaneous, full-duplex data connections.

Consider the voice/data lines as a loaf of bread sliced in the usual way. If you were to slice the same loaf again, this time perpendicularly to the original slices, you submultiplex the loaf. In the case of Rolm's datacomm system, 40 perpendicular slices would be needed to match Rolm's claimed line capacity.

The advantage of submultiplexing is that it removes what seems like a fixed limitation by effectively allocating parts of CBX time slots into voice or data portions as needed. Although data communications need less time per connection than a voice call, the actual connect time, percentage of lines used and number of calls in progress at any time are greater for data calls.

Submultiplexing, a key element of the data communications feature, integrates the switching of voice and asynchronous data, simultaneously, using the same telephone wiring for both types of transmission without compromising the voice communication system. The new feature includes capabilities to meet present and future requirements for high-speed, direct-digital, switched communications between asynchronous facilities.

Designed for facilities with 24 to 4000 extensions, the CBX provides as many as 74M bps of data to accommodate the ever-widening range of office-automation applications. The data-communications feature provides high-speed, direct-digital communications between computers and terminals for less than the cost of a 1200-bps modem.

marketing of Rolm's telecommunications division, says submultiplexing makes Rolm's product unique. "Submultiplexing will be the key ingredient in CBX systems for the next 10 years," he says.

Submultiplexing subdivides one voice bandwidth to accommodate as many as 40 full-duplex data connections at 2400 bps. In effect, says production manager Tomanek, "submultiplexing allocates the system's switching capacity" more efficiently than other techniques.

Moley says the major market for the CBX/data-communications system will be systems with 200 or more lines, but it also will be cost-effective for systems with as few as four terminals.

Rolm expects to begin delivering the data-communications components by year-end. Prices are set by Rolm's distributors (interconnect and non-Bell operating companies), but Tomanek says prices should range from $600-$800. —*Larry Lettieri*

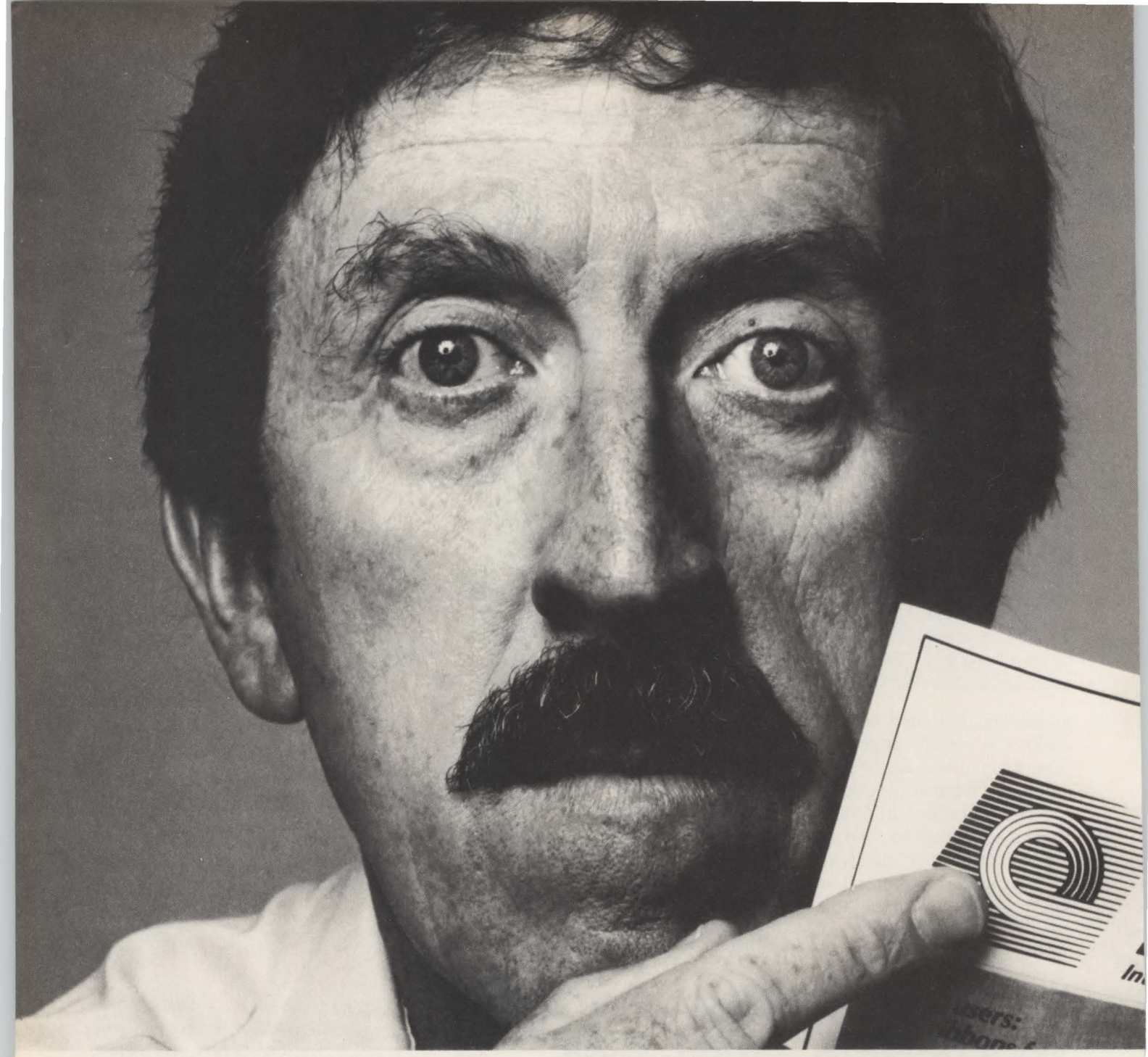
National's controller handles Winchesters, tapes, disk

When National Semiconductor Corp. offers a DEC-compatible multifunction single-board peripheral controller this month, it will mark the first entry into that market for the Santa Clara, Calif., semiconductor maker. The board is the first device built around a controller architecture that the company hopes will be the basis for a full line of new products.

With the device, National's memory systems group, which is shipping DEC- and Data General-compatible add-in memory boards, challenges year-old Spectra Logic Corp., Santa Clara, Calif., previously the only company offering such a product—the Spectra 21 tape and storage module device (SMD) emulating board, (MMS, October, 1980, p. 17).

National claims to have gone a step further than Spectra Logic by introducing a third interface on its board. Besides a tape transport and an SMD interface, the company has included a "port interface," designed to handle a high-speed semiconductor disk memory system that can replace DEC's RJS04/RS04 fixed-head disk subsystem (see "NURAM: National's new disk memory system," p. 42).

Tom Knight, National's memory systems group director, says the company's hex-wide controller board accommodates as many as four SMD interface-equipped Winchester-disk drives, emulating DEC's RM02 or RM03 removable-media drives. The board also handles as many as eight ½-in. tape drives or the streaming tape drives, such as Cipher Data Products' Microstreamer, which emulate DEC's TU10 tape transport. The board controls the new semiconductor disk device, emulating the RS04, Knight says.



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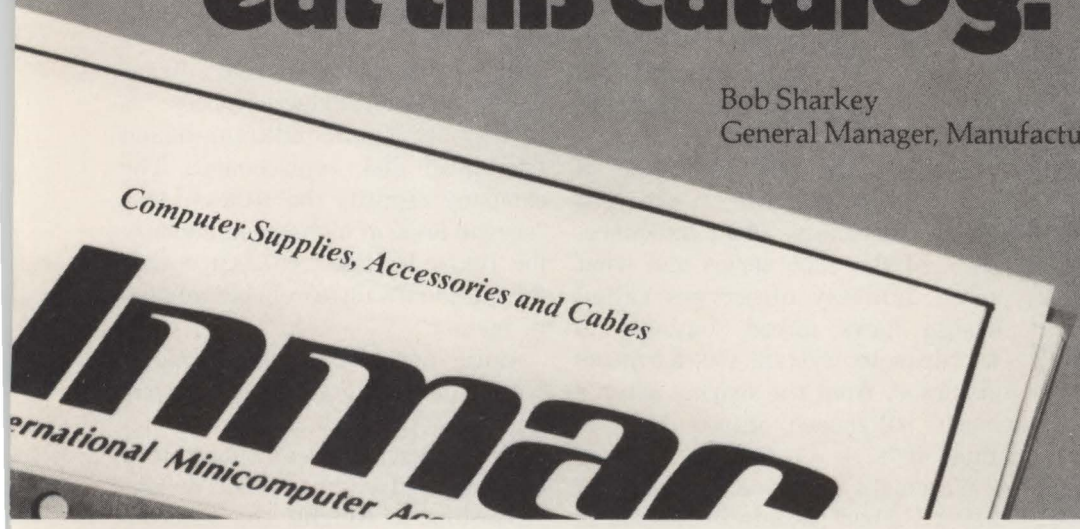

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In addition to the device interfaces, the board contains a Unibus interface and the controller circuitry. Knight says the firm has done a remarkable job of real-estate management by putting all these functions on one board. "The total chip count is only 200," he says.

At the heart of the device is a "micro-engine, designed to handle data—not process instructions," he says. "What's important in this market is how fast you move data, not do multiplication."

Tom Knight, National's *memory systems group director: "What's important is how fast you move data, not do multiplication."*

The transfer processing unit (XPU), as the micro-engine is called, is a bit-slice machine with a 40-bit-wide control word and a 150-nsec. internal clock. There are four priority interrupt levels, including direct memory access (DMA). Each has its own stack of registers, eliminating the need for switching registers everytime a new task is initiated, Knight explains. The interrupt levels, plus a 4K-byte buffer, add to the XPU's data-handling power, Knight says. "We've done little to the system and device interface logic. We've put everything into the controller."

National is counting on the XPU architecture to carry the company through a family of DEC-compatible controller boards planned for the next few years. Knight is not specific regarding future products, but he says that adapting the XPU to accommodate other tapes or disks is a trivial job. "It is simply a software task," he says. In developing the SMD interface, considered by many in the industry to be expensive and complicated, Knight says National has done the "worst-case situation. Anything else is easy."

Both Q-bus- and VAX-bus-compatible controllers are planned. Citing the lawsuit brought by DEC against Sunnyvale, Calif.-based Systems Industries for allegedly violating VAX bus patents (MMS, January, p. 24), Knight says, "National will not violate DEC patents" with either product.

Knight expects the XPU-based three-function board to be ready for delivery by spring after about 18 months in development.

National has the reputation of being a poor achiever in the OEM systems business. IBM's announcement of the 4300 series and what some industry observers called design flaws forced National to withdraw its System 400, a 370/138 emulator, from the market after a much ballyhooed introduction in June, 1978.

National's abortive challenge of DEC's Unibus patents in the fall of the same year resulted in its failure to bring a PDP-11/34-compatible machine, the Series 200, to market.

But Knight responds, "We're not in the paper tiger business." He points out his group's success in the DEC- and DG-compatible add-in memory business. "We've been delivering memory in quantity for more than a year now," he says, adding, "We're viewed as having the highest quality product in the industry. The controller is a natural extension of our product line. We intend to apply the same kind of expertise to the XPU that we've gained building memory."

National will build the controllers in the U.S. and Hong Kong. The company intends to market the device through its sales representatives in the U.S. and Europe.

Knight says the board will be sold in single-, double- or triple-function configurations. Prices for a single board range from $3000 to $6500, depending on the number of devices to be controlled. Customers who want to upgrade will be required to return the board to National for additional microcode and to ensure that the components are usable, says Knight. *—Larry Lettieri*

NURAM: National's new disk memory system

You've heard of RAM, ROM, PROM and EPROM, but have you ever heard of a NURAM? That's what National Semiconductor Corp. is calling its semiconductor-based fixed-head disk replacement. The company regards the NURAM as a "second level of high-speed memory for DEC's Unibus." NURAM stands for National's ultra-reliable auxiliary memory.

Until now, says Tom Knight, National's memory system's group director, "the only alternatives for PDP-11 users have been bulk RAM or core or a fixed-head disk drive." According to Knight, the semiconductor disk provides as much as 8M bytes of dynamic RAM in 512K-byte increments in a 12½-in. chassis. It is also available in 2M- and 4M-byte versions, he says. The memory is logically organized as a disk drive, he points out, "but from a performance standpoint, it doesn't act like a disk."

NURAM is not the first semiconductor disk. Intel Corp. introduced a device that was conceptually similar, and at least two others have also been introduced.

NURAM architecturally resembles a disk because it operates in bit-serial fashion, says Bill LeDuc,

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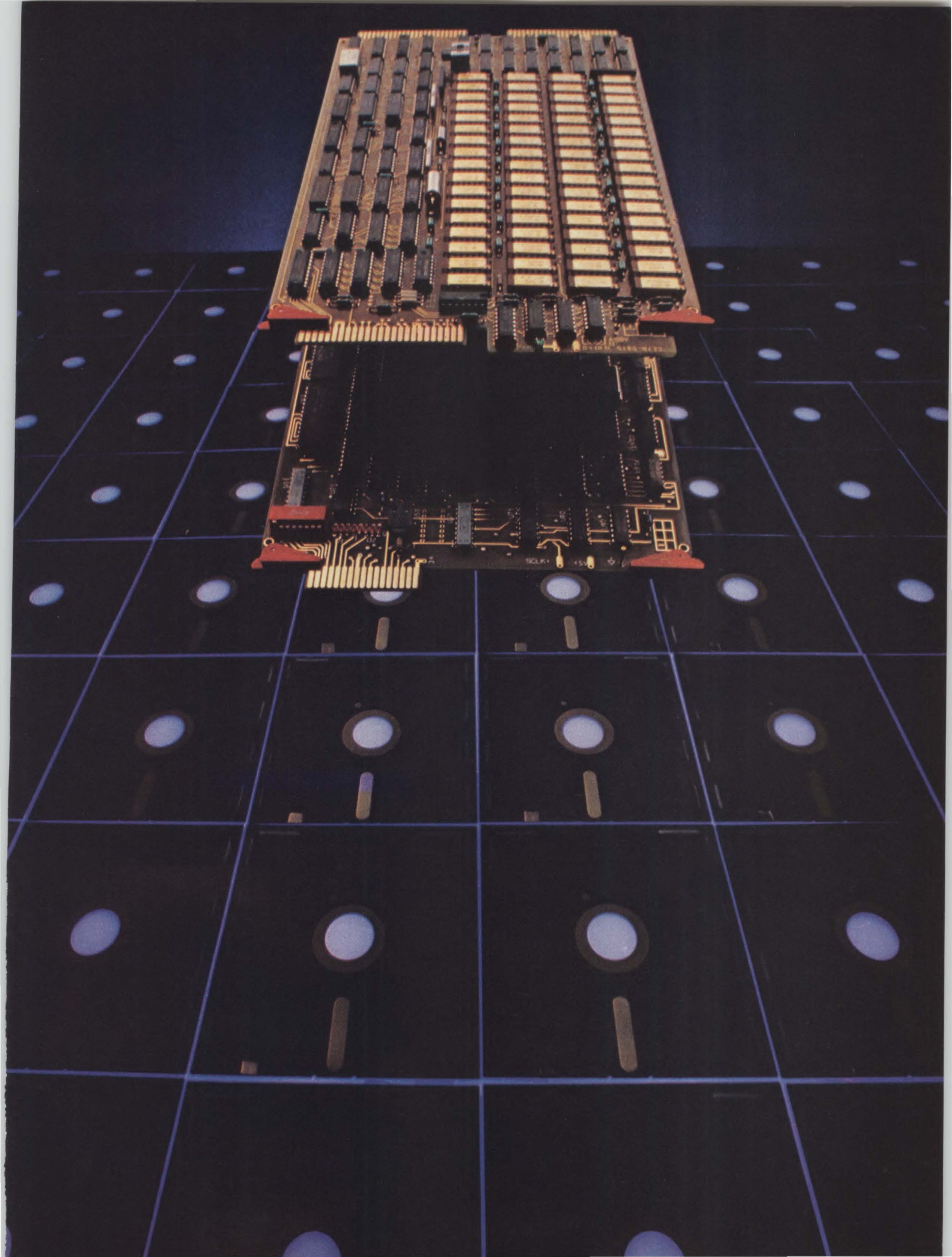

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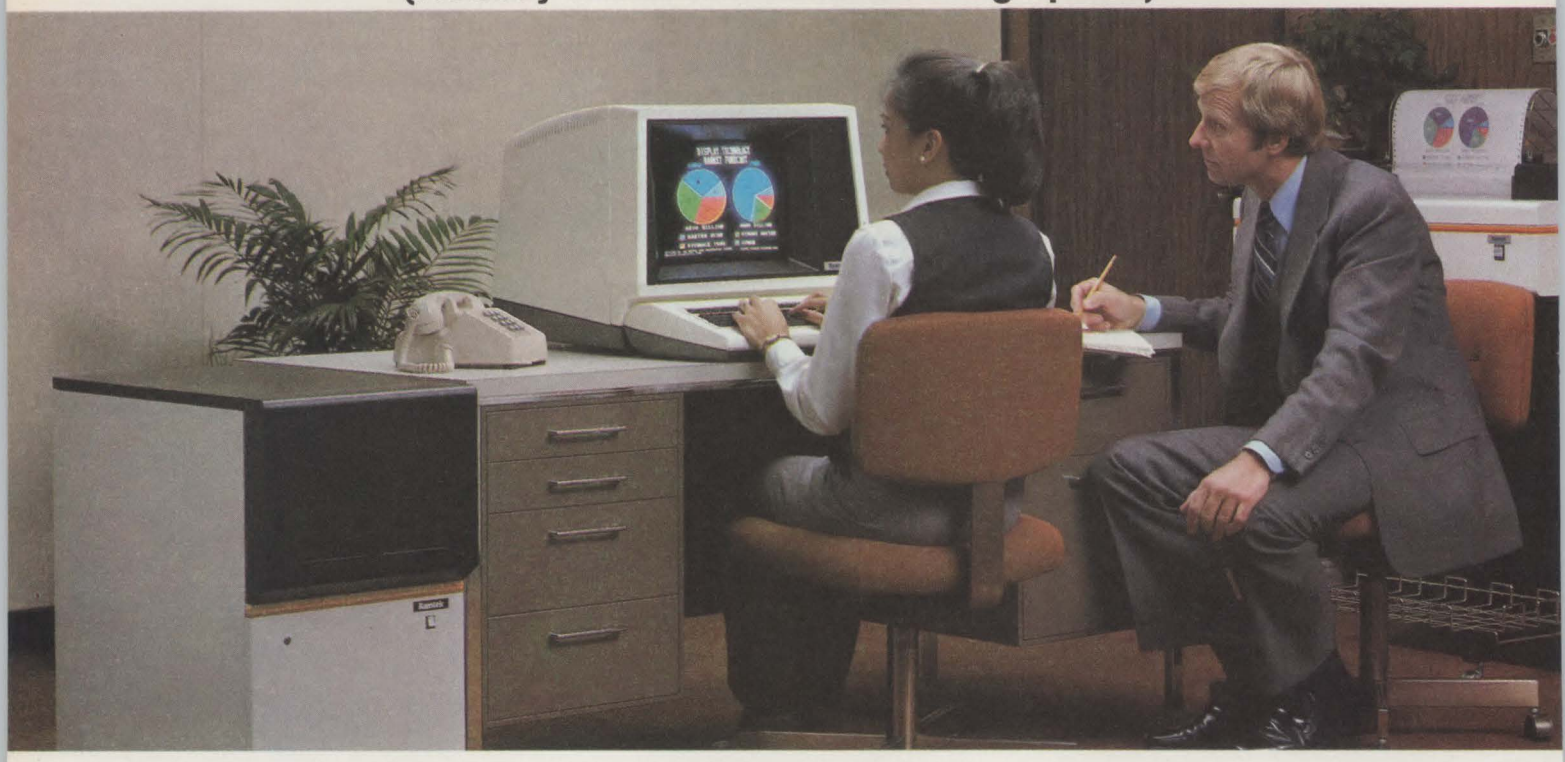

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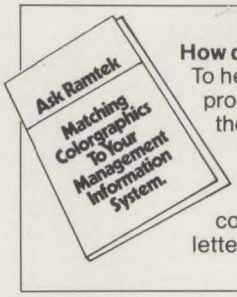

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product manager for the new memory. The architecture enables the company to use the error-correcting techniques used by disk drives, he says. Furthermore, each RAM is considered a sector of a disk, and each 512K-byte RAM board is a recording surface, LeDuc says.

National says NURAM compares favorably in price and performance with bulk RAM or core and fixed-head devices such as DEC's RS04. The RS04 is a fixed-head disk drive with a 512K-word storage capacity. National says NURAM's data rate is 500K bps—not as fast as RAM, which has a 2M- to 4M-bps data rate, and only slightly slower than the RS04's 800K bps. In terms of average access time, NURAM is considerably faster than the RS04, LeDuc says; 0.5 msec. compared with 8.5 msec. It is, however, slower than RAM, which has virtually instantaneous average access time.

Knight expects NURAM to sell for about $3000 to $4000 per megabyte. On an OEM cost/performance-per-megabyte comparison with RAM and a fixed-head disk, NURAM fares very well, says Knight. He bases his estimates on a $10,000-per-megabyte price for RAM and a $1500-per-megabyte price for an RS04.

National is using partially good RAMs in the memory system, but it does not affect the system's performance. It has built-in maintenance features that inform the user of the status of each RAM on a board and of the status of each board.

The system has three levels of performance degradation before anything catastrophic occurs. Knight says the parts count in the device has been reduced. "There are only 150 RAMs in the critical path to total system failure," says Knight. That feature makes the memory "ultra-reliable," he says.

LeDuc says serendipity brought about NURAM. "While we were deciding what to do with the partially good RAMs," he explains, "we discovered we had extra space on the controller board." The available space was used for the so-called port interface, he says.

Knight and LeDuc foresee a large OEM and end-user market for NURAM. "We're providing a way for PDP-11/34 users to improve their system's performance without having to move to an 11/44 or a VAX," Knight maintains. He sees NURAM serving as a buffer for small pieces of data-like file indexes. "We expect a 64-byte transfer to be typical," he says.

National plans to have evaluation units of NURAM in the field by early summer. —*Larry Lettieri*

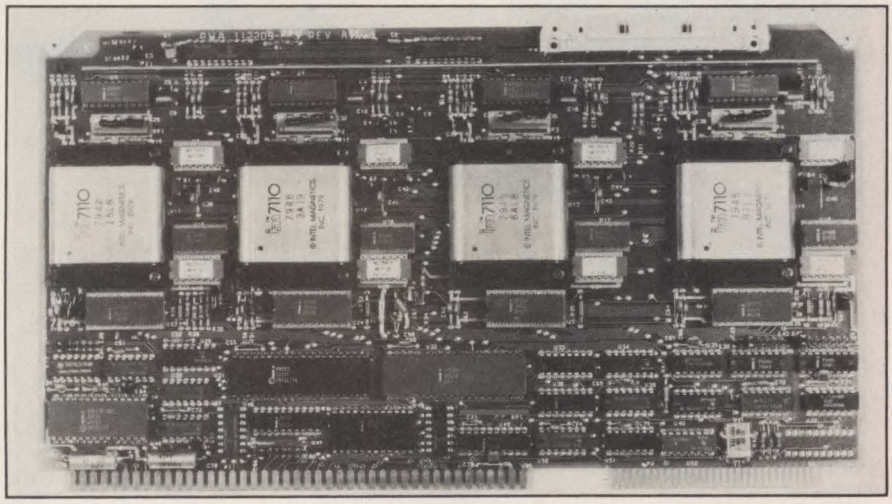
Intel's bubble-memory board offers storage alternatives

In an effort to increase OEM awareness of bubble memory, Intel Corp. introduced a 512K-byte bubble-memory board in December. The company is pushing bubble memory as a reliable storage medium for applications requiring nonvolatile memory, high data integrity and high tolerance to harsh environments.

At the same time, the company announced that price reductions for the new board will follow the guaranteed price cuts of its bubble-memory components. That's a move Intel made in August in an effort to spur market growth by curtailing OEM apprehensions about bubble prices.

The iSBC 254 bubble-memory board sells for $7050 in 100-unit quantities. Intel says the price will drop by the third quarter to $4625, and by the third quarter of 1982, prices will be as low as $2400 for 1000-unit quantities. These prices parallel those of the firm's BPK 72 bubble-prototyping kit, which sells for $995 in 100-unit quantities. That price will be cut to $595 in quantities of 5000 by August, and to $295 in quantities of 25,000 by August, 1982.

The iSBC 254 Multibus-compatible board uses Intel's IM 7110 1M-bit bubble-memory device. The board can accommodate as many as four 7110s, resulting in storage capaci-



Intel's iSBC 254 512K-byte bubble memory board *can be used in applications requiring high data integrity, nonvolatility and high tolerance to harsh environments.*

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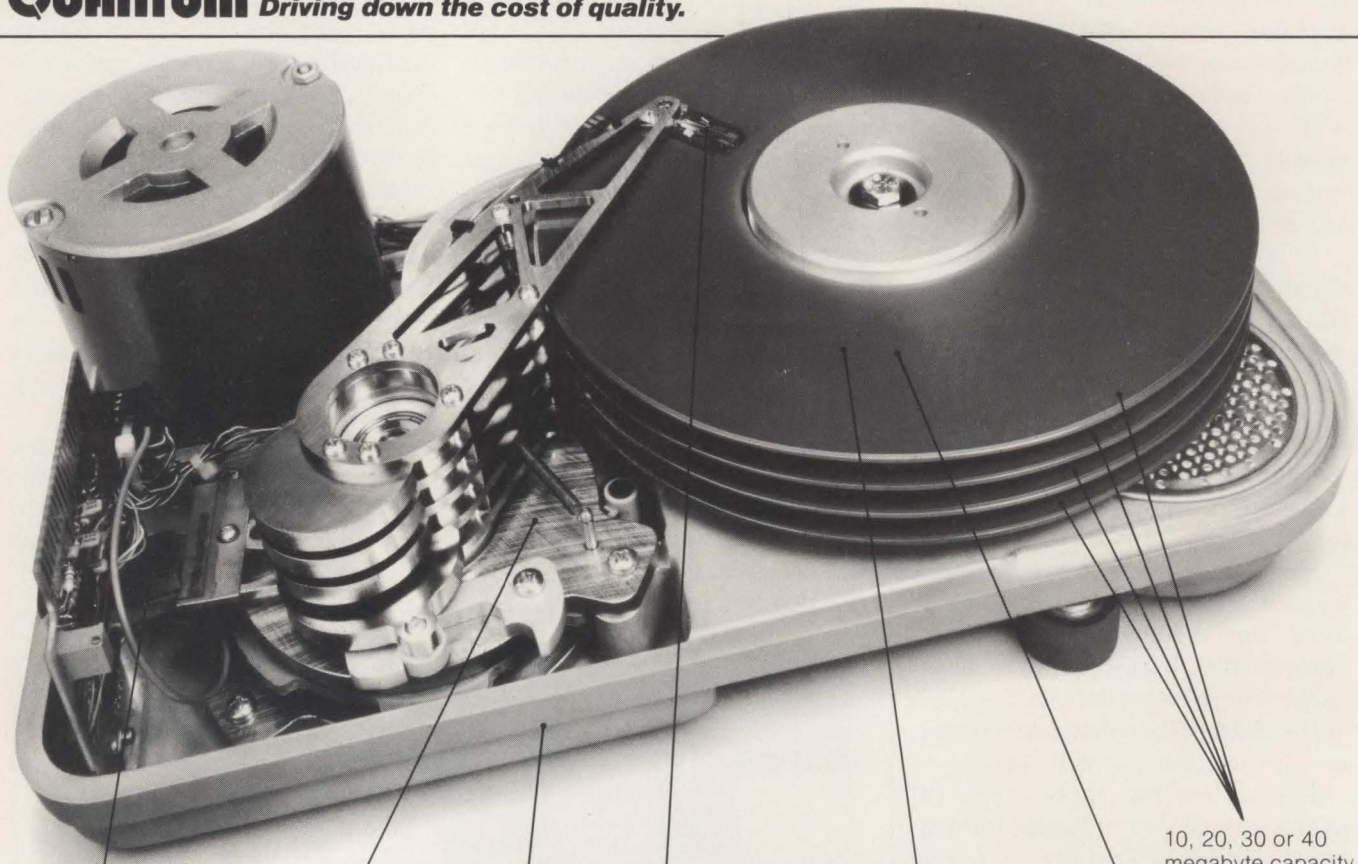

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ties of 128K, 256K or 512K bytes. The on-board IM 7220 controller, which features built-in power-fail protection and error correction (Intel's "fire code"), handles operation in direct memory access (DMA), interrupt or polled modes. Intel says the DMA feature, not previously available on Multibus boards, provides maximum flexibility in μp-based systems design.

Transfer rates vary with board capacity. A 128K-byte board has a maximum transfer rate of 12.5K bytes per sec., while the 256K- and 512K-byte boards have transfer rates of 25K and 50K bytes per sec., respectively.

The iSBC 254 can be driven by either iRMX/80 or iRMX/86, the firm's 8- and 16-bit real-time multitasking operating systems. The iSBC 254 is also compatible with 16-bit addressing for 8-bit processors and with 20-bit addressing for 16-bit processors.

The 254 is also fully compatible with the iSBC 250, a 128K-byte bubble-memory board introduced by Intel in 1979. Users of the 250 can easily upgrade to the 254, Intel claims.

With the introduction of the iSBC 254, Intel has shifted the marketing of board-level bubble-memory products from Intel Magnetics, Inc., the component group, to the company's OEM memory-marketing organization, the Memory Systems Operation (MSO).

MSO strategic marketing manager, Janice Carnes, says bubble memories are expected to offer systems designers an alternative to traditional disk and tape drives. "As μp systems proliferate, especially in severe environments and where low power is required, bubbles become the logical memory choice," says Carnes.

She says applications are using from 256K- to 2M-byte bubble memories. Typical applications include test equipment; monitoring gear, including seismic equipment; airborne and shipboard systems; data communications; medicine; and numerical and process control, which account for nearly half of all installed bubble memory, she says.

The market is expected to grow considerably over the next six years, Carnes says. Intel's figures indicate that acceptance of bubble memory will expand from $30 million in 1980, with about $4 million in systems products, to $40 million by the end of this year, with the systems segment reaching almost $8 million. Intel thinks the total market next year for bubbles will be $100 million, increasing fivefold by 1986. —*Larry Lettieri*

Removable bubble memories move into new markets

Executives at a major New York bank may soon be carrying bubble memory cartridges on business trips to foreign countries. The bank officials would use the cartridges to enter secret codes into electronic mail terminals for sending messages to the home office. This is one of the more intriguing applications envisioned for removable bubble memory systems now being introduced in the U.S. market.

Fujitsu America, Inc., pioneered removable bubble memory a year ago when it introduced a system that accepted as many as eight 8K-byte plug-in modules. The Japanese firm recently followed up that introduction with a system that uses 32K-byte cassettes—as many as four per system—for a 128K-byte total storage capacity.

Meanwhile, Fujitsu's U.S. competitors have not been idle. National Semiconductor Corp. will announce a removable bubble memory system later this month. Intel Corp. plans to introduce a system sometime during the second quarter of this year.

Texas Instruments Inc., also is believed to be developing a bubble cassette system. A TI spokesman confirms that the company is considering packaging its bubble chips in cassette form, but says a product introduction is not imminent. Several TI OEMs, however, have developed removable memory systems based on TI chips—an indication that TI may be experiencing customer pressure to supply bubble memory in cassette form. The OEMs are Q1 Corp., Computer Transceiver Corp. and Sangamo, Inc., which is using removable bubble memory in a system that monitors electrical power consumption in industrial buildings.

Fujitsu's recently announced model FBM43CA system comprises a controller board, cassette holders and the cassettes themselves, which contain a 256K-bit bubble memory chip and a linear driver circuit. Data is stored on the chip in the form of tiny magnetic domains, called bubbles, that are created and manipulated by a rotating magnetic field. The controller board contains an 8-bit parallel TTL interface for linking the system to a host μc. The controller, also available with an RS232 serial interface, accommodates as many as four cassettes.

Fujitsu's earlier model FBM31CA system uses cassettes based on the company's 64K-bit chip. The system's controller supports as many as eight cassettes and is available only with a parallel interface. Otherwise, it is similar to the 256K-bit system.

Prices of the Fujitsu systems range from $661.25 for a basic 8K-byte system to $3058.75 for a 128K-byte system with a serial interface. Extra cartridges sell for

$117.50 and $462.50 each for the 8K- and 32K-byte cassettes, respectively.

Pricing and specifications are not yet available for the Intel systems. However, Christie Robbins, marketing manager for Intel's bubble memory product line, says the system will use cassettes based on the company's 1M-bit bubble memory chip. Thus, the system's basic memory capacity—128K bytes—will be equal to the maximum capacity of the Fujitsu system, she points out. Moreover, because the system requires only one cartridge to attain that capacity, Robbins says, it will sell for substantially less than the Fujitsu system.

Storage capacities of the National Semiconductor system will range from about 100K to 1M bits per cassette, a company spokeswoman says. Prices for the cassette system have not yet been set, she says.

All three firms are aiming their systems at an emerging market for nonvolatile mass storage in applications where electromechanical memories—disks and tapes—are ruled out because of their fragility and size. "We're targeting our system at applications where floppy disks won't go," says Robbins, who cites process-control systems and portable data-collection terminals as typical applications. In these applications, she points out, bubble memory cassettes combine the advantages of solid-state reliability and compact size with that of nonvolatile storage.

Another potential application is in data security systems. For example, a major New York bank has been evaluating Fujitsu's bubble memory system for use in storing secret codes used by its executives to communicate with the home office while on business trips abroad. "The bank apparently feels bubble memory cassettes are slightly more stable and secure than tape cassettes," says George Neeno, marketing services manager at Fujitsu's components division in Lake Bluff, Ill. Neeno declines to identify the bank.

Despite their advantages, most observers believe bubble memory cassettes will be restricted to specialized applications for the foreseeable future because of their high cost compared to semiconductor and electromechanical memory systems. Neeno agrees. "We can't hope to compete with disks and tapes on a cost basis," he says.

Nevertheless, he believes that specialized applications will become a substantial—and profitable—market for bubble memory manufacturers. "We have had terrific response to our system," he says, adding, "I am puzzled that our competitors haven't already entered the market." *—Paul Kinnucan*

Data General hit hard in transition period

For many companies, the telltale signs of growth—tugging by managers to decentralize corporate control, efforts to focus corporate and product goals more clearly, and belt-tightening budget measures—seem especially acute at the $500 million revenue mark. Companies such as Wang Laboratories and Digital Equipment Corp. have leaped that hurdle with little apparent disruption of earnings. But Data General Corp. still is trying to recover from its ascent to the half-billion club in 1979, when revenues reached $507.5 million.

To the company's misfortune, its interim growth struggles are being accentuated and prolonged by a sluggish economy. The Westboro, Mass., company found no reprieve in the first quarter of 1981 from the earnings decreases it has been experiencing for more than a year. Although revenues of $156 million were up 13.7 percent over the same quarter last year, earnings dropped to $8.7 million before an extraordinary gain from the sale of 160,000 shares of Rolm Corp. stock. Net earnings that quarter last year were $11.9 million. Operating income declined to $20.5 million from $22.1 million the year before. Current operating margins are 13.1 percent, down from the healthy 18 to 20 percent margins the company enjoyed during its first decade of operation, when Data General's profits were the envy of the minicomputer industry.

Company president Edson D. de Castro blames the disappointing results on the double dip in the economy, high inflation and interest rates and a decreasing product demand in western Europe. Hardest hit were Data General's low-end products—microNova, Nova, Nova 4, CS small business computers and the S/140. Many of these products are sold through small OEMs that are easily affected by economic conditions. Order rates dropped, de Castro says, because these OEMs are hesitant to purchase in the face of high interest rates and sluggish economic performance. He adds that sales of the high-end lines, such as C/350, M/600 and MV/8000, were strong, but were not enough to offset low-end declines.

"The problem in the low end is a cyclical low," maintains de Castro. "We'll continue on plan with our developments here. We expect the business to pick up in the future." He says Digital Equipment and Hewlett-Packard have observed the same reduced demand for low-end products.

Yet, many analysts suspect the low-end problems are magnified by internal upheavals during a period of transition the company is experiencing as management tries to position DG for long-term growth. De Castro acknowledges that the company is undergoing a transition. "We clearly need to make short-term trade-offs to achieve longer-

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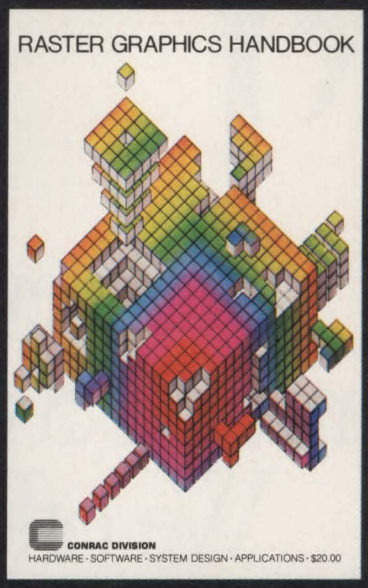

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term goals," he told analysts and stockholders at the company's annual meeting in January. "We are becoming a company less managed by individuals and instinct and more by objectives, policies and plans. The tough, start-up little firm dedicated to the next central processor and next quarter's profits is no more. Neither the time, our customers nor our employees would accept it as sound business." In the minds of many industry observers, this realization was long overdue.

"Data General has been proud that it has had central control. You could put your arms around the company. But at $500 million, your arms stretch," says Peter Lieu, an analyst with Arnholdt & S. Bleischroder, Inc., in New York. Lieu hopes the company can correct some of its problems. A major step in that direction would be to build a management team and delegate responsibility to those individuals.

One of the earliest signs of growth struggles affecting profits showed more than a year ago. In the fourth quarter of 1979, the company experienced the first earnings drop in its then 11-year history (MMS, March, 1980, p. 84). That decline was attributed to the cost of beefing up Data General's maintenance organization by hiring and training the people to staff it.

Additionally, the implementation of two decisions made last year squeezed profits. First, some product leadtimes were decreased, resulting in higher inventories for Data General when OEM orders were deferred. A part of that problem may have been the accelerated production of the Nova 4 minicomputer at the expense of high-end Eclipse production. Second, prices for the Nova 3 were increased five percent in December, 1979, but the increases were carried out incorrectly, the company says. DG allowed its OEMs to buy at the previous price during a grace period. The result was speculative

Data General's De Castro: *"The tough, start-up little firm dedicated to the next central processor and next quarter's profits is no more."*

ordering, similar to the double ordering that plagues the semiconductor industry. Some orders were later cancelled, leaving the company with a large inventory in May.

During 1980 the signs of growth became more painfully pronounced. The company showed stress in high turnover rates and reassignments in high-level management, sales managers and sales force. Meanwhile, it was also fleshing out new distribution channels, broadening its product offerings and attacking the high-end minicomputer market. One analyst says the company did not address transition issues early enough. And the results have hurt:

- The General Distribution Division, set up one year ago as a focal point for retail sales, needs a more appropriate product spread. "The product line currently constituted is not quite right for that area," admits de Castro. The products now offered by the division top-out in the $18,000 to $25,000 range. A new product, called TBS (tiny business system), is expected to sell for about $2000, say some sources. Announcement of TBS is expected this quarter; de Castro didn't mention it by name at the January meeting, but he did acknowledge development of hardware that is "more suitable" for the division.
- The company is late in specializing its sales force. Salespeople, de Castro says, have had difficulty selling a broad product line, causing the company to divide sales into three areas: industrial/scientific, business and federal. "There was some turnover in this group, greater than normal. And there was some loss in productivity in the group that has probably contributed to the slowdown in orders we have experienced," he explains. One analyst cited a high toll in the sales force turnover rate: U.S. sales, service and support personnel decreased from 1142 at the end of December, 1979, to 977 by the end of September, 1980, and there is a high turnover rate among district managers. De Castro says that transition is behind the company now.
- He wants to integrate the company horizontally and broaden its products, services, customers and market, through acquisition, if necessary.

But DG's attempt to gain a foothold in the graphics market slipped when Megatek Corp., San Diego., rescinded an agreement for acquisition by DG in January. Apparently undeterred by the move, de Castro says the company will persist in efforts to address the graphics market.

- Additionally, Data General has yet to offer a strong office automation entry, says Lieu. It should also have more distributed data-processing, commercial end-user and peripheral products, another analyst says.
- Although the MV/8000 is said to be selling well, de Castro admits that it was late reaching the market. Its introduction last spring was not in time to offset reduced

Mini-Micro World

orders for low-end products. The supermini does not yet contain 32-bit business or commercial compilers, as does DEC's VAX 11/780, but it will soon incorporate them.

• The company had a high legal bill in 1980, resulting from antitrust litigation with Fairchild Camera and Instrument Corp. and Keronix, Inc. The company expects the Fairchild case, which is scheduled for trial this month in San Francisco, to continue to be costly during a long appeals process.

• Within the last two years, more than four top managers have left the company for various reasons. Most recently, James Finke, who was the third highest paid DG executive and vice president for Europe, left the company in January, six weeks after he was assigned to a position with no profit and loss responsibility. Many analysts suggest the company will have to minimize turnover to move toward recovery.

A new business plan is reportedly in the works. De Castro says he may add more profit and loss centers to the five already in the company as it decentralizes. He has set cost control targets in all operating divisions. "Returning to the 18 and 20 percent operating margins of Data General's first decade will depend on our own productivity and asset management, as well as competitive conditions in the market," he said.

Many feel that economic conditions will not spring back for at least a year and will defer the company's progress.

"Data General is going through the classic transition of any company reaching the half-billion-dollar level. This is likely to represent a pressure for a good while, although they should come out of it stronger within one or two years," says Stephen T. McClellan, an analyst with Salomon Brothers, New York.

—Lori Valigra

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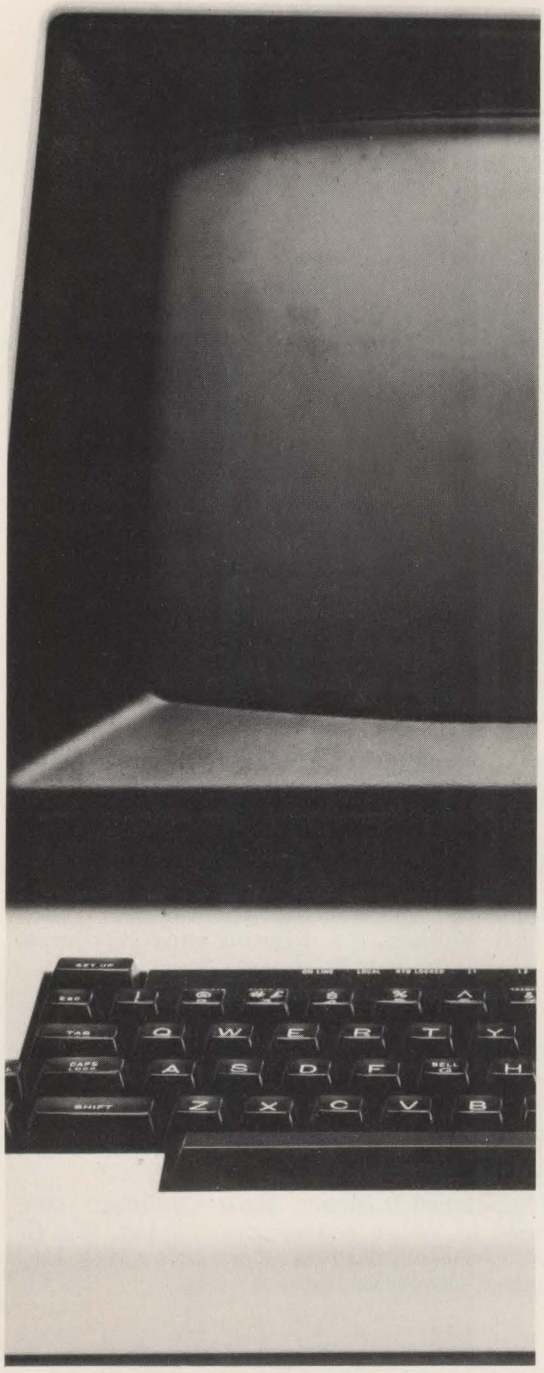

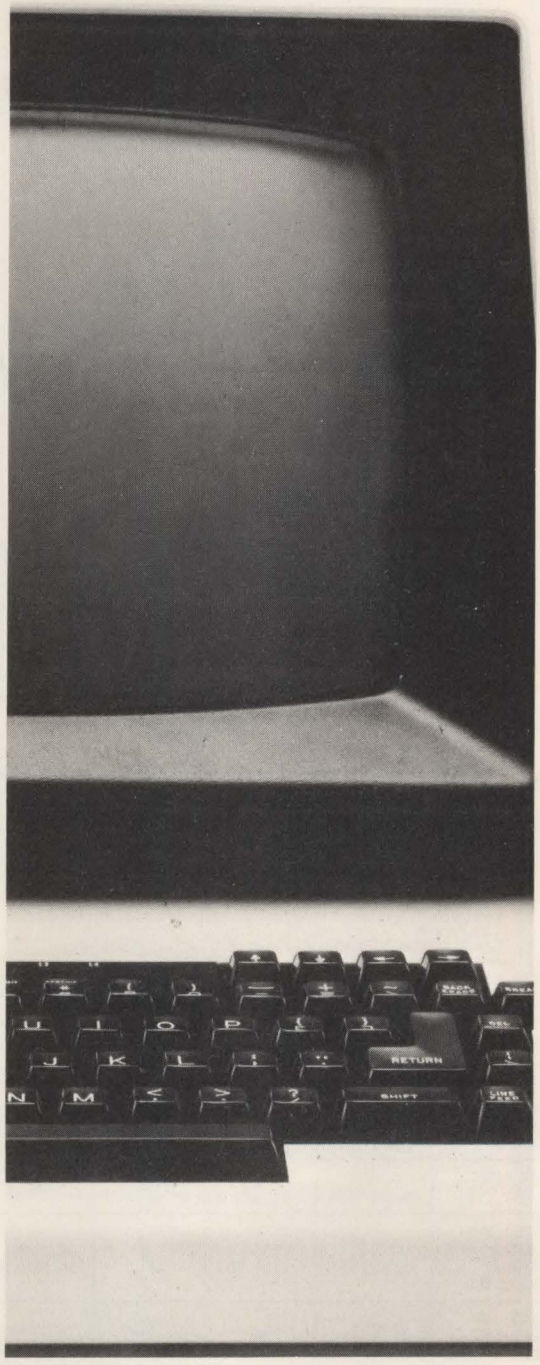

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Calendar

SHOWS & CONFERENCES

MARCH

23-25 Office Automation Conference, Houston, sponsored by the American Federation of Information Processing Societies (AFIPS). Contact: Office Automation Conference, P.O. Box 9659, Arlington, Va. 22209, (703) 558-3610 or (800) 556-6882.

23-27 Second International Flow Symposium, St. Louis, Mo., sponsored by the American Society of Mechanical Engineers (ASME), the National Bureau of Standards (NBS) and the Instrument Society of America (ISA). Contact: C. Douglas Hetrick, Director, Membership and Technical Services, ISA Headquarters, P.O. Box 12277, Research Triangle Park, N.C. 27709, (919) 549-8411.

24-26 Southwest Semiconductor Exposition, Phoenix, Ariz. Contact: Bonnie Crystall, SSE 81 Show Manager, Cartlidge & Associates, Inc., 491 Macara Ave., Suite 1014, Sunnyvale, Calif. 94086, (408) 245-6870.

24-26 Fiber-Optics Exposition, Cambridge, Mass., sponsored by Information Gatekeepers, Inc. Contact: Ellen M. Bond, Information Gatekeepers, Inc., 167 Corey Rd., Suite 111, Brookline, Mass. 02146, (617) 739-2022.

24-26 Second International Conference and Exhibition on Engineering Software, London, England. Contact: M.A. McSweeney, Exhibition Manager, ENGSOFT, Computational Mechanics Centre, 125 High St., Southampton, SOL OAA, England, (0703) 21397.

24-27 Printemps Informatique '81, Paris, France. Contact: Gerald G. Kallman, U.S. Representative, 30 Journal Sq., Jersey City, N.J. 07306, (201) 653-3304.

MARCH 30-APRIL 2

Interface '81, Las Vegas, Nev., sponsored by Datamation and the Interface Group. Contact: Peter B. Young, the Interface Group, 160 Speen St., Framingham, Mass. 01701, (617) 879-4502.

MARCH 31-APRIL 2

1981 Cincinnati Business Show, Cincinnati, Ohio, produced by Weber & Associates. Contact: Ray G. Nemo, Cincinnati Business Show, 5679 Creek Rd., Cincinnati, Ohio 45242, (513) 531-5959.

APRIL

1-2 Southwest Printed Circuits & Microelectronics Exposition '81, Dallas. Contact: Industrial & Scientific Conference Management, Inc., 222 West Adams St., Chicago, Ill. 60606, (312) 263-4866.

1-2 Communications in the 21st Century Symposium, Richmond, Va., sponsored by the Colgate Darden Graduate School of Business Administration (University of Virginia), the Annenberg School of Communications (University of Pennsylvania) and the Annenberg School of Communications (University of Southern California). Contact: Joyce Kravitz, Manager, Philip Morris Inc., 100 Park Ave., New York, N.Y. 10017.

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

CIRCLE NO. 31 ON INQUIRY CARD

Calendar

1-3 **"Assuring Quality in EDP Applications" Conference,** Chicago, sponsored by the Data Processing Management Association (DPMA) Education Foundation. Contact: DPMA Quality Assurance Conference, 12611 Davan Drive, Silver Spring, Md. 20904, (301) 622-0066.

1-8 **Hanover Fair '81,** Hanover, West Germany. Contact: Hanover Fairs Information Center, P.O. Box 338, Whitehouse, N.J. 08888, (201) 534-9044 or (800) 526-5978.

5-8 **Southeastcon '81,** Huntsville, Ala., sponsored by the IEEE. Contact: Willy Albanes, General Chairman, Southeastcon '81, Computer Sciences Corp., Defense Systems Division, 6022 Technology Drive, Huntsville, Ala. 35805, (205) 837-7200.

7-8 **"Top Secrets '81" Computer Security/Privacy Symposium,** Phoenix, Ariz., sponsored by Honeywell Information Systems. Contact: Security Symposium Registrar, Honeywell Information Systems, M/S T-99-4, P.O. Box 6000, Phoenix, Ariz. 85005, (800) 528-5343.

7-9 **Computerized Office Equipment Expo—Midwest '81,** Rosemont, Ill. Contact: Cahners Exposition Group, 331 Madison Ave., New York, N.Y. 10017, (212) 682-4802.

7-9 **Electro/81,** New York, sponsored by METSAC Sections and the Central New England Council, Region 1, Institute of Electrical and Electronics Engineers (IEEE), and New York and New England Chapters, Electronics Representatives Association (ERA). Contact: Dale Litherland, Educational Activities Manager, Electro, 999 North Sepulveda Blvd., El Segundo, Calif. 90245, (213) 772-2965.

9-12 **Southwest Computer Show & Office Equipment Exposition,** Dallas. Contact: National Computer Shows, 824 Boylston St., Chestnut Hill, Mass. 02167, (617) 739-2000.

13-14 **Executive Computer Conference,** Washington, sponsored by Infosystems. Contact: Kendall Burroughs, Conference Chairman, Executive Computer Conference, 1730 N. Lynn St., Suite 400, Arlington, Va. 22209, (703) 521-6209.

14-16 **Federal DP Expo,** Washington. Contact: Peter B. Young, The Interface Group, 160 Speen St., Framingham, Mass. 01701, (617) 879-4502 or (800) 225-4620.

15-16 **Southeast Printed Circuits & Microelectronics Exposition '81,** Orlando, Fla. Contact: Industrial & Scientific Conference Management, Inc., 222 W. Adams St., Chicago, Ill. 60606, (312) 263-4866.

19-22 **Electronic Warfare Symposium & Electronic Defense Exhibits,** San Antonio, Texas, sponsored by the Electronic Security Command, the Air Force Electronic Warfare Center, the Southwest Research Institute and the Western Region-Association of Old Crows. Contact: E.L. Bronaugh, Technical Program Chairman, P.O. Drawer 28510, San Antonio, Texas 78284, (512) 684-5111.

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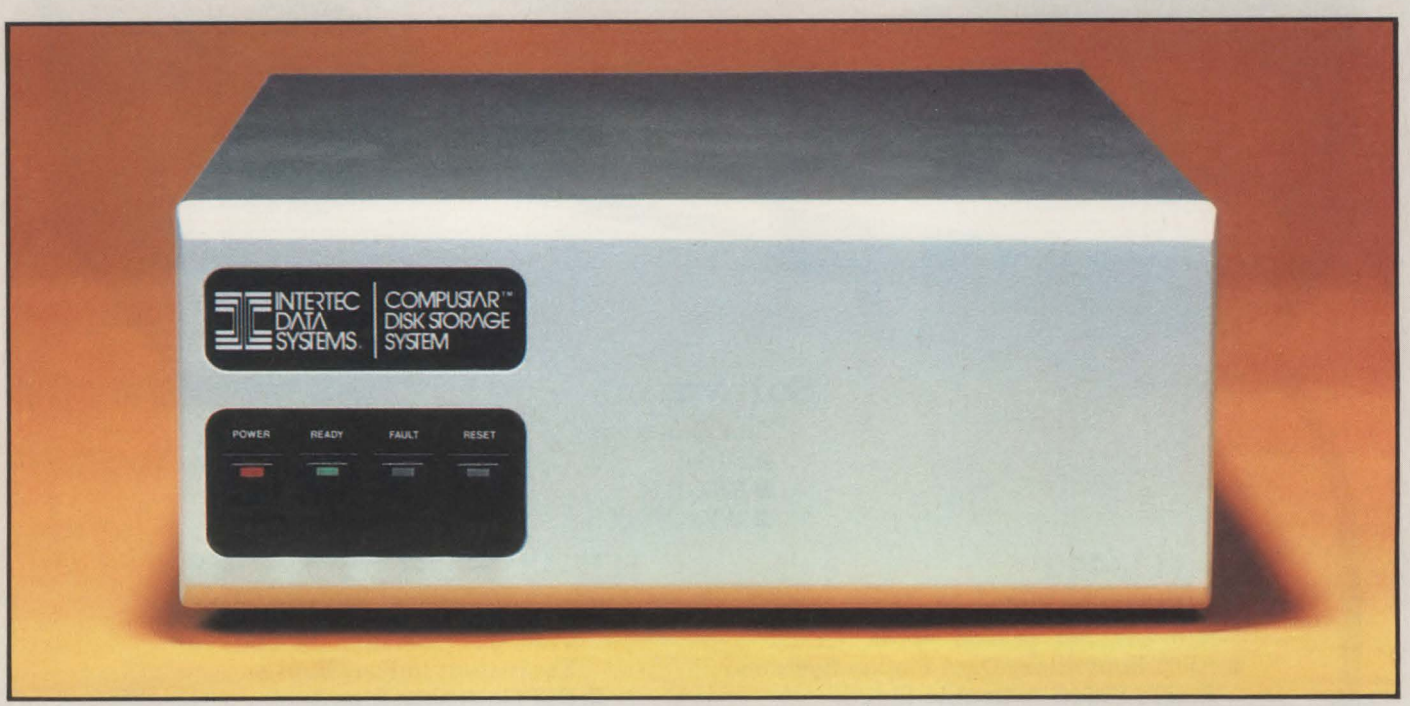

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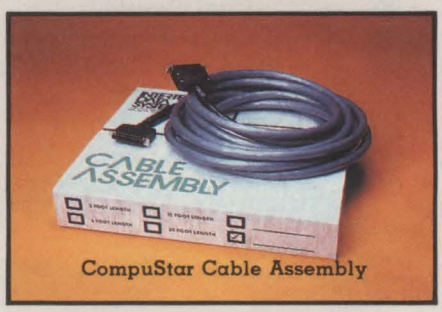

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CIRCLE NO. 37 ON INQUIRY CARD

Local area networks draw debate at Interface show

Since Xerox Corp. popularized the concept behind its Ethernet local area network, approaches to intra- and inter-company communications have come under close scrutiny. Such networks will be the subject of considerable evaluation and debate at the Interface data communications conference, to be held March 30 to April 2 at the Las Vegas Convention Center.

Interface '81 is expected to draw more than 9000 attendees for the 64 sessions and more than 200 exhibits.

About 60 percent of company communications are carried out within an office complex, according to a report in progress at the Yankee Group, a Boston-based market research firm. That percentage includes hand distribution of paper communiques. Within four to five years, at least 50 percent of company communications will be transmitted over local networks, while another 10 to 20 percent will employ local networks as a stepping stone to an external network, such as Telenet. The remaining 30 percent will be long-distance communications through external networks, such as satellite transmission, CATV-type networks and microwave.

A major problem in evaluating approaches is that there are not many local networks in operation today, says Frank Dzubeck, president, Communications Network Architects, Washington, D.C. As a result, the cost of implementing the networks is unknown. Dzubeck will chair a half-day session at Interface '81, at which panelists will present two opposing approaches and evaluate management, implementation and cost implications.

Dzubeck maintains that some of the newer approaches to networking, such as Ethernet and Zilog Corp.'s Z-Net, may not be cost-effective for certain users now or in the future. "Users must lay out pricing structures relative to their application: otherwise, local networks might not be good for them. You don't have to implement the latest sexy technology. Putting word processing and data processing on a twisted-pair (telephone-type) wire may suffice." Panelists from Xerox and Network Systems Corp. will give two opposing new technological approaches. Digital Equipment Corp., Intel Corp. and Xerox are working jointly to develop electrical, logical and protocol specifications (MMS, July, 1980, p. 17) that will enable other vendors to manufacture Ethernet-compatible equipment. Meanwhile, Network Systems believes its approach is easier for the user. The company's Hyberbus local network (see "Coaxial cable finds a home," p. 99), which will be introduced sometime this year, includes interfaces. Hyperbus performs network-to-machine translation through an 8-bit μp. It is a baseband coaxial network that operates at a rate of 6.312M bits per sec—the rate used by the Bell System.

"Network Systems views its customers as having a heterogeneous environment with different minicomputers, word processors and other equipment. We will have one physical wire to hook up diverse machines. With Ethernet, Xerox wants to create a homogeneous environment," meaning equipment must be compatible with Ethernet to be networked, says panelist Gary Christianson, vice president of development at Network Systems.

An early Ethernet user—Tony

Interface '81 *is expected to draw more than 9000 attendees for the 64 sessions and more than 200 exhibits.*

Mini-Micro World

Carlson, manager of data networks at the U.S. Senate Computer Center, Washington, D.C.—will help round out the panel. He will evaluate three approaches to local networking that he implemented: traditional telephone-type twisted-pair copper wires, CATV non-contention data links using point-to-point modems and frequency division multiplexing techniques and an early implementation of Ethernet. Carlson will evaluate issues he confronted in implementing and maintaining the three, including digging trenches to lay the wire, pre- and post-wiring of buildings and how to rent street space in a city. The Senate has used the local networks for several years for information retrieval from data bases and for interactive word processing.

Additionally, he will pinpoint trade-offs in forming the transmission paths. For example, a twisted-pair wire eases problem identification, such as whether a given terminal is communicating with the host. This identification is more complex on lines with more traffic, such as CATV lines. Ethernet has been installed in the Senate for two years.

A session led by Dr. Alan J. Weissberger, principal engineer at Memorex Communications Group, Cupertino, Calif., covers how to use μps in information networks. It is expected to foster some active debate among participants. A representative from Western Digital Corp. will discuss future trends in LSI and VLSI circuits for data communications. He will emphasize the importance of special-purpose controllers for data communications. A spokesman from Intel Corp. is expected to reveal some details of Intel's component and board approach to Ethernet, while a user from Memorex will explain how he used multiple Intel 8086 μps to design an X.25 concentrator that puts 32 serial communications lines onto one line to the X.25 network.

Weissberger points out two key issues in implementing μps. The first is whether semiconductor manufacturers will use general-purpose single-chip μcs or dedicated LSI circuits. Second, who will supply the software and how? If semiconductor manufacturers supply software, should it be in the form of licensed software or dedicated chips? Weissberger says Western Digital will put specific software functions on silicon in a preprogrammed chip. Intel will announce its approach.

The panel will then debate the trade-offs to consider in choosing single-board, custom or off-the-shelf μps with power supplies in networks.

More than 125 panelists will speak at the 64 conference sessions. Included are four introductory datacomm school sessions and 11 half-day special-focus seminars. One special session will be devoted to telecommunications considerations in getting business graphics from the computer to the user. "The person who said that a picture is worth a thousand words never had to digitize one," says session chairman Joel Orr, president of Orr Associates, Inc., Danbury, Conn.

Other sessions include those on how home information services apply to business, office automation, distributing network diagnostics, advances in mass storage, AT & T's reorganization and its impact on the computer and communications industries and evaluating standards efforts. One session discusses applications and advantages of 32-bit minicomputers over their 8- and 16-bit predecessors in performing transaction processing, for example. Chairman Jon Gould, vice president of O'Donnell and Associates, Neptune, N.J., will stress the importance of directly addressable extended memory for interactive, on-line applications.

—Lori Valigra

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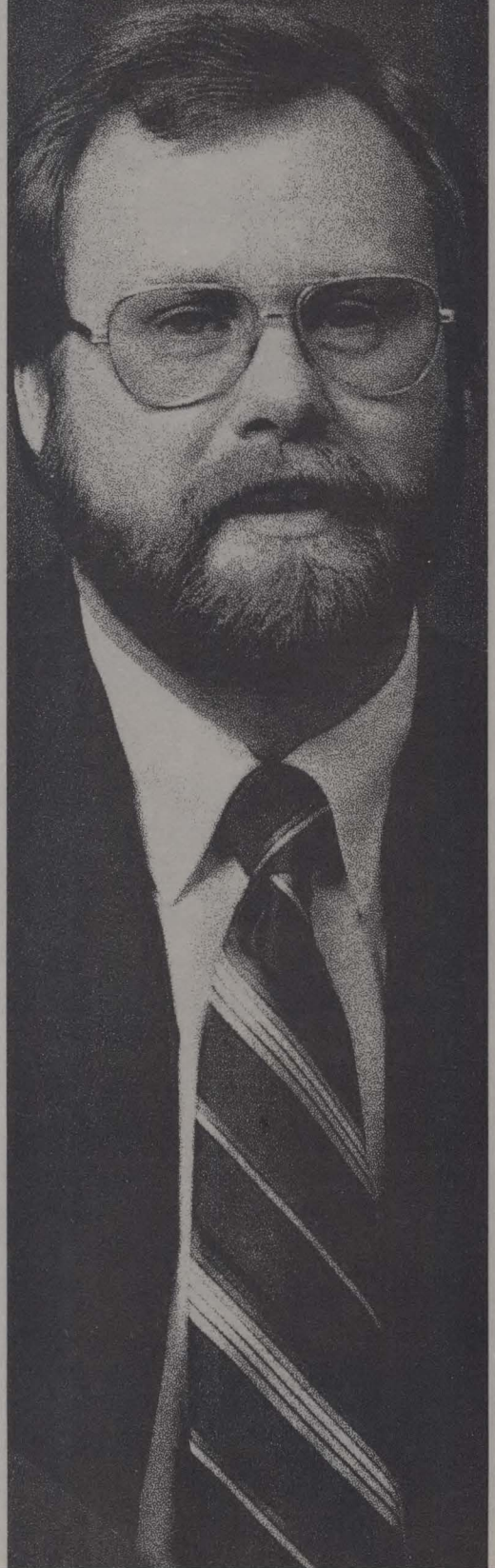

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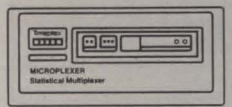

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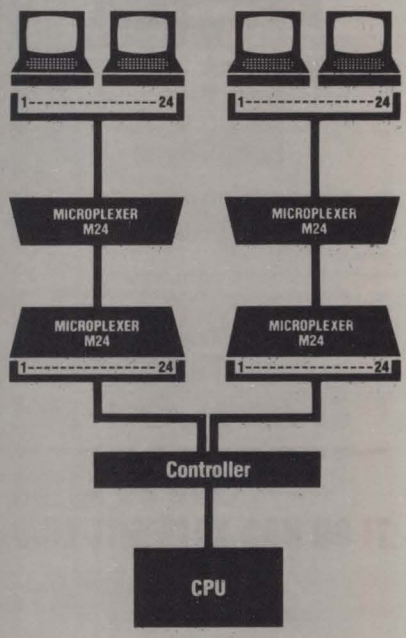

The University of Illinois uses over 60 Timeplex SERIES II MICROPLEXER statistical multiplexers to handle the input/output of more than 300 terminals linked to a computer in Chicago. This diagram illustrates a MICROPLEXER-based tail circuit at a remote location.

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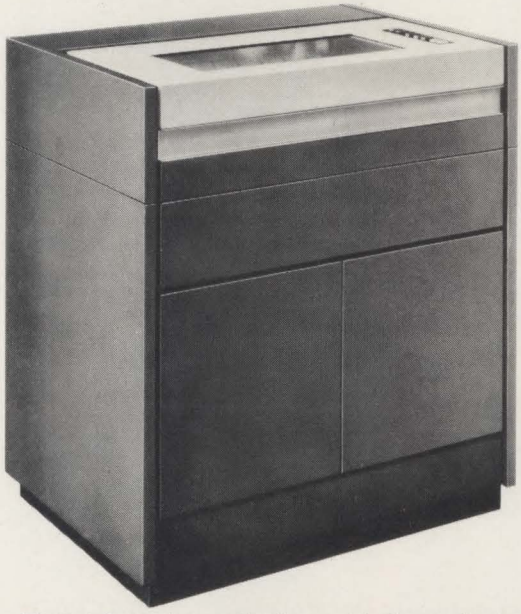

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½-in. tape-cartridge drives due—after IBM moves first

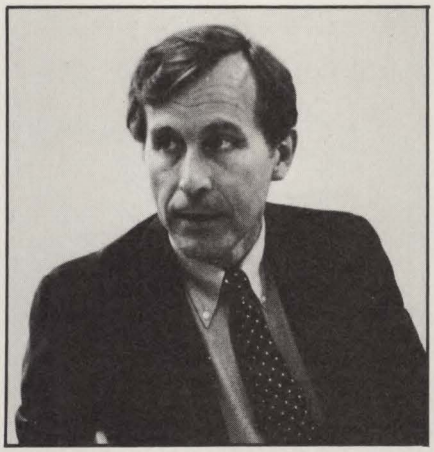
Tape transports that incorporate ½-in. cartridge media and that can handle backup in systems based on high-capacity Winchester-disk drives may appear on the OEM market this year.

So far, however, only a few small companies are moving ahead with evaluation quantities of both ½-in. cartridges and the drives needed to run them. Several suppliers of conventional ½-in. start/stop OEM tape transports also have expressed interest in these devices, but indicate that their move into the market depends on whether IBM will establish media standards for the new hardware.

One ½-in. tape-cartridge drive, the IU 1650, has already made its appearance and is being shipped in evaluation quantities from Interdyne Co., Van Nuys, Calif. Unveiled last year, the IU 1650 uses a 650-ft. reel of ½-in., nine-track, IBM-combatible tape and stores 56M bytes of data. Transfer rate of the device is 48K bytes per sec., which pushes total transfer time into the 20-min. range.

Interdyne plans to reduce this transfer time and is looking at 18- and 36-track hardware, says marketing vice president Bill Geist. Total capacity for the 36-track device would be 200M bytes, he says, and by increasing tape speeds by 30 in. per sec. to 90 ips, transfer rates of 300M bytes per sec. could be obtained. As a result, total transfer time of 300M bytes would be approximately 12 min. Price of the 56M-byte version of the Interdyne machine is less than $1000 in OEM quantities. A formatter, which handles serial-to-parallel conversion and other chores, is an extra $100. Prices for the 18- and 36-track versions have not been set.

Waiting in the wings are a number of other vendors. Furthest along may be Sunnyvale, Calif., start-up, Datadyne, Inc. Its hardware is in the design stage and could be unveiled this quarter.

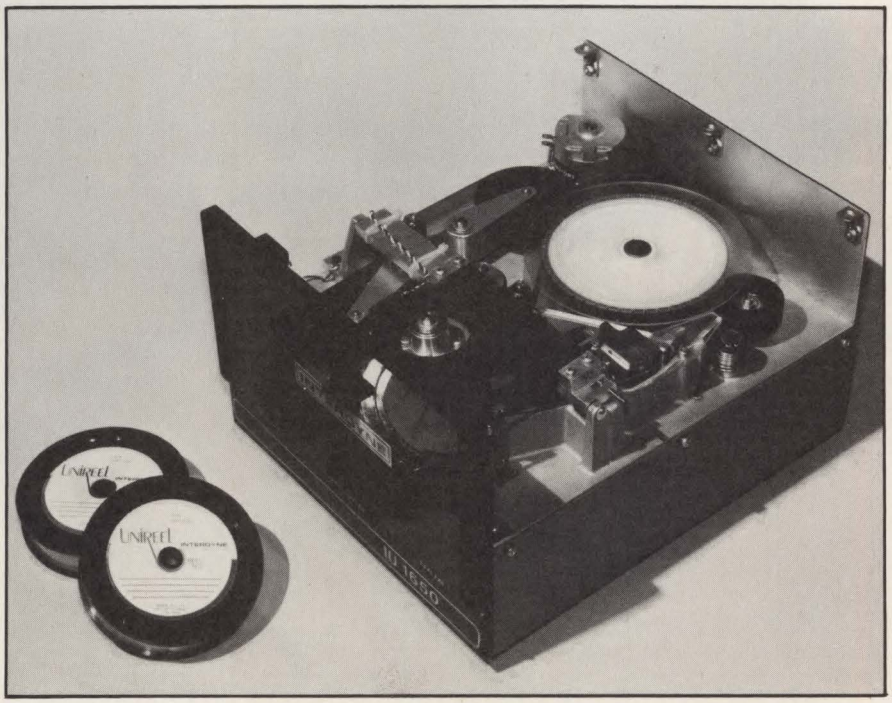


Industry analyst Ray Freeman Jr.: *"Ocotillo" is one of four ½-in. tape-cartridge drives developed by IBM as file backup for its 3370 and 3380 thin-film technology disk drives.*

Transfer rates for the new device are said to be around 500K bytes per sec. and could ultimately hit 1M bps—more than enough speed to match high-end Winchesters, such as Micropolis Corp.'s 1200 series 200-mm. drives and the recently introduced Series 8 devices unveiled last month by Ontrax Corp. (MMS, January, p. 39).

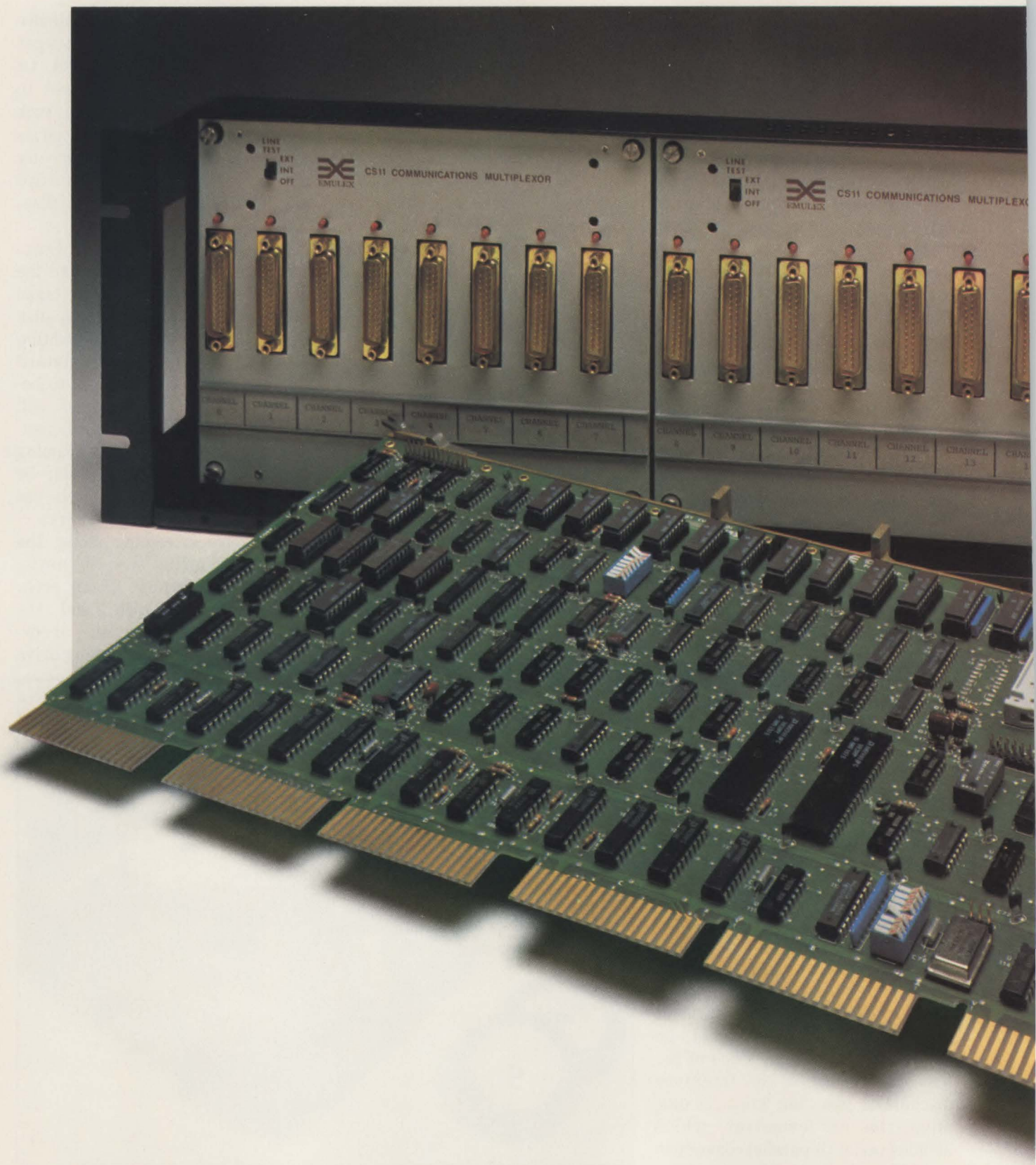
According to one report, Datadyne's new hardware will have the mechanical dimensions of an SA850 1M-byte, double-sided floppy-disk drive as well as the same mounting holes as the industry-standard Shugart hardware. The yet-to-be-named ½-in. cartridge drive will operate in an incremental fashion, as opposed to a pure streaming mode, a difference that could be significant to those planning to use tape as backup for Winchesters.

In a pure streaming mode, the tape keeps going once it starts, explains one vendor. If an error appears on the disk, and the Winchester enters an error-recovery mode, the streaming drive



Interdyne's IU 1650 *can store 56M bytes of data on a 650-ft. reel of ½-in. computer tape. Now being shipped in evaluation quantities, the drive is formatted into nine separate tracks, and will be available in higher-capacity 18- and 36-track models later this year.*

Improve your communication



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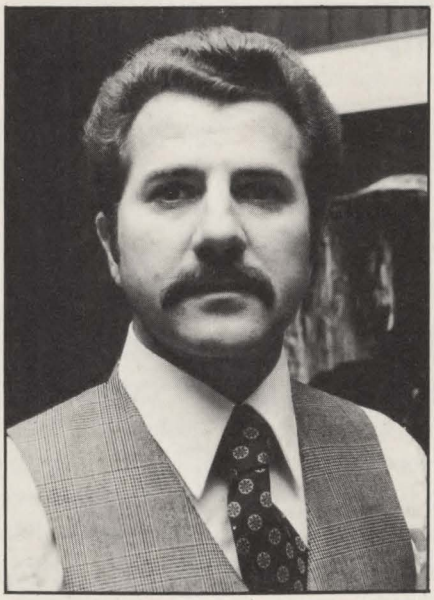
Many drives, labeled "streamers," avoid this problem by permitting users to stop the tape and return to the beginning of the error-recovery sequence or to the last known good block of data. Data-transfer rates in these drives are lower than if the device had been used in a pure streaming mode. Datadyne, seeking the best of both worlds—high transfer rates and the ability to transfer data mentally—reportedly will introduce a new concept to the backup market.

According to one source, the new drive will incorporate two recording heads, each capable of stepping 16 tracks and rotating along a 5-in. tape segment. The drive will use 6250-bit-per-in. group code recording (GCR) format, resulting in capacities of 4K bytes per track, or 128K bytes per tape segment, or block. Once all 32 tracks have been recorded, the tape is advanced, and the process is repeated on the second segment.

Initial storage capacities for the Datadyne device are said to be in the 80M-byte range using 300 ft. of tape in a 4-in. reel. (A take-up reel is included in the drive.) Most impressive, however, is the transfer rate. At 500M bytes per sec., 80M bytes can be transferred to or from a disk in 160 sec. Quantity price of the drive reportedly will be lower than $2000.

Also looking at the market for these drives is Newell Research Laboratories (NRL), Saratoga, Calif. The company designed a high-density (20,000-bpi), high-capacity (100M-byte), ½-in. tape cartridge first used several years ago in telemetry applications. Company president Chester Newell says NRL is looking at a potential commercial version of a MIL-spec drive using his company's cartridge. That drive is under development at the systems division of Genisco Technology Corp., Rancho Dominguez, Calif. (MMS, November, 1980, p. 6).

Newell stresses, however, that his company now is emphasizing ½-in. versions of the cartridge and 0.15-in. devices similar to those used for integral backup in the model 510 5¼-in. Winchester-disk drive announced by Irwin International, Inc., Ann Arbor, Mich., last fall (MMS, November, 1980, p. 45). Like a number of other vendors, NRL is holding back on its ½-in. cartridge and is waiting to see what happens at IBM's Tucson, Ariz., tape facility, where a ½-in. tape-cartridge drive code-named "Ocotillo" is under development.



Industry analyst Andrew Roman: *IBM's "Ocotillo" drive can be expected to move data at transfer rates ranging from 1.5M to 3.2M bytes per sec.*

Ocotillo, says industry analyst Ray Freemen Jr., Santa Barbara, Calif., is one of four ½-in. tape-cartridge drives in the Del Oro family, developed as file backup in conjunction with IBM's thin-film-technology 3370 and 3380 disk drives. The Del Oro drives may appear this year, says industry analyst Andrew Roman, Newark, Calif., and will move data at speeds of 1.5M to 3.2M bytes per sec. The drives will use a new 18-track media, will operate at bit densities of 20,000 bpi and will have 6250-bpi read-mode compatibility.

Size of the cartridge is the subject of some debate. Roman says the tape will be packaged in a 4-in. cartridge, but a number of other vendors watching IBM's moves say that two 4-in. reels will be mounted inside the cartridge. Whatever the size, Datadyne reportedly is moving ahead with its own cartridge design, but keeping the option of Del Oro compatibility open.

Interdyne's Geist, on the other hand, is less concerned with the development of a standard that could result from IBM's plans for its ½-in. tape-cartridge family. The fact that his firm is the sole source for the cartridges running on the IU 1650 is not a major problem, he says. "We are using industry-standard ½-in. tape and less than $1 worth of plastic parts." Anybody, he adds, can build the cartridge easily, and he anticipates that's just what Interdyne's OEMs will do. Nonetheless, Interdyne is not closing off its options, and Geist is keeping an eye on the Del Oro drives. "We feel that it would be easy to adapt our drive to an IBM media standard if we had to," he says.

Other OEM vendors are proceeding more cautiously in developing ½-in. cartridge-tape drives, and they are awaiting firm news from Tucson before making plans. "I'd hate to come out with my ½-in. tape cartridge and have IBM come out with something else," explains one executive. "My firm won't be first." A marketing executive at another tape-drive house says, "Anything that is non-IBM can be dangerous, but once its intentions are known, we just might come out with a product for the OEM market."

When IBM will announce its intentions is not known. Sources report that the Ocotillo drive—reportedly the first Del Oro device scheduled for announcement—could

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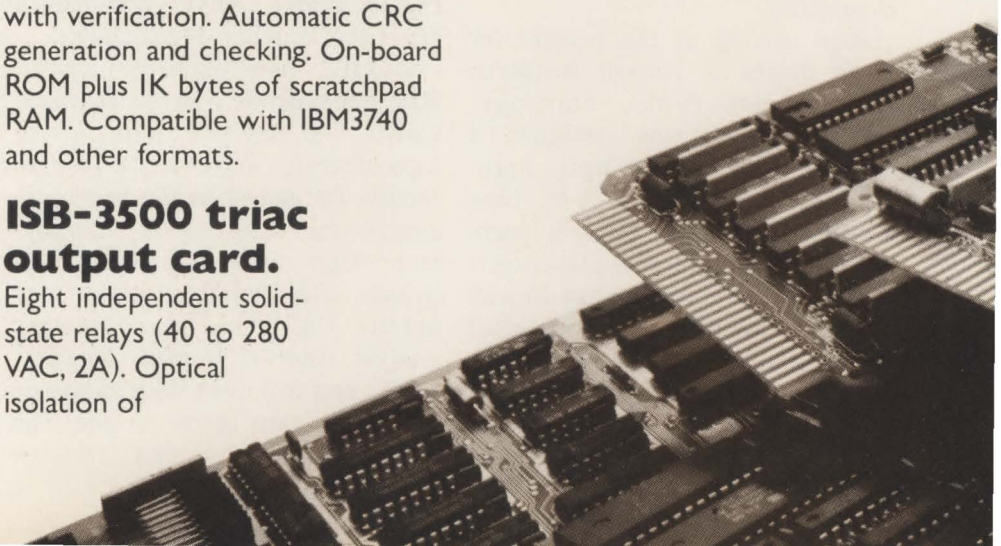

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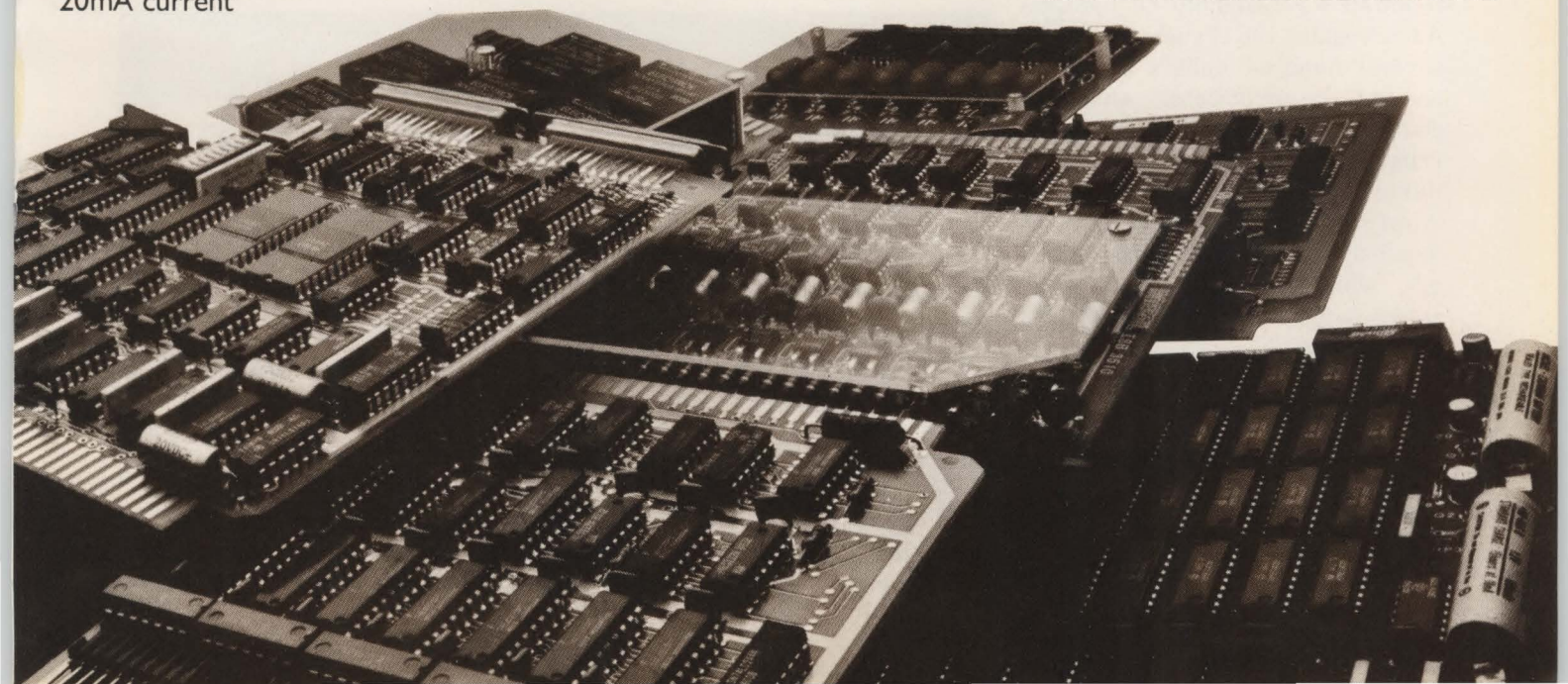


be introduced anytime within six to 18 months. One observer says Ocotillo was expected in conjunction with IBM's 3380 announcement last year. Another says the drive was due when IBM's first H-Series mainframe was unveiled. A spokesman for IBM in Tucson says only that it is company policy not to comment on unannounced products.

One observer sums up the frustration felt by many vendors anxious to explore the market for ½-in. cartridge drives: "This hardware may be inevitable, and many vendors are getting ready to jump in. But IBM will define the product regardless of when it appears." Another executive says, "IBM is the only stumbling block to the widespread acceptance of this type of hardware, even though the applications it will be used for are not IBM-dependent." —*John Trifari*

Smith-Corona Typetronic types at speed of sound

When the Smith-Corona Group introduced an ultrasound-driven electronic typewriter in October (MMS, November, p. 6), computer industry observers took heed, although the Typetronic is billed strictly as a typewriter that cannot be upgraded. The company says there are no plans to manufacture a computer printer version, but many observers say ultrasound and its benefits should be applied to printers.

The Typetronic is driven by high-frequency (100-KHz to 200-KHz) sound waves, emitted by a steel rod. Use of this rod cuts the number of electromechanical parts required for assembly 50 percent. As a result, the Typetronic costs several hundred dollars less than competing products, and the company claims the machine is very reliable because it has fewer moving parts than other typewriters. Applying that technology to expensive electromechanical printers, which need frequent repair, seems to be a move toward solving this problem.

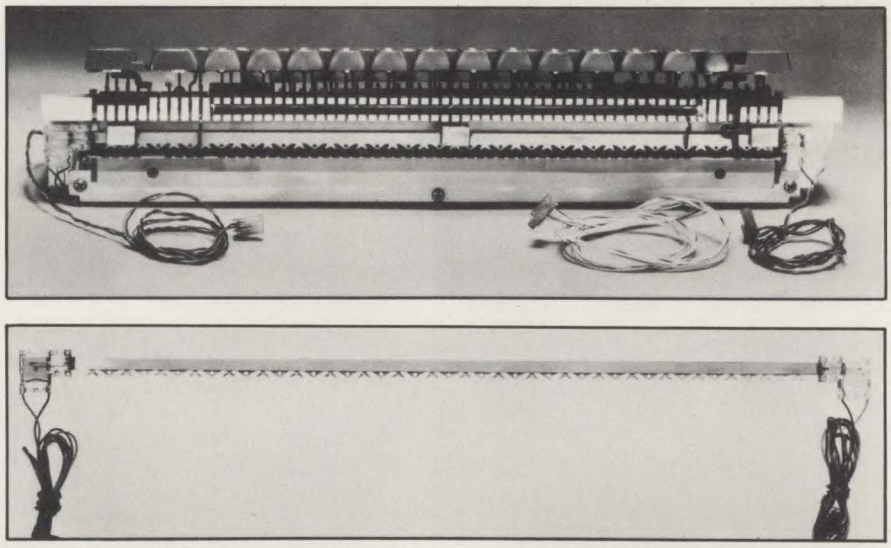
"Computers and word processors are not the applications for which the product was developed. I don't know if it will go in that direction in the future," says Walter Wright, a marketing spokesman for the company.

But market observers believe Smith-Corona will branch out to the printer market. The company will miss a large potential market if it does not incorporate the technology into a terminal or on-line printer, says Michael Dortch of the Yankee Group, a Boston market research firm. "It is not possible for them to stop here (with a typewriter). If they don't do it (use the technology in a printer), someone else will," he says.

Ultrasonic rods are simple and inexpensive, says the company. Use of the rod replaces the need for many of the gears, levers, wires and switches used in electromechanical typewriters.

The principle of operation is relatively simple, explains Sigurd Hoyer-Ellefsen, vice president of development and engineering at the Smith-Corona Group's Consumer Products Division.

- Each key connects to a series of spring levers beneath the keyboard. The left side of the lever rests against a thin magnetic strip beneath and parallel to the ultrasonic rod.
- A typist depresses a character key on the keyboard.
- The depressed key deflects the right side of the spring lever downward. When the downward force exceeds the magnetic force on the left side of the lever, the energy from the right side dissipates to the left, causing release of the left side from the magnetic strip.
- The left side, which has obtained an impact force from key



The pulse of the Typetronic *is the ultrasonic rod—situated below the keyboard—with teeth that correspond to keyboard positions. Each key's sound wave has particular characteristics and speed, which activate the proper typewriter element.*

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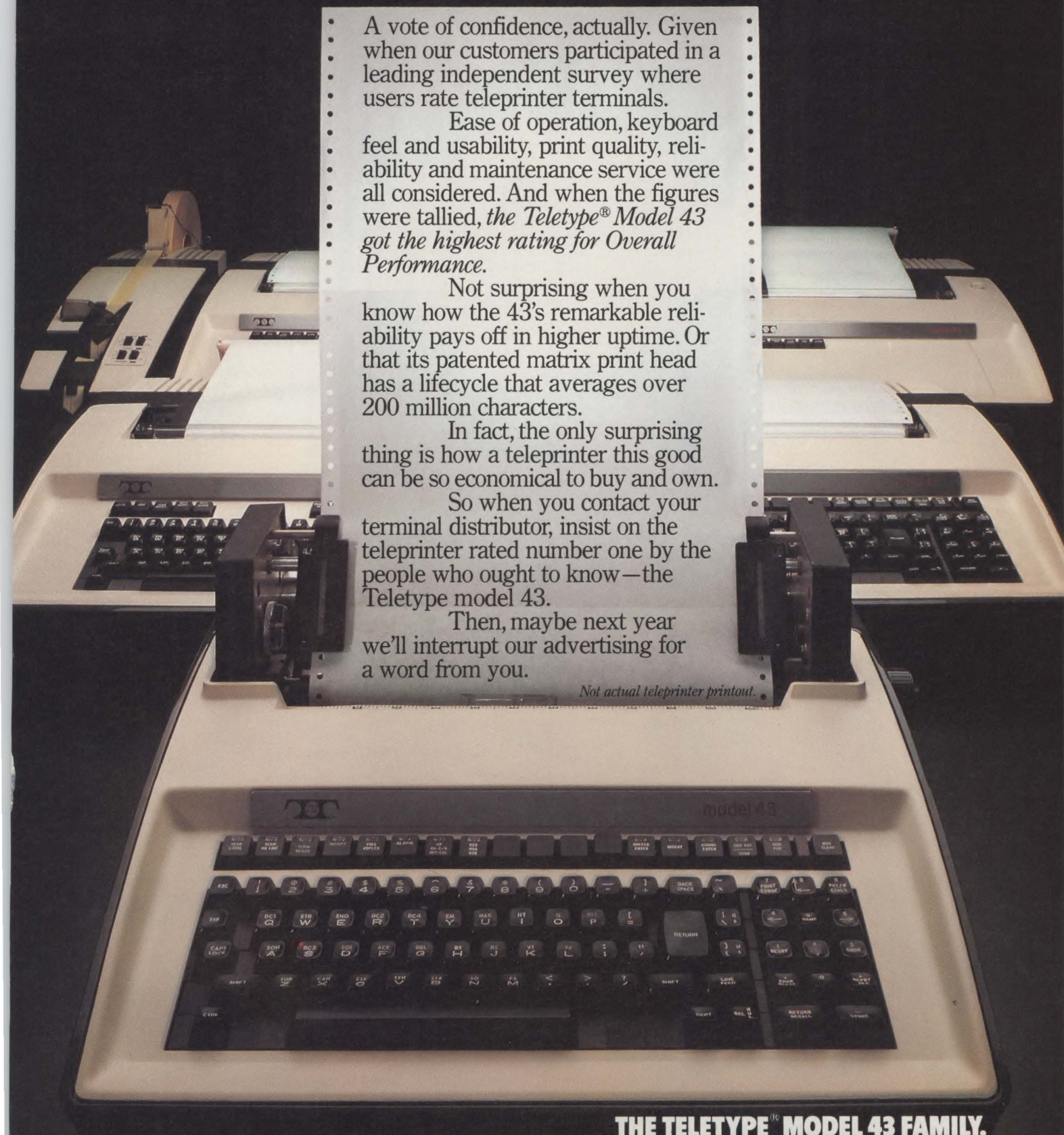

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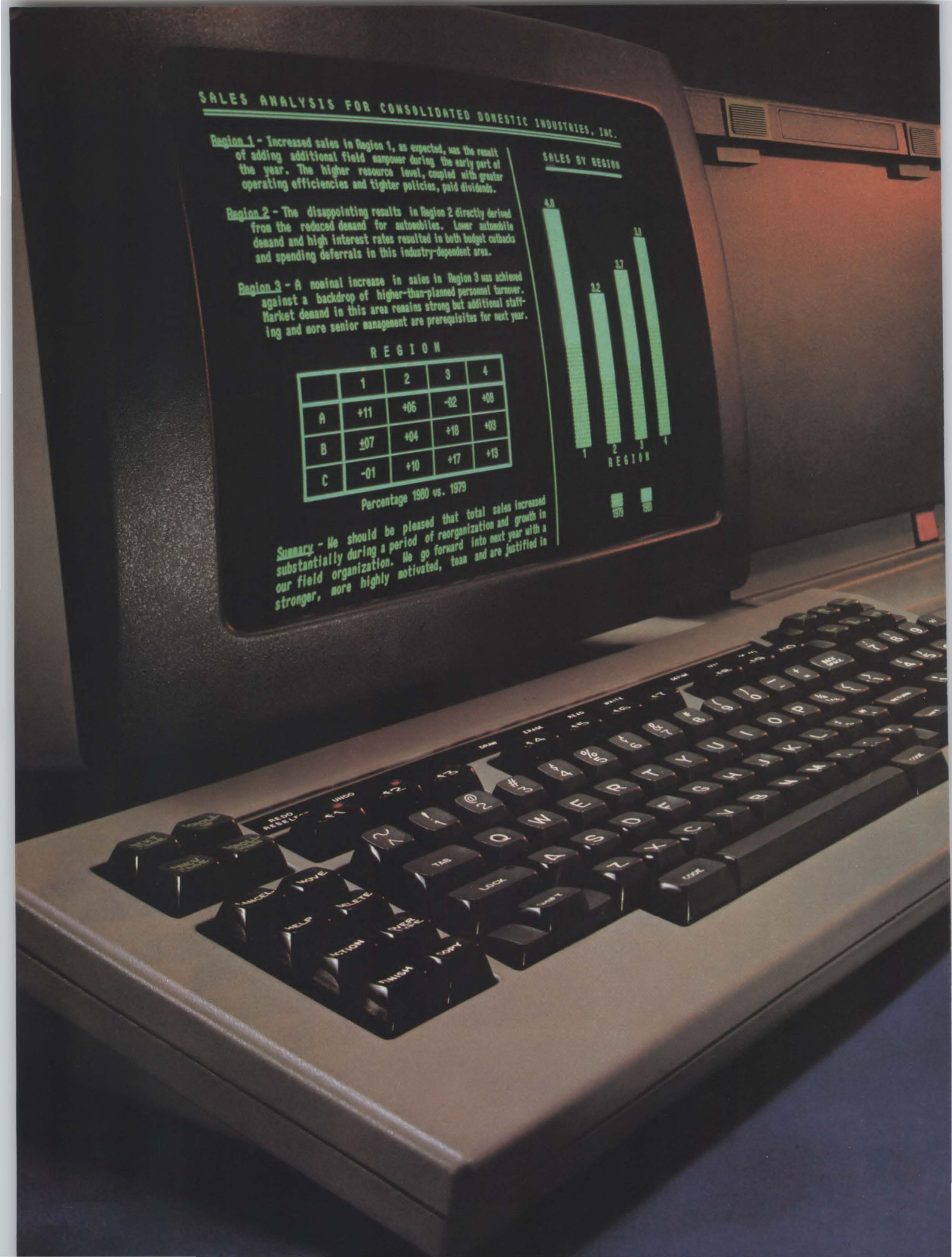
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Region 2 - The disappointing results in Region 2 directly derived from the reduced demand for automobiles. Lower automobile demand and high interest rates resulted in both budget cutbacks and spending deferrals in this industry-dependent area.
Region 3 - A nominal increase in sales in Region 3 was achieved against a backdrop of higher-than-planned personnel turnover. Market demand in this area remains strong but additional staffing and more senior management are prerequisites for next year.
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3.2
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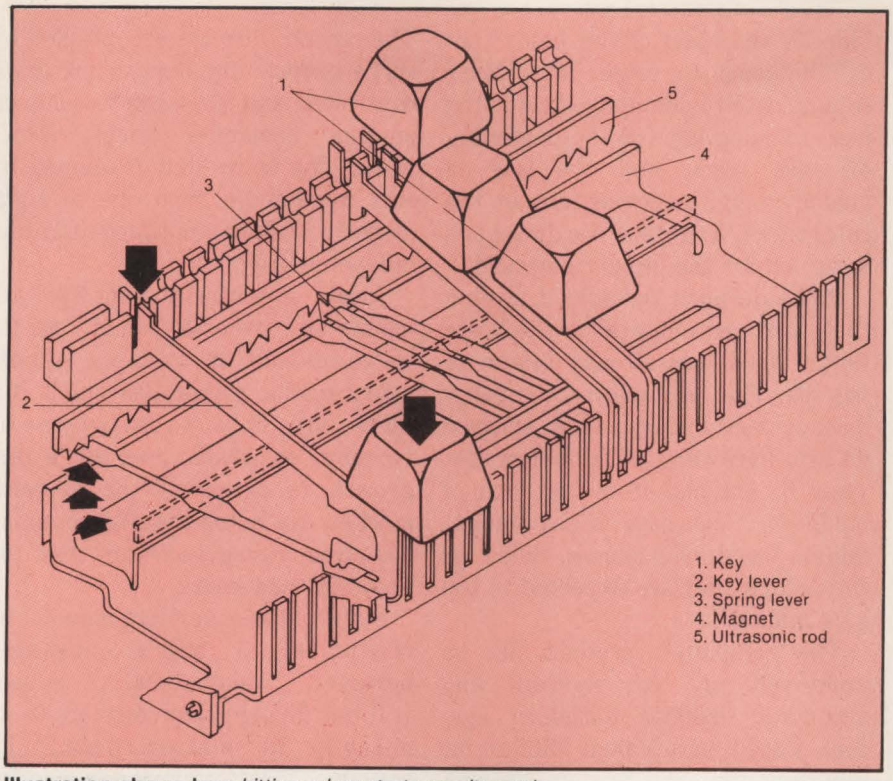


Illustration shows how *hitting a key starts an ultrasonic signal that results in a letter being typed.*

depression, hits the ultrasound rod. Each key corresponds to one spring lever, which, in turn, corresponds to one tooth on the rod.

- When a spring lever strikes the appropriate tooth, a high-frequency sound wave is generated. That wave moves to both ends of the ultrasound rod, where it is received by an electronic sensor.
- Each sensor, or transducer, changes the mechanical sound wave into an electrical signal. Because of the distance traveled, each wave reaches each sensor at a different time, thus determining which key was struck. The sensors are wired to a custom LSI μp, which decodes the wave, determining which sensor received the wave first by the travel time that has elapsed.
- The wave is then digitized and activates a stepper motor, which positions a daisy-wheel print element.

The Typetronic is the result of a four-year, multimillion-dollar effort. Hoyer-Ellefsen says the company modified the product several times before getting the teeth in the correct shapes and identifiable by logic. The company claims that 25 concepts used in the design could be patented.

The company initially used a circular steel rod, but the spring levers could not repeatedly hit the correct spot on a circular object. As a result, the sound wave may differ each time the rod is hit. This problem is eliminated by the toothed rod, explains Pete Guzman, director of the Cortland, N.Y., laboratory where the product was partially developed and is manufactured. Teeth were put into the rod so that the spring lever would meet the same spot each time it was activated.

Character differentiation can be obtained on three other levels, Guzman says. Some teeth are angled to the left, some to the right, and some symmetrically. Groups of three teeth alternate right-slant, symmetric and left-slant across the rod. The right side of the rod receives signals angled to the left, the left side receives signals angled to the right, and both sides receive symmetric signals. Guzman will not specify the price of the rods, but an observer says they probably cost only a few dollars to manufacture. The company manufactures 90 percent of the parts for the Typetronic.

The typewriter produces as many as 15 cps, but the keyboard and logic accept as many as 800 words per min. in spurts. The 10 last-typed characters are held in memory for error correction. The Smith-Corona daisy-wheel element is composed of glass-reinforced nylon and is available in nine styles. It will sell for $5 compared with $25 for other daisy wheels.

The Typetronic has undergone extensive testing and poses no environmental danger, Hoyer-Ellefsen claims. The sound is contained in the rod, and the frequency is above the hearing ranges of people and animals—15 KHz and 25 KHz, respectively.

—Lori Valigra

Demand for diskettes prompts new system

By the end of last year, more than 42 million diskettes storing proprietary software and program updates had been delivered to domestic users, reports one Orange County, Calif., executive, and millions more are on the way. The result, says Al Alcala, co-founder and president of Media Systems Technology, Inc. (MST), is a logistics bottleneck that threatens to strain the abilities of hardware vendors to distribute software for their systems on a widespread basis.

"No one ever thought about the problems inherent in duplicating large numbers of diskettes," says the head of the Santa Ana supplier of automatic floppy-disk duplication and initialization systems. "For the most part, this remains a strictly manual task." To duplicate a floppy

disk, Alcala explains, a floppy-disk drive usually is used. "One California minicomputer house has a row of 50 5¼-in. minifloppy drives lined up on a bench," he says. Diskettes are then copied one at a time. "Hopefully, the good ones are separated from the bad ones during the certification procedure, and everything is put into the right piles."

What Alcala sees as a floppy-disk duplication explosion can be attributed in large part to the steps systems vendors are taking to protect their software from unauthorized copying. "Everyone wants to protect their markets," he says. "The trick is to make it hard for a disk to be copied once it gets out into the field, and to force the user to go back to the vendor if he wants duplicates or updates."

The impact on a systems vendor can be significant. Compugraphic, Alcala says, duplicates 250,000 floppy disks a year; Digital Equipment Corp. does 20,000 a month, and Lanier runs off 1000 per working day. "The more successful a hardware vendor becomes with his product, the more floppy disks he has to duplicate," Alcala says. Retailers can't be too much help, because there's no way the proprietary formats incorporated into the disks by the vendors to stop software bootlegging can be precisely duplicated and used, he adds.

These formats can present substantial obstacles to anyone contemplating the unauthorized copying of someone else's software. "They're like road maps," Alcala explains, "and they're getting more and more cloak and dagger every day." One technique used is a "test-under-mask" feature that can be incorporated into the peripheral controllers of a vendor's systems and that can lock out unauthorized software.

Another technique is to incorporate unique address marks to identify the start of the fields that can be used to store data. More sophisticated techniques include the use of analog keys at the beginning of each track and the use of analog-to-digital converters in the controllers, a system Alcala says is designed for the "really paranoid."

MST's decision to build a system that can automatically duplicate floppy disks has already begun to pay off. The 18-employee company, incorporated in May, 1978, shipped its first hardware in October of that year. By the end of its first year of business, Alcala says, it had done $1 million worth of business. Sales for the second year are expected to top $2.4 million.

The company's product line is anchored on the System 300 automatic diskette initializer system. Based on a Naked Mini 16-bit minicomputer, the System 300 will handle 8- and 5¼-in. single- and double-sided media. Single-sided 8-in. diskettes can be duplicated at the rate of 80 per hr., double-sided floppy disks at the rate of 45 an hr. Speeds for 5¼-in. media are 144 and 124 diskettes, respectively.

Announced last summer, the System 800 handles each vendor's formats through software developed at MST under a nondisclosure agreement. The system can handle as many as 50 diskettes at one time per loader and handles initialization of the media (establishment of track #00). Diskette certification also is handled during duplication. In this process, the System 800 writes data onto the diskette bit-by-bit on the next. Disks that pass all tests are routed automatically to one hopper; those that fail, to another.

MST has also taken a lesson from its customers and arranged things so the System 800's proprietary floppy-disk-based control software cannot be duplicated without authorization. "Anyone could actually copy the diskette if he wanted to," Alcala concedes, "but I don't think it would do him any good." The reason: formats are handled by MST's proprietary floppy-disk drive controller, and MST diskettes run on another controller simply won't work. The controller developed by MST can handle from one to eight diskette loaders simultaneously and independently.

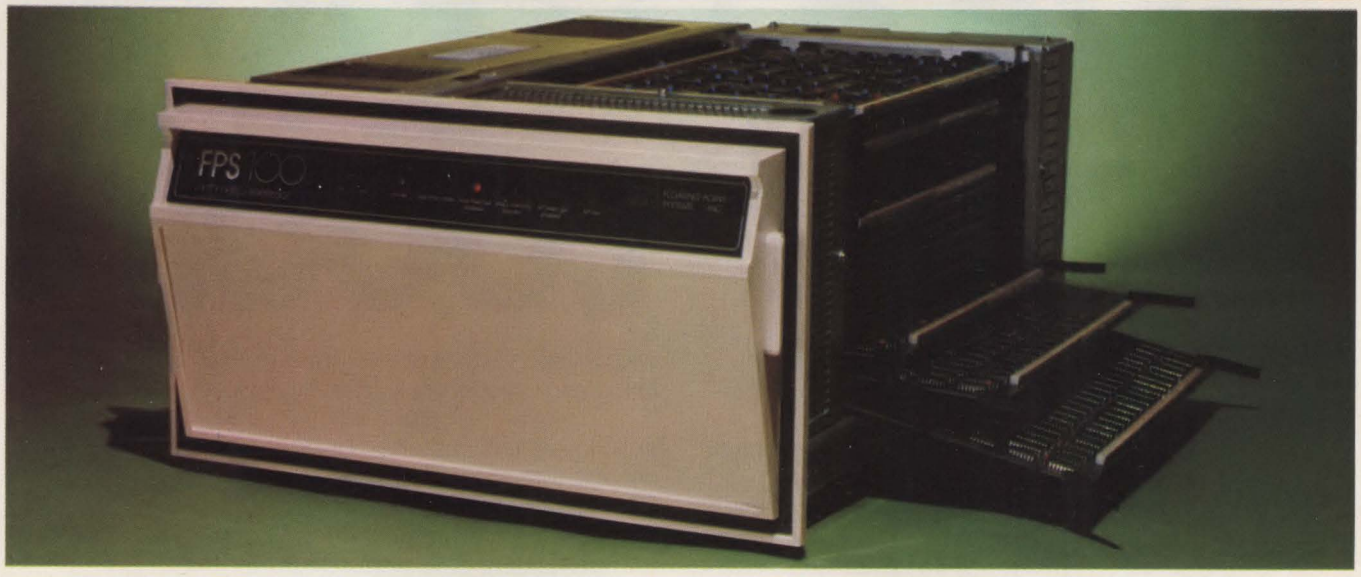
Alcala says the System 800 will handle any diskette format. "So far we've installed 20 systems. Almost every media maker has one." But there are only so many media vendors, so Alcala sees MST's real growth in terms of the systems market. He notes that his company has already targeted more than 100 potential customers.

Some of these vendors may not be receptive to MST's message, however. "Many systems houses will not divulge their formats to an outsider no matter what," he explains. "They will remain wedded to manual duplication techniques, or to their own in-house systems." (MST also supplies media loaders to a number of other suppliers for use in their own systems.)

Alcala is also moving toward what he calls the "postal instant press" approach to diskette duplication. In this case, MST plans walk-in regional centers that will permit users to bring in any quantity of diskettes to be duplicated. No provision will be made, however, for proprietary formats. Duplicating, initializing and certification will be limited to diskettes using IBM formats, all of which are in the public domain. The first center is scheduled to open this spring in Waltham, Mass.

Despite the potential retailing offers, however, MST's main thrust will be to the systems market. "We already have a nine-month backlog," Alcala says, "and we anticipate that the company will be growing at the rate of at least 50 percent a year for some time to come." Prices for the MST System 800 range from $30,000 for a single-loader system to $86,000 for an eight-loader configuration.

—John Trifari



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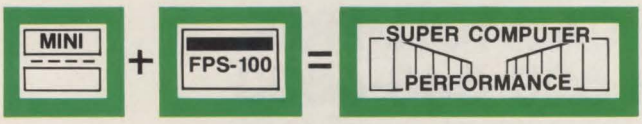

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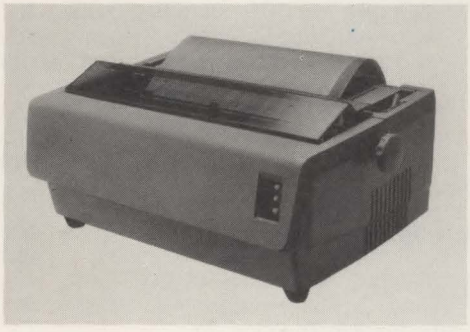

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Editorial

NCC frustration

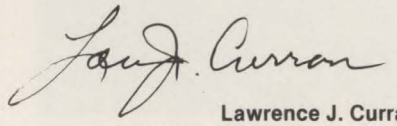
Even though the National Computer Conference is still several weeks away (May 4 to 7 at Chicago's McCormick Place), it's not too soon to return to a theme sounded almost a year ago in this column: the difficulty that small, innovative companies face in getting decent NCC exhibit space. These companies are usually new ventures whose entrepreneurial principals are eager to show their wares to the world. Those products need the broadest possible exposure to get a fair test of market acceptance, but the companies may not be able to qualify for anything but NCC's waiting list because they haven't previously exhibited.

Justly frustrated because they can't get assurance from the American Federation of Information Processing Societies, chief sponsor of NCC, that they'll be able to get exhibit space in May, officials at some of these companies are looking for other ways to bring their banners to those attending the show. Spurred by the success that Seagate Technology had in an off-site exhibit last year, a small group of start-up peripheral equipment manufacturers has secured exhibit space in a Chicago hotel near McCormick Place, and will be getting the word out more broadly about who they are and where they will be as the show approaches.

Finis Conner, executive vice president of Seagate Technology, says more than 500 people visited the Seagate suite during NCC last year, even though to do so meant they had to drive 25 to 30 minutes from the Anaheim Convention Center. Conner is convinced that the exposure has been instrumental in the early success of Seagate's 5¼-in. Winchester-disk drive. "We tried desperately to get space at NCC last year, but only at the last minute were we told that we could get into the cellar of the Disneyland Hotel," says Conner, "and we couldn't put a booth together in 30 days."

Seagate tried again for this year's NCC, but found itself buried very early beneath more than 200 other companies on the waiting list. That's when Conner decided to spearhead an effort to band together with officials from like-minded companies to get close to NCC, if they couldn't be in it. These firms make hardware including floppy-disk drives, tape backup devices and peripheral controllers. "Our objective was to be on the NCC floor," Conner says, "but we can't afford to bet our company on the benevolence of NCC or anyone else that space will become available."

Seagate's experience is fairly typical of many companies hoping for NCC space, and if NCC management can't find a way to accommodate them, the companies will find other formats that will. We commend them for their efforts.



Lawrence J. Curran
Editor

Letters

TERMINAL SEARCH

To the editor:

My awareness of the existence of data-capture devices on the market has been greatly assisted by your publication. However, I have yet to locate an alphanumeric data-collection terminal that also reads MICR.

With the prospects of the Federal Reserve's plan to truncate checks early in the deposit stages and transmit electronic payment data thereafter, such a terminal could have significant benefits, such as allowing the capture of both MICR and variable (payee/endorser) data.

Please let me know if you are aware of the existence of such a terminal.

T.J. Arfsten
Director
Fraud Analysis & Control
American Express Co.
New York, N.Y.

(Editor's note: We are researching reader Arfsten's request, but would be glad to hear from other readers who may know of such a terminal. Please contact the editor, Mini-Micro Systems, *221 Columbus Ave., Boston, Mass. 02116.)*

BACKUP NOTE

To the editor:

We were surprised to see in your article "Winchester backup revisited" (MMS, September, 1980, p. 91) no mention of the widely used Winchester backup supplied by Corvus Systems, called the Mirror (patent pending). It uses standard video technology and video cassette recorders to provide backup for our 10M- and 20M-byte Winchester disks. Total capacity of the cassettes used in the system is 120M bytes, thus providing archival storage capability as well as security backup. Backup rate is 1M byte per min. so that the contents of an entire disk can be transferred in 10 or 20 min.

Price of the Mirror system, including a video cassette recorder available from several commercial sources, is less than $1500. The Mirror interface sells for $790. This interface converts the output of the Corvus disk drive into a stream of serial bits in a form suitable for recording on a video tape recorder. Incidentally, the data signal from the Corvus Mirror interface is compatible with both NTSC (U.S. standard), PAL and SECAM (European standards). The signal can be recorded on any video tape recorder and is not limited to video cassette recorders, although these are undoubtedly the most convenient because of their easy loading capability, low cost and ready availability of video cassettes.

Joseph D. Hughes
Vice President of Marketing
Corvus Systems, Inc.
San Jose, Calif.

CREDIBILITY GAP

To the editor:

In your December, 1979 issue, you listed McAuto as a supplier of interactive computer graphics systems ("Interactive computer graphics systems," p. 68). I forwarded a letter to you last January in which I updated configuration information on our Unigraphics system.

You can imagine my disappointment when I received the December, 1980 issue and found that McAuto had been dropped from the Table of Interactive Graphics Systems Suppliers.

McAuto is, and will continue to be, a vital and viable supplier of interactive graphics systems. We introduced additional systems, software and applications in 1980 to further enhance our Unigraphics.

J.J. Moelk
Manager
Product Planning and Marketing
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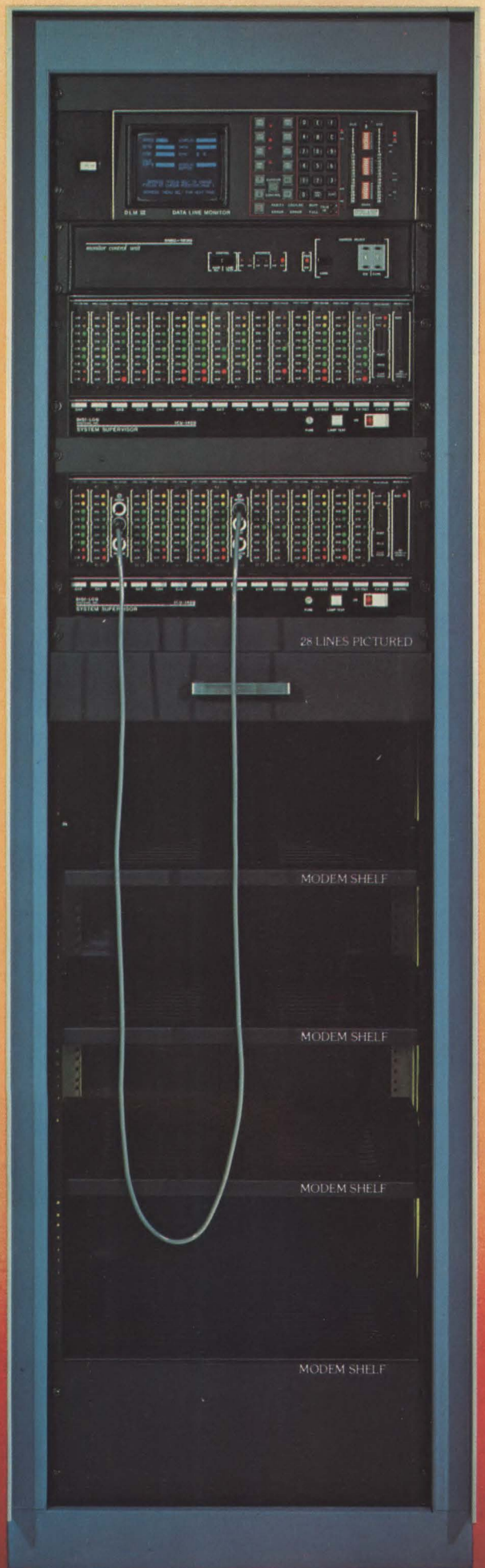
Our April issue will emphasize integrated office systems, including personal work stations, an exciting new class of product that combines the functions of communication, word and information processing, and data entry/retrieval. Feature articles include:

- A survey of packages for converting general-purpose processors to text processors.
- An overview of the market and applications for personal work stations.
- A tutorial on the architectures and technologies employed in personal work stations.

Also: A preview of the National Computer Conference, an introduction to the Ada programming language and more on Motorola's approach to high performance μc systems.



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Packet-switching systems go private

WALTER A. LEVY, Edgewood Computer Associates

Once limited to the public-sector realm of common carriers, packet-switching technology is catching on in private data networks

The basic technology of packet-switched networks, which convert data streams into fixed-length bundles or packets of information that can be more efficiently managed by computers, has been around since the late 1950s. Until very recently, however, packet-switching systems have been installed only in the public sector by common carriers because of technical restrictions, and because they have required extensive development time and expense. It is fair to say, however, that packet-switching systems will have arrived as a viable technology for private data networks before the end of this year.

The original packet-switching networks—the classic example being the ARPANET developed by Bolt Beranek and Newman for the Department of Defense—were designed to interconnect dissimilar computers and terminals for sharing widely dispersed processors. Today there is as much intelligence in a desk-top terminal as there was in many of the early ARPANET computers. But although the need now is for message switching rather than intelligence sharing, the technology employed in ARPANET and its descendants is exactly what is required.

Packet-switching systems have been slow in reaching

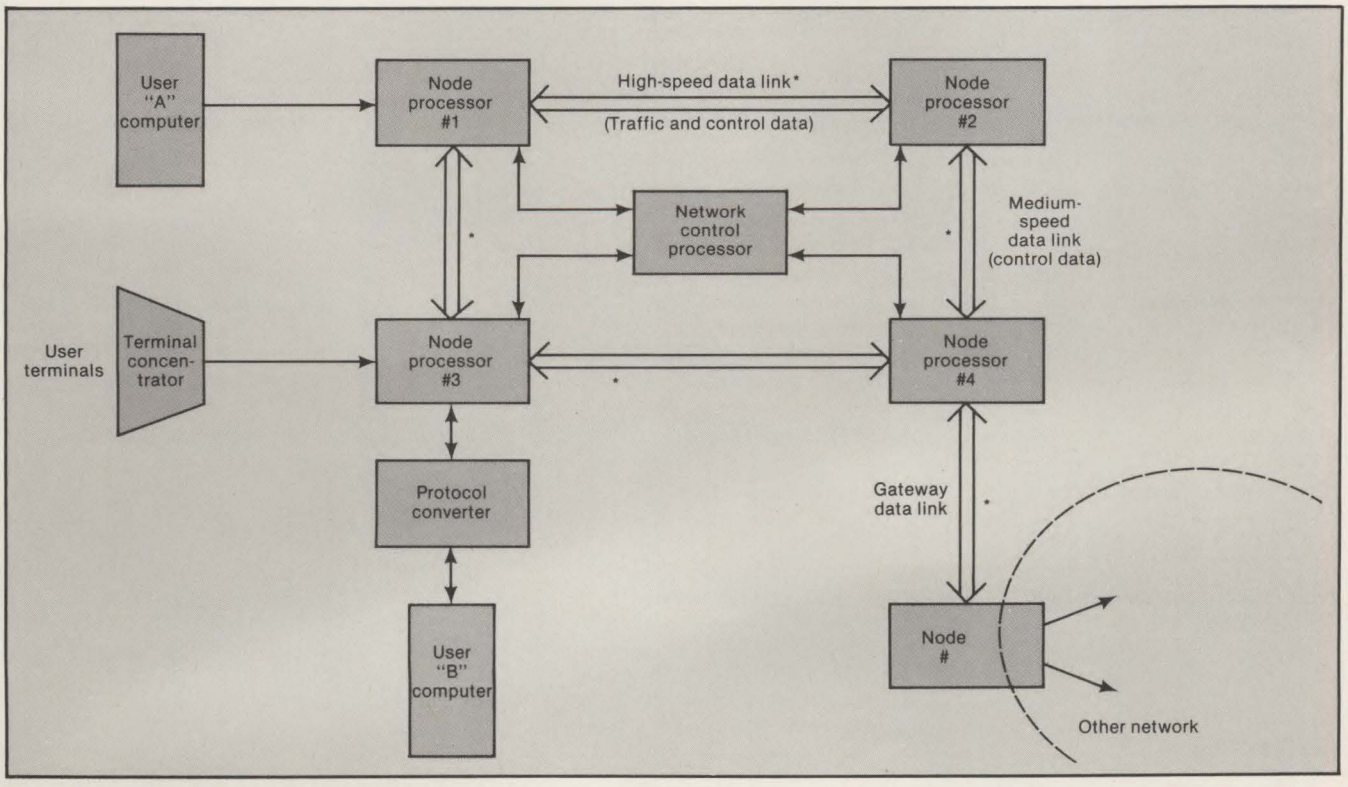

Fig. 1. Basic elements *of a packet-switching network.*

Packet switching still represents the most efficient approach so far to the problem of transferring data between different and geographically distributed computers and terminals.

private data networks for two reasons. First, they have been unable to handle the high-speed, synchronous, polled transmissions that are characteristic of private-sector networks. This stems from the early packet-switching charter of supporting the asynchronous, "protocol-free" traffic typical of low-speed timesharing terminals. Second, these custom systems have been too expensive for the lower traffic volumes of private data networks.

A transition is taking place, however, because packet switching still represents the most efficient approach so far to the problems of transferring data between different and geographically distributed computers and terminals. During 1980, several packet-switching suppliers reported complete installations of systems in which the technical obstacles mentioned above were overcome. Some networks are now supporting synchronous traffic, a development that will accelerate this year. Also, the custom installation is yielding to lower-priced off-the-shelf products, which are becoming available because packet-switching system procurements have been or are about to be consummated by a number of important "leading-edge" user organizations. A strong, well-financed and highly competitive group of suppliers has emerged and is pursuing new business opportunities with vigor and commitment.

Definitions and scope

This article presents the results of a survey of all the known vendors of packet-switching systems now selling in the U.S. market. The survey was restricted to companies that sell complete systems, rather than components, because the market for these systems is still largely the province of "turnkey suppliers." Also omitted are systems "on either side" of packet switching, such as statistical multiplexers on one hand and host-processor-controlled networking systems (such as SNA and DECNET) on the other, in the interest of focusing on a specific class or system.

The term "packet switching" applies here only to

TABLE OF PACKET-SWITCHING PRIVATE NETWORK SUPPLIERS

The following table includes only vendors of complete packet-switching systems serving the U.S. market. It does not consider suppliers of components that are part of those systems. The table was developed for *Mini-Micro Systems* by Walter A. Levy, president of Edgewood Computer Associates.

Manufacturer Model	Resident processor(s) and maximum memory	Automatic switchover	Protocols supported
Bolt Beranek and Newman Pluribus	as many as 14 16-bit minis, 1M byte	Y	Arpanet 1822, Arpanet HDLC, X.25 HDLC, X.25 bisynch
Bolt Beranek and Newman C/30	16-bit minicomputer, 128K bytes	Y	Arpanet 1822, Arpanet HDLC, X.25 HDLC, X.3
GTE Telenet TP 4000S	two Mostek 6502As, 256K bytes (active), 512K bytes (backup)	Y	X.3, Telenet ITI, HASP, 2780/3780, X.25
Northern Telecom, Inc. SL-10	as many as 15 bit-slice processors, 4M bytes maximum	Y	bisynch: 3270, 2780/3780, HASP; CCITT X.25: HDLC and bisynch; X.3/28; IBM 2740
SESA Honeywell PSX	multiple Z80s, more than 20M bytes	Y	X.25, CCITT X.3, BSC 3270
Siemens Corp. EDX-P	DEC PDP-11/44, 1M byte	Y	X.25, X.3, bisynch 3780
Tran Telecommunications Corp. M3201	Computer Automation LSI-2, 128K bytes	N	not applicable
Tran Telecommunications Corp. M3216 XPRO	16-bit minicomputer, 128K bytes	N	X.25
Tymnet Tymnet II "Engine"	as many as nine 16-bit minicomputers, 1M byte	Y	X.25, X.75, 2780/3780, 3270, start/stop

systems that perform a *significant set of useful functions* in addition to breaking up a logical block of data into smaller units (packets) for the purpose of moving it efficiently from source to destination. The real value in packetizing data arises from the ability of packet-switching systems to perform higher-level functions while switching these packets; that is, the ability to interconnect terminals and computers to each other notwithstanding differences in language, speed, code and protocols. Consequently, the focus is on that group of systems that can be used to build manageable networks of "dissimilar computers." Simpler systems, such as statistical multiplexers, are ruled out because they cannot handle the problems of protocol conversion and of supervising large populations of computers and terminals. Host-controlled networking systems are also excluded because they are intended to perform only within the product line of the manufacturer offering the system. The distinction is critical to understanding the entire bewildering field of computer networking systems.

Most packet data networks are used by domestic and foreign common carriers. End users have only recently begun to install private versions of these systems. This timing is fortunate because common carriers must assure the compatibility of their networks, so packet data networks have evolved under the guidance of international telecommunications standardization organizations. Common carrier networks can talk to each other, but computer manufacturers' network systems cannot.

A single-line packet-switching system (Fig. 1) data network is constructed of a set of nodes, usually connected in a ring structure by high-speed data links. Users can access the system through concentrators, which function almost identically to statistical multiplexers, combining low-speed interactive data from terminals into a single high-speed stream.

When a user "signs on," his first message to the system is the address of the computer to which he wishes a connection. The system routes this request to the node processor servicing the desired computer, where it is forwarded to the user's computer for acceptance or rejection. The process is analogous to placing a long-distance telephone call. Once the "data call" has been accepted, a user and the computer exchange data interactively, sharing the network with other such "conversations" until one party or the other terminates the "data call."

There is no "central site" in a packet-switching system. All nodes are treated as equals, and traffic flows freely through the network from any originating node to any destination node. All user terminals and computers are treated equally as "users" or "subscribers" to the system. No host processor is allowed to control the network, and the failure of any host processor or terminal will have no adverse effect on network integrity.

Network supervision is vested in a separate computer system—the Network Control Processor. The NCP exchanges control information with, and collects traffic statistics from, each of the nodes. The NCP/node linkages may be direct, through lower-speed circuits, or indirect, through the normal inter-nodal trunklines. Thus, the NCP in Fig. 1 could obtain traffic data from nodes two and three directly, while it obtains data from nodes one and four indirectly through the trunklines from those nodes to nodes two and three. The NCP need not be co-located with any of the nodes, although it probably will be.

Packet data networks can interface other such networks through high-speed "gateway" linkages, as long as the two networks meet common gateway standards. Most vendors of these systems are working to achieve compatibility through the CCITT X.25 and X.75 standards. X.25 is a CCITT standard that governs both the data-line protocol between two devices, and the call-placement protocol for users of a packet-switching network. X.75 governs the gateway procedures by which two interconnected, but otherwise independent, packet-switching networks exchange call-placement data. X.75 assumes the two networks conform to X.25.

But interconnecting packet networks to user comput-

Communications line characteristics	Performance
as many as 456 lines for a maximum load of 5M bps, 50 to 19.2K bps asynch, 2.4K to 64K bps synch	750 packets per sec., 8-msec. delay, 230K bps per trunk
as many as 169 lines for a maximum load of 800K bps, 50 to 19.2K bps asynch, 2.4K to 64K bps synch	380 packets per sec., 8-msec. delay, 56K bps per trunk
maximum load is 230K bps, 50 bps to 2.4K bps asynch, 1.2K to 56K bps synch	X.25 trunk to X.25 trunk: 205 packets per sec., 15-msec. to 48-msec. delay, 56K bps per trunk
as many as 1200 lines at 2M bps connected load; 75 to 9600 bps asynch at 1200K to 72K bps synch	1000 packets per sec., 8- to 80-msec. delay, 72K bps per trunk
as many as 128 lines; 50 to 9.6K bps asynch, 1.2K to 56K bps synch	2000 packets per sec., 20-msec. delay, 56K bps per trunk
as many as 1000 lines; 50 to 1.2K bps asynch, 1.2 to 64K bps synch	1000 packets per sec., 1-msec. delay, 64K bps maximum
as many as 30 trunks at 64K bps each to a maximum of 650K bps	M3201 is a protocol-dependent TDM switch that can handle as many as 2000 channels through concentrators
as many as 64 synch lines at 64K bps each to a maximum of 350K bps	800 packets per sec., 1- to 1.5-msec. delay, 64K bps per trunk, requires an M3201 to operate as a complete node, as many as four M3216s can share one 3201
as many as 256 asynch lines of 110 to 1.2K bps each, plus 32 synch lines of 2.4K to 9.6K bps each	20K characters per sec., less than 100-msec. delay, 56K bps per trunk

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The term 'packet switching' applies here only to systems that perform a significant set of useful functions, along with breaking up a logical block of data into smaller units.

ers and terminals presents larger technical problems than providing a compatible inter-network gateway. This results from the lack of fundamental compatibility between the protocols used in many terminal and computer data-communication systems and the natural form of protocols used in packet data networks. Users of these networks must rely on vendors to provide special protocol-conversion facilities or must purchase them separately from other vendors.

Packet data networks integrate control over data traffic because information on circuit behavior from even the most remote portions of the network can be brought to a single supervisory position at the NCP.

Because of the ring structure and the lack of dependence on a central site, packet data networks are more survivable than are centrally operated networks. They can "run in the dark" without the NCP for limited periods, and both NCPs and node processors can be duplexed for added reliability.

Computer manufacturers' networking systems

Computer manufacturers offer networking systems based on their product lines. While these systems can provide comparable types of network-management features to those offered by packet data network systems, there are some important differences resulting from the business philosophy and performance objectives of the vendors. Because packet data network vendors are in the business of helping users talk to a variety of systems and networks, they have been willing to work within the framework of international standardization programs to promote inter-network compatibility.

The computer manufacturers offering their own host-controlled network systems are not concerned with intersystem compatibility, and each manufacturer offers its own system. The fact that many manufacturers are now offering X.25 compatibility does not, unfortunately, assure that their network systems will be able to talk to each other, claims notwithstanding.

There is a distinct difference between the designs of computer manufacturers' data networks and the designs of packet data networks. A computer manufacturer providing a host-controlled data network is concerned with a user's ability to solve a complete network-oriented data-processing problem: from terminal to data base on disk and back. If the data-processing problem is to be solved by software resident in several locations, the supplier needs to provide facilities that will help the user implement a distributed-processing application.

Network control, while essential, is only part of the total problem; the host-controlled network must be a carefully designed portion of a larger entity: a distributed-processing control system. IBM's System Network Architecture (SNA) is such a larger system.

Another way to look at this difference is through the conceptual framework provided by the International Standards Organization (ISO). ISO defined a seven-level "provisional architectural model" of user-to-user data communications, in which "user" can mean program or terminal. This model has helped professionals organize their thinking about the subject. It has also led to implementation efforts in which designers attempt to divide portions of a large software system into modules corresponding with the ISO levels, although with only moderate success.

The ISO levels are: Level 1, physical and electrical link control (technical); Level 2, data link control (protocols); Level 3, network control (addressing, routing and reporting); Level 4, transport end-to-end control (user's "get-put network"); Level 5, session control (initiation of user's applications); Level 6, presentation control (device-independent to device-

Vendor	Typical Configuration	Availability Features	Service Features
Bolt Beranek and Newman, Inc.	BBN C-70 with 128K-byte memory and 160M-byte disk	duplex, 5-min. switchover, call placement not interrupted	on-line network supervision, data capture, off-line traffic reports
GTE Telenet	Prime 550 or 750 with 1M- to 2M-byte memory and 80M-byte disk	duplex, fast switchover, call placement not interrupted	on-line network supervision, data capture
Northern Telecom, Inc.	on-line supervision: SL-10 500K-byte partition of SL-10 node plus dual 10M-byte disks, off-line processing: PDP-11/70 or IBM 370	duplex, fast switchover, no interruption to call placement	on-line network supervision, data capture, off-line reports
SESA-Honeywell	Honeywell Level 6/43 or 6/53 with 256K-byte memory and dual 10M-byte disks	duplex, 30-sec. switchover, call placement not interrupted	on-line network supervision, data capture, optional off-line reports
Siemens Corp.	PDP-11/44 with as much as 1M-byte memory and 67M- to 250M-byte disks	duplex, fast switchover, call placement not interrupted	on-line network supervision, data capture, optional off-line reports
Tran Telecommunications Corp.	functions performed within M3200 node processor with dual floppy disks	duplex, manual switchover	on-line network supervision, data capture
Tymnet	Tymnet II Engine with 1M-byte memory and 40M-byte disks	duplex, switchover in less than 6 min., depending on network size	on-line network supervision, data capture, off-line reports

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Network control is only part of the total problem; the host-controlled network must be part of a larger entity: a distributed-processing control system.

dependent format conversion); Level 7, application (user-written programs).

Packet data networks have implemented the first three of these levels of control. They can receive data calls in a "telephone-call-like image" and route them to their destination. Thus, two packet network designers can successfully coordinate their X.25 level 3 procedures to assure inter-network compatibility by relying on established standards and terminology. These networks do not, however, address any of the higher levels, nor are they likely to in the foreseeable future. Levels 4 to 7 are defined only in broad, conceptual terms. Because host-controlled systems, designed to support the user's implementation of total systems, must cope with all seven ISO levels, computer vendors have had no alternative but to go their own ways, competing to give the users the best total service offering.

Packet data network elements

PDNs are constructed using four basic types of processing elements: node processor, network control processor, concentrator and protocol converter. Some vendors supply these elements in the form of separate freestanding processors. Other vendors supply them in consolidated form as functionally distinct elements combined in a single processor.

- **The node processor** is the basic processing element of a PDN. The NP receives data from its input lines, determines its routing and transmits it toward its intended destination. The NP can also capture information about data calls that may be used in network supervision and accounting.

Node processors are usually engineered for high-speed data switching, remote unattended operation and low equipment costs. They are usually provided a bare-bones operating system and programmed for efficiency by the vendor.

The NPs of a network communicate with each other through a network standard data-link protocol designed for high performance and flexible traffic management. The NPs also communicate with the NCP to exchange statistical and supervisory data.

Some vendors' systems grant the NPs almost total control over call placement, addressing, routing and security functions, reserving to the NCP only the supervisory and statistical functions. Other vendors' systems limit the role of the NPs, requiring call placement to be handled by the NCP. The latter systems tend to be less costly because the NPs can be simpler, but they are more vulnerable to bottlenecks or failure of the (usually) single NCP.

- **Network control processors** maintain data links to all NPs in a network. They collect data call information originated by the NPs and integrate this information to provide displays and permanent records of network conditions. The NCP is typically a general-purpose

Vendor Product	Communications Lines Supported	Network Access Lines	Features
Bolt Beranek and Newman, Inc. C/30	as many as 63 lines at 1M bit connected, 50 bps to 19.2K bps asynch	as many as 10 lines	proprietary processor, statistical multiplexer, real-time diagnostics, remotely controllable from network control processor
GTE Telenet TP4010, 4020, 4030	as many as 256 lines at 230K bps connected load, see TP4000S node processor for line types		6502A-based, statistical multiplexer, real-time diagnostics, remotely controllable from network control processor
GTE Telenet TP3010	as many as 27 lines at 38.4K bps combined with network access line load, 50 to 9.6K bps asynch and 1.2K to 9.6K bps synch	one line at speeds as high as 19.2K bps	Z80-based; watchdog timer; remotely controllable from network control processor
Northern Telecom, Inc. SL-10	small configuration SL-10 node processor can serve as concentrator		
SESA-Honeywell TIM	as many as 16 lines at 38.4K bps connected load, 1.2K to 19.2K bps synch, X.25 link protocol	speeds as high as 19.2K bps synch, X.25	Z80-based
Siemens Corp. EDX-P	small configuration EDX-P node processor can serve as concentrator		
Tran Telecommunications Corp. M3211	as many as 124 lines at 19.2K bps connected load, 75 to 9.6 bps asynch, 1.2K to 9.6K bps synch	one line at 9.6K bps	8080-based, statistical multiplexer, real-time alarms, controllable from M3200 node network control processor
Tran Telecommunications Corp. M3212	as many as 124 lines at 64K bps connected load, 1.2K to 9.6K bps asynch, 1.2K to 19.2K bps synch	three lines to 48K bps each, 64K bps total	same
Tymnet	concentrator functions performed in Tymnet II "Engine" node processor		

Node processors are usually engineered for high-speed data switching, remote unattended operation and low equipment costs.

medium-scale minicomputer fully configured with disk driver, printers and video displays. Operators at the displays receive traffic and network equipment condition reports on-line. The operators may issue commands to the network from their consoles to alter the NP's traffic-handling characteristics or to identify and isolate equipment malfunctions. The NCP also records traffic data for use accounting and long-term planning purposes.

• **Concentrators** combine several low-speed asynchronous data streams into a smaller number of high-speed synchronous data streams, typically to permit groups of low-speed terminals to be connected economically to an NP.

Concentrators are engineered for low cost per low-speed line, and for reliable remote unattended operation. They usually have very limited processing functions and perform none of the routing and data capture functions of the NP. Often, the concentrator is physically integrated in the NP.

• **Protocol converters** provide a bridge between dissimilar NP and user equipment (host processors or terminals) data link protocols. Protocol converters are engineered for low-cost equipment, remote unattended operation and custom programmability. They normally connect one or two high-speed synchronous lines and have a different economic balance than concentrators. Custom programmability is important because many protocol conversion applications are user-oriented and unique. Protocol-conversion functions are often incorporated in NPs.

Although prices are usually published in tables, it is not done here because packet-switching systems are sold today only on a custom-project basis, and each proposed installation is individually priced. However, the following are representative system costs: NPs sell for $50,000 to $150,000 each; NCPs sell for $300,000 to $500,000, depending on size and degree of redundancy; professional service charges are typically $500,000 to $1 million, depending on the amount of special software required and network complexity.

U.S. MANUFACTURERS OF PACKET-SWITCHING SYSTEMS

Manufacturer	For More Information, Circle No.
Telenet (division of GTE), Vienna, Va.	454
Tymnet (division of Tymshare), Cupertino, Calif.	455
Bolt Beranek and Newman, Cambridge, Mass.	456
Siemens Corp. (subsidiary of German parent), Iselin, N.J.	457
SESA (subsidiary of French parent), Honeywell, Herndon, Va.	458
Northern Telecom (division of Bell Canada) Belleville, Ont.	459
Tran Telecommunications (division of Amdahl), Marina del Rey, Calif.	460

• **Node processor configuration.** Every vendor is using multiple computer technology in the node, providing large amounts of directly addressable memory (typically as much as 1M byte), redundancy and automatic switch-over. All vendors are using μcs. Only one vendor, Siemens, uses a conventional minicomputer (the PDP-11/44) in its NP. Siemens also uses Intel 8085 μps in the node for line adapters.

• **Devices and protocols supported.** The basic protocols are: X.25, X.75 gateway, asynch, X.3 ITI PAD, contention bisynch and 3270 bisynch. All vendors intend to support this basic set of devices and protocols, but none can presently. There is as yet no indication of whether or when support will be provided for IBM's SNA and SDLC.

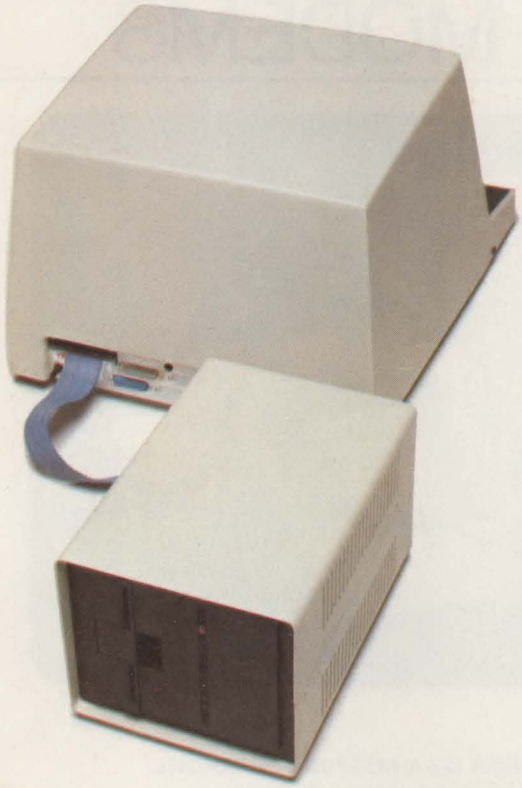
• **Performance.** Switching speed for pure synchronous traffic (X.25 in to X.25 out) is in the range of 200 to 2000 packets per sec. This kind of performance is possible because of the extensive use of μps in synchronous line adapters and the relative simplicity of the packet-switching function. Tymnet rates its system at 20,000 characters per sec., rather than in packets, because the Tymnet node processor performs many of its functions in software, on a character-by-character basis. Packet-switching nodes that perform extensive character handling with asynchronous traffic cannot yield the same throughput possible with pure synchronous traffic.

Each system provides HDLC-type trunk lines to minimize queuing delays and permit multiple priorities of traffic to share a trunk efficiently.

All systems surveyed provide open-ended addressing schemes with no practical limit on the structure or size of a network and its user community. All systems provide security and access-control features. Closed-user groups are available in all systems, and password control in most. All systems surveyed provide multiple routing with automatic route selection, extensive network supervisory facilities and automatic failure recovery.

All vendors are committed to building more integrated systems. Although most of them are presently building "outboard" concentrators and protocol converters, they are moving toward integrating these functions in the node processor. The high unit costs of stand-alone devices and the difficulty of integrating them are causes for this movement. ■

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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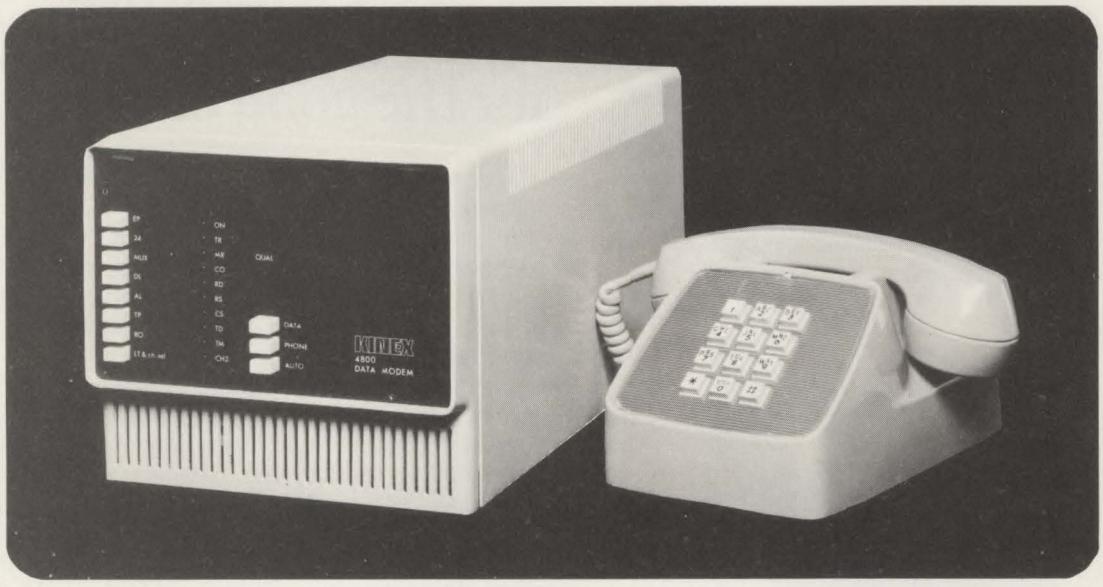

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Coaxial cable finds a home

WALTER A. LEVY, Edgewood Computer Associates,
and MICHAEL ROTHBERG, Chase Manhattan Bank, N.A.

Limited distance networks beckon as data communications planners seek inexpensive alternatives to twisted pairs

Coaxial cable technology as a transport medium for data communications is neither new nor revolutionary. It has been used for almost 20 years in data communications and CATV applications. Its utility in local networks makes the technology especially interesting. The advent of inexpensive μps, distributed data-processing networks and office-automation and word-processing products has compounded the need for an effective and inexpensive alternative to leased twisted-pair communications lines to link this hardware.

The superior cost-effectiveness, flexibility and performance of baseband and broadband coaxial cable compared to twisted pairs have been proven in numerous installations. The high speed, high channel density and low error rates of "coax" (Fig. 2) will attract growing numbers of data communications systems planners.

It is becoming increasingly difficult and costly to pull additional cables through existing conduits and troughs in many office buildings because of the proliferation of interconnected devices and private networks. When planners realize that a single ½-in.-diameter coaxial cable can replace 1500 or more twisted pairs, the cost benefits of installing and maintaining coax become apparent.

The time and cost of sorting out and performing continuity checks on masses of twisted-pair "spaghetti" is significant. If the coaxial cable is "interrupted," all terminations will be affected. But diagnosis and repair can usually be done rapidly and simply, and can be further expedited by using diversely routed backup cables. Cable installation expenses can be recouped quickly and must be balanced against the lease and maintenance costs of the twisted pairs. Users considering coax should also assign some value to the salvageable copper in existing facilities.

Baseband and broadband explored

Baseband networks are not effective for long distances. Most cable-based local networks, such as Ethernet, use baseband transmission, which is suitable

Supplier	Model No.	Data Rate	Efficiency Hz/Bit	Mode	Electrical Interface	Fixed Frequency (FF) Frequency Agile (FA)	Price	Notes
Amdax Corp.	740	19.2K bps	5.0	SYNCH HDX, FDX	RS232C	FF	$995	
Amdax Corp.	741	9.6K bps	10.0	ASYNCH, HDX, FDX	RS232C	FF	925	
Amdax Corp.	741R	9.6K bps	10.0	ASYNCH, HDX, FDX	RS232C	FF	RPQ	For severe environments
Sytek-Network Resources	120	128K bps	2.5	SYNCH, ASYNCH	RS232C	FA	995	
Sytek-Network Resources	200	2M bps	3.0	SYNCH, ASYNCH	RS449	FA	1500	

Table 1. Broadband *RF data modems.*

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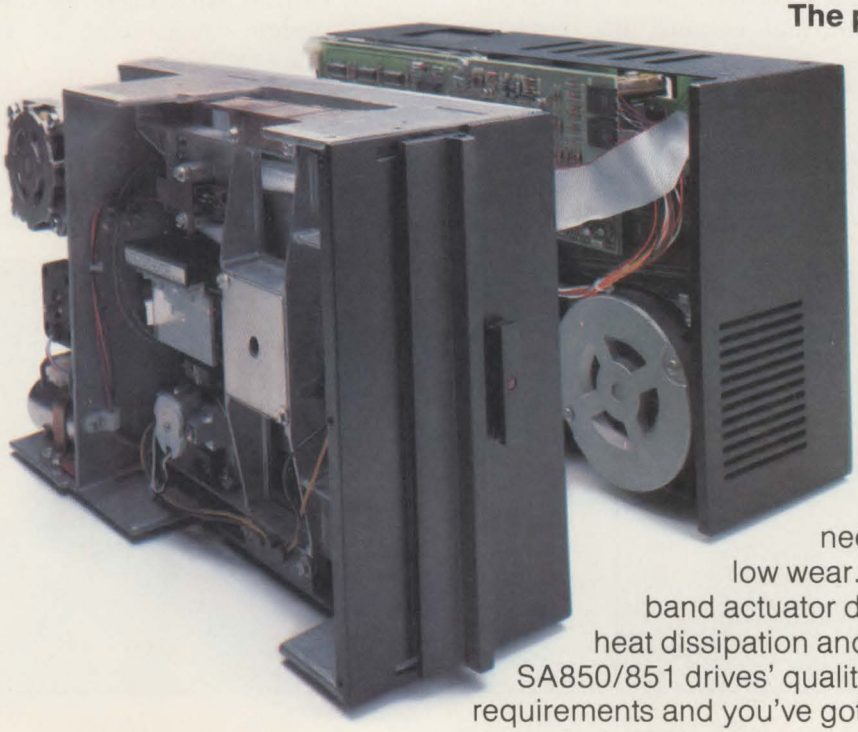

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CIRCLE NO. 57 ON INQUIRY CARD

The superior cost-effectiveness, flexibility and performance of baseband and broadband coaxial cable compared to twisted pairs have been proven in numerous applications.

for relatively short cable lengths of 1 km. to 2 km. When substantial distances are involved, cable-based networks connect to standard commercial telephone facilities that operate at 9.6K bits per sec. A local network may have a data rate ranging from 128K bits per sec. to 10M bits per sec. The transmission rate mismatch might require that substantial buffering be provided.

Conversely, CATV broadband cables are radio-frequency (RF) modulated and can accommodate significantly longer-distance communications. For example, Mitrenet and Sytek's Localnet use an RFM signal, which results in improved bandwidth and transmission distance of 15 km., but at the expense of higher-cost components.

The physical difference between baseband and broadband cable is that the insulated baseband carrier is surrounded by a woven copper mesh, while broadband uses a sleeve of extruded aluminum (Fig. 1). A more significant difference is the cable's data-transmission capacity. While baseband coax can support as much as approximately 50M bits per sec. in a half-duplex mode, broadband cable will carry more than 100M bps in a full-duplex mode. Broadband coaxial cable also offers significantly higher immunity to electromagnetic and radio-frequency interference than does baseband (Fig. 2).

Physical connection to either baseband or broadband coaxial cable is accomplished by using a simple "tap-off" device, which is essentially a "T" connector that pierces the outer jacket and conductor and makes contact with the inner conductor. These inexpensive taps can be removed and installed at other locations on the cable at will.

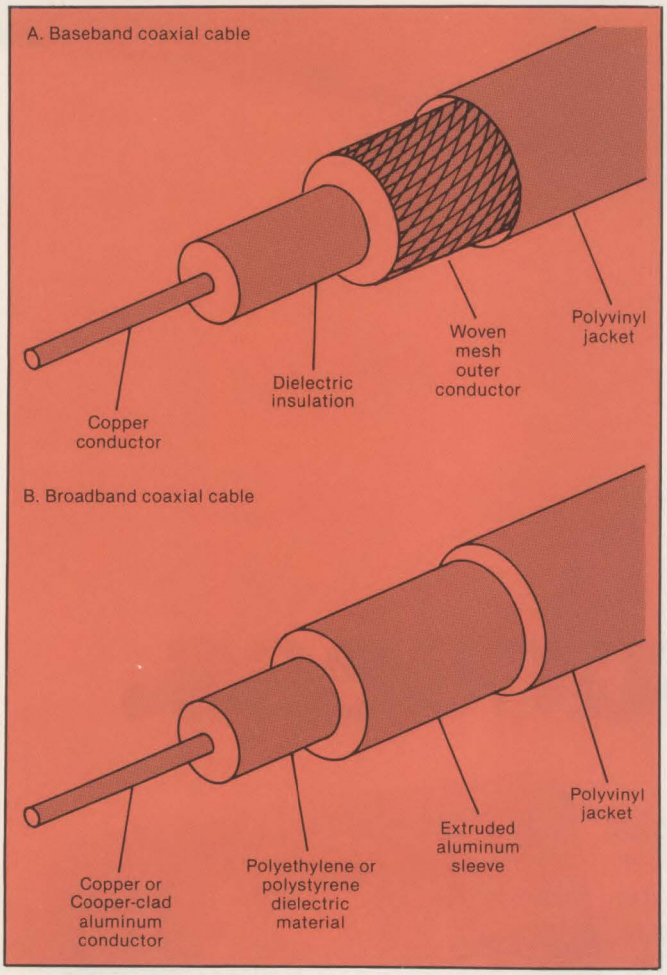


Fig. 1. The physical differences *between baseband (A) and broadband (B) cable, other than the slightly greater width of the broadband conductor, is the woven mesh outer conductor of the baseband and the extruded aluminum sleeve of the baseband.*

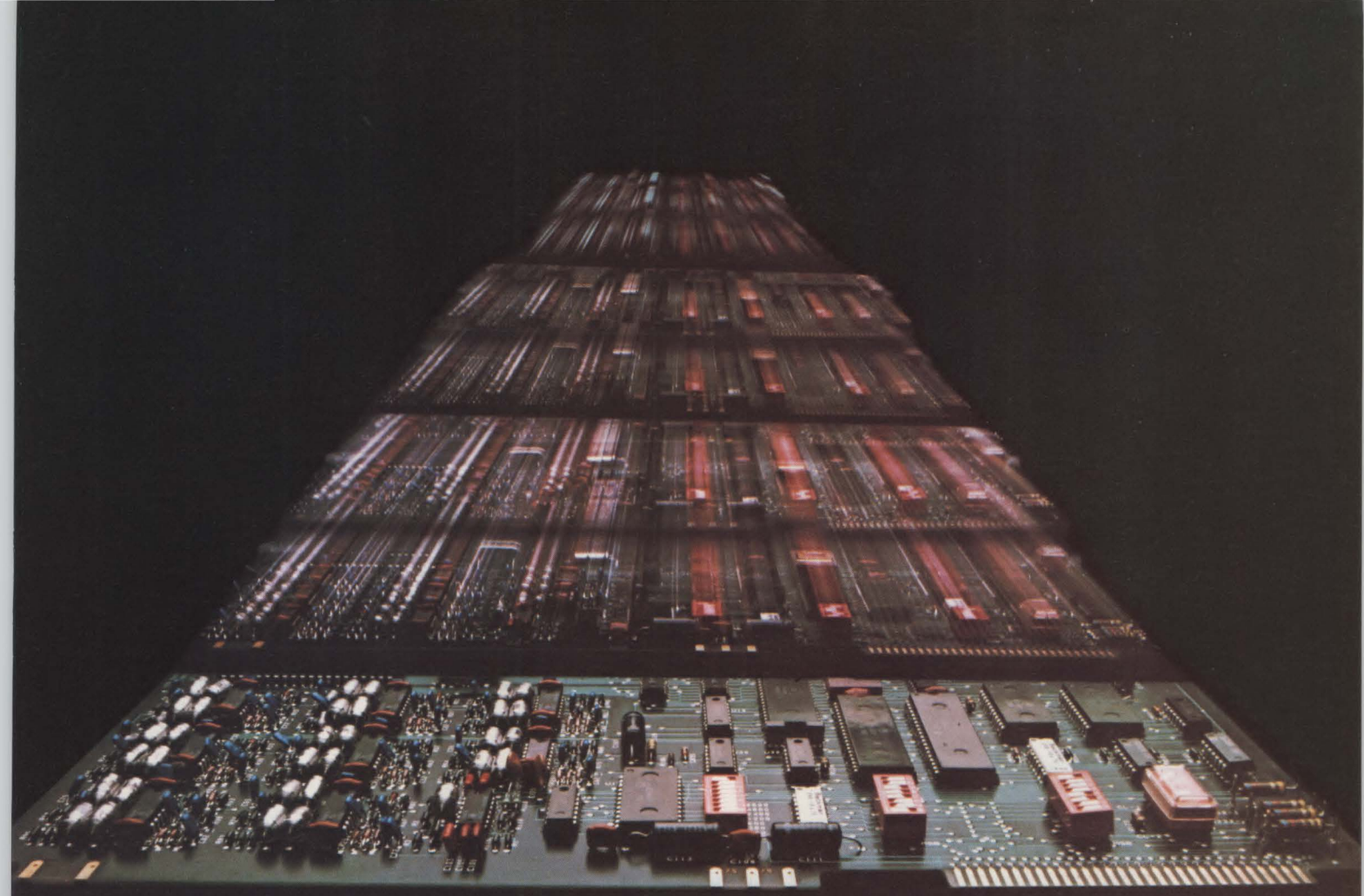
Applications govern the choice

More important than the physical difference between the two cable types are the applications considerations for each. All devices are connected to the common broadband cable, and each operates independently on a specific assigned frequency-derived channel in a point-to-point mode. Each channel is transparent to communications protocols, and numerous independent services can be supported simultaneously. CATV, computer-to-computer transmissions and asynchronous terminals all share the same "pipe" without concern for the protocol peculiarities of each other.

A typical broadband facility is a "passive" transport medium. A frequency translator at the head of the cable converts signals from the return to the forward

	Baseband	Broadband
Maximum distance (km.)	2	15
Data rates (approximate)	45M to 50M bps	100M to 140M bps
Mode	Half duplex	Full duplex
EMI/RFI immunity	50 dB	85 dB
Multi-drop capability	up to 100 devices in contention for a single channel	1500+ channels with one or more devices per channel
Channel access	TDM/Contention (CSMA/CD)	FDM/FSK with contention or polling for multi drops on a given channel
Approximate cost per ft. (cable only)	.20-.25	.31-.35

Fig. 2. Comparison of *baseband and broadband media.*



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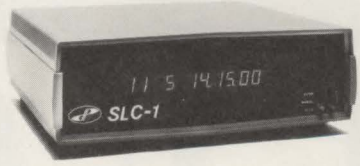
Naked Mini[4]	TCU-310 • $385



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DIGITAL PATHWAYS

CIRCLE NO. 59 ON INQUIRY CARD

Physical connection to either baseband or broadband coaxial cable is accomplished by using a 'tap-off' device.

channel. Each discrete channel is derived and accessed using frequency-division-multiplexing modems. Depending on the application's requirements, a modem can be either fixed-frequency crystal-controlled, able to transmit at a single frequency or frequency-"agile" and "tunable."

When two devices speak to each other, the first transmits on a return or low-band channel, which is converted to the forward or high-band channel at the head end. The second device listens and receives the message on the return channel, then transmits its response on the forward channel. This paired use of channels facilitates full-duplex operations, and, although it is highly unlikely with terminal devices, the high-transfer rates attainable in this mode make it suited to computer-to-computer transmission (Fig. 3).

Broadband techniques are most often used in a point-to-point configuration. A variety of station-level modems and devices are available for connection to the broadband cable system. Table 1 describes some of the major suppliers' products. System level devices, such as head-end translators and repeaters, are described in Table 2.

Intelligence and protocols

If a network designer wants to multidrop several devices from a single frequency-derived channel, the modem or cable-access device is no longer passive, but must include intelligence to facilitate a contention or polled protocol. The use of a wide channel for multiple devices is commonly encountered in baseband-cable systems using a contention-bus architecture.

The baseband bus is a shared communications facility, which is passive in itself. But a data packet transmitted on the bus is "heard" by all stations, necessitating the incorporation of address recognition in each station. Further, a means of determining availability of the media must also be incorporated

Supplier	Device Description	Bandwidth Data Rate	Approximate Purchase Price
Amdax Corp.	Head-end data translator #1009 (receives signals on return channel, adds 156.25 MHz and distributes signal on forward channel)	18 MHz	$4000
Amdax Corp.	Switch-over unit #1099 (fail-safe switch-over unit for redundant data channel translators)	Not applicable	$950
Amdax Corp.	DAX 1140 (high-speed data exchange unit)	56K bps	$1800
Jerrold	Repeaters, amplifiers	Not applicable	$800-$2000
Sytek-Network Resources	Network monitoring and control facilities	Not applicable	$11,000-$300,000

Table 2. Broadband system *level components.*

The suppliers presented here are not intended to be all-inclusive. There are a number of other equipment suppliers and developers, who did not respond to our questionnaire, or whose products are limited to supporting their own product families

	Ethernet	HYPERchannel	Net One	HYPERbus	Localnet System 20	Localnet System 40
Supplier	Xerox Corp.	Network Systems Corp.	Ungermann-Bass, Inc.	Network Systems Corp.	Sytek, Inc.	Sytek, Inc.
Cable Type	5 ohm RG/8	75 ohm	RG/8	75 ohm	4	4
Signal Type	Baseband	Baseband	Baseband	Baseband	Broadband	Broadband
Data Rate	10 Mbps	50 Mbps	4	6 Mbps	2 Mbps per channel	128Kbs per channel
Maximum Multidrop	250	64	250/segment	250	100,000	100,000
Maximum Cable Length	1.5 km[1]	4000-5000 ft.	5	1 km.	3	3
Access Protocol	CSMA/CD	CSMA/CD	CSMA/CD	CSMA[2]	CSMA/CD	CSMA/CD

1. Ethernet can be structured with a maximum of three segments of 450 meters each.
2. Hyperbus does not use a collision detection scheme, but rather requires an acknowledgement from the receiving station.
3. Maximum cable length data not available, but repeaters must be placed at 2-km. intervals.
4. Information not available.
5. Maximum cable length data not available, but repeaters must be placed within 4000-ft. intervals at 4 MHz, or 1500-ft. intervals at 10 MHz.

Table 3. Commercially offered *coaxial-cable-based limited-distance network systems.*

When mixing network and system vendors, a degree of interfacing via software or microcode will always be required.

because the bus is available to all transmission devices.

The most commonly used access protocol that satisfies these requirements is carrier sense multiple access with collision detection (CMSA/CD). Three phases of operation are used in this protocol. The first is "carrier sense," or "listen before talk," in which the network adapter or transceiver monitors the bus to detect a carrier signal. If no carrier is sensed, the device is free to transmit. The second phase of operation, "collision detection," or "listen while talk," provides a fail-safe measure when two devices decide the channel is free and initiate transmission within the same time period. By monitoring the channel during transmission, the device can detect any interference and discontinue the transmission. The third phase is "back-off," in which each device releases the channel, and, using a randomizing algorithm, exercises a back-off period before retransmitting.

To configure a contention bus architecture, a network designer must consider a number of system requirements, including distance, aggregate data rate and the number of drops on the bus. When mixing network and system vendors, some interfacing via software or microcode will be required.

A three-level architecture (Fig. 4) puts these requirements into perspective and delineates their relationships. The first is the "transport media," including cables, taps, splitters, repeaters and, for broadband systems, the head-end retransmission equipment. Second is the network level, which includes modems, intelligent bus transceivers and interfaces with external devices. Third is the user level, encompassing terminals, computers and other devices to be connected.

Some representative three-level networks

Several commercially offered network products fit into this structure. There are some minor differences in allocation of these functions to the three levels, as well as variations in the carrier-access and collision detection-schemes (Table 3). The packet formats vary, but all contain the same relevant data elements.

Ethernet (Fig. 5) is probably the most publicized contention bus architecture offered today. Developed at Xerox's Palo Alto, Calif., research center, it is named for luminiferous ether, the medium that transmits radio waves. Ethernet is a broadcast packet-switching

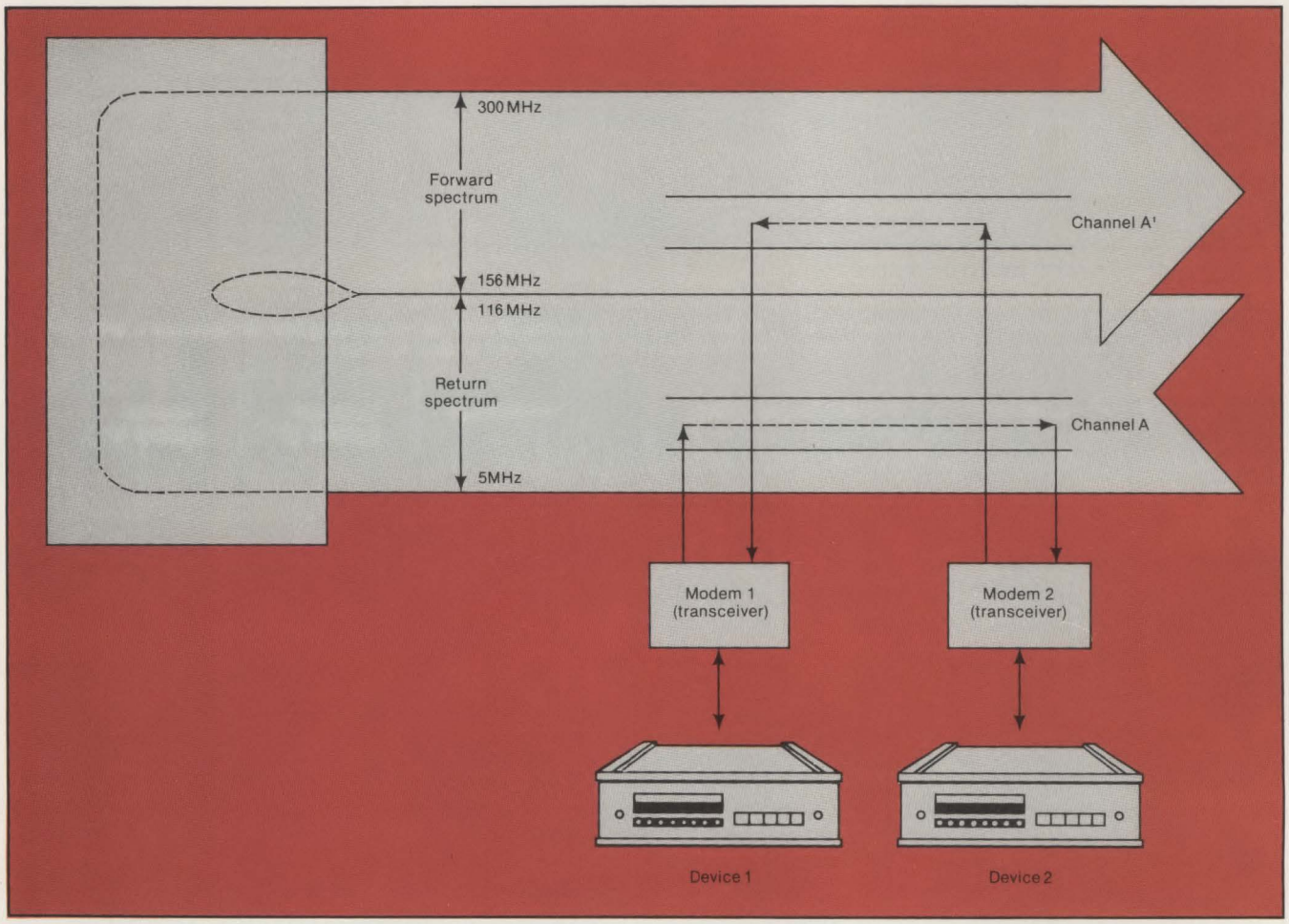


Fig. 3. Device 1 transmits data *on channel A and receives data on channel A1, while device 2 transmits on channel A1 and receives on channel A. This paired use of channels facilitates full-duplex operations, and, although it is highly unlikely with terminal devices, the high transfer rates attainable in this mode make it well-suited to computer-to-computer transmission.*

medium, in which each station's transceiver selects appropriate messages based upon the packet's leading address. The Ethernet packet is composed of a synchronization pulse, a destination address, an origin address, a text section and a cyclical redundancy check.

Ethernet appears to have been designed primarily to support Xerox's entry into the office automation market, and the alliance involves Digital Equipment Corp. and Intel Corp. (MMS, July, 1980, p. 17). Interfaces and compatible transceivers will probably be developed for other "foreign" devices. Three segments of the cable may be linked, each having a range of about 450 km. A total of 255 devices may be dropped from the bus.

Another major contender in the limited-distance network arena is Network Systems Corp., with its Hyperchannel and Hyperbus offerings. Similar to Ethernet in many ways, Hyperchannel can extend to 4000 and 5000 ft. without repeaters. A maximum of 64 devices can be multidropped from Hyperchannel, which uses an 8-bit address.

Network Systems Corp. is somewhat unique in that it offers specialized adapters for interfacing IBM, DEC, Data General, Modcomp and Perkin-Elmer computers. Link adapters are also available to tie a backbone trunk to leased telephone lines, as are device adapters for plug-compatible CDC and IBM tape drives (Fig. 6).

Another supplier of limited-distance cable networks is Sytek, Inc., with its manufacturing subsidiary, Network Resources Corp. Sytek offers two high-performance network products, Localnet 20 and Localnet 40. Unlike the other contention bus systems, the Localnet products operate on broadband CATV cable and can support as many as 120 128K-bit-per-sec. CSMA/CD networks on a single cable.

Sytek offers a variety of cable adapters called TBOX and TMUX units. The TBOX units are RF modems that also contain local packet-switching intelligence at the station level. A TBOX includes a full-duplex FM transceiver, which allows insertion of a 156-MHz offset spacing between the transmit and receive frequencies.

The TMUX unit can be used to interface as many as eight devices with an RF transceiver. Other adapters are available to bridge channels on a cable using frequency-agile modems integrated with a μp. This device, a TBRIDGE, will monitor four channels via software selection for packets requiring interchannel transfer.

The suppliers discussed here and presented in Table 3 are not all-inclusive. There are a number of other equipment suppliers and developers who did not respond to our questionnaire, or whose products are limited to support of their own product families. Included in the latter category are systems from

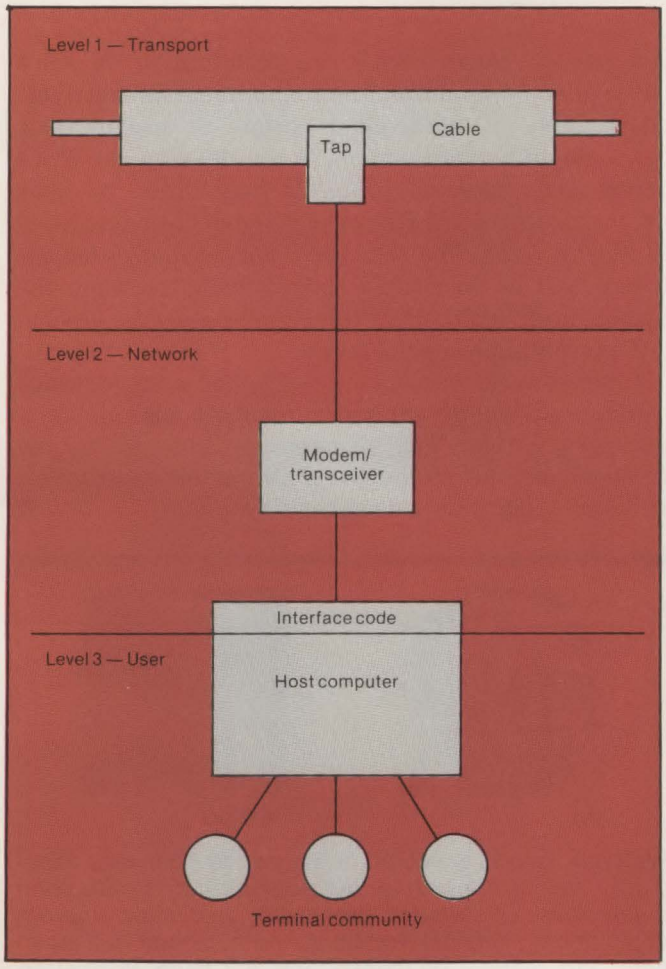


Fig. 4. It is convenient *to consider the requirements at three levels: transport, network and user. Interface code, resident in the host computer, might also be considered part of the network.*

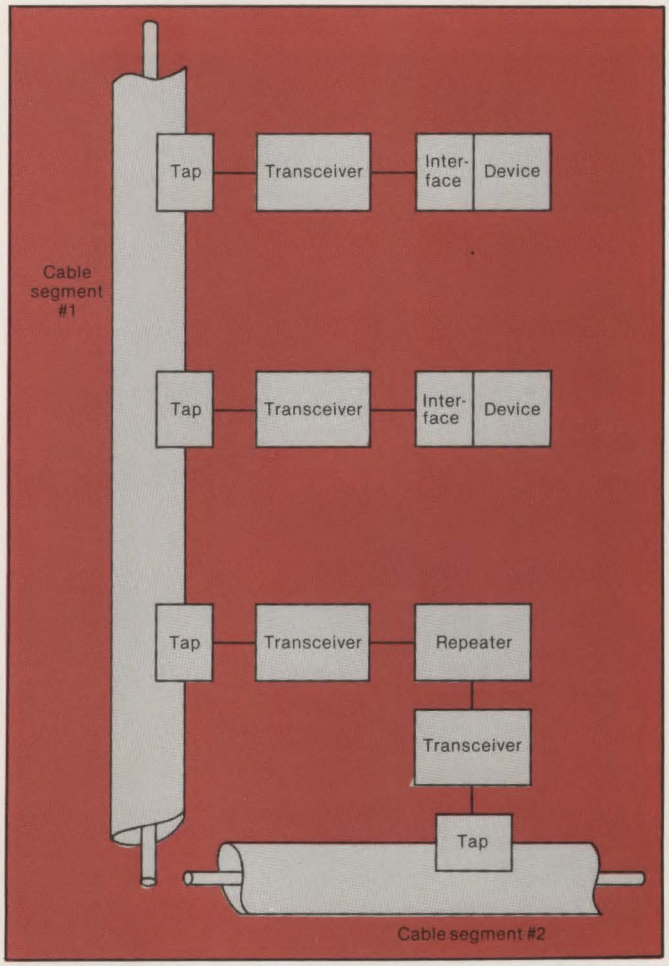


Fig. 5. Ethernet is a broadband packet switch *where each transceiver examines the destination address of all transmissions. Several cable segments may be connected.*

The growth of limited-distance coaxial cable networks appears to be unprecedented.

Datapoint Corp. and Zilog Corp. Numerous coaxial cable networks have been privately developed and installed, as well.

The growth of limited-distance coaxial cable networks appears to be unprecedented. They will probably

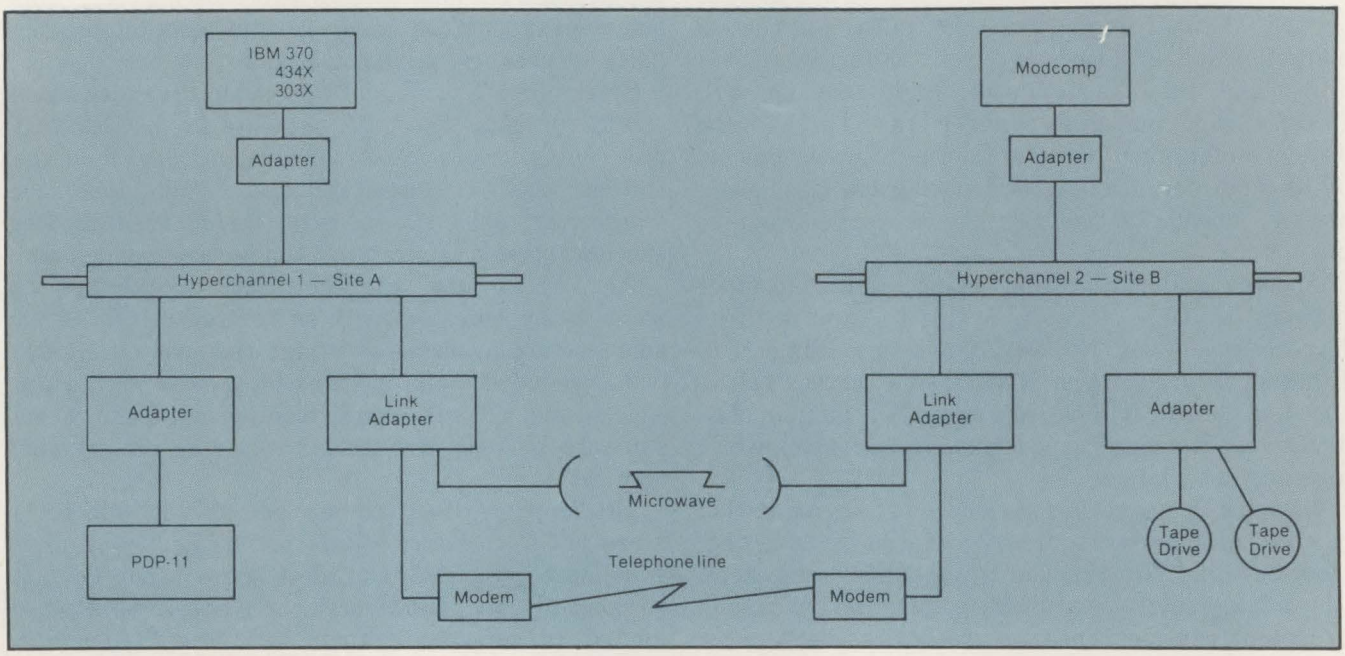


Fig. 6. Network Systems Corp.'s Hyperchannel *can be configured to support several different processors and devices, as well as additional channel segments.*

continue to expand with the proliferation of office automation μp products. The requirement for distributed systems of multivendor origin is placing new demands on network suppliers and developers. While access and link-level protocols may differ to some extent, adapters and transceivers have been developed to fill the voids. The real issue and challenge for the future will be to achieve compatibility between the higher-level protocols involving end-to-end, session- and presentation-control levels.

Internetwork gateways are another area in which significant development will be required (MMS, September, 1980, p. 105). "Talk (of gateways) is cheap," but the development and acceptance of compatible standards is still only a gleam in a designer's eye. ■

A GLOSSARY OF TERMS

Baseband transmission: transmission of digital data without modulation.

Broadband transmission: transmission involving the modulation of the radio frequency carrier by the digital data signal.

Broadcast packet switching: the transmission of packets on a "contention bus" where all data is heard by all devices on the channel, and is selected by each device through address-recognition techniques.

Frequency agility: certain broadband cable adapters or modems that can be adjusted to operate at different frequencies. Contrast with fixed frequency devices, which operate on only one frequency.

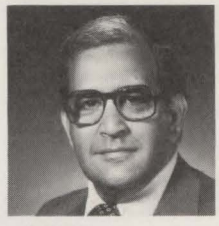
Full duplex (FDX): form of transmission supports bidirectional signals simultaneously. In the case of broadband transmission, the term denotes simultaneous transmission on forward and return frequencies.

Half duplex (HDX): a form of transmission that supports bidirectional signals, not simultaneously.

Insertion loss: a decrease in signal amplitude resulting from the termination of a device on a cable.

Radio frequency (RF): in the context of a broadband frequency spectrum, those frequencies from 5.75 MHZ to 300 MHZ.

Levy



Rothberg

Walter A. Levy is president of Edgewood Computer Associates, Inc., a consulting firm specializing in data communications, distributed processing and minicomputer applications. **Michael Rothberg,** now a second vice president and technology consultant at Chase Manhattan Bank, has worked in the computer industry for 18 years.

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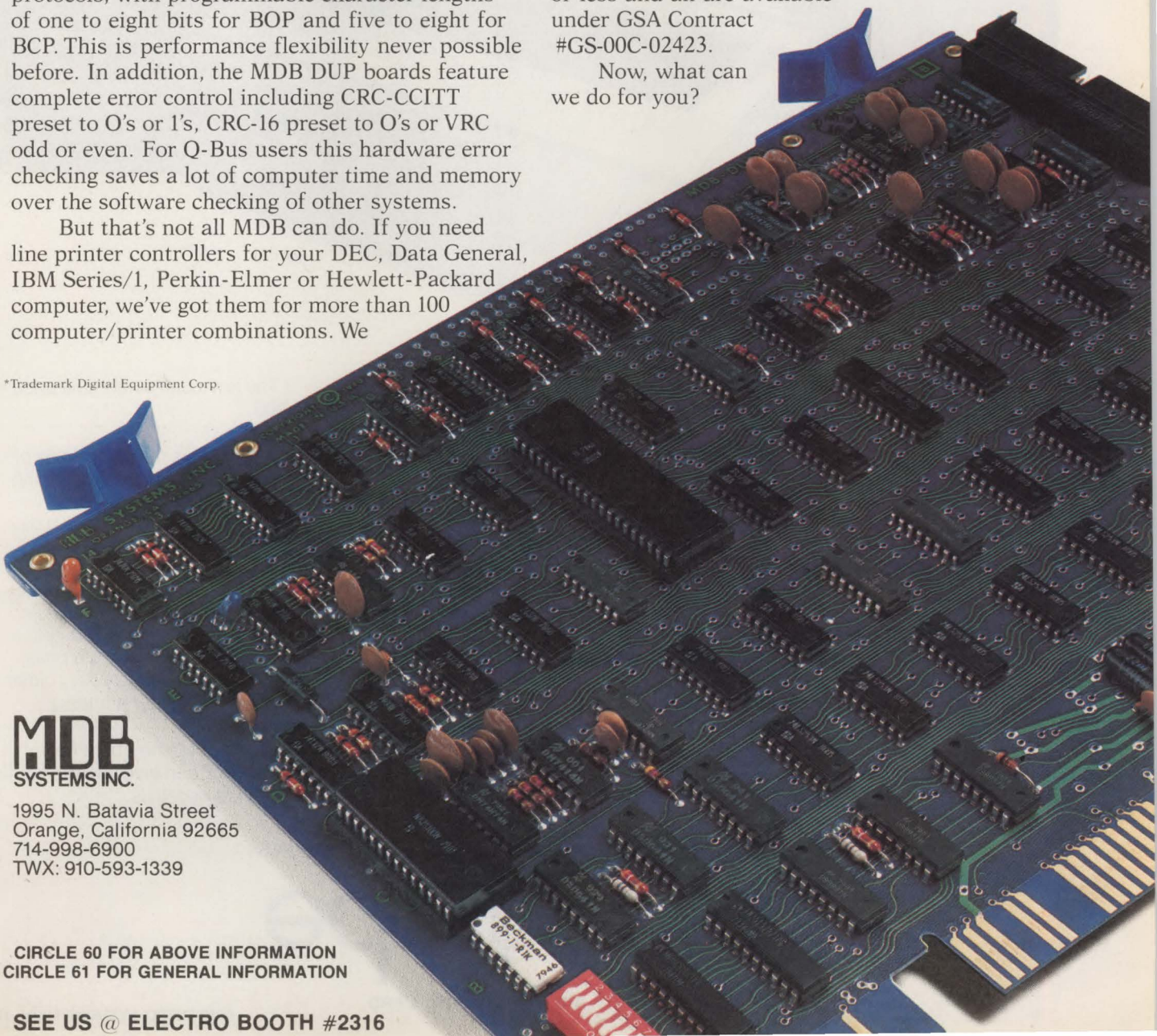

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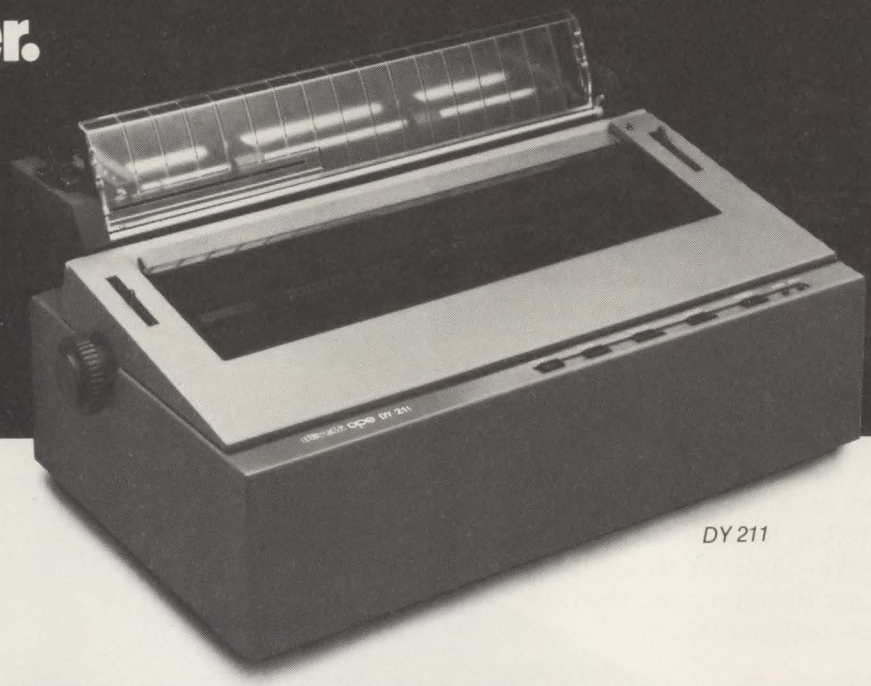

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CIRCLE NO. 62 ON INQUIRY CARD

ENCRYPTION

The NBS Data Encryption Standard: products and principles

HEATHER BRYCE, Motorola, Inc.

How the National Bureau of Standards' Data Encryption Standard does what it does, and what's available to do it

Valuable information of any kind needs protection from unauthorized access and/or alteration. In the case of computer data, this means more than placing a padlock on a door. Protection requires sophisticated cryptographic techniques, such as those provided by the National Bureau of Standards Data Encryption Algorithm (DES).

Data are particularly vulnerable when being moved from one site to another. Not only are the data subject to unauthorized access, but information may be altered before it reaches its destination. If this happened in a bank, money could be transferred to a thief's account. The theft could go unnoticed for a long time, and when finally discovered, it could be untraceable.

Cryptographic techniques used for this type of data protection scramble, or encrypt, the data before they are sent downline. The data are encrypted by the DES with a variable 56-bit key known only by the sender and intended recipient. Unless the key is known, an intruder cannot unscramble the data (see "The NBS Data Encryption Standard," p.114).

Component, subsystem, system

The DES has been implemented in a single chip, the MC6859 data security device (DSD). The DSD is available alone, incorporated into a board-level product or as the central element in a self-contained, stand-alone module. As the level of integration increases, so does the initial

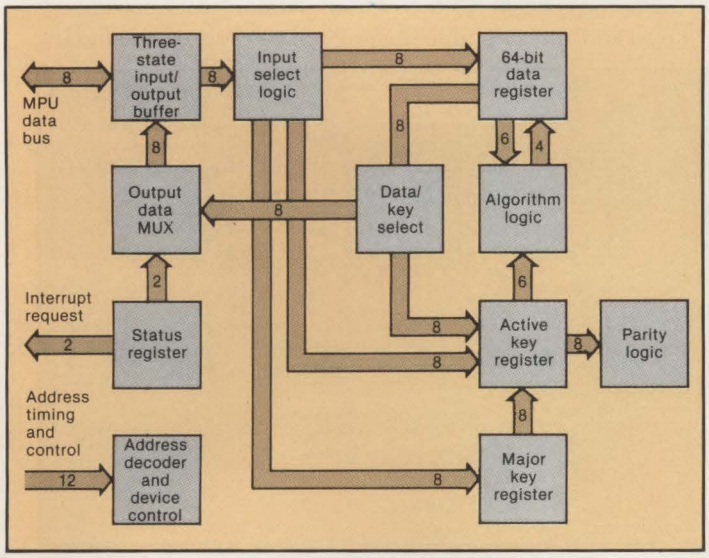

Fig. 1. Data security *device block diagram.*

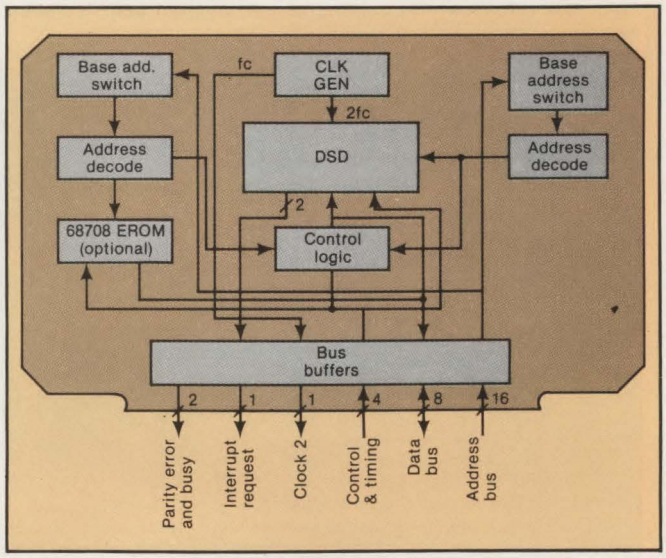

Fig. 2. MGD6800DSM *clock diagram.*

The Info-guard DES4100 series from Codex, for users who do not want to develop their own hardware or software, has the highest level of integration.

price. The price of development time, software and hardware decreases, however, so the trade-offs involved must be weighed.

Purchasing an MC6859 alone initially costs less than buying it as part of a board-level product or stand-alone module. Further, it enables a user to customize hardware and software.

The MC6859 is an NMOS device in a 24-pin package. It requires a single 5V power supply and is directly compatible with the MC6800 μp. Other μps can also control the DSD.

Fig. 1 shows an internal block diagram. Eight bytes are fed in one at a time to fill either the 64-bit data register or the 64-bit active key register. The 64-bit active key register codes the algorithm that scrambles or unscrambles the 64-bit data block before transmission.

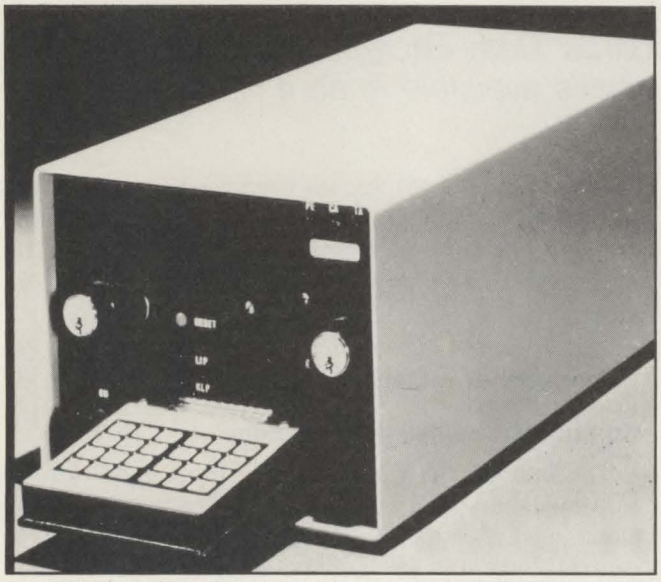

Fig 3. The Info-Guard *data security system includes this network security module, which performs the NBS Standard. The complete Info-Guard key management system also includes a key generator and a key loader.*

Motorola's Government Electronics Division offers three data security modules (DSMs) for systems integrators who prefer working at the board level. The MGD6800 DSM (Fig. 2) supports the M6800 EXORciser or a Micromodule system. An optional 68708 EROM allows control program storage or encryption key storage. A similar module, the MGD8080DSM, supports an Intel 8080.

A third module, the DES1100DSM, which supports a PDP-11, has a μp on-board and is a self-contained data encryption module.

System-level integration

The Info-guard DES4100 series from Codex, for users who do not want to develop their own hardware or software, has the highest level of integration. The series consists of a stand-alone network security module (NSM) and an optional key management system, consisting of a key generator module and a key loader module. These products (Fig. 3) perform the complete cipher function, require no programming, have minimal effect on system throughput and are transparent to the communication system in which they are used.

The NSM, which performs encryption/decryption, can be installed between a modem and a terminal or a controller in an RS232C network, or between a communications line and a terminal in a current loop (TTY) network. Fig. 4 shows a functional diagram of an NSM-based communication system.

The front panel of the basic NSM desk-top unit measures 7.2 × 6.2 × 15 in. It contains three system alarm LEDs that indicate parity error, cryptographic alarm (indicating the system is in clear text mode and encryption is not being performed) and alarm condition; an illuminated power input switch; and two Underwriters Laboratories-approved security locks. Two dissimilar keys are required for access to a 24-key keypad and a nine-digit hexadecimal display. Partial removal of the front panel activates a tamper switch that zeros the RAM, making key access impossible.

The keypad is used to enter primary and secondary keys and for downline loading of the entered secondary

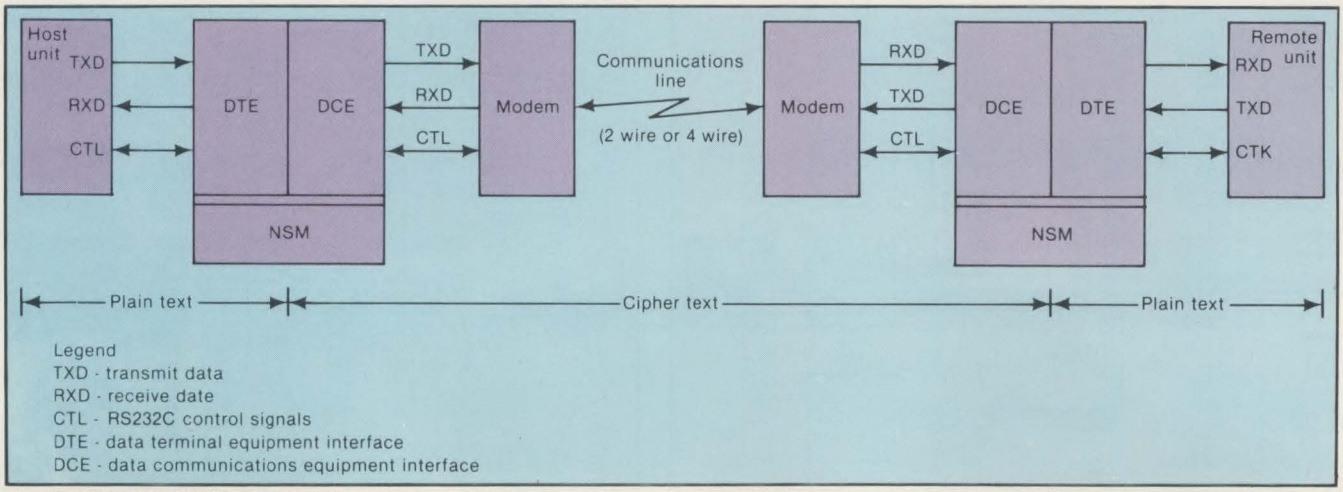

Fig. 4. DES4100 NSM *functional diagram.*

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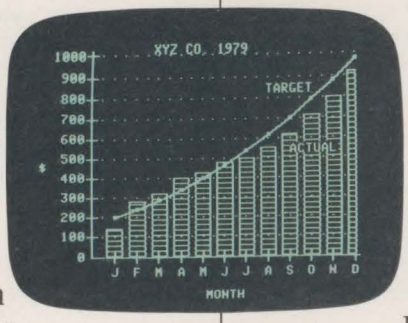
1 In research

Apple personal computer systems help you collect, store and analyze data as fast as you can load a disk and execute a program. Because more than 100 companies offer software for Apple, you have the largest program library for manipulating your data in the personal computing world. Need special programs? Use any of Apple's development languages — BASIC, FORTRAN, Pascal.

2 In engineering

Apple personal computer systems let you define models, make trade-offs and refine prototypes. Want to study cause and effect of several variables? Apple computes new results instantly and displays them in colorful, easy-to-read graphs, charts or plots on a video monitor.



3 In production management

Apple personal computer systems make it easy to gather data, analyze productivity, measure yields and facilitate all phases of production control. Want to speed up repetitive tasks?

Rely on Apple's word processing capabilities to write, edit and print your reports.

Apples grow with you.

Whichever system you pick, Apple never locks you into a single configuration. You can use up to four or eight I/O accessory expansion slots to add an IEEE bus, Apple's Silentype™ printer, a modem or a graphics tablet. Add memory up to 64K bytes or 128K bytes. Add up to four or six 5¼" disk drives without adding any overhead.

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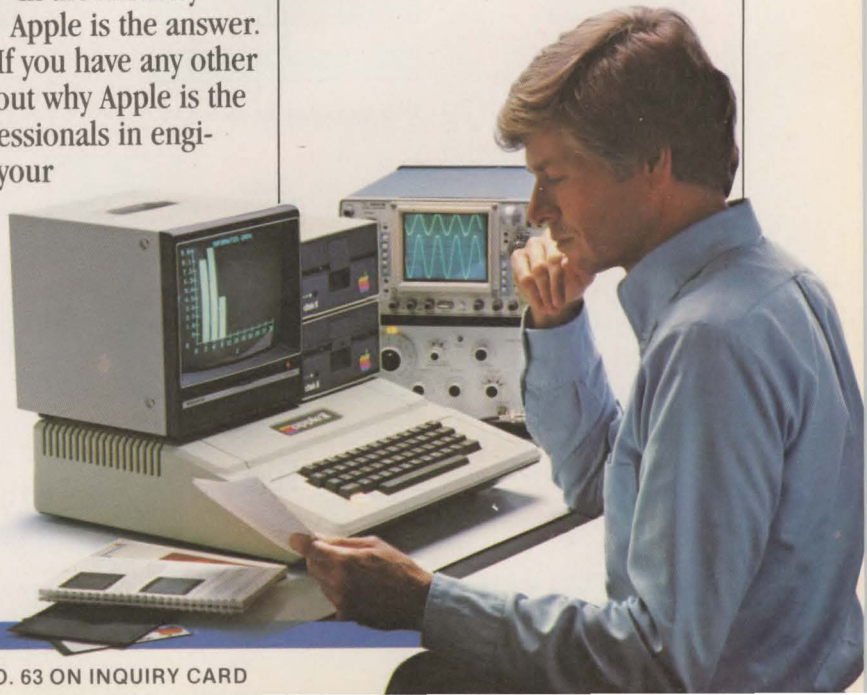
If you have any other questions about why Apple is the pick for professionals in engineering, see your nearest Apple computer dealer or call **800-538-9696**. In California, **800-662-9238**. Or write: Apple Computer, 10260 Bandley Drive, Cupertino, CA 95014.

	Apple II	Apple III
Maximum Memory Size	64K bytes	128K bytes
Screen Display	40 column (80 column with peripheral card) 24 Lines Upper Case	80 column 24 Lines Upper Case/Lower Case
Screen Resolution (B&W)	280 x 192	560 x 192
Screen Resolution (Color)	140 x 192 (6 colors)	280 x 192 (16 colors)
Keyboard	Fixed	Programmable
Numeric Key Pad	Accessory	Built-in
Input/Output	8 expansion slots	4 expansion slots plus built-in: disk interface RS-232 interface Silentype™ printer interface clock/calendar
Disk Drives	Add-on one to six drives	One drive built-in, plus interface to support three more drives
Languages	BASIC Fortran 77 Pascal Assembly Pilot	Enhanced BASIC Fortran 77 Pascal Assembly
Typical Configuration Pricing	CPU, 48K RAM, single disk drive, B&W Monitor (9"), Silentype™ printer, and BASIC. **$2875.00***	CPU, 96K RAM, integrated disk drive, B&W Monitor (12"), Silentype™ printer, SOS, Enhanced BASIC. **$4865.00***
*Suggested retail price.		

apple computer inc.



THE NBS DATA ENCRYPTION STANDARD

The National Bureau of Standards' Data Encryption Standard (DES) defines how to encrypt 64 bits of binary data. The result is 64 bits of cipher text. A 56-bit key is used for coding, and because the key is determined by the user, it is at the core of the security. To decipher data, a user would have to know the key used to encipher data. Fig. 5 shows this basic concept.

With 56 bits to define a key, there are more than 70 quadrillion different keys that can be used. This means that there are more than 70 quadrillion variations on the encryption algorithm. However, if a key is obtained by an intruder, the system loses its security.

The DES uses a series of basic cryptographic techniques in the algorithm that make up a lengthy and intricate computation. The flowchart for the enciphering computation is shown in Fig. 6.

First, the 64-bit block of data undergoes a permutation that rearranges the bits according to a specific matrix. After a series of multiple cipher operations, a 64-bit block of data undergoes a final permutation, the "inverse initial permutation," that results in the totally ciphered text of 64 bits. Between the initial permutation and the inverse initial permutation, 16 iterations take place. Each iteration is mechanically the same, but a different key value is used each time.

After the initial permutation, the 64-bit permuted block of data is split into two 32-bit halves. The right half undergoes a permutation that results in 48 bits (Fig. 7). This is because the matrix that specifies how the bits are to be arranged duplicates 16 of the bits.

These 48 bits undergo an exclusive -OR with a 48-bit key value. The key value has been obtained through encipherment on the original 56-bit key. The exclusive -OR operation results in 48 bits that are altered to result in 32 bits. This is accomplished by taking the eight sections of 6 bits each ($8 \times 6 = 48$) and making them eight sections of 4 bits each ($8 \times 4 = 32$), using a 6-bit to 4-bit selection table. The 32 bits are then permuted again to another 32-bit value.

When the right half and the key have been reduced to 32 bits, this value is exclusive -ORed to the until-now-unaltered left half. That completes the first iteration of the computation.

For the second iteration, the result just obtained becomes the right half, and the unaltered right half from the first iteration becomes the left. Then the new left and right halves are ready for the second iteration, a procedure that is repeated 16 times with a different key value used each time. Fig. 8 shows the key schedule calculation giving the 16 key values. Only one key is entered to begin the computation. The selection and protection of this key is of utmost importance in determining the security of the total system. There are three ways to protect the key. It can be made as random as possible and changed as often as possible, and a key hierarchy of two or more keys can be used. If the key is random, an intruder could not guess its value easily. If the key is changed, an intruder would have only a limited time to use it. A hierarchy of two or more keys is best illustrated by a safe within a safe. The first key is used to obtain the second key. Then the second key allows access to the data.

The Motorola MC6859 supports a two-key hierarchy. A primary key is written to the device and stored. Then a secondary key is written to the device. The secondary key can be encrypted using the DES and the primary key by writing the secondary key to a specific address in the MC6859. When the secondary key has been encrypted, that value will be used as the key for coding the data that follow. Thus, an encrypted secondary key is the key used to code or decode data.

If a key is difficult to obtain, then two keys will be twice as difficult. An intruder must know that a two-key hierarchy is being used, and he must know the values of both keys. A user should store the key values in two different locations so that both cannot be stolen at once.

The two-key hierarchy allows versatility in system design. One guard can generate and control one key, while another guard handles the second key. Systems developed with the MC6859 take advantage of this extra security capability.

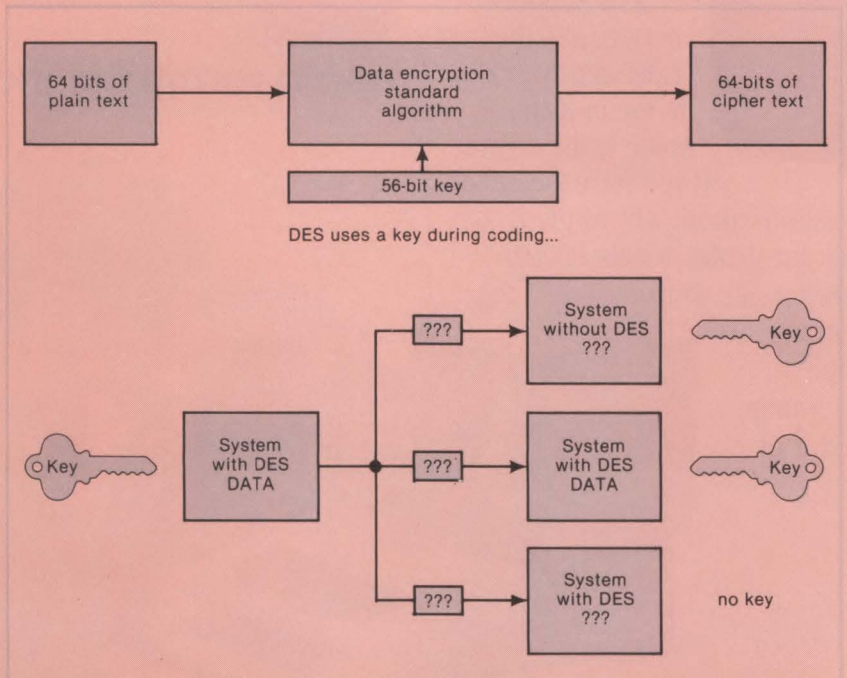


Fig. 5. The DES and the key *are required before encrypted data can be deciphered.*

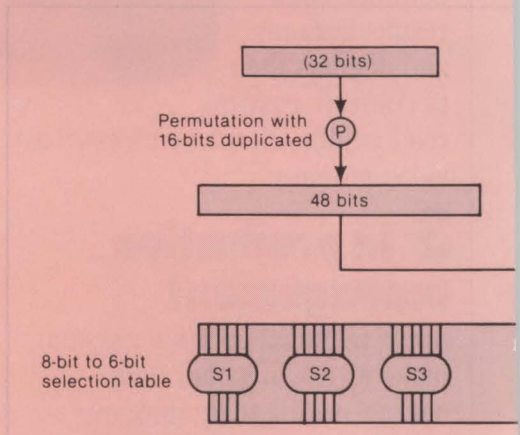


Fig. 7. One *of 16 iterations.*

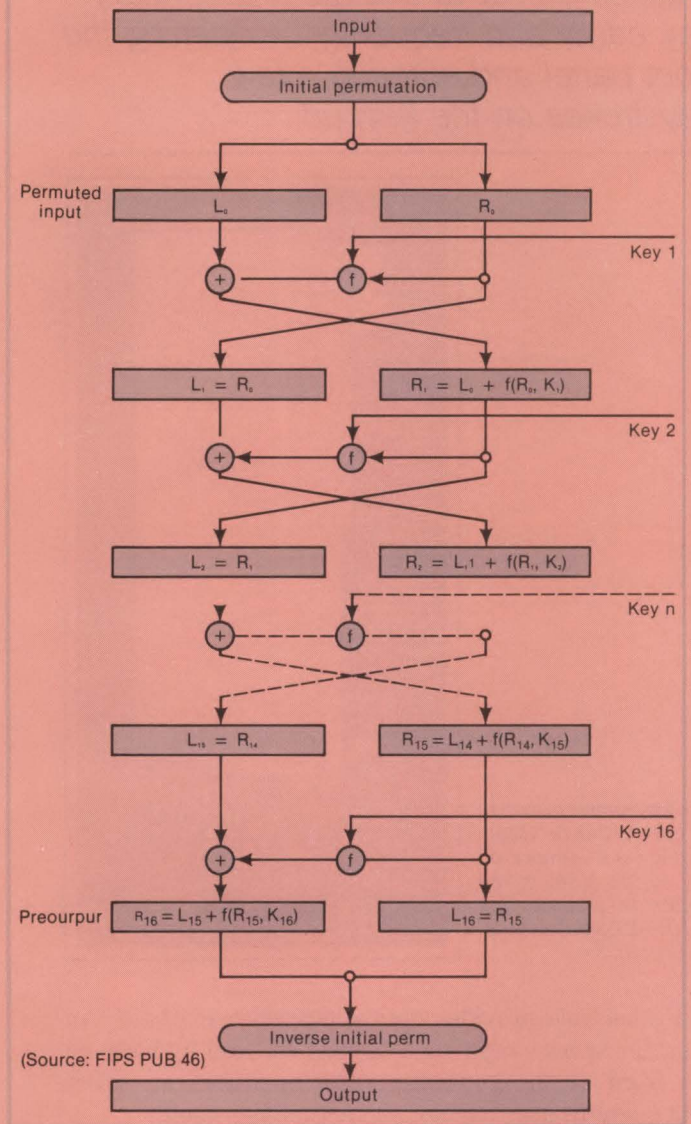
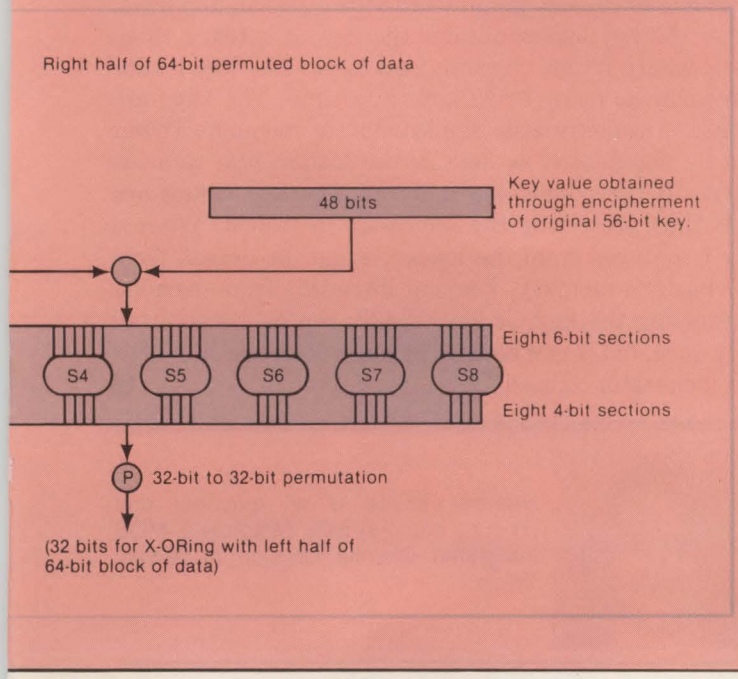


Fig. 6. Enciphering *computation. (Colored section is detailed in Fig. 7.)*



The NSM includes diagnostic routines that are invoked each time the NSM is powered up or when the test switch is pushed.

key. Following installation, a unique set of keys can be installed manually.

The NSM includes diagnostic routines that are invoked each time the NSM is powered up or when the test switch is pushed. Faulty operation is signaled by a test lamp on the back panel. Automatic secondary key generation enables a user to change a secondary key easily and frequently by opening the front panel and entering a few keystrokes on the keypad. This causes an internal random number generator in conjunction with the DES to generate a secondary key. The secondary key can be encrypted and downline-loaded to the receiving station.

Key management

Because the selection, storage and communication of the keys are the most important measures of the security of the system, a key generator and key loader are available to assure the highest level of protection. The key generator randomly generates and stores keys

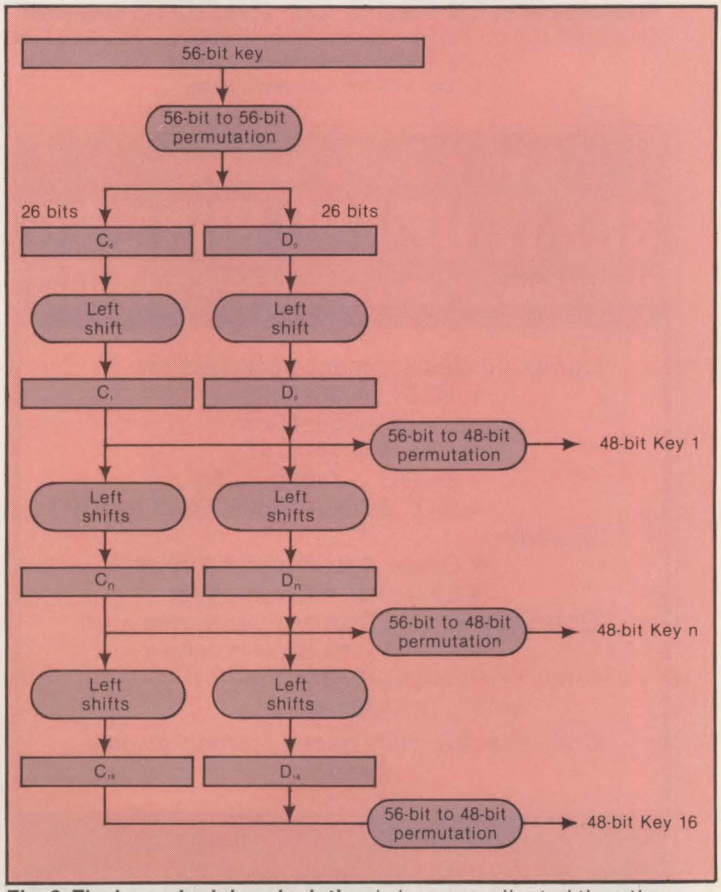
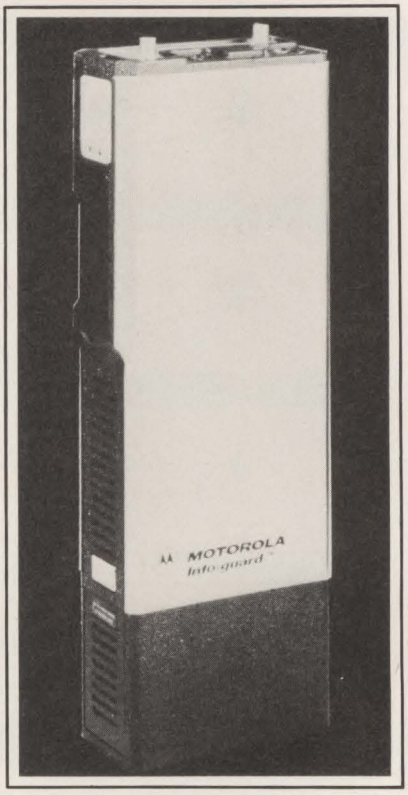


Fig. 8. The key schedule calculation *is less complicated than the enciphering computation. The 56-bit key is permuted and then split into two 26-bit halves. Each half undergoes a 1- or 2-bit left rotation, depending on the iteration. The halves are reconcatenated and undergo another permutation, this time resulting in the 48-bit halve that is used in the enciphering computation. This procedure is repeated 16 times to give a different key value for each of the 16 iterations.*

Automatic secondary key generation enables a user to change a secondary key easily and frequently by opening the front panel and entering a few keystrokes on the keypad.



The key loader *provides an optical link for transferring the generated key to the NSM in the Codex Info-Guard line of NBS-DES data security products.*

and otherwise provides optical control over them. An operator selects keys via a keypad secured by locks on the front of the generator. The operator can select which key to use, but not the actual key itself.

The key loader is connected through an optical interface to the key generator to load the random keys. After the key loader obtains the key, it is taken to an NSM, where it can transmit new keys. The key loader can carry as many as 32 keys at a time. The keys are stored in a nonvolatile semiconductor memory. Power can be maintained as long as the loader case remains intact. If the panels are removed, the key values are lost, thus protecting the key while in transit. When a key is entered from the loader, it can be erased from the loader's memory, keeping intruders from learning or stealing the key. A key usually can be transmitted only once, but it can be used at more than one site if the key generator is used. ■

Heather Bryce is an engineer and product planner with Motorola's MOS Integrated Circuits Division in Austin, Texas.

New iSBX™ Multimodule™ boards

Intel® introduces a whole new dimension in configuring single board computer systems.

Intel pioneered the concept of flexible microcomputer *system* design in 1976, with our family of iSBC™ single-board computers interfaced via the Multibus™ system bus—presently accepted as the industry standard.

Now we've extended this well-accepted concept to *board*-level design: A new generation of Multimodule boards interface to iSBCs via the new iSBX bus. So now you have a second design option. You can expand systems in large increments with Multibus boards. Or in smaller, more economical increments with Multimodules.

The key to configuration flexibility

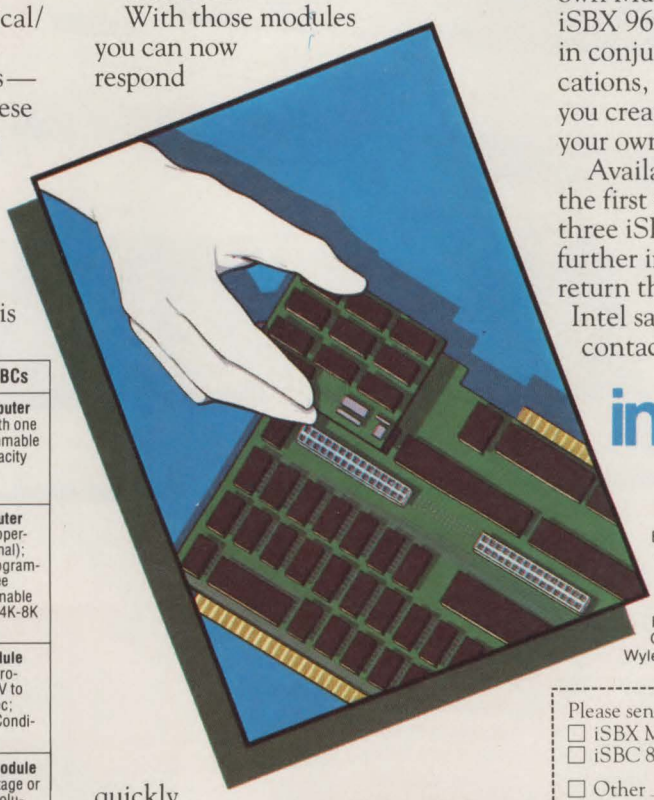
The iSBX bus—the first physical/electrical interface for direct on-board expansion of iSBC systems—assures compatibility between these systems and the emerging Multimodule product line.

Present on all future Intel single-board computers, the iSBX bus saves design time and space, and facilitates fast, easy upgrading. System performance is also improved because Multimodules tie directly to the iSBC internal bus. Connection to the iSBX bus is made with a set of rugged connectors—one on the iSBC board, the other on the Multimodule itself.

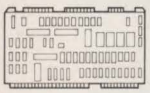
The new Multimodule family

Multimodules represent a whole new family of plug-in expansion boards. They allow you to add a variety of special performance features to your existing iSBC system. Currently available add-ons are shown below. Soon you'll also be able to add other Multimodules for IEEE 488 GPIB control, communications, peripheral interfaces—and more.

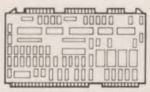
With those modules you can now respond quickly to new applications opportunities. Examples? For data acquisition from thermocouples and strain gauges, simply plug in the iSBX 311. For 4-20 ma current loop control, use the iSBX 328. In laboratory control applications, instead of an independent math processor, now you can choose the more economical iSBX 331 or 332 math modules.



New Multimodules and iSBX Bus-compatible iSBCs



iSBC 80/10B Single Board Computer
8080A-based microcomputer with one iSBX bus connector; 48 programmable I/O lines; one USART; timer; capacity for 1K-4K bytes RAM; up to 16K EPROM



iSBC 80/24 Single Board Computer
8085A-2 based microcomputer operating at 4.8 MHz (2.4 MHz optional); two iSBX bus connectors; 48 programmable I/O lines; one USART; three programmable timers; programmable interrupt controller; capacity for 4K-8K bytes RAM; up to 16K EPROM

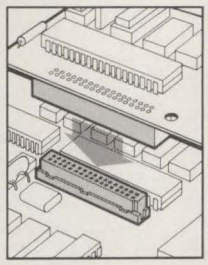
iSBX 311 Analog Input Multimodule
8 or 16 input channels, voltage protected; 12-bit resolution; ±20 mV to 5V full scale; 20 kHz samples/sec; compatible with iCS 910 Signal Conditioning Termination Panel

iSBX 328 Analog Output Multimodule
8 channels of analog output; voltage or 4-20 ma current loop; 12-bit resolution; compatible with iCS 910 Screw Termination Panel

iSBX 331 Fixed/Floating Point Math Multimodule
Fixed point single- (16-bit) and double- (32-bit) precision arithmetic; floating point single- (32-bit) precision functions; floating-to-fixed and fixed-to-floating point conversions; transcendental functions

iSBX 332 Floating Point Math Multimodule
Single- (32-bit) and double- (64-bit) precision arithmetic; compatible with proposed IEEE format and existing Intel floating point standard

Three Multimodule-compatible iSBC boards



iSBX 960-5 Connector

Intel's 8-bit iSBC 80/10B, 80/24 and 88/40 single-board computers are the first of many iSBCs to offer iSBX Multimodule expansion capabilities. The first two are improved versions of widely used iSBC boards. (See table).

Custom tailoring, too

For users who want to design their own Multimodule boards, Intel offers iSBX 960-5 connectors. When used in conjunction with the iSBX specifications, this set of connectors lets you create modular boards that meet your own unique requirements.

Available from Intel today are the first six iSBX Multimodules and three iSBX-compatible iSBCs. For further information, or to order, return this coupon or call your local Intel sales office or distributor. Or contact Intel at the address below.

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Please send information on:
☐ iSBX Multimodules ☐ iSBC 80/10B
☐ iSBC 80/24 ☐ Configuration Guide
☐ Other _____
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You needn't stop there. You can change keys, key functions, even keyboard locations. And the 950's microprocessor based design means you can customize the firmware for your system.

Of course the 950 has premium TeleVideo performance—advanced editing with wraparound, split screen with line lock, and smooth scrolling. It also features a 25th status line, speeds to a true 19.2 kilobaud, and 15 special characters for powerful line graphics.

Contact TeleVideo for a detailed brochure, or call today to discuss how you can use these capabilities to make this terminal uniquely yours. TeleVideo, Incorporated, 2149 Paragon Drive, San Jose, CA 95131. (408) 946-8500.

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SEE US AT INTERFACE. BOOTH 1020

CIRCLE NO. 68 ON INQUIRY CARD

A data management system for minicomputers

HARVEY M. WEISS, Weiss & Associates

Database Systems Corp.'s TAGS can eliminate programmer overhead, maintenance problems and system development delays and errors

Good-bye, application programmer; hello, user! A software system is available that can eliminate programmer overhead, system development delays, system development errors and the problems associated with maintenance. TAGS, for total automatic generating system, is an exciting, relatively new data management system written for users of Prime Computer, Inc., hardware. It was developed by Database Systems Corp., Phoenix, and is an example of a capability that has been needed to increase the productivity of system developers.

TAGS is user-friendly. In a session shorter than two hours, the author designed, developed and implemented a system. No application code was written or required, which, in itself, makes this package justifiable.

Developed to run under Prime's Primos operating system, TAGS provides computer users with a tool to "get the job done." Users can design a system, except for those processes requiring complex calculation code, without the aid of a data-processing professional.

Screen, transaction and report design are all performed under the control of the system components. Installation and maintenance of TAGS appear to be simple, and vendor support gets good ratings from customers.

The system's main shortcomings are its lack of a dictionary, security below the field level, automatic generation of additional indexes and automatic recovery/restart processes. But, of a possible 400 points, we give TAGS a rating of 312, which is excellent in that many of those facilities, such as a DBMS simulation facility, are not a concern. At a price of approximately $45,000 for all components, this product provides

```
*CREATE

DO YOU WANT RESPONSES SAVED IN PROC? YES
ENTER PROCEDURE NAME: S2PROC
ENTER PROCEDURE DESCRIPTION: Procedure File for PROP. LIST

ENTER DIRECTORY (UFD) NAME   : ELIOT
ENTER DIRECTORY PASSWORD     : (CR) (Hit carriage return)
ENTER FILE NAME              : PROP. LIST
ENTER FILE DESCRIPTION       : Real Estate Listings for MASS.
ENTER FILE PASSWORDS         : (CR) (Hit carriage return)

DOES FILE ALREADY EXIST? NO

DO YOU WANT MINIMUM OPTIONS? YES

DO YOU WANT TEXT WITH EACH RECORD? YES

**ENTER SEARCH DESCRIPTORS**

ENTER DESCRIPTOR NAME        : TOWN
ENTER LENGTH IN CHARACTERS   : 20 (32 chars. max.)

ENTER DESCRIPTOR NAME        : BEDRMS
ENTER LENGTH IN CHARACTERS   : NUM4

ENTER DESCRIPTOR NAME        : BATHS
ENTER LENGTH IN CHARACTERS   : NUM5
ENTER NUMERIC PICTURE        : 9V9

ENTER DESCRIPTOR NAME        : GARAGE
ENTER LENGTH IN CHARACTERS   : 6

ENTER DESCRIPTOR NAME        : PRICE
ENTER LENGTH IN CHARACTERS   : NUM1

ENTER DESCRIPTOR NAME        : TAXES
ENTER LENGTH IN CHARACTERS   : NUM1

ENTER DESCRIPTOR NAME        : TAXRATE
ENTER LENGTH IN CHARACTERS   : NUM1

ENTER DESCRIPTOR NAME        : $END

**ENTER DISPLAY DESCRIPTORS**

ENTER DESCRIPTOR NAME        : VALUATION
ENTER LENGTH IN CHARACTERS   : NUM1

ENTER DESCRIPTOR NAME        : STREET
ENTER LENGTH IN CHARACTERS   : 25
```

Fig. 1. A portion *of the create function within POWER that is used to build a file.*

This series of reports is intended to provide sufficient knowledge about DBMS to allow potential users to determine if they should consider adopting it. A technical overview is provided along with a subjective evaluation of the product. The evaluation is the result of an analysis of the data received from the company and interviews with users. Some of the material here was extracted from the company's documentation with company approval.

TAGS—for total automatic generating system—is a relatively new data management system written for users of Prime hardware. It is an example of a capability that has been needed to increase the productivity of system developers.

capabilities not expected for some time from large-scale system suppliers.

What tags is

TAGS, a data management system designed for and implemented on all Prime Computer models 350 through 750, interfaces with the Primos operating system. TAGS incorporates all utilities implemented under Primos, requires 128K bytes of main memory to run and is stored in 2K-byte records on disk for a

EXPLAINING THE EVALUATION MATRIX

The evaluation matrix is the chief tool used in evaluating TAGS. In a competitive evaluation, the matrix would list the criteria used, the vendors being considered and the ratings each vendor receives. (Not all criteria are used each time.) The first step is to establish an importance weight factor for each criterion. This factor establishes the relative importance of a feature or capability of the DBMS in meeting system requirements. A scale of 1 to 10 is used. The vendor's software is then rated, again on a scale of 1 to 10, according to its ability to meet that criterion, establishing the vendor's requirement score. Multiplying the importance weight factor by the vendor's requirement score produces an effective score for the vendor for that criterion.

For example, if one of the selection criteria, a data base loader (software), is extremely important, it could be assigned a weight of 10. If vendor #1 does not provide such a feature, its ability to meet this criteria might be 1. The resulting effective score for this criterion for this vendor is 10 (1 × 10 = 10). However, vendor #2 might provide such a product, receiving a rating of 10. That vendor's effective score would then be 100.

Once all criteria used in the selection process have been weighted, and all vendors' responses have been given a rating, their effective score can be calculated.

The criteria listed in the matrix comprise a standard list that could be used to define system requirements for a data base. Details of their meaning can be found in any document describing DBMS capabilities, or are available from Weiss & Associates.

The evaluation matrix is used only to establish a rating for TAGS and its ability to meet all the criteria as if all had an importance weight of 10. If a criterion receives a score greater than 7, it indicates that TAGS could effectively meet that system requirement. A score of 4 to 6 indicates it is marginally satisfied, and a score lower than 3 is unsatisfactory.

EVALUATION MATRIX VENDOR RATING: TAGS

SELECTION CRITERIA	VENDOR SCORE
1 Data Manipulation Capabilities:	
1.1 Data Manipulation Processes	8
1.2 Privacy, Security Techniques Used	8
1.3 Error Recovery Procedures Employed	6
1.4 Data Integrity Controls	9
1.5 Format Modifications Ability	8
1.6 Redundancy/Consolidation Controls	8
1.7 File Growth	8
Possible: 70	55
2 Query Capabilities:	
2.1 Availability of Feature	10
2.2 Ease of Use of Feature	10
2.3 Capability of Feature	10
Possible: 30	30
3 Application Programming Complexities:	
3.1 Program/Data Independence Levels	10
3.2 Methods Used to Define Manipulation and Retrieval Operations	8
3.3 Subsystem View Development	8
3.4 Data Base Schema Description Process	6
3.5 Programmer Skill Required	10
Possible: 50	42
4 Physical File Design:	
4.1 Physical File Organization(s) Used	8
4.2 Record Types Supported	7
4.3 Record Change Capability	8
4.4 Ability to Combine Records	8
4.5 File Space Management Method Used	5
4.6 Indexing Methods Used	8
4.7 Logical Record Definition Process	10
4.8 Logical Structures Used	6
Possible: 80	60
5 Datacomm Interface Capability:	10
Possible: 10	10
6 System Installation:	
6.1 Physical File Distributing Control	10
6.2 Data Base Loading Facility Available	10
6.3 Hardware Configuration Requirements for DBMS	10
Possible: 30	30
7 DBMS Utilities:	
7.1 Performance Statistics Gathering	2
7.2 Minimum Reorganization	6
7.3 Simulation Facility	1
7.4 Data Dictionary Facility	1
Possible: 40	10
8 Secondary Features:	
8.1 System Performance	8
8.2 DBMS Maintenance Policy	9
8.3 Systems Design and Development Time	10
8.4 System Designer Training Time	10
8.5 Ease of Installation of DBMS	9
8.6 Documentation Available	7
8.7 Vendor Support Provided	8
8.8 Vendor Responsiveness to Hardware/Software Changes	6
8.9 Customer Experience	8
Possible: 90	75
Total Possible: 400 TAGS: 312	

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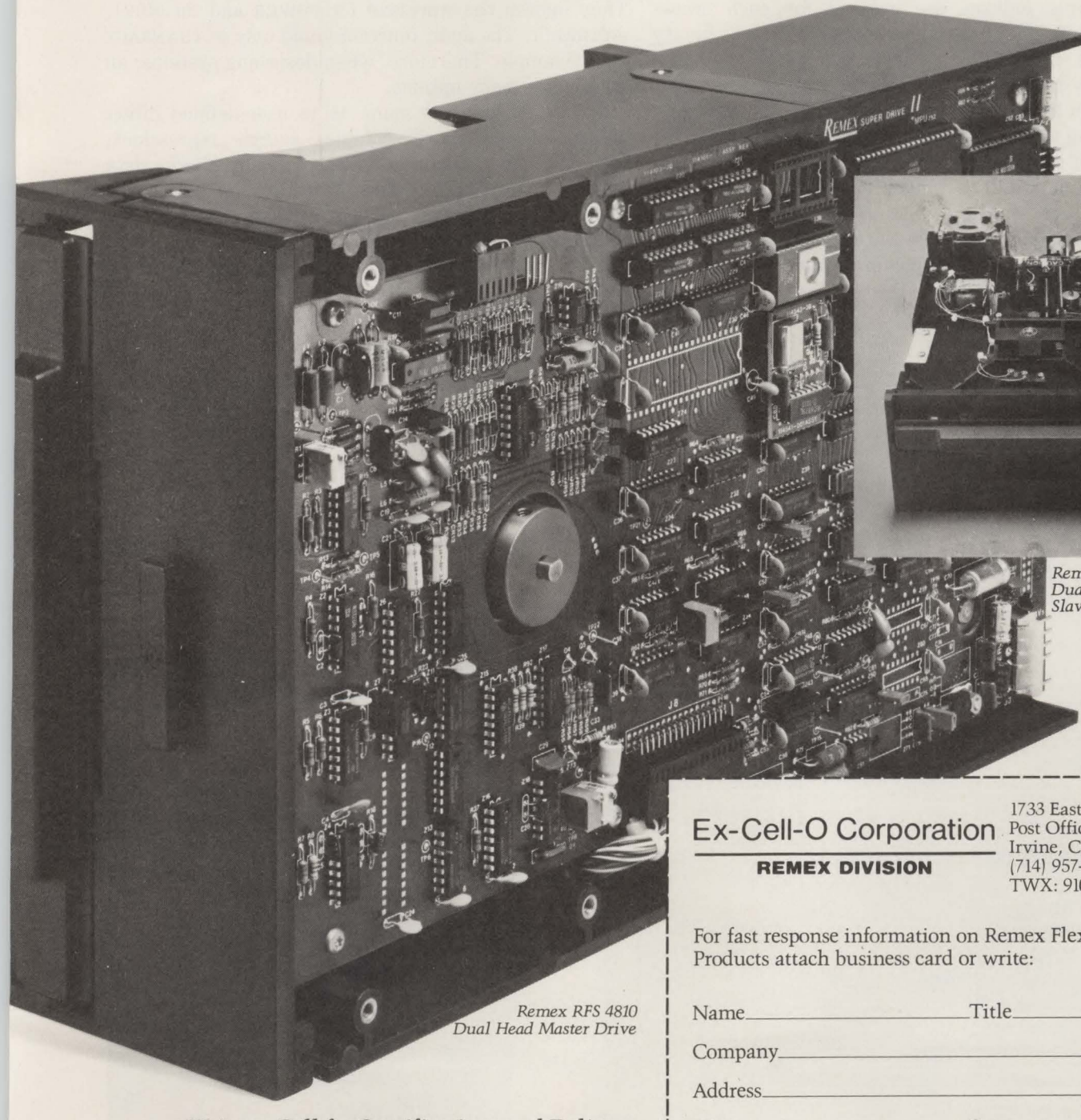

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TAGS's shortcomings are its lack of a dictionary, security below the field level, automatic generation of additional indexes and automatic recovery/restart processes. But its rating is excellent.

total of 6K bytes. The system supports both on-line and batch-processing modes.

TAGS provides fast access to data in a variety of ways. It incorporates Prime's Midas file-access technology. This technology supports the partially inverted index technique in which data is stored sequentially and multiple indexes are created for each access requirement. The system also supports Prime's binary sequential, binary direct access and ASCII sequential file access methods. Files created outside the TAGS system can be made compatible without the unloading and loading that usually accompany file conversion.

The self-contained system has its own language, almost eliminating the need for programming language. A set of design commands provides all the programming language necessary to develop a system, and processing commands generate the code to input, process and produce system outputs. A system can also incorporate codes written in COBOL, FORTRAN and PL/1.

Structurally, TAGS consists of three components. These include POWER, which provides the tools for data organization and management; ENTRY, which offers a key-to-disk replacement, providing high-speed data entry; and TRANSACT, which creates screens, establishes edit and validation requirements and defines processing transactions used by POWER in its data-manipulation operations.

System components

The components of TAGS overlap. TRANSACT and ENTRY can perform the same processes as POWER. They lighten the workload for POWER and, in effect, enhance it. The audit function found only in TRANSACT is an example. Therefore, when designing systems, an author has many options.

POWER includes as many as 18 user-defined direct access keys; supports complex search expressions, including range evaluation; automatically checks data type and length; interfaces with foreign files; and provides text processing and editing, dynamic file linking and report design and presentation.

With POWER, a file with as many as 512 fields can be

DATA BASE FILE DEFINITION

Enter Function: __

1—Quit
2—Define New File
3—Change Existing File
4—Delete File
5—Display All Files
6—Print All Files
7—Display A File
8—Print A File

File Reference Name: _____

POWER or FACTS File Name: _____ POWER, FACTS or REFORMAT __ (P) (F) (R)

File Password: _____

File Treename: _____

File Type: __ M—Midas A—ASCII B—Binary

File Record Length: _____ (in words)

POWER or FACTS Minimum Options __ (P) (F)

Create New File _____ (YES or NO)

DATA BASE FIELD DEFINITION

Function— __

1—Quit
2—Add
3—Change
4—Delete

Field Name— _____

Record Position—_____

Field Data Type— __

1—Character
2—Real*8
3—Real
4—Integer (Comp)
5—Integer*4
6—Decimal
7—Packed Decimal

Character Length—_____ (CHAR TYPE ONLY)

Decimal Picture

_____

Midas Index— __

Sign— __ 1—Leading Separate 2—Trailing Separate 3—Leading 4—Trailing (Default)

Figs. 2, 3. An example *of how TRANSACT simplifies the definition of files and their fields.*

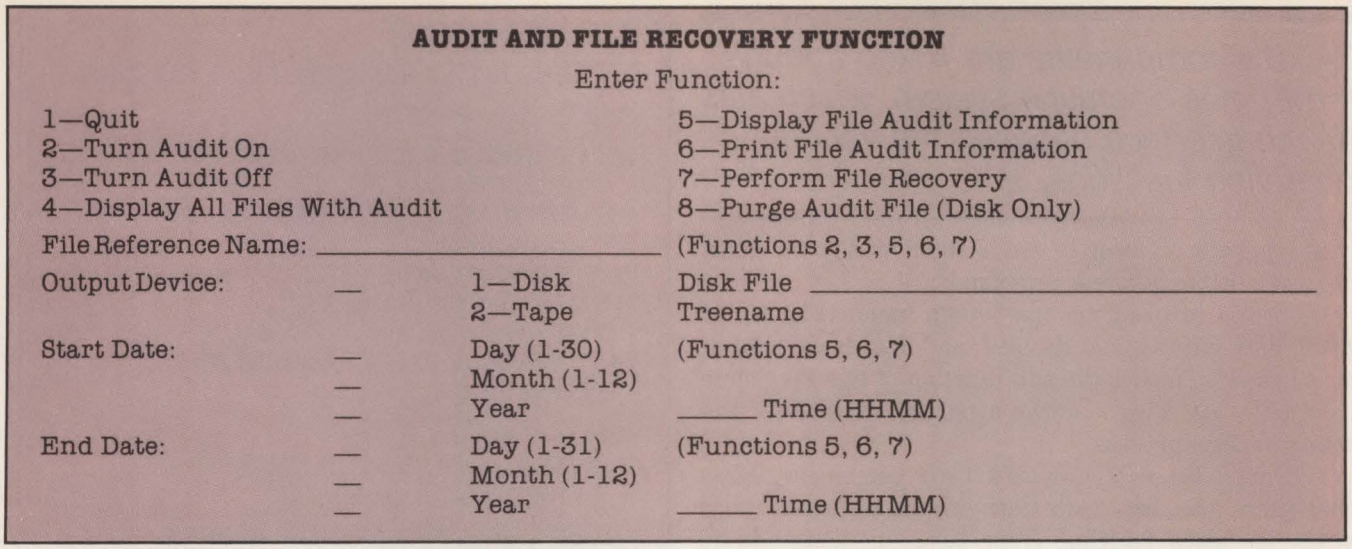


Fig. 4. The audit function, *which is a powerful feature of the TAGS systems.*

created. As many as 18 search descriptors, or fields, can be as long as 32 characters. Data entered through POWER can be processed on-line, in batch-mode or interactively with a screen format.

Users can define ad hoc or heuristic searches to select one, some or all of a set of data. Displays can be defined for terminals or the printer, using a forms and reports function, which enables a user to "paint" the desired display or report in an interactive session. The ability to store the result of this session as a transaction is optional.

The second TAGS component, TRANSACT, enhances POWER's I/O functions by providing an interactive session for the definition of system transactions and the screens and reports associated with these transactions. With TRANSACT, a user can design screen menus and develop transaction processes, thus automatically generating the parameters required by POWER. TRANSACT passes the parameters to POWER, which then develops the code for processing the data.

The third component, ENTRY, can be used as the data-entry vehicle in high-volume data entry. Fields can define the basic functions of editing and validating, and batch balancing functions and error correction can be performed.

TAGS's components are linked together through the Primos operating system, which acts as an interface between the operating functions. TAGS provides users with a powerful tool to accomplish data management tasks easily, effectively and at a price affordable to almost any organization.

Using the data management system

Fig. 1 shows a portion of POWER's create function that is used to build a file. As each file description is created, it is stored in a directory. Security, user IDs, etc., are also stored in the directory. TRANSACT also can be used to perform this function by passing the data it receives from the user to POWER. Figs. 2 and 3 show how TRANSACT defines files and fields.

The method of establishing controls and audits is important to all systems. TRANSACT's audit function

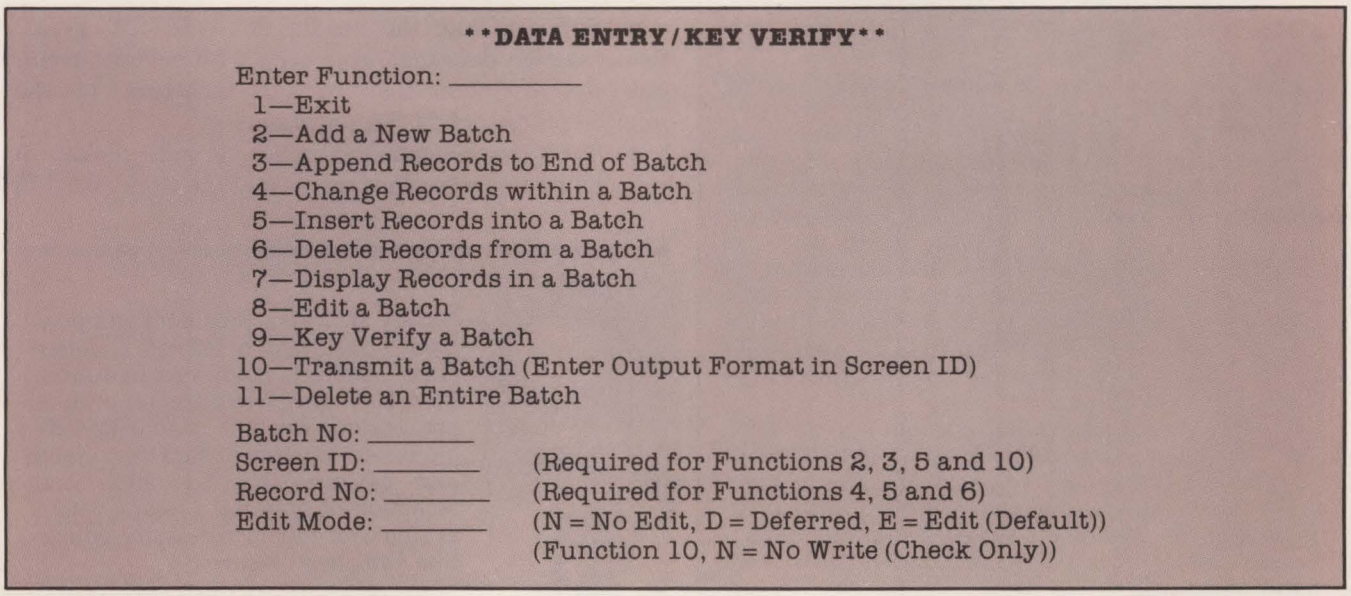


Fig. 5. If ENTRY is used, *it is invoked via this screen menu.*

TAGS's components are linked through the Primos operating system, which acts as the interface between the various operating functions.

(Fig. 4) enables a user to establish or modify the audit process with only a few commands.

ENTRY is invoked via the screen menu (Fig. 5). If batch data entry is not desired, and data is entered in an interactive mode, the add function of POWER can be used (Fig. 6). Fig. 7 shows a partial example of the report-design process.

A partial list of Database's TAGS customers shows that users are large-scale data-processing applications with file sizes ranging from tens of thousands to hundreds of thousands of records. Customer comments include:

- "The system tripled development productivity."
- "The software is sound. All errors are ours."
- "We felt documentation is not totally user-oriented, causing us to require application programmers to develop systems."
- "If the documentation was less data-processing-oriented, we would not need a DP-type to run the shop."
- "Except for some very technical code requirements, TAGS gives us all we need."
- "ENTRY and FORMS eliminate the programmer's job."
- "Support from the vendor has been just great. Some system degradation is seen with several users, but we attribute that to the structure of the minicomputer, not to the software."
- "TAGS has eliminated much of the delay in responding to users. They do most of the work now." ■

```
*ADD
     **ENTER RECORD INFORMATION**
TOWN                 : ASHLAND
BEDROOMS             : 4
BATHS                : 1.5
GARAGE               : 1 CAR
PRICE                : 70000
TAXES                : (CR)
TAXRATE              : .09
VALUATION            : 1.00
STREET               : OAK DRIVE
SETTING              : RESIDENTIAL
HOUSETYPE            : RANCH
          **ENTER TEXT**
     # NICE (WOODED) AREA
       # (HIGH TAXES)
          # $END
        KEYWORDS**
```

Fig. 6. A partial example *of POWER's add function.*

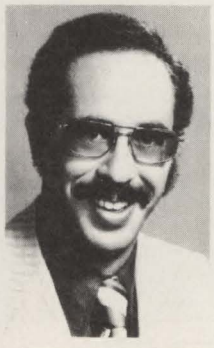
```
* REPORT CREATE
     REPORT GENERATOR FOR PROP. LIST
CREATING REPORT01
ENTER REPORT DESCRIPTION: REPORT FOR
  PROP. LIST
ENTER NUMBER OF LINES PER PAGE: 20
NUMBER OF SKIP LINES: 2
NUMBER OF LINES IN TITLE: 2
NUMBER OF SKIP LINES: 2
DO YOU WANT A TITLE ON EACH PAGE? YES
DO YOU WANT PAGE NUMBER AT TOP OF
  PAGE? YES
ENTER TITLE LINES
# @TAX RATES FOR REAL ESTATE
# @LISTINGS AS OF $DATE
NUMBER OF LINES IN HEADING: 2
NUMBER OF SKIP LINES: 2
ENTER HEADING INFORMATION
LINE 1
COLUMN POSITION: 5
HEADING VALUE: NAME OF TOWN
COLUMN POSITION: 20
HEADING VALUE: PRICE
```

Fig. 7. A partial example *of TAGS's report-design process.*

DATABASE SYSTEMS: A COMPANY OVERVIEW

Several ex-employees of Prime Computer started Database Systems Corp. in August, 1978. The company's initial product was POWER, now the main component of TAGS. POWER's success resulted in a contract between Database Systems Corp. and Prime that gave Prime marketing rights to the product. POWER can now be obtained from either source, along with the components TRANSACT and ENTRY, which complete the system package. If the product is purchased—it can't be leased—from Database Systems Corp., system upgrades, support service and two days of training are provided. Support for the product is also provided if it is obtained from Prime.

Database Systems provides consultation services, data-processing services and timesharing services, or will develop a turnkey system, as desired by a customer. The number of TAGS customers has been difficult to ascertain because Prime also sells the product; Database Systems claims to have sold the system to more than a dozen users.



Harvey M. Weiss, president and principal consultant of Weiss & Associates, Denver, Colo., has had more than 20 years of experience in data processing. His firm's activities include development of data base plans and designs and evaluation and selection of data base management systems for clients in industry, education and government.

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SYSTEM INTEGRATION

Requirements for high-performance microcomputers

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

Processor architecture and system flexibility make 16-bit units attractive for scientific data-processing applications

The first article in this series (MMS, November, 1980, p. 81) discussed the trend toward more complex and higher-performance μc systems. This article examines the general requirements for higher-performance systems. A future article will describe the capabilities of such systems in Motorola's VERSAmodule line of board-level products.

Today's popular 8-bit μcs are used primarily in low-end control and automation applications, and in general-business information processing. Their limited I/O capacity locks them out of sophisticated machine-control applications, their restricted arithmetic capabilities exclude them from scientific data processing, and their relatively low memory-address capacity keeps them out of complex fields, including "artificial intelligence."

Advanced 16- and 32-bit processors overcome these limitations. Fig. 1 lists applications for higher-performance μc systems.

APPLICATIONS MATRIX
8-, 16- AND 32-BIT μc SYSTEMS

APPLICATION SEGMENT	8-BIT	16-BIT	32-BIT
INDUSTRIAL AUTOMATION			
Continuous process control	X	X	
Machine control	X	X	
Automated testing and inspection		X	X
Material handling		X	
Energy management	X		
Supervisory control		X	X
Data collection	X	X	
LAB AUTOMATION			
Medical	X	X	
Scientific		X	
Quality control	X	X	
Design automation		X	X
BUSINESS INFORMATION PROCESSING			
Financial systems		X	X
Data base management		X	X
Intelligent terminals	X	X	
Management information systems		X	X
COMMUNICATIONS			
Message switching	X	X	
Network Supervision		X	

Fig. 1. Table shows the relative *suitability of 8-, 16- and 32-bit μc systems to various categories of applications. As the price/performance ratio improves, the higher-performance 16- and 32-bit systems find broader applications.*

Performance factors

The performance of μcs depends on processor architecture and system flexibility. Processor architecture determines the system's throughput, which depends on the width of the data stream, the memory addressing range and the processor's ability to handle high-level languages efficiently. System flexibility depends not only on the processor, but also on the design of the system to handle sophisticated multiprocessor systems, which is a function of the system bus design, as well.

In the processor architecture, an expansion of the data stream from 8 to 16 bits doubles the amount of data that can be transmitted during one cycle of operation. Sixteen-bit processors are available from many manufacturers; Motorola's MC68000 has internal data registers that are 32 bits wide, making internal operating speed even greater than that of other 16-bit designs.

Increased data width is only a small part of the improved architecture that accompanies 16-bit designs. VLSI technology permits more than 100,000 transistor equivalents to be processed on a silicon chip. The added

A strong impetus exists for the adoption of a standard bus structure that will accommodate all system requirements for the forseeable future.

circuit complexity this allows in 16-bit processors supports speed-enhancing asynchronous bus operation (compared with synchronous bus operation in conventional 8-bit machines), and implements efficient use of high-level languages, which greatly facilitate user program development.

In memory addressing, 16-bit processors handle address values as long as 24 bits, compared with an address range of 16 bits for 8-bit machines. This restricted direct-addressing range of 8-bit processors becomes a serious limitation because demanding applications often require the loading of large blocks of data into high-speed memories.

Processors with a limited direct-addressing range are not excluded from operating in a large-memory environment. However, they require the addition of complex memory-management circuitry, which not only increases cost, but also significantly reduces overall speed.

When the performance of μps is meshed with the requirements of sophisticated μc applications, a menu of desirable design features emerges. Multiprocessor system architecture and a high-performance system interconnect bus are among the more important. Others include an interface with intelligent peripheral controller modules, a large amount of RAM and a "private bus" on each processor board.

Multiprocessor system architecture

A high-performance multiprocessor system is a collection of two or more μc boards sharing the processing load and communicating through an interconnect bus. The μcs would not necessarily have to exhibit similar processing capabilities, but each would have to be capable of assignment as a "bus master." Fig. 2 shows a simplified representation of such a multiprocessor system, containing two primary μc boards, an intelligent peripheral board and an expansion RAM board.

Multiprocessor architecture should include:

- **Mixed technologies on the bus.** In anticipation of 32-bit technology, higher-performance μp systems should allow processors of 8-, 16- and 32-bit capabilities to operate and interact efficiently. This means that a system bus must not only support sufficient address, data and control lines to accommodate as many as 32 bits, but must also indicate, with each bus transaction, the size of the address or data element being transmitted.
- **Semaphores and resource use.** A semaphore is a resource status byte used in μp systems whose resources, such as an I/O device or a block of memory, can be shared by various processors. The operating system software sets the semaphore non-zero when the associated resource element is in use, and sets it zero when the resource again becomes available.

A problem can arise in interrupt-driven systems if

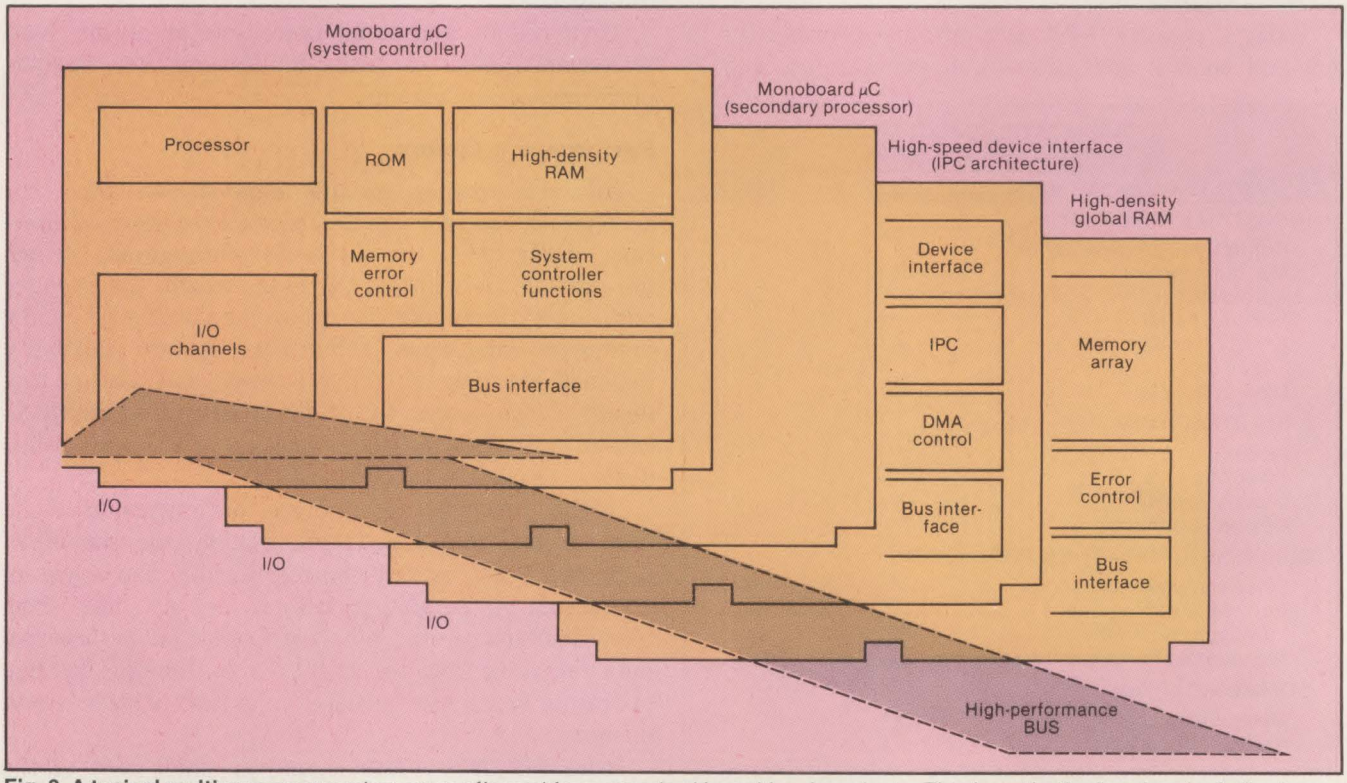

Fig. 2. A typical multiprocessor *system as configured from standard board-level products. This hypothetical system includes two μc boards, 128K bytes of "global" RAM on the system bus, 128K bytes of "private" RAM divided between the μc boards, and an intelligent interface to a high-speed hard disk. Such a configuration could be used for scientific data processing, with data base management and four user video terminals.*

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The performance of μcs depends on processor architecture and system flexibility.

the software inspecting the semaphore is interrupted after testing a zero-value semaphore—but before setting it non-zero—and if the interrupting routine also checks the same semaphore. The system solution to this potential conflict requires a processor instruction for test-and-set that requires two memory accesses back-to-back—one for read and one for write—and a system bus protocol that executes the test-and-set operation in a bus cycle.

- **System controller functions and protocols.** A system controller distributes use of the system bus on a priority basis and enables quick intercommunications between processors in response to asynchronous system events. The system controller is a μp function assigned to manage those bus lines involved with bus request, grant, busy and clear, and with the interrupt-request and interrupt-acknowledge sequence.

A versatile system bus structure is the key to implementing a flexible, high-performance multiprocessor system.

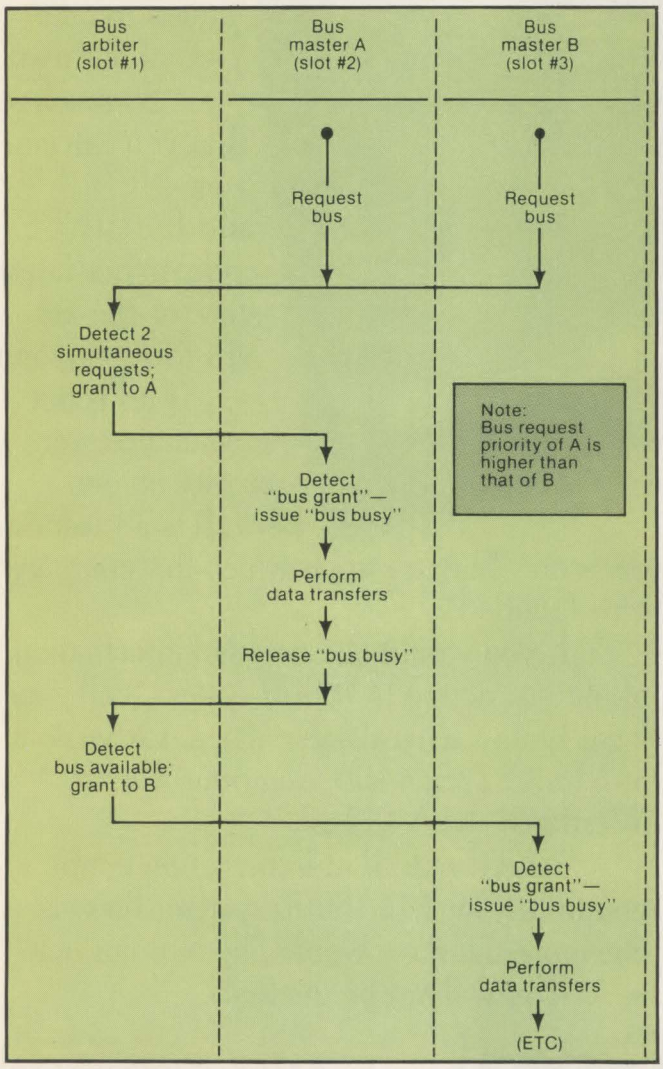

Fig. 3. Bus arbitration flowchart *shows how priorities are resolved when there are two simultaneous bus use requests by bus masters with different priorities.*

Requirements for high-performance system bus

A customized system bus may be designed to accommodate the requirements of a complex dedicated system. But a strong impetus exists for the adoption of a standard bus structure that will accommodate all system requirements for the foreseeable future. Such a bus would handle 32-bit processors and permit interaction of any number of processors and peripherals in a system. The characteristics of such a bus include:

- **High-speed capabilities.** Bus speed is measured in bytes per sec. or data-transmission rates supported by the bus. The speed of the buffer devices that drive the bus lines, and the electrical capacitance and length of the physical bus structure limit bus speed.

A state-of-the-art bus supports 2 million to 3 million transactions per sec. Buses now being designed ultimately should support 5-MHz to 10-MHz transfer rates as suitable bus driver devices become available. Those rates are equivalent to 20M to 40M bytes per sec. because as many as 4 bytes (32 bits) of data can be transferred in parallel within the new bus structures.

- **Direct memory-addressing capabilities.** Some estimates of direct-memory-addressing range requirements can be made based on the requirements for such higher-performance applications as timesharing and artificial intelligence. To support a timesharing environment with eight to 16 users, each with a dedicated user area in RAM of 64K to 256K bytes, a total requirement of 4M bytes or more represents a conservative minimum. Many artificial-intelligence applications require even more. Sophisticated pattern-recognition problems demand large data arrays representing time samples of some visual or aural event, through which endless correlations must be calculated. All the data ideally should be in RAM at one time to facilitate a time-efficient process, and such sampled data fields can run as high as 10M bytes. Yet even 4M bytes require a 22-bit minimum address field—6 bits greater than the 16-bit standard of 8-bit systems. To support more complex applications, a standard of 24 bits (3 bytes) is recommended. This constitutes a direct-addressing range of more than 16M bytes.

- **Asynchronous control.** Typical 8-bit processors are designed for synchronous data transfer; that is, each communication between sender and receiver on the bus is accomplished within a fixed amount of time, regardless of the equipment's speed capabilities. In advanced μc applications, devices with different speed characteristics can coexist within a single system. For instance, a hard disk transfers data much faster than a floppy disk or an asynchronous serial communications channel. If a system is synchronous, communications are limited to a rate compatible with the slowest link in the system.

An asynchronous system enables any two devices on the bus to communicate at the highest rate consistent with the capabilities of the two devices. It does so

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Multiprocessor bus architecture allows addition or deletion of major system elements without greatly disturbing other system elements.

through control signals that enable the receiver to acknowledge that it has received the last data transmitted before the sender makes more data available for transfer. This handshake method of communications demands more communication lines on the bus, but that is a small price to pay when compared with the greatly increased throughput capacity.

• **Interrupt handling.** A high-performance μc system bus must support multiple intelligent bus masters distributed along the bus, and a mechanism must be available to allow interrupt signaling among the masters. For example, one master station in the system may wish to interrupt the routine of another master to cause it to change its program sequence.

This feature is best implemented by incorporating five to 10 interrupt lines in the bus, with an interrupt-priority level assigned to each. Another mechanism must control an interrupt-acknowledgement sequence and pass an interrupt-vector number along the system bus from the interrupting device to the responding processor. The vector number designates which of the processor's interrupt-response routines should be executed in response to the current interrupt. The bus interrupt and acknowledgement protocol must allow rapid switching of routines by the interrupted master, with minimum impact on other activities on the system bus.

• **Bus-arbitration control.** In a high-performance system, the bus must support multiple bus masters, or intelligent nodes, that can request control of the system bus to perform data transmission. Bus masters usually can generate a bus request, acknowledge the granting of the "bus mastership" and take control of the system bus, manage asynchronous data transfer on the bus and monitor requests from the system controller to terminate activities on the bus when a higher-priority bus master is waiting to use the bus.

In a system with multiple bus masters, each master has access to the bus only under a priority scheme. Data transfer rates between a hard-disk controller and its global buffer memory normally would be greater than those of a serial terminal controller. As a result, the bus-request priority of a hard-disk controller would

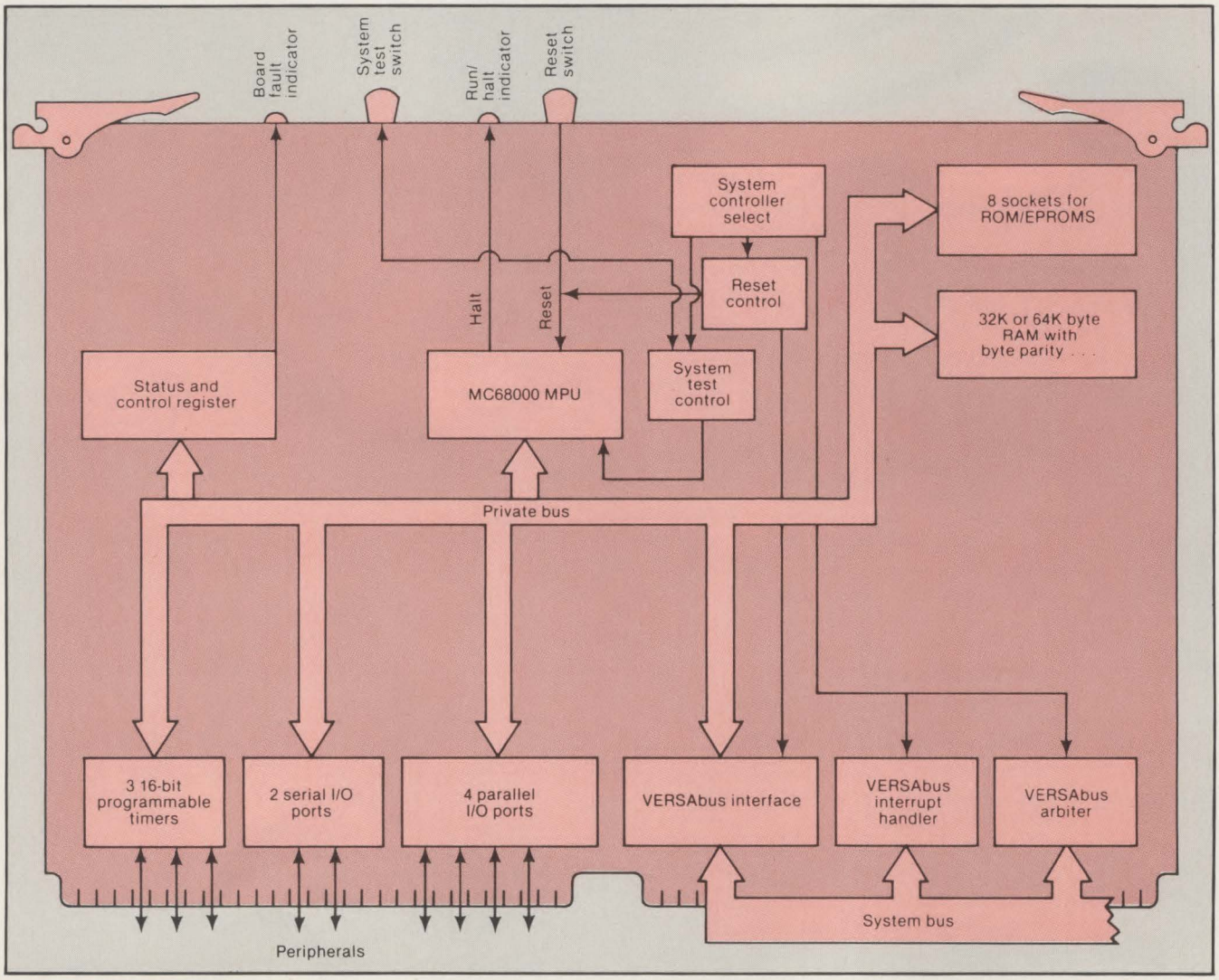

Fig. 4. Monoboard μc block diagram *shows the private bus, internal to the board, interconnecting the major processor, memory and I/O.*

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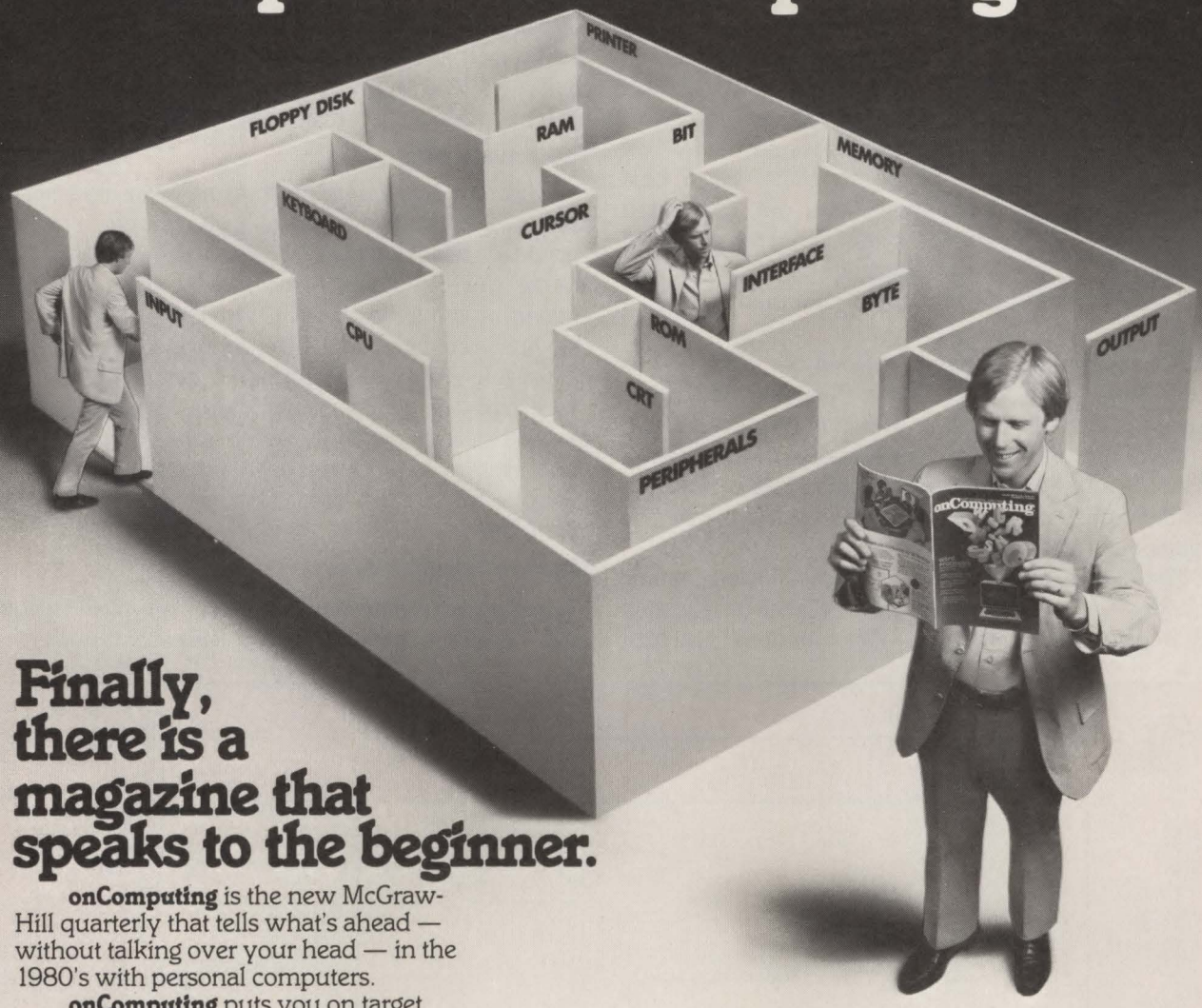

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EDAC functionally provides both single- and double-bit error detection, plus single-bit error correction.

be higher than that of a terminal controller. Thus, a high-performance bus must manage multiple priority levels of bus requests from the various bus-master devices (Fig. 3). This typically should be implemented with multiple bus-request lines, each at a different priority level. As in the case of the bus-interrupt request lines, about five to 10 bus-request lines are needed to handle advanced μc systems. Each bus-request line must be paired with an associated bus-grant line by which the system controller, which processes the bus-request activity, will notify the requesting bus master that it can now take control of the bus.

- **Bit-expansion capacity.** Today's system bus should have the "hooks" and "handles" to allow expansion to 32-bit architecture. This includes providing for 32 bits of data and 32 bits of non-multiplexed address. A user can save significant system redesign costs if he does not have to adopt a new bus when he expands his system to 32 bits.
- **Mixed technologies.** A bus should allow 8-, 16- and 32-bit processors to coexist because each will have a place in processor and I/O controller functions that must intercommunicate in the system. This means that control lines are provided that indicate whether an address being transmitted is 16, 24 or 32 bits, and whether data is 8, 16, 24 or 32 bits wide.
- **Modular system expansion.** Multiprocessor bus architecture allows addition or deletion of major system elements without greatly disturbing other system elements. For example, if system performance requirements increase over time, another processor board could be added to the bus to share the processing load with existing system processing elements.

The private bus

A system bus interconnects major processing elements, specifically boards, in a system just as a "private" bus provides an intercommunication path among the components—processor, memory and I/O elements—on a board (Fig. 4). "Private" implies that this bus is seldom coupled to the principal system bus. The result is a great performance benefit—intra-board processing can continue, while other system activities proceed independently between other stations on the main system bus. Overlapped processing can have a positive impact on total system performance and throughput.

Memory requirements

Higher-performance μc applications typically require modular RAM expansion boards. Memory requirements

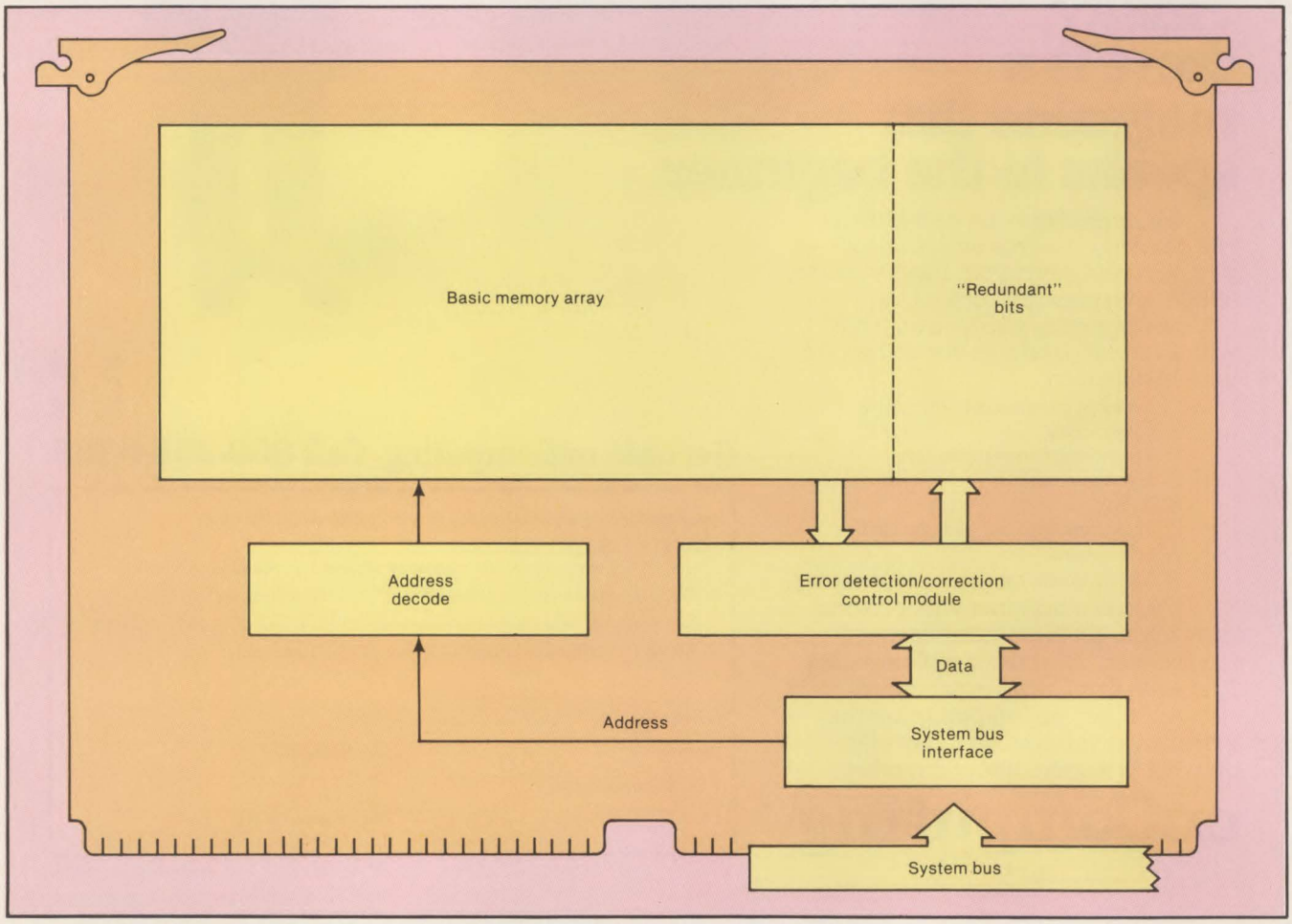

Fig. 5. Block diagram of memory *board with error detection/correction feature.*

associated with the main μp-board differ somewhat from those on the expansion boards. On-board RAM is commonly implemented with 16K- or 64K-bit dynamic RAM devices for a total on-board capacity of 32K to 128K bytes.

Higher-end applications commonly require on-board error checking and dual port control. Byte parity generation and checking is usually sufficient for bit-error control in an on-board RAM array as large as 128K bytes. However, if provided, a user should be able to deactivate it easily, because parity generation and checking can take as much as 20 percent of total access time. A user whose application does not require error control can trade that feature for the increased RAM program execution speed.

Opinions differ on the subject of dual port control for on-board μc RAM. Dual port RAM can be accessed from the on-board processor, and from an off-board processor or controller through the system bus. The benefit is that both the on-board and off-board processors or controllers can have direct access to the same RAM segment.

In practice, however, the implementation is complicated by the options that the circuit designer faces. He must answer these questions:

- What is the priority of access to the shared RAM when both the on-board and off-board CPUs are in contention?
- Should only a portion of on-board RAM be shared, and the remainder left to the on-board CPU?
- Should lock-out of some portion of RAM be provided, and if so, should it be dynamically alterable under program control?

The complexity of the resulting dual-port RAM can make the feature expensive, both in direct cost and in the displacement of some other board feature that could otherwise be provided.

Most high-performance μc systems require RAM bit-error control. The use of parity error detection is common in large RAM arrays, but a system designer must carefully evaluate error detection and correction (EDAC) (Fig. 5).

EDAC functionally provides both single- and double-bit error detection, plus single-bit error correction. But the overhead to achieve EDAC is substantial in both cost and memory-timing degradation. For a RAM array organized into 16-bit words, six redundant bits are appended to allow single-bit error correction, resulting in roughly a 38 percent cost increase. The circuitry to generate and check the redundant bits adds about 60 to 100 nsec. to a memory read or write. EDAC may add as much as 20 to 25 percent to total memory access time, depending on basic memory speed.

Intelligent peripheral controller architecture

Higher-performance μc systems typically contain

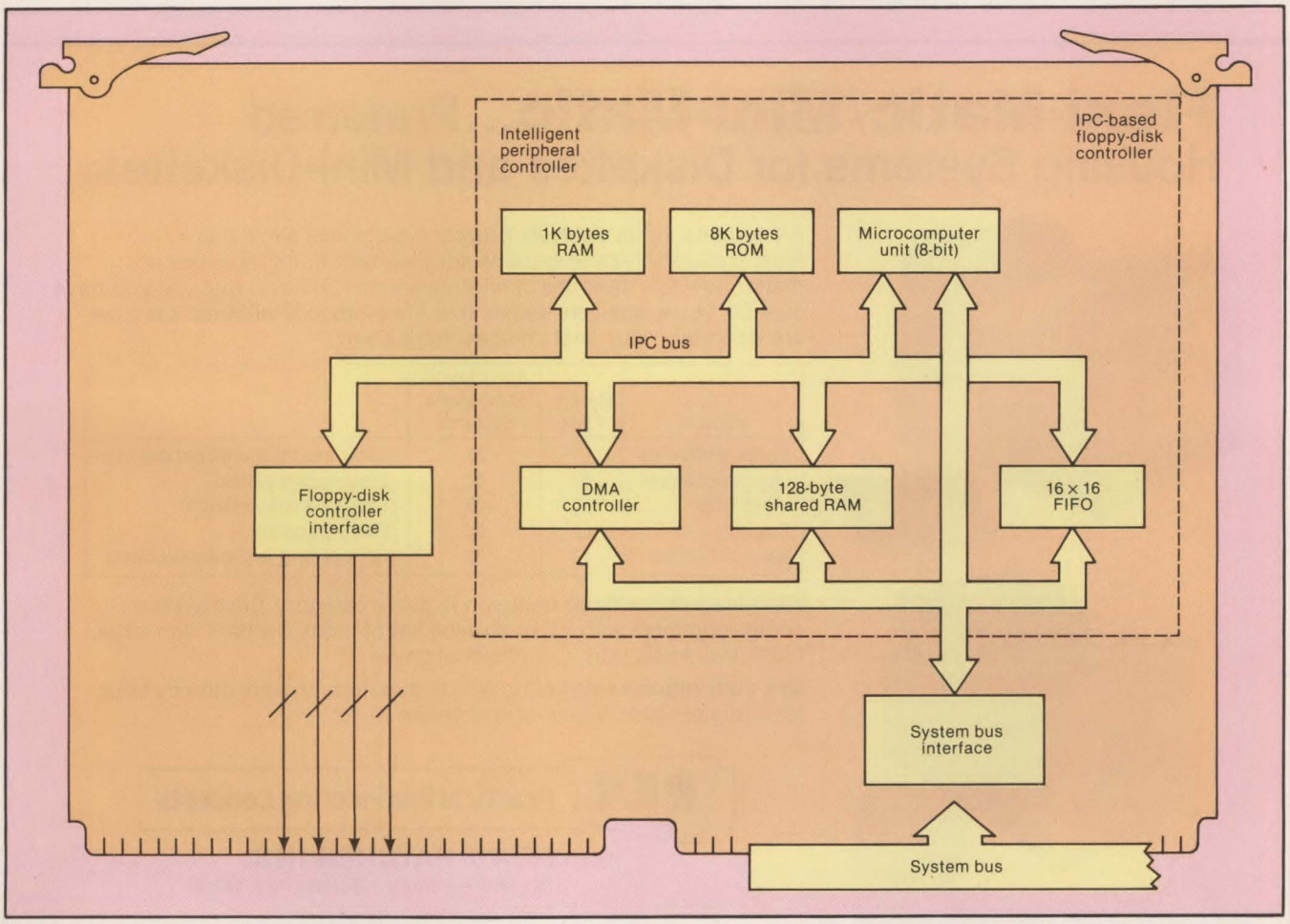

Fig. 6. Block diagram of typical *intelligent peripheral controller board shows the principal functional elements of the IPC within the outline.*

The primary benefits of IPC architecture are higher system performance, higher reliability and easier application software design.

floppy- and hard-disk units, high-speed synchronous communication channels and high-speed, multichannel A/D and D/A converters.

Managing these complex peripherals can be burdensome to the main system μp. Consequently, in advanced systems, such tasks are moved to intelligent peripheral controllers (IPCs), which contain one or more μps with associated I/O control firmware.

IPCs are more frequently implemented in specialized 8-bit μps, such as the Motorola MC68120, a peripheral device supporting the MC68000 MPU. However, the trend for very-high-performance applications is to implement the IPC functions with "bridge"-type 8-/16-bit processors, such as the Motorola MC6809, and even to full-blown 16-bit μps.

A typical IPC (Fig. 6) should:

- Contain a full interface to the system bus and act as bus master, containing the necessary bus-request and bus-grant-acknowledge control circuitry.
- Include a direct memory access (DMA) channel and control circuitry to allow direct high-speed access to any system global RAM available on the system bus.
- Allow communication between the main system processor and the IPC in straightforward "command packets" and "data packets." Data packets typically should be less than 50 bytes long so that the IPC does not "hog" the system bus during transfer of large blocks of information.
- Include self-test and failure notification capability.

The primary benefits of IPC architecture are higher system performance, higher reliability and easier application software design. Removing many of the low-level details of I/O management from the main system processor results in better system performance. Parallel processing can be achieved between the main processor and the peripheral processor in the IPC module. The IPC's ability to perform diagnostic activities enhances reliability. ■

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

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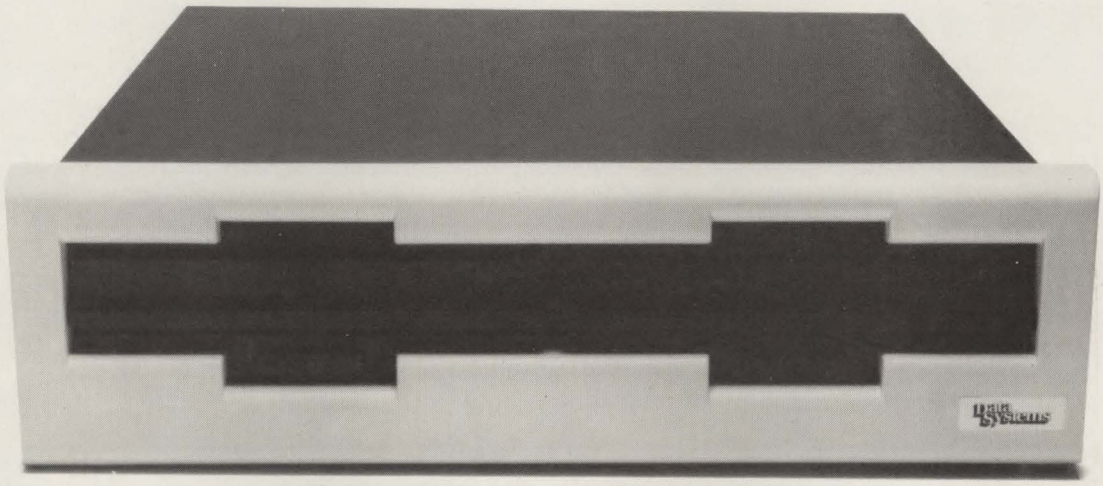

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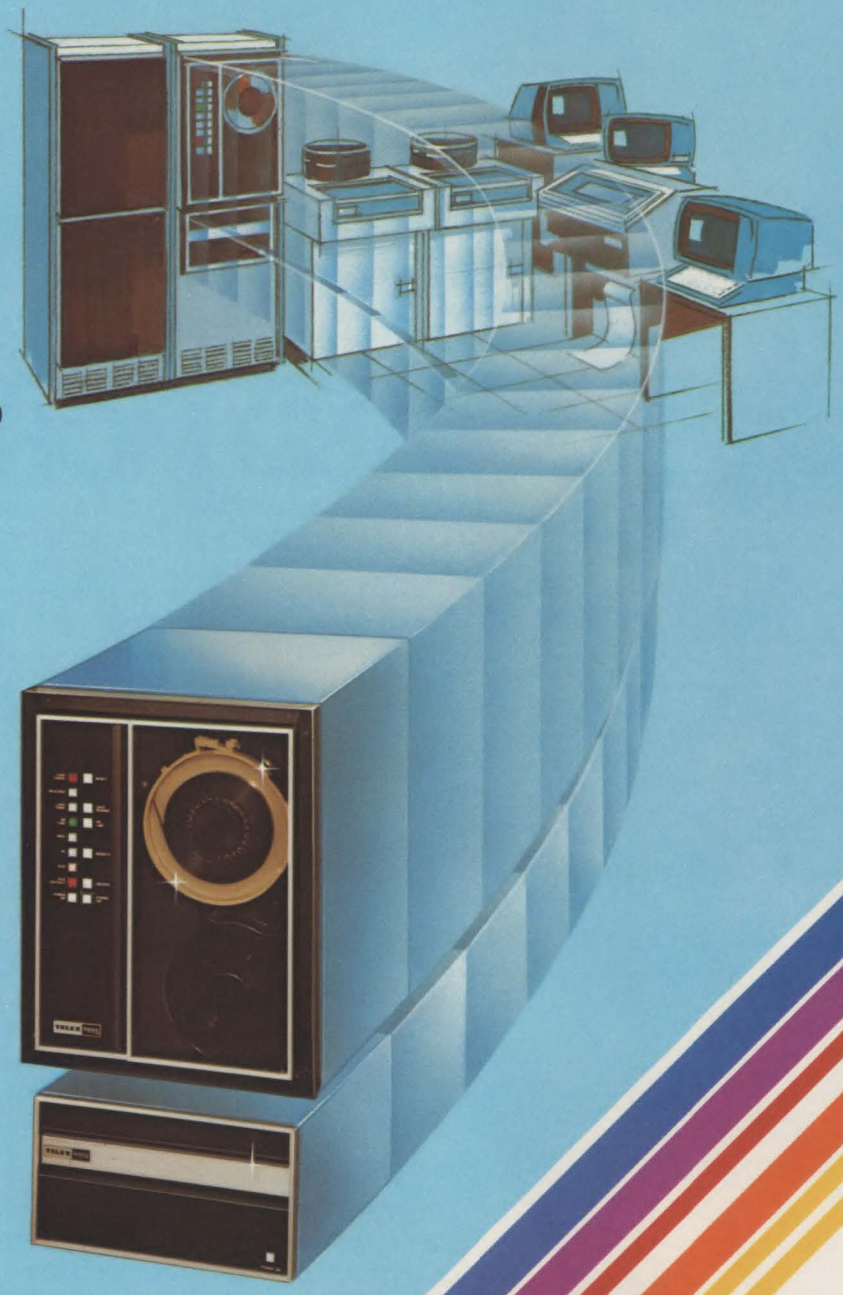

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CIRCLE NO. 77 ON INQUIRY CARD

Inquiry language speeds reporting, scheduling

Eight-minute procedures replace five man-weeks of coding for Motorola's production reporting and maintenance scheduling

Installing a new system often brings mixed emotions to data-processing managers. On one hand, there is a sense of pleasure in working with modern new equipment; on the other, there is a twinge of dread at the thought of the months, or even years, that must be devoted to converting applications programs from the old equipment to the new.

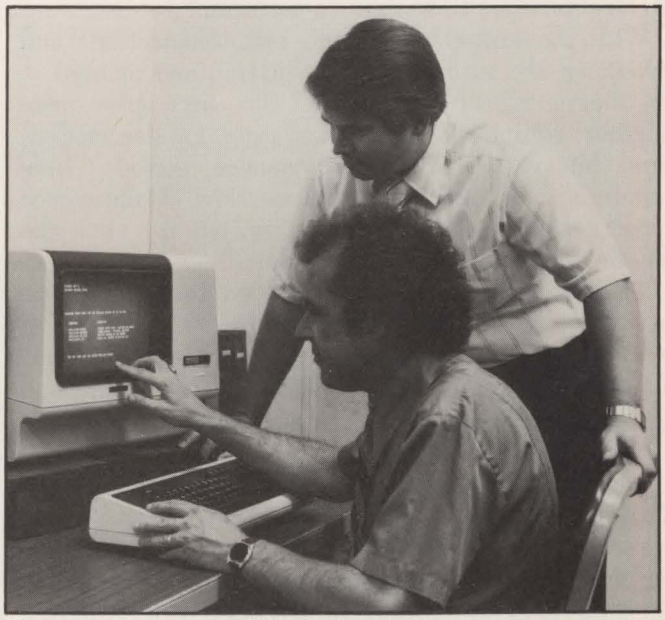
There was no such delay at Motorola's Semiconductor Group in Phoenix, however. In about three months, engineers there installed a new computer and brought up a sophisticated system for semiconductor-production reporting and preventive-maintenance scheduling that they estimated normally would have taken four man-years to develop.

The new system, a Digital Equipment Corp. PDP-11/34 was installed in October, 1979. By January, 1980, Dick Azzi, manager of epitaxial system engineering, and his staff of three had developed a comprehensive data base and prepared report-generation programs. Previously, management reporting and some maintenance-scheduling programs were handled by a Control Data Corp. CDC-1700, while other maintenance programs were scheduled manually.

The key to this fast changeover is Digital's inquiry and report-generation language, Datatrieve-11, running on the PDP-11/34 with 128K bytes of main memory and dual RK07 disk drives, each with 28M bytes of mass storage. Other peripherals include six VT100 video terminals, a 600-line-per-min. printer, two tape transports and a card reader.

Datatrieve is interactive and has English-language commands somewhat similar to COBOL, such as SELECT, DISPLAY, SORT, MODIFY, REPORT and PRINT. Files and records also are named. Commands are free-form with simple syntactical rules. Datatrieve is a command interpreter that both interprets and acts on each statement as received; time-consuming compilations are not required. It has report-writing facilities that allow reports to be written using data residing in appropriate RSX11M operating system files, or from data that has been preselected and manipulated using Datatrieve commands. Report formats then can be stored for future use.

The epitaxial group manufactures silicon wafers for Motorola's line of rectifiers, transistors, integrated circuits and μps.



Department manager Dick Azzi, *epitaxial systems engineering group (foreground), and program analyst Ronald E. Gilbert examine Datatrieve-11 command-function menu on VT-100 video terminal.*

Datatrieve is interactive and has English-language commands somewhat similar to COBOL.

```
DTR> READY RECLAIM SHARED WRITE
DTR> SHOW RECLAIM-SEARCH
PROCEDURE RECLAIM-SEARCH
FIND FIRST #."NUMBER OF WAFERS WANTED" OF RECLAIM WITH SUBSTRATE EQ #."SUBSTRATD
            DOPE EQ #."DOPANT" AND
            RESIST BETWEEN #."MINIMUM RESISTIVITY" AND #."MAXIMUM RESISTIVID
            THICK BETWEEN #."MINIMUM THICKNESS" AND #."MAXIMUM THICKNESS"
FOR CURRENT PRINT
REPORT CURRENT SORTED BY BIN,DOPE ON LP:
SET REPORT-NAME = "EPI WAFER SYSTEM"/"WAFER SHIPMENT REPORT"
PRINT BIN,DEVICE,SUBSTRATE,DOPE,RESIST,THICK,BADGE,SDATE
AT BOTTOM OF DOPE PRINT SKIP,COL 115,"WAFERS FOUND ",COUNT
REPORT END
PRINT SKIP 2,"YOUR REPORT IS NOW ON THE PDP-11/34 PRINTER",SKIP 2
IF #."DO YOU WANT THESE DEVICES DELETED FROM INVENTORY" NE "Y" ABORT
"DEVICES NOT DELETED, THEY ARE STILL IN INVENTORY" ELSE ERASE ALL THEN
PRINT SKIP 2,"DEVICES DELETED"
END-PROCEDURE
DTR> :RECLAIM-SEARCH
Enter "NUMBER OF WAFERS WANTED": 25
Enter "SUBSTRATE": G10
Enter "DOPANT": PH
Enter "MINIMUM RESISTIVITY": 3.75
Enter "MAXIMUM RESISTIVITY": _
```

Clear, English-language *prompting statements guide users through Datatrieve procedures.*

Silicon wafers 2 to 5 in. in diameter are placed in large epitaxial reactors, heated to about 1200°C and treated with minute quantities of chemicals, such as phosphorous or boron. The group has hundreds of reactors and other processing equipment to manufacture the large number of wafers Motorola requires.

Effective preventive maintenance

"The preventive maintenance programs list more than 20,000 jobs that must be performed on all the equipment in the wafer fabrication areas," says Azzi. "The jobs may be small, such as changing a room air filter that requires 10 min., or quite large, such as a complete epitaxial-furnace checkout that takes 10 to 16 hr. The latter may consist of 20 to 30 individual jobs each requiring 5 to 90 min. to perform."

With the PDP-11/34 system, maintenance lists and schedules are automatically formatted and printed at the beginning of each week. The lists give room number, equipment number and type, job description, time interval between maintenance periods, time required to do the job and data last done. Maintenance schedules carry similar information, but also show the day on which the work is to be done.

The forms are "burst" and given to maintenance personnel, who, after performing the work, check off items and return forms to the epitaxial systems engineering group. Data buses are updated quickly and the completed-work files are appended with appropriate date-last-done information.

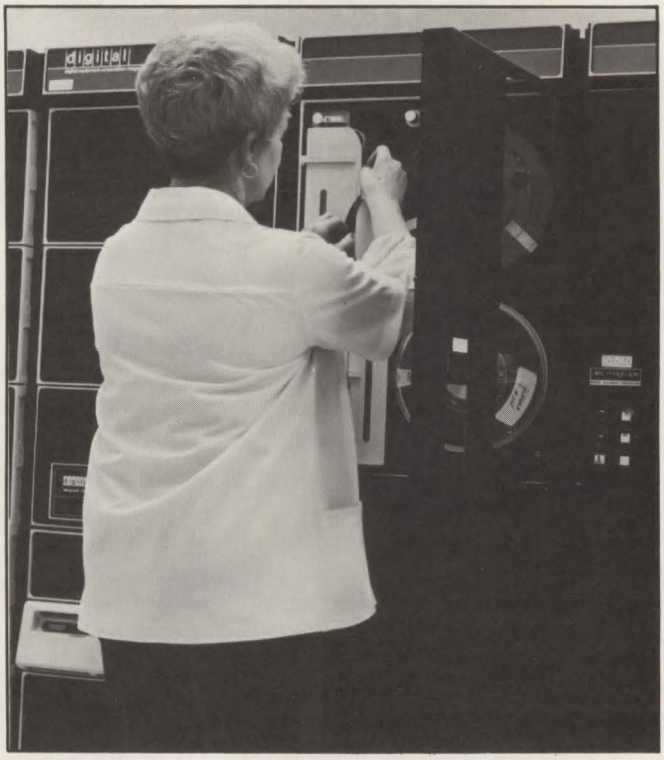
Various management reports are generated from the data bases. These might include the status of all equipment by job code, furnaces with overdue maintenance or sorting by any other parameters. "Installing the data bases for the preventive-maintenance program required about four man-weeks," notes Ronald E. Gilbert, programmer analyst. "That included coding the 20,000 jobs from printed records, debugging files and our own learning time. We then spent a day and a half working with maintenance supervisors to determine list and schedule formats so we could generate the forms."

Datatrieve also expedites production reporting. Here, the number of wafers started each day forms the initial data file. Other data added to the files are process type, yields (percentage of wafers that pass tests after processing) for that process, location of wafer areas that house the equipment for each process and other product-specific factors. As wafers are processed and tested, the number that are within specification by type and size, along with test results, are entered into the minicomputer.

From these data, daily, weekly and monthly production reports are generated. For example, a daily yield summary lists the number of wafers processed by size, giving actual yields compared with Motorola's typical yield for that process. Should the yield be below normal, additional reports might pinpoint the trouble to a specific process, furnace or employee number. Still other reports break down production by device type, substrate, dopant, resistivity and furnace.

"Datatrieve makes this possible," comments Azzi. "There are no applications programs; rather, we are accessing various files by parameter, viewing and formatting the results on the CRT, then printing the selected data. It gives us an easy way to populate, modify, manipulate and retrieve a file as well as to intermix data among files.

With the previous applications-program-based CDC-1700 system, it would take five to seven man-weeks to prepare a report-generating program. Now



A DEC PDP-11/34 *with Datatrieve permits fast preparation of specialized management reports.*

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CIRCLE NO. 153 ON INQUIRY CARD

With the PDP-11/34, maintenance lists and schedules are automatically formatted and printed at the beginning of each week.

we can have one ready for printing in 8 to 15 min. As a matter of fact, printing often takes longer than formatting," he says.

Besides installing management reporting and maintenance scheduling on the PDP-11/34, Azzi's group has developed a wafer-reclamation system. Not all semiconductor wafers processed meet the exacting specifications necessary for later fabrication of a specific type of transistor or integrated circuit; however, they may be useful for other devices at a later date. Instead of scrapping out-of-specification wafers, Motorola carefully tests and classifies then by substrate type, dopant, resistivity and epitaxial-layer thickness, and then stores them in numbered bins.

Upon receiving a work order for a certain type wafer, a production supervisor enters the specifications into the terminal. An example of the Datatrieve statement could be: DISPLAY, RECLAIM WAFERS, SORTED BY DESCENDING RESISTIVITY BETWEEN 13.00 AND 9.00. Datatrieve then searches the data bases for those that meet requirements and displays the wafer location and bin number, along with complete specifications.

The appropriate wafers then may be selected. The statement might be: PRINT RESISTIVITY, THICKNESS AND BIN OF CURRENT COLLECTION WITH RESISTIVITY GREATER THAN 10.00 SORTED BY DESCENDING BIN. Printed output then can be used as a picking slip. "The system saves a lot of wafers that otherwise would be scrapped," notes Azzi, "and further improves the department's yield. Reclaimed-wafer inventory reports also are included with the periodic management reports."

Datatrieve has five privilege-code levels that control the ability to access files. Production workers have their own password and associated privilege code, which limits them only to retrieve. System programmers use code levels to retrieve, modify, write and fully extend files.

"We are not using any applications programs in the management reporting, preventive maintenance or wafer reclamation systems," says Azzi. The programs are written with Datatrieve using near-English-like statements. "They are all done with Datatrieve. We had about four cabinets full of program listings with the old CDC-1700. There was no conversion per se. After installing the data bases, we simply built a number of very simple procedures that allows us to access them."

"It's been a remarkable experience," concludes Gilbert. "At a previous employer we embarked on a similar, but not so extensive, project. When I left three years later, the applications-programming conversion still had not been completed." ■

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OPINION

Debunking the debunker

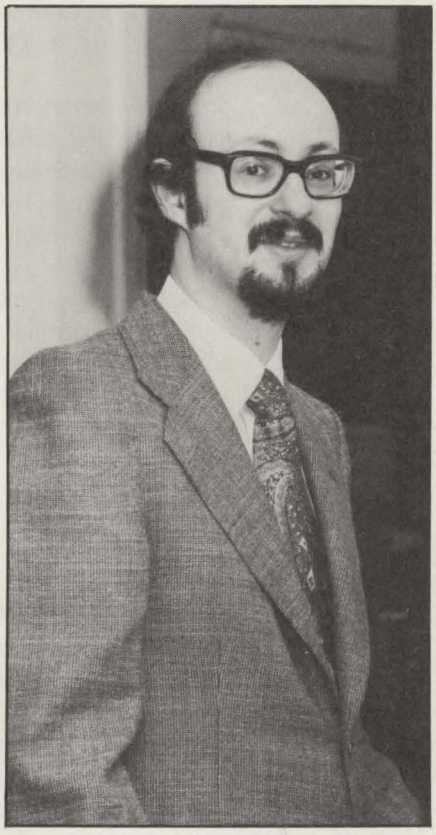
ROBERT D. GRAPPEL, Hemenway Associates, Inc.

A professional software writer, who also has a hardware background, voices another opinion about development systems

In his article "Debunking the development system myth" (MMS, August, 1980, p. 107), Edwin Lee, president of Pro-Log, Inc., argues that the large and growing selection of programming tools available to μc software engineers is unnecessary, and counterproductive. He contends that we have all been brainwashed—that evidence to support the use of such tools as assemblers and high-level languages is misleading. These arguments have generated some heat among software writers, as the letters to the editor columns reflect. As a professional software writer, with both hardware and computing backgrounds, I'm compelled to refute Lee's arguments. A development system may not be necessary, or it may be a vital need, depending on the task at hand.

A paragraph from his article asserts, "The hobbyists and the applications programmers share a common objective: to get one system working. A development system and high-level languages seem useful to them. Their measure of effectiveness is the time and money required to go from the concept to one working system—and it is this measure that has been used to judge all development systems. But it is the wrong measure for a professional engineer."

First, Lee separates the world into two camps: the hobbyists and applications programmers in one, and the "professional engineers" in another. He says that what is good for one camp is not necessarily good for the other. There is some "snobbery" evident here. I know as many EEs who are also computer hobbyists as I do programmers who have a μc in the basement. As a "software engineer" and "professional," I am not upset by being grouped with hobbyist computer users. In fact, I would imagine that many more hobbyists use Lee's minimalist approach to programming than do their "professional" counterparts.



A development system *may not be necessary, or it may be a vital need, depending on the task at hand, argues software writer Robert D. Grappel.*

But Lee would have us believe that the goal of programmers should not be "getting the thing going in the shortest possible time." In any business, time is money, especially when a scarce resource like trained programming talent is involved. Lee says, "The product of professional engineering is documentation for manufacturing and field service," I'm confused: If I write a program I can load into the hardware and it performs the desired function, isn't that "documentation?" I have the program source listing, the object code, the memory dump and any further documentation that would be written to describe the program.

There are two types of program documentation: that which is part of the program text itself and that which comprises user manuals and functional specifications. The program-text documentation is facili-

tated by high-level languages and good assemblers. The other class of documentation is done the same way regardless of how the programs themselves are written. That a lot of programmers (professional or hobbyist) stop the documentation process after the program runs is a sad fact, but it's certainly not an indictment of tools that can speed the development process. By speeding the program-development steps, high-level tools may aid documentation by providing more time for it to be done, free from the pressures and distractions of coding and debugging.

Lee argues against the use of high-level languages by using an electrical engineering example.

He says that engineers choose the correct flip-flop structure from hundreds available, while hobbyists (remember that application programmers are included in this camp) can make do with a given flip-flop. First, a flip-flop is really a high-level construct. I don't think many engineers consider the functions of the dozens of components within the flip-flops they use. They simply pick the appropriate circuit. The schematic drawing of a flip-flop is typically a box with labeled wires—an example of a high-level abstraction if there ever was one. How does this differ from a high-level language statement?

Perhaps it is because Lee believes the engineer is already comfortable with the flip-flop abstraction, while the high-level language is something new and strange. His argument would have engineers designing tube circuits because those "newfangled" transistors are new and strange. Software is a fact of modern engineering life; the engineer will have to learn it to stay professional.

Another example Lee uses is the "high-level language" word *multiply*. Why is this a high-level language word? Because the 8-bit chips don't have a multiply instruction? We have all implemented multiplication subroutines of various types while programming 8-bits μps. There isn't much to it, but why continually reinvent the wheel and be surprised that it is still round? The trade-offs that Lee mentions are valid, such as floating-point versus fixed-point and size of values. But many high-level languages provide the ability to make these choices within the "high-level" environment. I assume that the designer of the software tools I buy knows his business. I accept that the multiplication subroutines/macros/P-codes/etc. in them are coded about as well as I could code them, if I wanted to. As the computers we program get more and more powerful, more and more of these housekeeping details are becoming single machine instructions. To claim that a true professional engineer must worry about these details every time a program is written seems a bit farfetched.

High-level languages are simply tools. Good engineers are aware of all the tools available and know where and when to apply each tool.

The primary point Lee seems to make is that a true professional should not tolerate the inefficiencies that result from the use of programming tools such as high-level languages. First of all, the use of an assembler (Lee seems proud that his company's programmers don't use one) adds not 1 byte of code nor 1 μsec. of execution time to a program. Hand-coding is laborious, not too amenable to good documentation, and it complicates the task of debugging a program. As μps get more complex, hand-coding an optimal program becomes more difficult. Skilled hand coders must climb a huge learning curve on each new processor—a learning curve lowered substantially with a potent macro-assembler, text editor and other modern tools. Second, why is it unprofessional to have an unoptimized program? We are writing programs to solve problems; if the problem is solved we should direct the resources (programmers, machines, etc.) to new problems.

Not many μp applications require the last measure of hardware performance. Lee's company, Pro-Log, makes PROM programmers. Does a PROM programmer need optimum μp power? It is questionable. Inefficient code may not be esthetic, but if it solves the problem, use it. The typical trade-off in software is between speed and memory use. Memory prices are dropping rapidly, and μps are getting faster and faster, but the price of software expertise has remained roughly constant. The professional engineer should consider the number of problems solved per unit time as the primary measure of his productivity.

Finally, the most important way to optimize a program is to find the optimal algorithm. The choice of algorithm can mean factors of 10 improvement in speed and size. The way to encourage such optimization is to make it easy to try new and different algorithms. The quicker the programmer can try out a new approach, the more likely it is that he will find the best way to solve the problem. The inefficiencies of high-level approaches will become less important when the choice is between a good and bad algorithm.

High-level languages, assemblers, etc. are simply tools. A good engineer, or any good craftsman, is aware of all the tools available and knows where and when to apply each tool. There are times for low-level approaches and other times for high-level approaches. Does Lee imply that we force carpenters to build houses with only a cross-cut saw and hammer? It can be done, but I wouldn't want to pay the carpenter for the extra labor. Similarly, I disagree with the software scientists who would have us abandon assembler language completely in favor of high-level languages.

Robert D. Grappel is vice president of Hemenway Associates, Inc., Boston, a software house specializing in system software for minicomputers.

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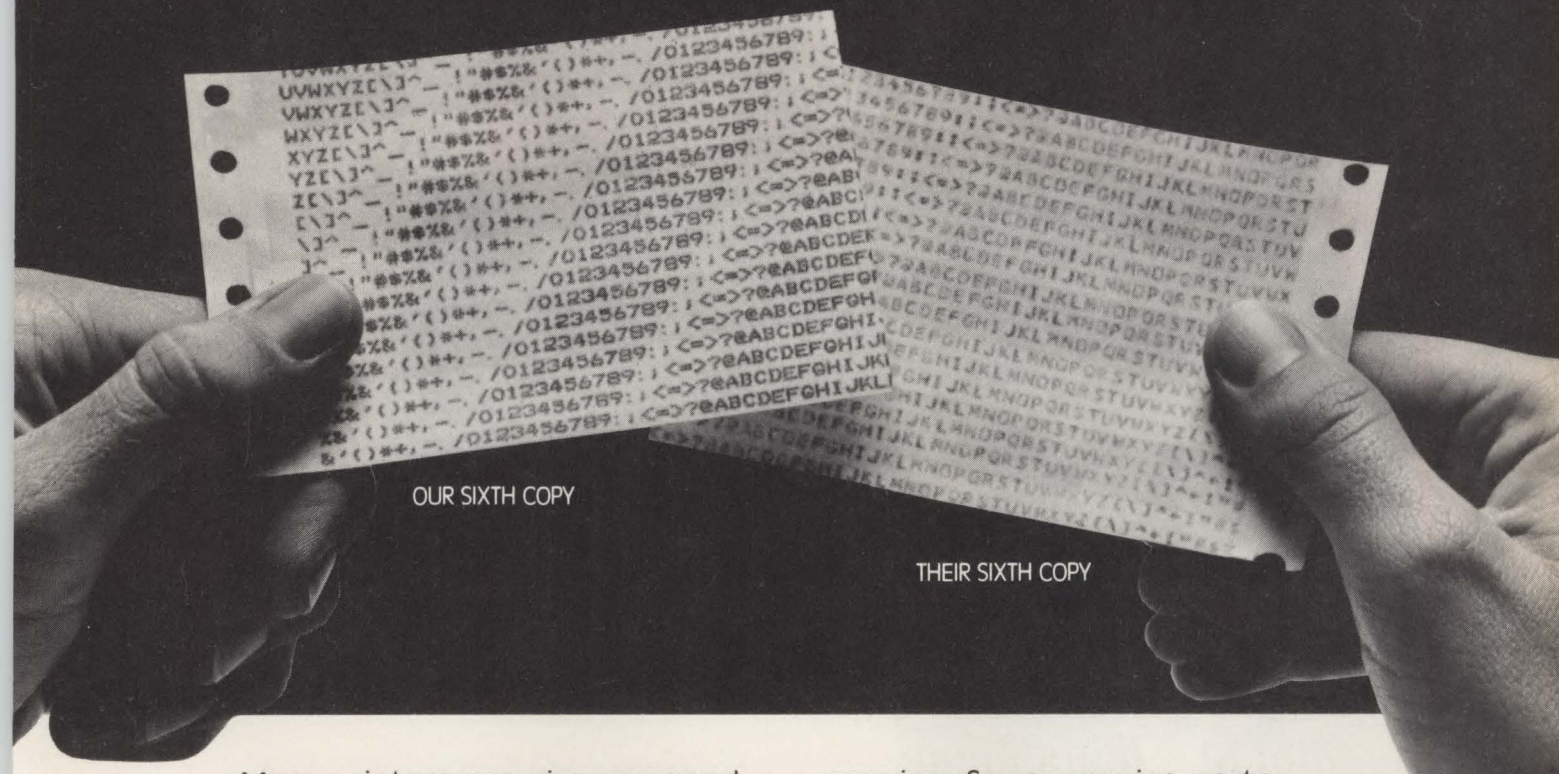

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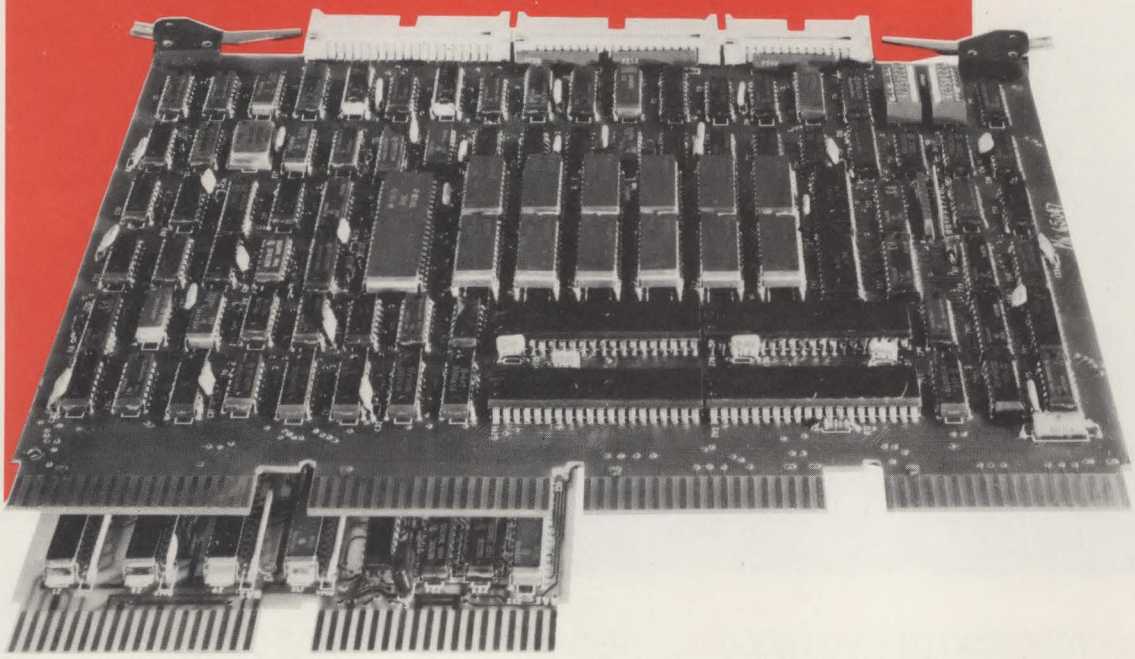

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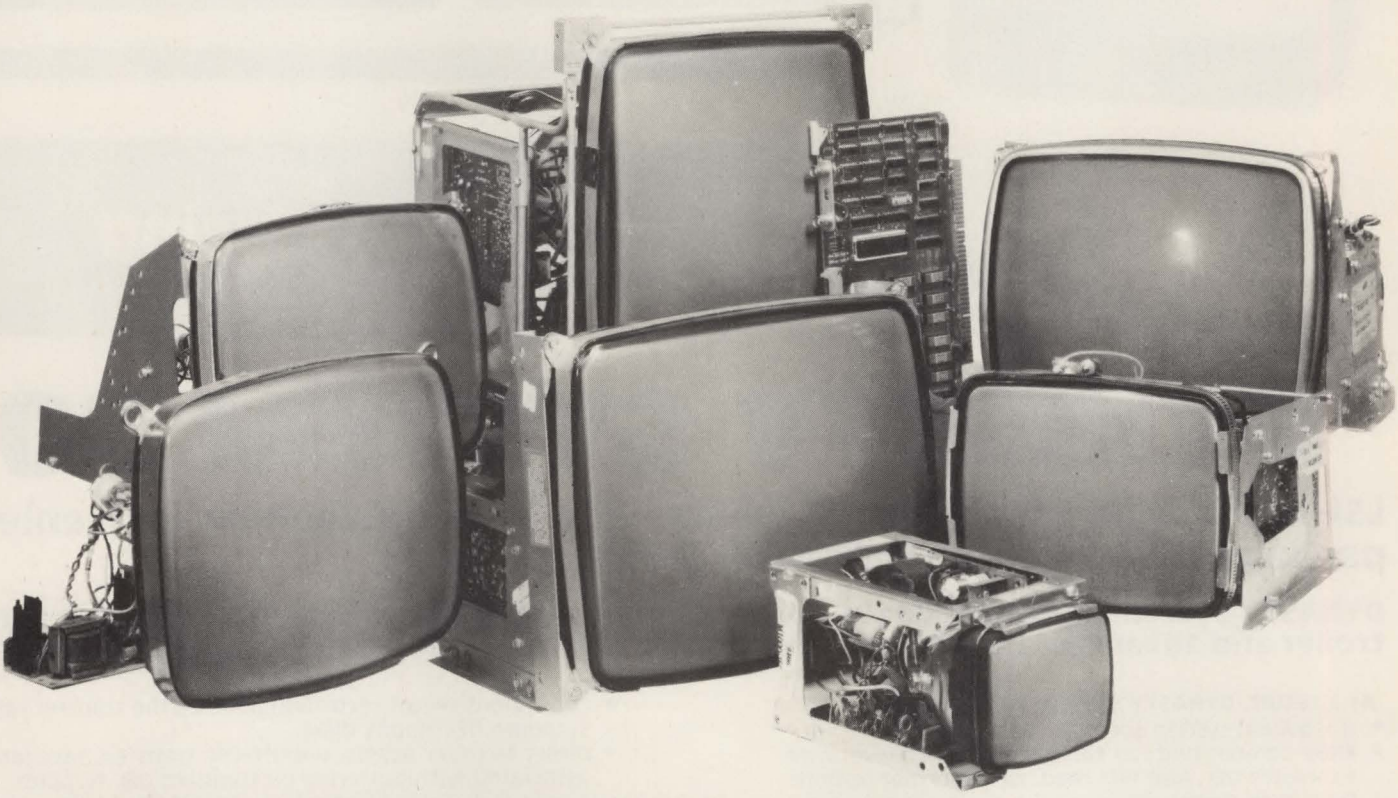

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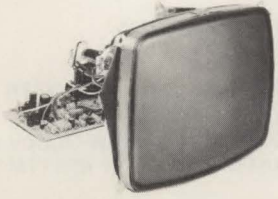

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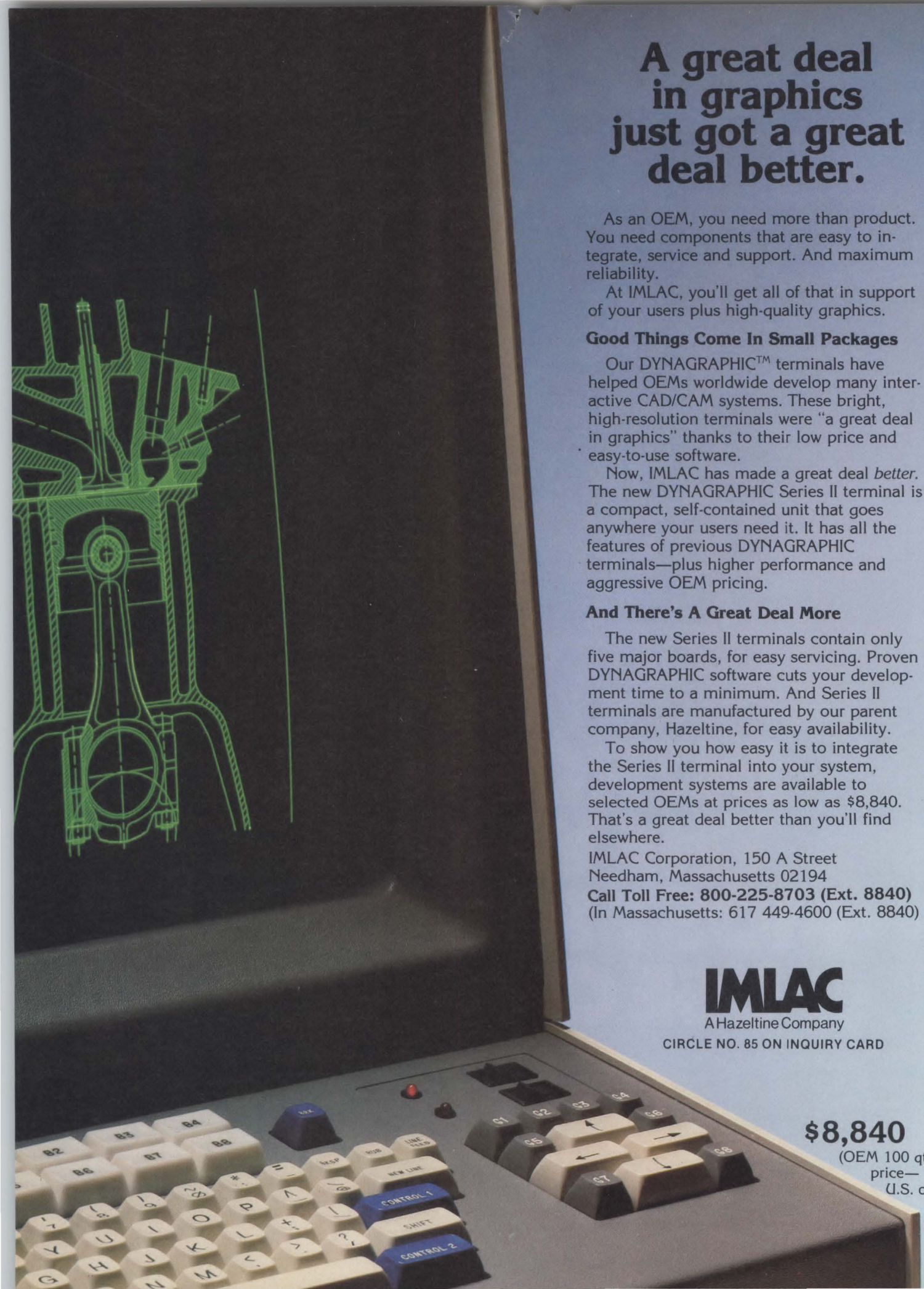

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NRC adds high-speed network to product line

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The new System 40 supports 300 to 400 MHz of communications bandwidth and, through frequency division multiplexing, can be used in conjunction with NRC's low-speed System 20 package.

A complete network can include host processors, peripherals, mass-storage systems, high-speed work stations, multiple low-speed front-end peripheral networks and gateways to remote network facilities.

The heart of the System 40 is a distributed multiprocessor architecture that consists of an Intel 8086 protocol processor, an 8089 communications processor, an RF modem and a variety of host interfaces.

Initially, NRC plans to market the System 40 with a Unibus adapter for DEC's VAX and PDP-11 series minicomputers. Standard network adapter units will be Intel Multibus-compatible.

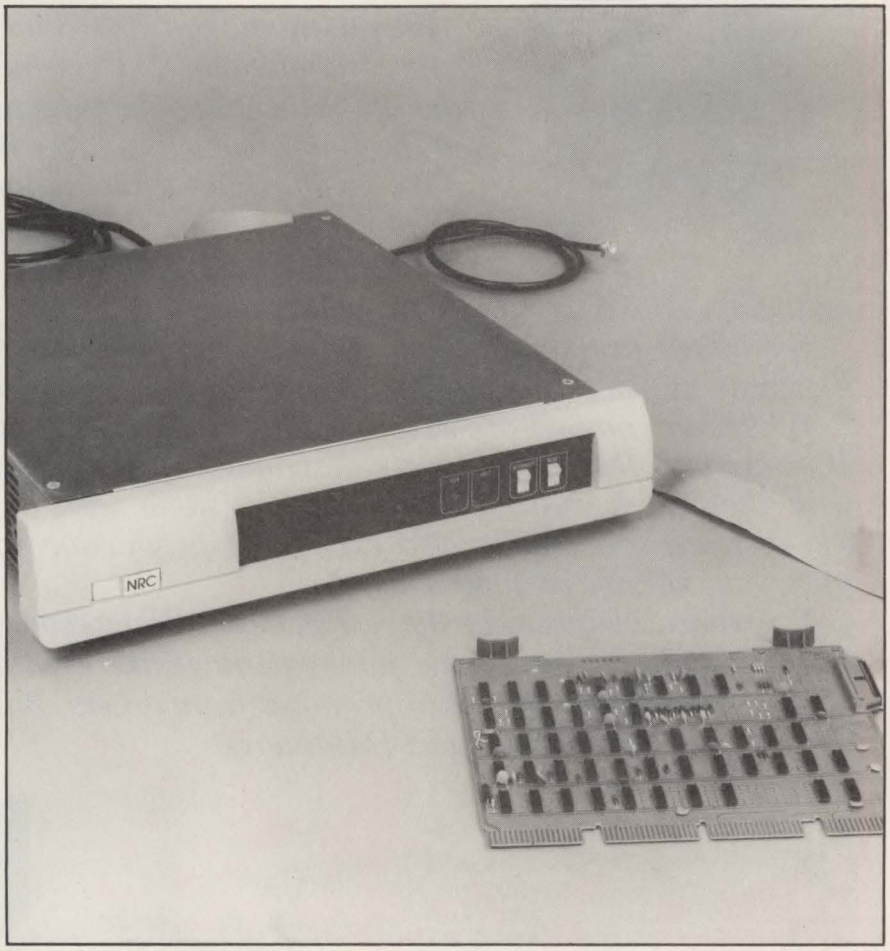
Other components of the system include a System 40 bridge; a System 40/20 bridge, which connects the System 40 network with the System 20 and which includes speed-matching features and concentrator/multiplexer services; and a LocalNet T-Verter, a central retransmission unit that provides simultaneous receive/transmit support.

Like the System 20, the System 40 is based on CSMA/CD packet-communications techniques and uses the broadband coaxial cable medium to provide communications intelligence at each user interface. The network system makes transparent protocol implementation and services, such as package assembly/disassembly, buffering, virtual circuit control management, error and flow control, protocol and code conversion, speed matching and data security.

System 40's CSMA/CD mechanism has a 2M-byte-per-sec. throughput with a total average access time of 10 msec.

Besides supporting high-speed packet communications of as many as 5 logical channels, System 40's distributed intelligence allows for incorporation of five optional services: gateways for network interconnection, symbolic resource naming and access control, network security and privacy, network monitoring and control and special-purpose and advanced services.

The network adapter unit is priced at $3515 with a standard Multibus; the VAX PDP-11 interface, $1500; the System 40/20 bridge, $5800; and the LocalNet T-Verter, $3500. Price for the System 40 bridge has not been announced. **Network Resources Corp.,** Sunnyvale, Calif. **Circle No 260**



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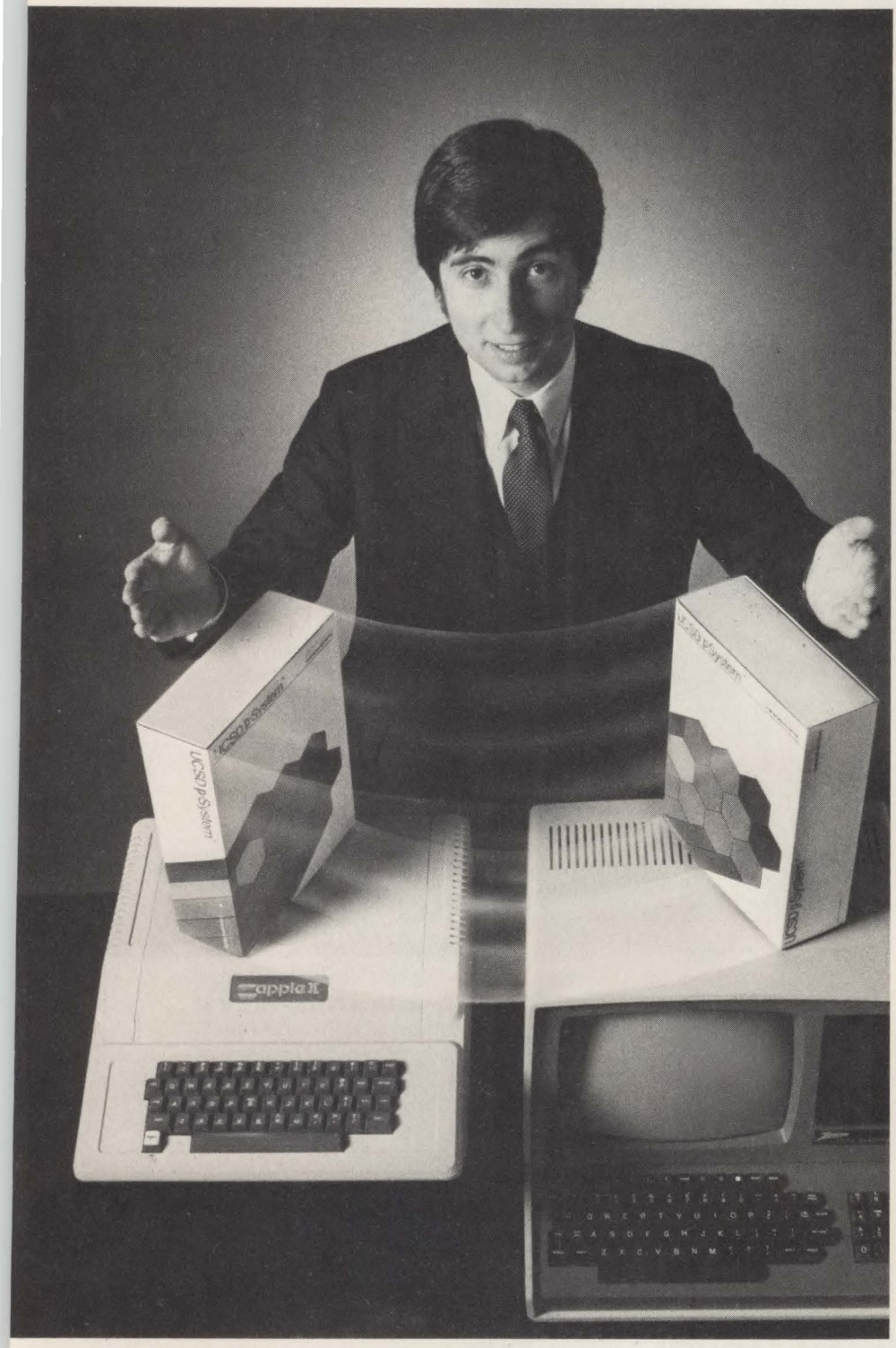

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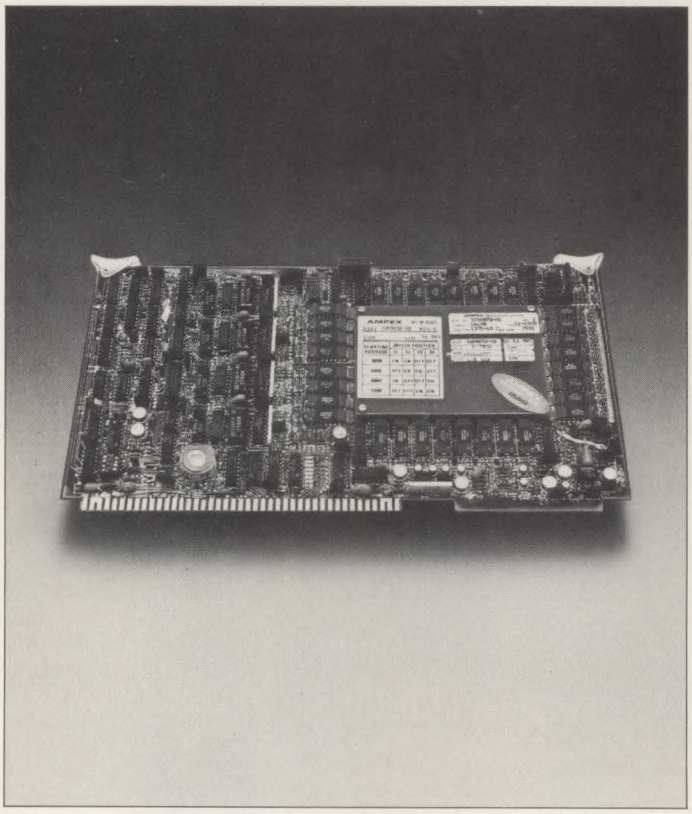

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CIS COBOL products run on the 8080 or Z80 microprocessors under the CP/M* operating system, and on the LSI-11 or PDP-11 processors under RT-11. They are distributed in a variety of disk formats and come with a utility that enables you to use any make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

OEMs

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

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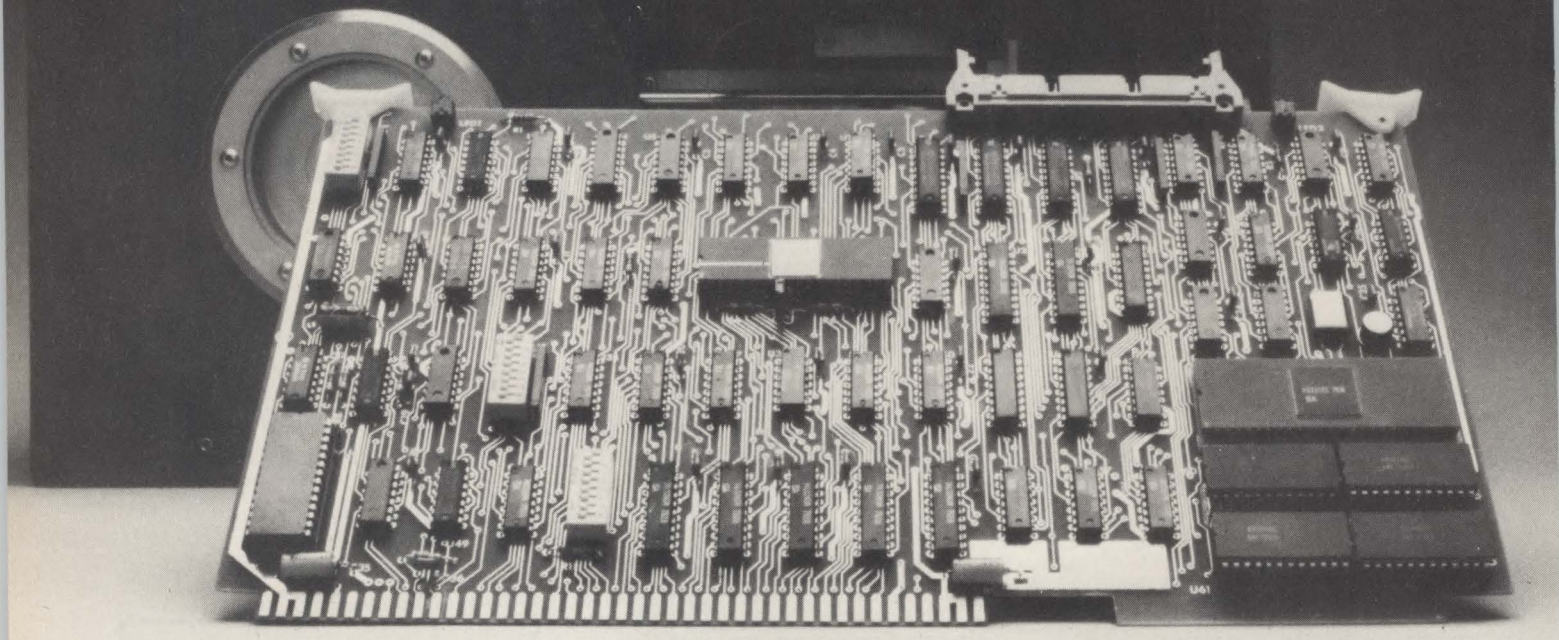
CIS COBOL distributors include: Vector Graphic, Onyx Systems, Altos Computer Systems, Lifeboat Associates, Research Machines, Telecomputing, Modular Business Systems, Rair, Midlectron, Rostronics and Johnson-Laird Inc. †Intellec is a trademark of Intel Corp. *CP/M is a trademark of Digital Research Inc.

The little guys have done it again.



PRESENTING THE FIRST ANSI WINCHESTER DISK CONTROLLER FOR MULTIBUS.™ AVAILABLE TODAY. FROM INTERPHASE.

The WDC 2880 is an Intelligent Controller for up to 8 ANSI X3T9.3 compatible Winchester drives. It gives your MULTIBUS system true performance.

Hardware ECC, Automatic Error Recovery, Sector Interleaving, Bad Track Mapping, and Overlapped Seeks mean High Performance on the Disk side.

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Software Compatibility across the Interphase Family – SMD Controller, Cartridge Disk Controller, and all future disk products – means a maximum return on your software investment.

Drivers for many standard Operating Systems available now.

You've come to expect high quality innovations first from Interphase. The most talented Intelligent Disk Controller specialists in the country. And the WDC 2880 is no exception. It is elegant, well designed, affordable and available off the shelf.

But that's not all. We give you full support to help you integrate it into your system. So why wait for someone else? Call or write us today.

INTERPHASE corporation

We stay ahead of our competition so you can stay ahead of yours.

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CIRCLE NO. 90 ON INQUIRY CARD

Zeda computers announces portable systems

The Z80-based 520 series of portable μcs includes a CPU, a CRT display, a floppy-disk drive and a detachable keyboard. The systems can use 110/220 VAC outlets, 12V DC or internal batteries. Each unit contains 48K bytes of dynamic RAM, 2K bytes of video RAM, a double-density minifloppy disk controller and a built-in, 200K-byte, double-density drive. Prices range from $4195 to $4495 in single-unit quantities, with OEM discounts available. **Zeda Computers International Ltd.,** Provo, Utah.

Circle No 261

System has 64K-byte RAM

The MT500 μc system for data and word processing includes a full video display, a Z80A μp, a CP/M operating system, 64K bytes of RAM, two 500K-byte 5¼-in. floppy-disk drives and a Selectric-type keyboard. A 45-cps letter-quality printer and integral 103- or 212A-compatible modems are optional. The MT500 sells for less than $6000. **Multi-Tech Systems, Inc.,** New Brighton, Minn. **Circle No 262**

System provides storage and retrieval

The Adstar, an automated document storage and retrieval system, enables users to locate a document through menu selection and/or a variety of inquiry prompts. The system includes as many as 145 ways of searching an index value. Other features include on-line annotation, user-designed vocabulary and multilevel file-security protection. Prices start at $39,000. **Acctex Corp.,** San Francisco, Calif.

Circle No 263

System monitors machine performance

The TRAC μp-based time, rate and count system, for monitoring and reporting production activity and downtime, continuously updates and displays 13 production statistics and 10 downtime categories. Other features include two independent counters that allow tallying of good and rejected parts, and detection of stoppages and downtime as short as 1/16 sec. Price is $2255. **Xytec Corp.** Beaverton, Ore. **Circle No 264**

Word-processing system aimed at auto sales

The TC 1000 word-processing system for automobile dealerships includes a terminal, software and a printer. The system edits and prints text, and memorizes and displays input. Prices start at $7045. **Reynolds + Reynolds Co.,** Dayton, Ohio. **Circle No 265**

Process control systems use POL language

The MOD 3103 and 3106 process-control systems employ 16-bit ECC. The systems support modular configurations of programmers, terminals, color graphic operator consoles and high-speed disks, and use POL (process-oriented language) software. **Taylor Instrument Co.,** Rochester, N.Y. **Circle No 266**

Portable system combines components in 50-lb. unit

The Report/80 portable business system includes two CPUs, memory, a keyboard, a video display, two minifloppy-disk drives, a dot-matrix printer and two RS232C ports in a unit that weighs less than 50 lbs. The unit comes in two versions. Model II includes two 740K-byte double-sided, double-density drives, and sells for $8950. Model 15 includes two 1.4M-byte double-sided, quad-density drives, and sells for $9950. **Systel Computers, Inc.** Cupertino, Calif. **Circle No 267**

Minicomputers extend Sperry line

The V77-500 and V77-700 16-bit minicomputers include memory mapping and control, ECC, hardware multiply and divide and DMA. The systems offer optional writable-control store (WCS) of 2K words and include the VORTEX II operating system, which supports FORTRAN IV, COBOL, RPG II and micro and macro assemblers. The systems also support moving-head disk and magnetic-tape drives, keyboard/CRT display terminals, line and character printers, card readers, general-purpose interfaces and A/D interfaces. **Sperry Univac,** Blue Bell, Pa. **Circle No 268**

New Products

interfaces and controllers

MDB introduces IEEE 488 bus controller

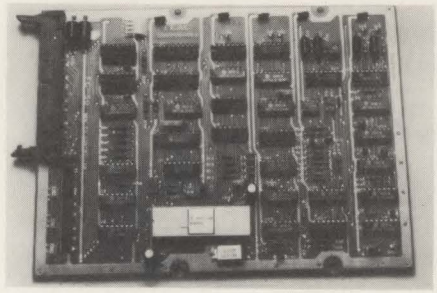
This IEEE 488 bus controller for Perkin-Elmer computers generates parallel and serial polls, extends control to other intelligent devices and, when switch enabled, acts as a system controller. Other features include a talker function, a listener function, service request, remote/local and parallel poll. Price is $1250 in single-unit quantities. **MDB Systems, Inc.**, Orange, Calif. **Circle No 269**

Analog input module connects to μcs

The CMC AIM 16 analog input module, a 16-channel A/D converter, can be connected to Pet, Apple, Kim, TRS-80 and other μcs through an 8-bit input port and an 8-bit output port. Input voltages from 0V to 5.12V are converted to a count between 0 and 255. Resolution is 20 mV per count, with .5 percent ± 1-bit accuracy. The module is priced at $179. **Connecticut microComputer, Inc.**, Brookfield, Conn. **Circle No 270**

Video controller offers graphics, alphanumerics

The MCV-1023 single-board multichannel video controller, intended for on-line information, graphics and data-processing applications, is compatible with Multibus architecture and other CRTs. The unit offers graphics and alphanumeric character generation, control and logic functions, intermixable text and graphics display and three software-selectable character fonts. Price is $995. **Metacomp, Inc.**, San Diego, Calif. **Circle No 271**



Teac announces floppy-disk controller

The model FC-50 5¼-in. floppy-disk controller can be used with the vendor's single- or double-sided drives and can read, write and format single- or double-density disks. Other features include use of LSI μp technology, connection of as many as four drives in daisy-chained configuration and IBM sector format compatibility. **Teac Corp.**, Montebello, Calif. **Circle No 272**

Pacesetter.

IDT 2000. Out front in cost-effective color graphics.

No other supplier can match the performance of IDT terminals, monitors and video generators. The design objectives of every IDT unit, high quality, reliability and ease of maintenance, are earning IDT products a reputation for innovation and cost-effectiveness. Behind our new 2000 color terminal is the experience of IDT people in developing, marketing and servicing color graphic systems for a wide range of applications.

In the 2000, the result is a highly reliable, state-of-the-art terminal with the versatility in capabilities, packaging, interfacing and system options demanded by the expanding color graphics marketplace.

IDT 2000. In step with your needs.

- ☐ **Can be configured to suit your present needs and easily expanded later.**
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- ☐ **MACROGRAPHICS™ and RAMPICS™, two of several proprietary packages that enhance speed, enable animation and simplify programming.**
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CIRCLE NO. 92 ON INQUIRY CARD

Now, a low-cost smart CRT joins the Bantam family.

Need block mode editing capability? An optional second page? Our new 550S is for you. Doing a lot of numeric data entry? Our new 550E has the features you need. Want a terminal that's easy to operate and easy on your budget? Our economy Model 550B is the simplest operating CRT you can buy.

And all three come with a full-year warranty on parts and labor.

The star of this low-cost CRT family is the new microprocessor-driven 550S. It's functionally three terminals in one, with distinct operating modes for conversational timesharing, transaction processing, and text manipulation or software development.

On site and/or depot maintenance services for all Perkin-Elmer terminals are available through our own service force of 450 people located in 53 cities coast-to-coast.

The other new member of our 550 family is the highly reliable 550E. Like the 550B, it's driven by a custom LSI chip and has only 19 integrated circuits, giving you a 42,000 hour MTBF. The 550E features a dedicated keypad for numeric entry and cursor movement.

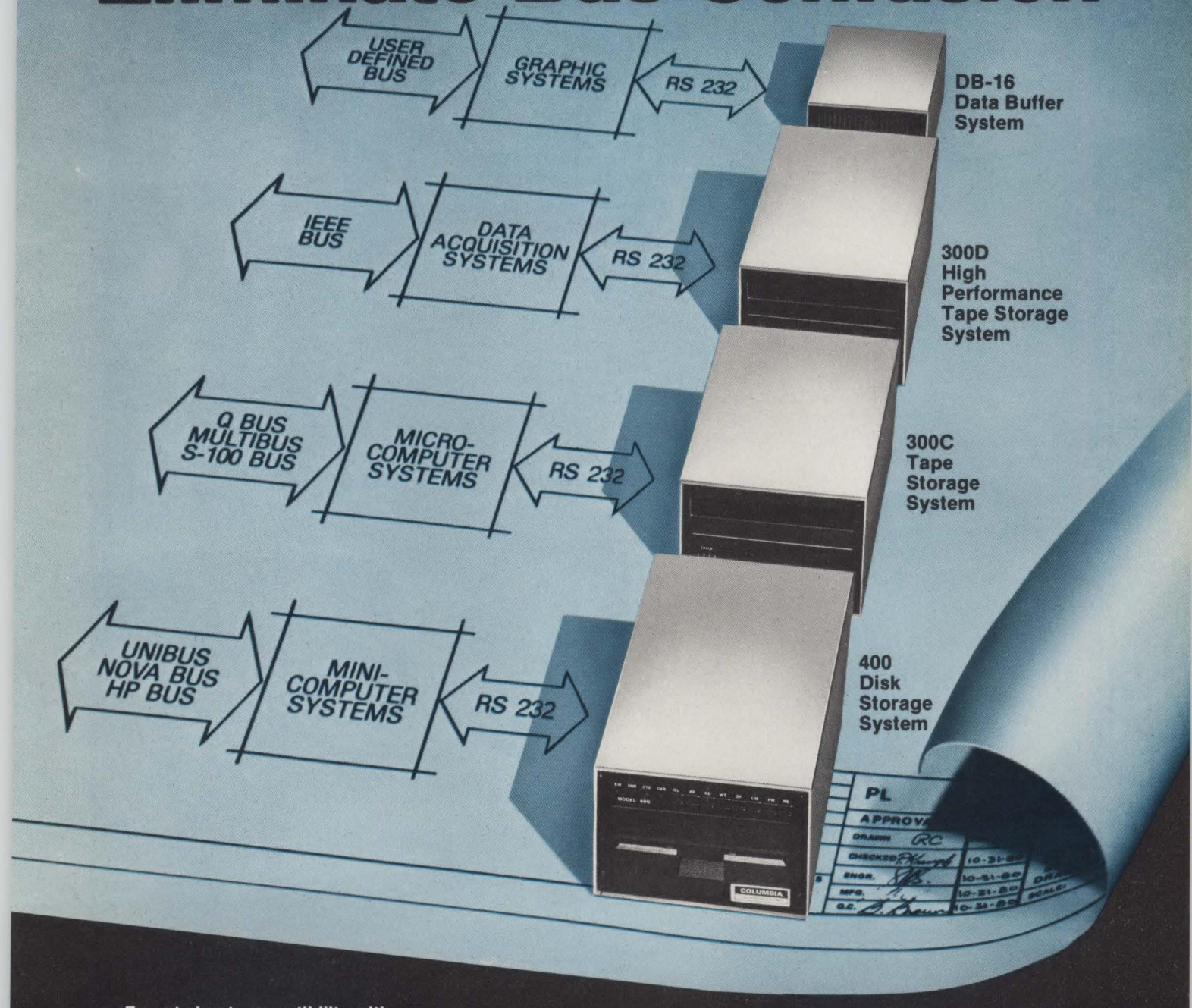
Perkin-Elmer is a Fortune 500 company with terminal sales offices located in Atlanta, Boston, Chicago, Los Angeles, New York, San Francisco, and throughout Europe. Distributors: Arrow Electronics • Automated Business Computers • Computer Peripherals of New England • Computer Peripheral Technology • Data Terminal Mart • The David Jamison Carlyle Corp. • PAX Computer Co. • Selecterm • The Thorson Company • Transaction Data Systems • U.S. Robotics • Westwood Associates.

For more information write: Perkin-Elmer, Marketing Communications, 2 Crescent Place, Oceanport, NJ 07757. **Or call toll free: (800) 631-2154. In NJ, call (201) 870-2412.**

PERKIN-ELMER

CIRCLE NO. 93 ON INQUIRY CARD

Our RS-232 Peripherals Eliminate Bus Confusion



Forget about compatibility with the Multibus, Q bus, S-100 bus, Unibus or the host of others. Most systems have an RS-232 data port. So select an RS-232 compatible peripheral from Columbia Data Products and leave the bus confusion to others.

System compatibility isn't all you get with CDP peripherals. You also get microprocessor intelligence in our floppy disk, cartridge tape or RAM based storage systems.

That intelligence gives you remote control and failsafe operation for data acquisition applications ...comprehensive editing for data entry, graphics and data processing applications...file management and telephone data logging for data communications applications.

And Columbia Data peripherals also deliver performance. Dual port data transfer rates can be up to 19.2K baud, with storage capacity of 5.15 Mbytes on tape, 180 Kbytes on disk and 32 Kbytes in RAM. The buffered input and output ports can be set at different baud rates to match system requirements and constraints...or achieve data rate conversions.

With intelligent tape and disk systems priced under $1400 and semi-conductor storage under $700 in OEM quantity, you get that compatibility and performance at the right price.

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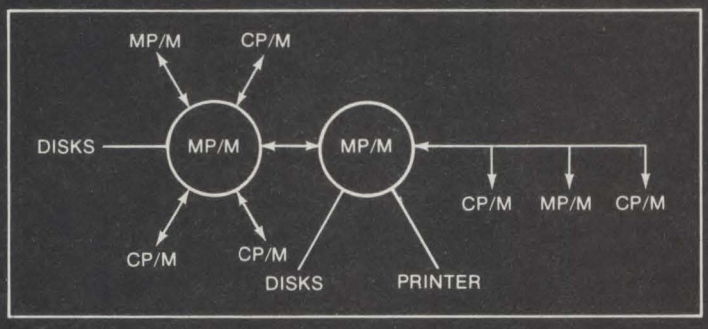
CIRCLE NO. 94 ON INQUIRY CARD

Microcomputer Networking From Digital Research

CP/NET™ brings CP/M® based networking to the microcomputer world.



Now you can use CP/M, Digital Research's "industry standard" operating system, in a network environment. In conjunction with MP/M™, our high-powered multi-user system, a variety of CP/NET configurations allow you to share your valuable resources among a number of masters running MP/M, and slaves running CP/M or MP/M.

- ***Share and transfer disk files***
- ***Share printers and consoles***
- ***Share programs and data bases***

As with all Digital Research products, CP/NET is compatible with a large variety of computer hardware, allowing a network to be constructed with any combination of shared memory, parallel I/O or serial links with any protocol.

For the office or the classroom, as well as the application development environment, contact Digital Research or your hardware supplier to find out how CP/NET can enhance your system's flexibility and convenience.

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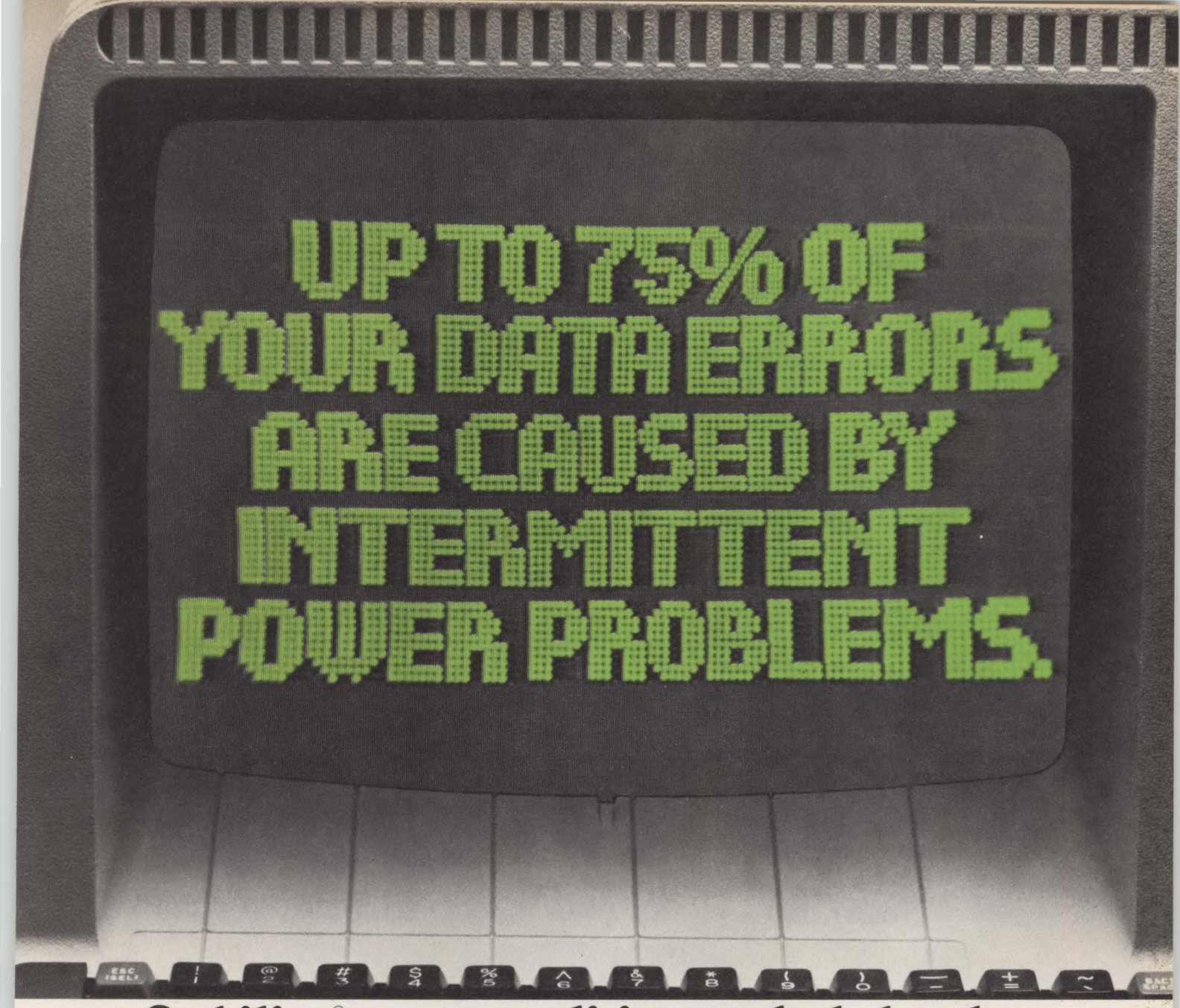
CIRCLE NO. 95 ON INQUIRY CARD



Stabiline® power conditioners slash data loss and errors.

Most data loss and errors are caused by electrical noise and line voltage fluctuations. Not by your hardware or software, as many people think.

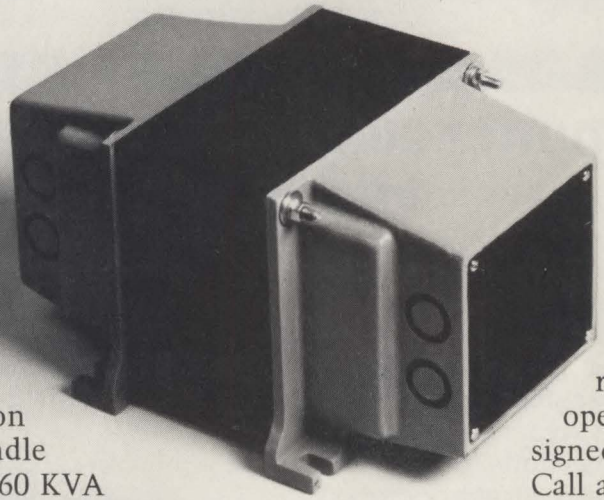
Stabiline® Automatic Voltage Regulators intercept these power irregularities before they can cause problems in microprocessors and computers. They virtually eliminate powerline variations before they create erratic operations, damage components or shorten equipment life.

Let us show you how to condition your power input with one of Superior Electric's many power conditioners. All designed with state-of-the-art technology to provide smooth, dependable power, in lightweight, low cost units.

Call Richard Pettey 203-582-9561 or write The Superior Electric Company, Bristol, CT 06010 today for a **FREE problem power troubleshooting manual and complete product information.**

Superior Electric

HIT'S the end of the line for noise.



When you want to get rid of trouble-makers like spikes, transients, and all that noise, riding on your power line, just pick up the phone and ask for a HIT.

HITs (High Isolation Transformers) can handle 1 KVA single phase to 60 KVA three phase. Common mode noise can be subdued by as much as 146 dB. Effective interwinding capacitance is as low as 0.0005 pF.

Your HIT can be wired for 120 VAC or 240 VAC input or output (240 or 480 VAC input on larger models) for use as a combination stepdown transformer and noise-isolation device. Every HIT is rated for 50 or 60 Hz operation and is designed to UL specs.

Call and tell us about your noise problems. We'll HIT you with the answers.

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CIRCLE NO. 97 ON INQUIRY CARD

Small Printers

Big Performers

OKIDATA MICROLINES

The Okidata Microline 80 printer set the standards for the home computer market. Now there are two new low cost Microlines for business use that have already won the praise of the most demanding OEMs—the Microline 82 and 83—setting new standards for performance, reliability and flexibility.

Using a tiny, seven-pin head that weighs less than four ounces, the Microline 82 and 83 produce sharp, crisp copy *and graphics* on plain paper, multipart forms. The unique head is driven bidirectionally by an elegantly simple mechanism at 80 cps in the Microline 82 and 120 cps in the 83. Short line seeking logic further boosts throughput by 80% over equivalent unidirectional printers.

The low mass, high performance Microline head is warranted for 200,000,000 characters.

OEM savings add up because there is no need to stock different models (and spares) for different customers. The Microline 82 and 83 include *both* RS232C serial and Centronics-compatible parallel interfaces as standard equipment. Both printers have friction platens that accept adjustable snap-on tractors and form controls that include vertical tab, top of form and a vertical format unit.

Since 1972, Okidata has been building the best. There are thousands of Okidata printers in computer rooms throughout the world bearing nameplates of the top OEMs in the industry. The same standards of excellence have been applied to the low cost Microline Series—two motors, rugged cast aluminum base, *no* compromises. Call today for details. Representatives throughout the world.

Unretouched, actual size samples of Microline printing. Standard, double width and condensed characters and 64 block shapes for charts, diagrams and illustrations.

OKIDATA

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609-235-2600

CIRCLE NO. 98 ON INQUIRY CARD

Okidata is a subsidiary of
Oki Electric Industry Company, Ltd.

First compare quality. Then compare cost.

Morrow Designs' 10 megabyte hard disk system: $3,695.

MORE MEMORY. LESS MONEY.

Compare Morrow Designs' DISCUS™ M26™ hard disk systems to any system available for S-100 or Cromemco machines. First, compare features. Then, compare cost per megabyte. The M26 works out to under $200 a megabyte. And the M10 is about half the cost of competing systems.

COMPLETE SUBSYSTEMS.

Both the M10 (8"), and the M26 (14"), are delivered complete with disk controller, cables, fan, power supply, cabinet and CP/M® operating system. It's your choice: 10 Mb 8" at $3,695 or 26 Mb 14" at $4,995. That's single unit. Quantity prices are available.

BUILD TO FOUR DRIVES.

104 Megabytes with the M26. 40+ megabytes with the M10. Formatted. Additional drives: M26: $4,495. M10: $3,195. Quantity discounts available.

S-100, CROMEMCO AND NORTH STAR.*

The M26 and M10 are sealed-media hard disk drives. Both S-100 controllers incorporate intelligence to supervise all data transfers through four I/O ports (command, 2 status and data). Transfers between drives and controllers are transparent to the CPU. The controller can also generate interrupts at the completion of each command ...materially increasing system throughput. Sectors are individually write-protectable for multi-use environments. North Star or Cromemco? Call Micro Mike's, Amarillo, TX, (806) 372-3633 for the software package that allows the M26 and M10 to run on North Star DOS. MICAH of Sausalito, CA, (415) 332-4443, offers a CP/M expanded to full Cromemco CDOS compatibility.

Morrow Designs' 26 megabyte hard disk system: $4,995.

AND NOW, MULT-I/O.™

Mult-I/O is an I/O controller that allows multi-terminal and multi-purpose use of S-100 and Cromemco computers. Three serial and two parallel output ports. Real time clock. Fully programmable interrupt controller. Designed with daisy-wheel printers in mind. Price: $299 (kit), $349 assembled and tested.

MAKE HARD COMPARISONS.

You'll find that Morrow Designs' hard disk systems offer the best price/performance ratios available for S-100, Cromemco and North Star computers. See the M26 and M10 hard disk subsystems at your computer dealer. Or, write Morrow Designs. Need information fast? Call us at (415) 524-2101.

Look to Morrow for answers.

MORROW DESIGNS

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*CP/M is a trademark of Digital Research Corp.
*Cromemco is a trademark of Cromemco, Inc.
*North Star is a trademark of North Star Computers, Inc.

CIRCLE NO. 99 ON INQUIRY CARD

New Products

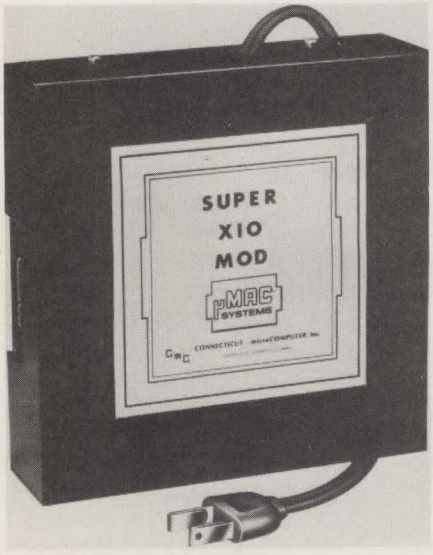
interfaces and controllers

Disk controller is Nova-compatible

The model 2601 disk controller is compatible with Data General Nova series software and Pertec model 3462 disk drives. The unit uses one or two disk drives and has 40M-byte mass storage. The model 2601 sells for $1800, with quantity discounts available. **Ardent Computer Products, Inc.,** Dobbs Ferry, N.Y. **Circle No 273**

Line-printer controller is PDP-11-compatible

The LPC 11 line-printer controller, which is compatible with PDP-11 Unibus computers, includes on-board DIP switches to allow easy selection of address and vector locations. The unit, including a 25-ft. cable, sells for $525, with OEM discounts available. **Computer Extension Systems, Inc.,** Houston, Texas. **Circle No 274**



System provides home security

The Super X-10 mod, intended for use with PET, Apple, TRS-80, KIM and other μcs in home or office security systems, controls as many as 256 remote devices by sending signals over house wiring to BSR remote modules. The module has eight digital inputs and eight digital outputs and can be connected to switches at windows and doors. The system is priced at $249 in single-unit quantities. **Connecticut microComputer, Inc.,** Brookfield, Conn. **Circle No 275**

DECsystem controller has six printing speeds

The LPC-20 plug-compatible controller, for DECsystem-10 and -20, handles 300 to 1800 lines per min. printers speeds. The unit employs two bipolar 2901 bit-slice μps and a 2910 μp control unit. In single-unit quantities, the LPC-20 is priced at $6500. **BDS Computer Corp.,** Menlo Park, Calif. **Circle No 276**

micros

SSM unveils Z80 CPU board

The CB2 Z80 CPU board for S-100-based systems operates at 2 MHz or 4 MHz by DIP switch selection and includes sockets for two 2716 or 2732 EPROMs or HM6116 2K RAMs. Separate run/stop and single/step switches permit system evaluation without a front panel. Other features include firmware vector jumps and an output port that controls eight extended address lines. Price is $654. **SSM Microcomputer Products,** San Jose, Calif. **Circle No 277**

Computers feature Ada Microengine

The ME1600 family of μcs incorporates the Ada Microengine μp. The unit features a 16-bit data path, 24-bit addressing, the Sentinel/24 bus and multiprocessor architecture. **Western Digital Corp.,** Newport Beach, Calif. **Circle No 278**

Announcing the New Line of Voltage Regulating Transformers from Jefferson.

Jefferson's Voltgard™ gives tight voltage regulation and isolation along with low harmonic content. This makes the Voltgard™ ideal for use on all kinds of process control equipment, NC machines and any electronic equipment where a low harmonic content is needed for suitable operation. Various sizes up to 11 KVA.

Jefferson's Electrogard™ provides a wide input range along with tight regulation and the ability of output voltage adjustment. The Electrogard™ has the capability of withstanding high inrush currents without total voltage collapse which is needed to start your equipment. The Electrogard™ comes in sizes up to 10 KVA.

Jefferson's Minigard™ protects your sophisticated computer systems, POS terminals, word processors and other electronic equipment from brownout, over-voltage, transients, common mode noise, transverse mode noise and the Minigard™ is also current limiting. Minigard™ can eliminate the need for a dedicated line. Various sizes up to 11 KVA.

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Litton

CIRCLE NO. 100 ON INQUIRY CARD

printers

Alphacom introduces matrix printer/plotter

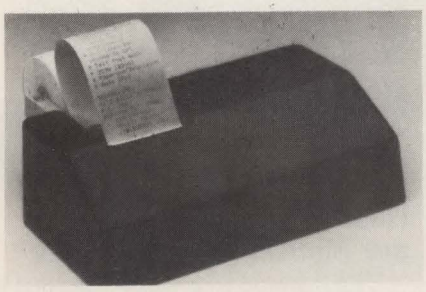
The Sprinter 40 matrix printer/plotter prints as many as 240 40-character lines per min. using a 280 × N dot matrix. User-selectable interfaces include parallel 7-bit ASCII and RS232C with baud rates as high as 9600. Print mode is 40 5 × 7 dot-matrix characters per line with 96 ASCII characters. **Alphacom, Inc.,** San Jose, Calif.

Circle No 279

Miniature printers print 80 cpl

The EUY-5E and EUY-5T miniature alphanumeric printers print 32, 40, 64 or 80 characters per line in a 7 × 5 dot matrix. The EUY-5E can print at 120 lpm, while the EUY-5T prints at 48 lpm. Each measures 7.68 × 2.56 × 2.76 in. and prints on 127-mm. 5-in.-wide paper. OEM prices are $145 for the EUY-5E, $196 for the EUY-5T. **Panasonic Co., Electronic Components Division,** Secaucus, N.J.

Circle No 280



Thermal printer includes serial interfaces

The PL-20EX 20-column thermal printer is available with RS232, 20-mA-loop and TTL serial interfaces. Other features include a 5 × 7 dot-matrix print head, 2½-lpi print speed, 91 ASCII characters, an invert mode and a paper-out sensor. The PL-20EX sells for $315 in single-unit quantities, and $261 in 100-unit quantities. **Telpar, Inc.,** Addison, Texas. **Circle No 281**

Matrix printer features push-button self-test

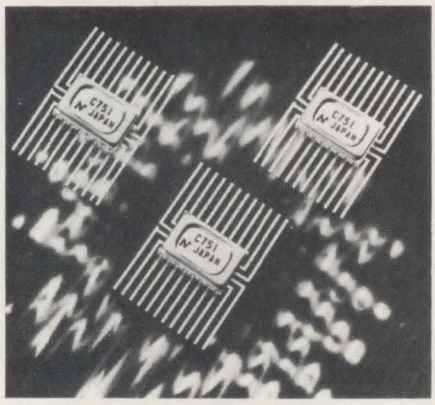
The PM-LC11 dot-matrix printer terminal incorporates a push-button self-test feature that enables electronic and mechanical functions to be tested. Other features include a nine-wire, bidirectional print head, parallel, RS232 or current-loop interface and 600-character FIFO buffer storage. Single-unit price of the PM-LC11, including a parallel interface and a 25-ft. cable, is $2307, with OEM discounts available. **Plessey Peripheral Systems,** Irvine, Calif. **Circle No 282**

New Products

components

Harris announces data-acquisition devices

The HI-5900 and 5901 data-acquisition devices are packaged in 32-pin DIPs. The HI-5900 provides eight differential input channels, and the HI-5901 has 16 single-ended input ports. Input signals are multiplexed and amplified into an output track and hold amplifier. Price is $110 in 100-unit quantities. **Harris Semiconductor,** Melbourne, Fla. **Circle No 283**



Magnetic disk drives use read/write IC

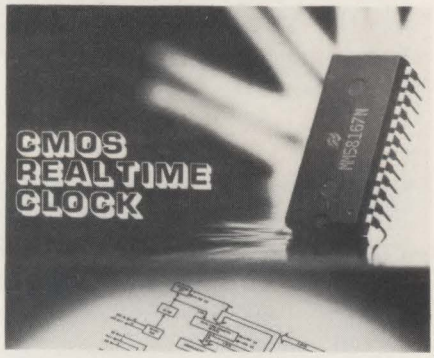
The μPC7518 monolithic bipolar analog read/write IC for magnetic disk drives can be used with as many as four independent heads. Each μPC751B circuit contains four write drivers, four read preamplifiers, an output line driver, head select logic and fault-monitoring circuitry. Each device has read, write and idle operating modes. It sells for $12 in 1000-unit quantities. **NEC Electron, Inc.,** Santa Clara, Calif. **Circle No 284**

Peripheral circuit has four I/O ports

The Z8036 Z-CIO device, a general-purpose peripheral circuit, combines counter/timer, parallel I/O and interrupt controller functions on one chip. It contains two independent, double-buffered, bidirectional, eight-bit I/O ports and a special-purpose four-bit port. The chip also has three independent 16-bit counter/timers, each with as many as four external access lines. The device sells for $29.25 in quantities of 10 to 99. **Zilog, Inc.,** Cupertino, Calif. **Circle No 285**

Mupac offers assembled drawer for connectors

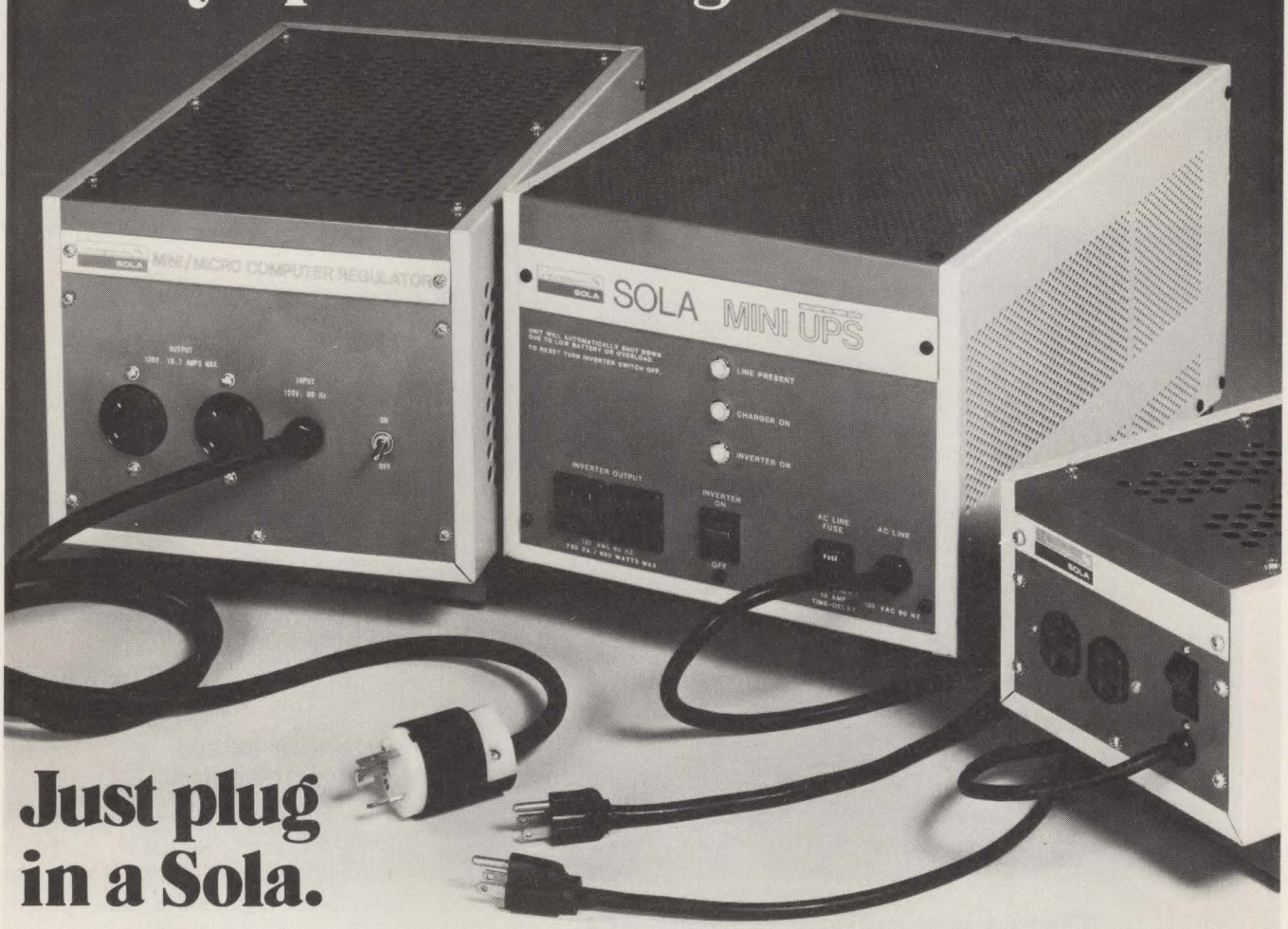
This fully assembled drawer contains connector backplanes, slides and handles. The backplanes are slotted between each connector to allow air movement through the backplanes. The slides enable the drawer to pull out of a 19-in. cabinet and pivot for access to the backplanes or panels plugged into the backplanes. The drawer packages as many as 26 of the vendor's wire-wrappable panels. The drawer sells for $1408.56 in quantities of one to nine. **Mupac,** Brockton, Mass. **Circle No 286**



Real-time clocks are Microbus-compatible

The MM58167 and MM58174 Microbus-compatible real-time clocks include bidirectional data buses to facilitate interface with μp systems. The MM58174 measures from tenths of seconds through months and calculates leap years. The MM58167 measures thousandths of seconds through months and has alarm functions. In quantities of 100, the MM58174 sells for $8.50, the MM58167 for $9.25. **National Semiconductor,** Santa Clara, Calif. **Circle No 285**

Want reliable power for office electronics without costly special wiring?



Just plug in a Sola.

With minicomputers, terminals, word processors, disk memories and high-speed printers, you often get instructions to put in a "dedicated" power line. But, instead of breaking through walls, cutting trenches in floors, laying special conduit, pulling lots of wire and adding more breakers and switchgear to get reliable power, why not simply plug a portable Sola Power Protector into the outlet that's already there?

Dedicated lines can add anywhere from $1200 to $8000 or more per machine, even in new construction. For a fraction of that cost, a Sola Micro-Minicomputer Regulator not only replaces the dedicated line but does what dedicated lines can't do. It raises and lowers voltage to compensate for line fluctuations and brownouts. It blocks out electrical noise, and destructive power dips or surges. Our new Mini-UPS goes one step further. Its built-in battery maintains power when your electric utility fails. This keeps your electronics running smoothly until your generator comes on line. Both units are available in 60 Hz or 50 Hz.

Dedicated lines, at best, minimize power disturbances that are caused by other equipment in your building. Sola Power Protectors guard you against all kinds of power line disturbances regardless of where they originate. Check this chart to compare effectiveness.

	spikes and faults	dips and surges	line noise		Brownout	Blackout
			common-mode	transverse mode		
	momentary sharp voltage peaks or split-second power outages	short-term high or low voltages due to load start-up or shut-down	Unwanted voltages or frequencies due to bad grounding, switching, or radio-type interference		Planned voltage reductions in response to high demand	Total loss of line power
			line-to-ground interference	line-to-line interference		
Dedicated Line (with dedicated ground)	some, internal only	some, internal only	some, internal only	some, internal only	No	No
Ultra-Isolation Transformer	Yes	No	Yes	No	No	No
Sola Micro-Minicomputer Regulator	Yes	Yes	Yes	Yes	Yes	No
Sola Mini-UPS	Yes	Yes	Yes	Yes	Yes	Yes

Don't go through another day risking electronic malfunction due to unreliable power. Talk to your local Sola Electric representative or distributor. Or contact Sola Electric, 1717 Busse Road, Elk Grove Village, IL 60007. (312) 439-2800. We're the people who invented power protection 50 years ago.

The Power Protectors

A UNIT OF GENERAL SIGNAL GS

SOLA

CIRCLE NO. 102 ON INQUIRY CARD

components

Augat announces horizontal card cage

This horizontal card cage enables users to combine analog and digital circuits within one enclosure, and allows combining of wire wrap with stitch-weld and stitch-wire boards or PC cards. Guide separator locations are optional to permit mixing single-, double- and triple-width boards. Prices for one to four pieces range from $248.75 to $644.50. **Augat Inc.**, Attleboro, Mass. **Circle No 288**

Controller supports four DMA channels

The HD46504/MC6844 DMA controller supports four DMA channels and has a 1M-byte-per-sec. transfer rate. The controller can be used in any μp system. The HD46504/MC6844 is priced at $11.85 in quantities of 100. **Hitachi America, Ltd.**, Arlington, Ill.

Circle No 289

Wiring plane modules come in six sizes

These wiring-plane building blocks, available with 18, 36, 72, 108, 216 or 324 sockets, contain 16-pin sockets with wire-wrap tails and re-wired power connections to pins 8 and 16 of each socket. Each block contains 18 sockets and occupies 2.45 × 4.14 in. Price is approximately $44 per block. **EECO Inc.**, Santa Ana, Calif.

Circle No 290

Extender board debugs circuitry

This 18-in. extender board, designed for the IBM Series/1, enables users to debug their own circuitry. It includes four plug-in socket adapters. The extender board is priced at $395 in single-unit quantities. **MDB Systems, Inc.** Orange, Calif. **Circle No 291**

Interface accommodates 95 16-pin IC chips

The EPS 272-38-15 universal wire-wrappable IC board, designed for use with the Intel SBC 80/10 and 80/20 μc systems, plugs into the SBC 604 modular cardcage/backplane bus system. The board includes power interface connections for ±5V and ±12V DC. It accommodates as many as 95 16-pin IC chips or an equivalent combination of 14, 16, 18, 22, 24, 28 or 40-pin IC chips. Price ranges from $2 to $3 per IC position. **Garry Manufacturing Co.**, New Brunswick, N.J. **Circle No 292**

WHEN IT COMES TO PUTTING IT ALL ON DISPLAY, THE ORION-60/S4 STANDS ALONE.

Magnavox combines the superior display and control features of the plasma-panel-based Orion-60 terminals with the powerful S4 Micro-Computer System.

The result is a stand alone graphics system that allows you the freedom to develop a wide variety of graphics application and development programs—while maintaining complete control over program storage, program-generated data, library routines and other facilities.

The Orion-60 display terminal offers full graphics with floppy-disc storage, as well as optional rear-projection functions. It lets you create your own displays and enter data by simply touching the screen with your finger. So you can program your own character sets and generate vectors of any length to absolute coordinates. And because the Orion-60 is plasma-based, you'll get bright, high-contrast images free of jitter or distortion.

The S4 Micro-Computer has system software with development capabilities that are as good or better than those found in many larger computer systems.

Features include CP/M* 8080 system utilities, Fortran with 32K RAM, and a full range of graphic utility routines including window, zoom, sub-image movement and rotation.

The Orion-60/S4.

For a demonstration, call or write Tyler Hunt at Magnavox Display Systems, 2131 South Coliseum Boulevard, Fort Wayne, Indiana 46803, (219) 482-4411.

Magnavox
DISPLAY SYSTEMS

**CP/M is a trademark of Digital Research.*

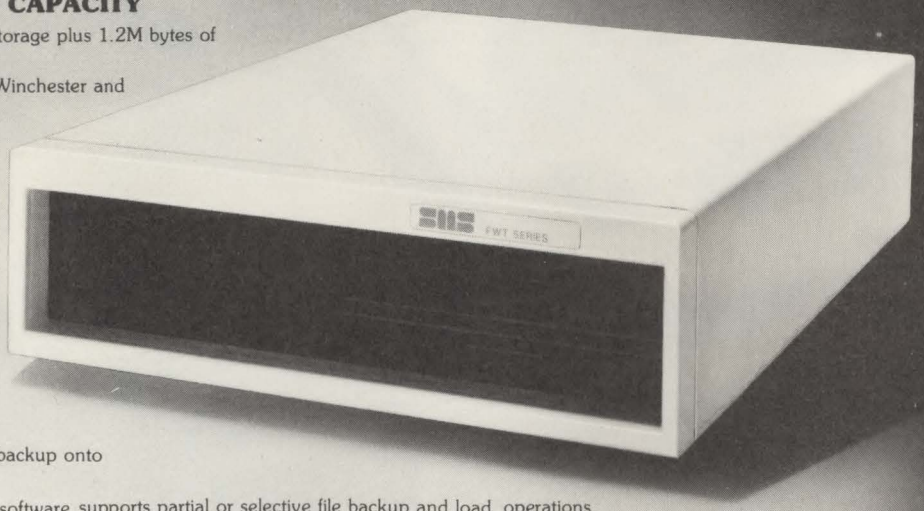
CIRCLE NO. 104 ON INQUIRY CARD

SMS' FLINCHESTER DISK SYSTEM FOR DEC® COMPUTERS

Winchester plus floppy disk storage and latest controller technology establishes new standard for DEC compatible disk storage.

SMS Flinchester peripherals provide 8.9M bytes of 8" Winchester disk storage and 1M bytes of floppy disk storage for DEC's PDP-11 and LSI-11 computers! In only 5¼" of table top or rack space you also get the following benefits:

AVAILABLE SOON!!
Look for 20M byte and 30M byte Flinchester systems in the near future.



MAXIMUM PERFORMANCE AND CAPACITY

- **8.9M bytes** of formatted Winchester disk storage plus 1.2M bytes of usable floppy disk storage.
- Fast data transfer of **427K bytes/sec** for Winchester and 63K bytes/sec for floppy.

INDUSTRY COMPATIBLE

- Automatic recognition of DEC RX01, RX02 and **IBM** diskette formats.
- Plug compatible with DEC PDP-11 Unibus and LSI-11 Q-bus.
- Increases performance of DEC's RT-11 and RSX-11M operating systems.
- Emulates DEC's RX02 floppy disk system.

CONVENIENT "MINUTE-PER-MEGABYTE" BACKUP

- Only **40 seconds** required for Winchester backup onto 1.2M byte floppy diskette.
- Standard RT-11, RSX-11M and SMS utility software supports partial or selective file backup and load operations.

UNSURPASSED RELIABILITY

- Modular construction and minimal parts count insure **long MTBF** and 15 minute MTTR.
- Off-line system and drive test.
- On-board **self test** verifies correct system operation.
- CRT initiated **super diagnostics** ease system test and fault isolation.
- **Automatic bootstrap** tests CPU, memory and DMA operation before software loading.

EXCEPTIONAL DATA INTEGRITY

- Winchester disk **flaw management** deletes permanently flawed disk areas.
- Automatic **error retry** recovers soft or temporary errors.
- **ECC (Error Correction Code)** recovers corrupted data without system shut down.
- Patented PLL circuitry requires no field adjustments and provides maximum margin for worst case bit shifted data recovery.

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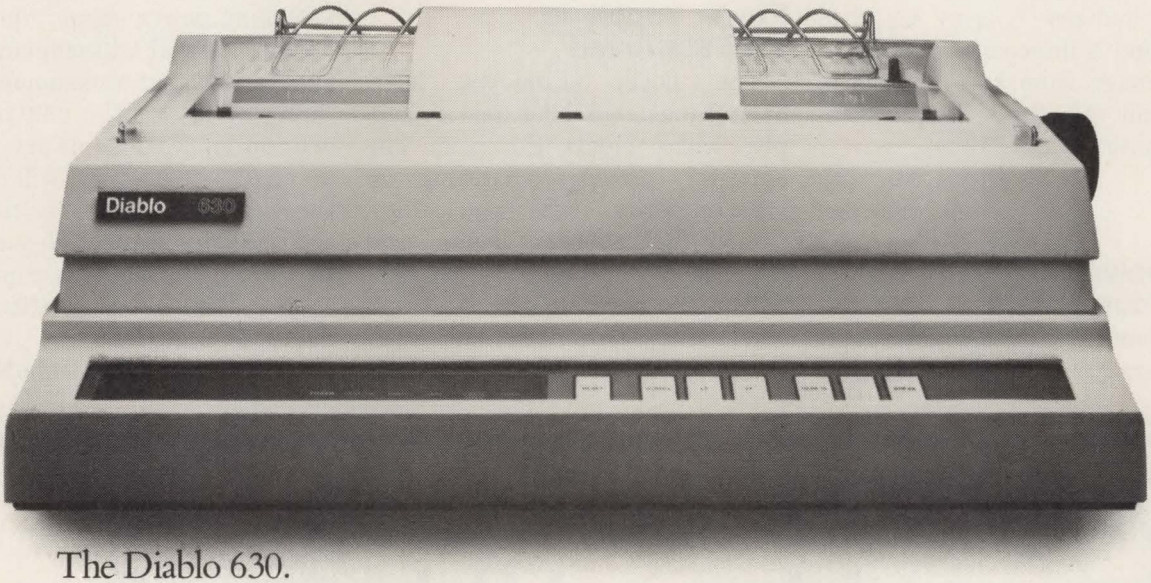
(415) 964-5700 TWX: 910-379-6577

CIRCLE NO. 105 ON INQUIRY CARD

If you want a choice in print wheels, there's only one choice in printers.

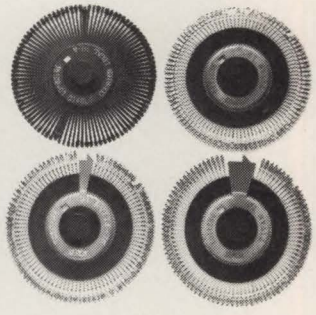


The Diablo 630.

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

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

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



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

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

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

To Diablo 630 printers.

Diablo Systems

XEROX

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CIRCLE NO. 106 ON INQUIRY CARD

power supplies

Switching power supplies have 120W output

The series 4120 switching power supply contains two output channels, each of which terminates on an unbreakable barrier strip. Each output channel achieves a minimum efficiency of 70 percent, with full power of 120W from 0°C to 50°C,with no derating. Input voltage is 90V to 130V AC and 180V to 260V AC, 47 to 450 Hz and is internally strappable. Prices range from $115 to $235 in single-unit quantities. **Power General,** Canton, Mass.

Circle No 293

UPS powers small computers

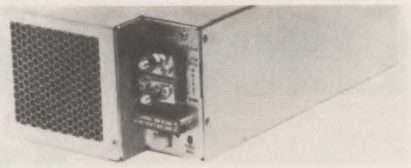
The model DSU720 uninterruptible power system for small business computers, PABX, process-control and other μp-based equipment can be supplied with battery power from 5 min. to more than 4 hr. Options include filtering that allows operation in critical RFI/EMI environments and a static transfer switch that operates the bypass in as little as 1 msec. Price is $2255. **Gould-Deltec,** San Diego, Calif.

Circle No 294

Power supply is VDE approved

The model XL200-3501 200W open-frame switching power supply, which meets European VDE approval, provides switching for medium-power data- and office-processing systems. The unit supplies power on four outputs—+5V at ±1 percent primary output and auxiliary outputs of −5V, ±12V at 9 percent. U.S. prices are $385 in single-unit quantities and $300 in quantities of 100 to 249. **Boschert, Inc.,** Sunnyvale, Calif.

Circle No 295



Five-output supply has 850W of power

The model PM 2679 five-output switching power supply, developed for medical and telecommunications applications, has a maximum power rating of 850W. The unit operates over an input range of 92V to 138V AC or 184V to 250V AC, will regulate through line dips to 80 or 160 VRMS and provides regulated outputs of 2V to 60V DC. The unit is priced at $1190. **Pioneer Magnetics, Inc.,** Santa Monica, Calif.

Circle No 296

Smart screen size: 15"

15-inch display heads the Executive 80™ list of smart ergonomic features.

When you look at the business end of a terminal, you expect to see a clear, crisp display. That's exactly what you'll see on the Executive 80™ standard 15-inch display. Executive 80 gives you a viewing area that's 25% larger than the competition's 12-inch screens — at no extra cost. Since a larger screen is easier to read, you can expect increased throughput, fewer errors, and greater comfort for your operators.

Hazeltine's attention to ergonomic detail doesn't stop with the larger screen. You can order the tiltable screen with detached keyboard for greater operator convenience. And the *Enhanced Video Option* features smooth scroll, selectable double-size characters, and switching between 80- or 132-column format from the keyboard.

Put Executive 80's big screen to the test. You'll agree it's the smart way to look at data.

Call today and we'll send you additional literature and pricing information. Call toll-free (800) 645-5300 — in New York State call collect (212) 752-3377.

CIRCLE NO. 108 ON INQUIRY CARD

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Computer Terminal Equipment
Greenlawn, NY 11740
(516) 549-8800

Hazeltine Executive 80

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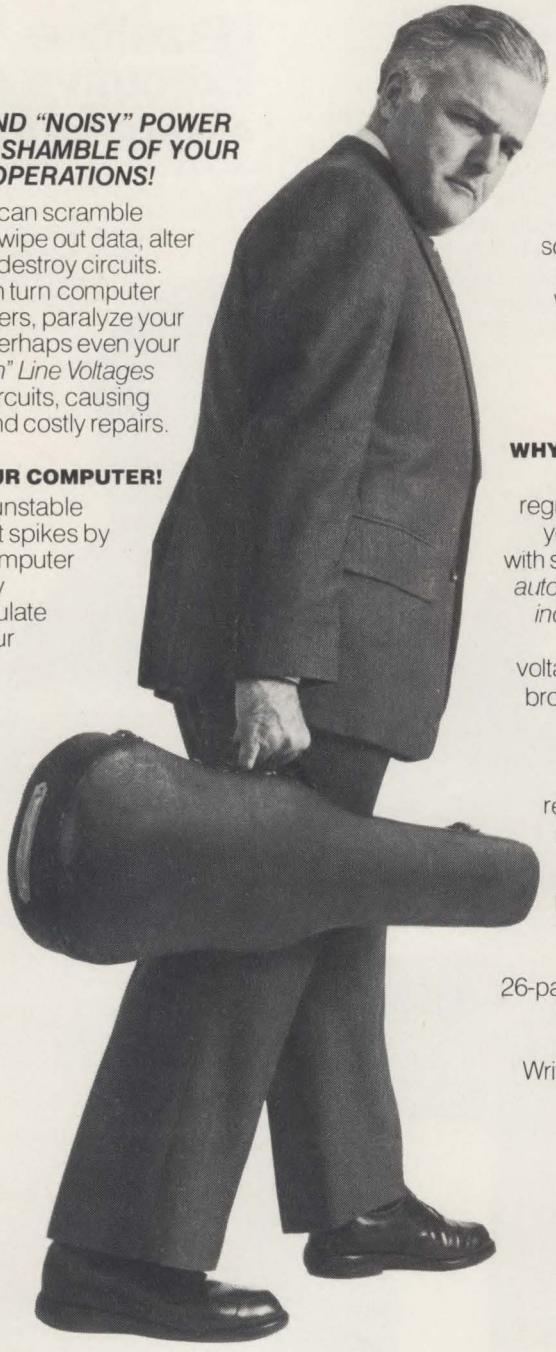
"Protection is my business...
My ISOREG® Computer Power Modules
PUT AN END TO POWER-RELATED COMPUTER PROBLEMS"

Says Emil Rechsteiner, President of Frequency Technology, Inc.



UNSTABLE AND "NOISY" POWER CAN MAKE A SHAMBLE OF YOUR COMPUTER OPERATIONS!

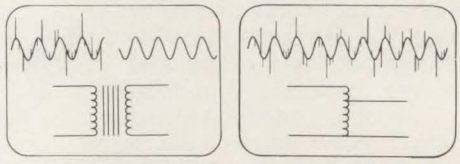
Voltage Spikes can scramble computations, wipe out data, alter programs and destroy circuits. *Brown-outs* can turn computer runs into disasters, paralyze your equipment—perhaps even your business! *"High" Line Voltages* can burn out circuits, causing interruptions and costly repairs.

PROTECT YOUR COMPUTER!

. . . from noisy, unstable power. Filter out spikes by isolating the computer from "raw" utility power and regulate voltages for your computer!

WHY ISOLATE?

An isolation transformer electrically separates the computer from the utility power and filters out voltage spikes that scramble computations, wipe out data, even destroy circuits.

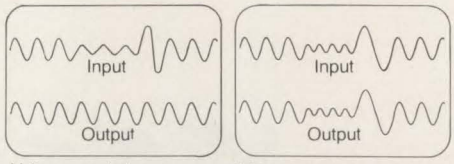


Line-to-load isolation shields computer from sharp, destructive voltage spikes.

Without isolation computer is exposed to spikes even when power is supplied by voltage regulator.

WHY REGULATE?

A voltage regulator powers your computer with stable voltage *automatically* and *indefinitely* even when utility voltages droop to brown-out levels.



Voltage regulation ensures stable voltage during brown-outs or voltage surges.

Without regulation, voltages sag and surge even when power is supplied by isolation transformer.

DON'T SETTLE FOR HALF PROTECTION!

An isolation transformer filters out spikes but does NOT regulate voltages; a voltage regulator stabilizes voltages but does NOT filter out voltage spikes. Don't spend a penny on half-protection! Get full protection . . . from ISOREG!

ISOREG = ISOLATION + REGULATION

ISOREG Computer Power Modules put an end to power-related computer problems! Let me send you our new 26-page brochure on *ISOREG COMPUTER POWER MODULES* rated from 125VA to 25kVA single-phase, 7½ to 75kVA three-phase, 60 Hz and 50 Hz.

Write me, or call our toll free number, or use the Reader Service Card of this magazine to obtain our new brochure, free.

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CIRCLE NO. 109 ON INQUIRY CARD

interactive terminals

Terminal emulates Burroughs TD830

The model 2830 video display terminal emulates the Burroughs TD830. The 2830 incorporates concatenation with auto bypass, which allows a powered-down terminal in a concatenated string to be automatically bypassed without recabling around the terminal. Other features include multiple page operation, forms mode, tabulation, format function, editing functions and data-highlighting schemes. Price of a basic 2830 is $2950 in single-unit quantities. **Delta Data Systems Corp.,** Cornwells Heights, Pa.

Circle No 297

Zenith announces video display terminal

The Z19 has a 12-in. diagonal screen with a 24-line × 80-character format, plus a 25th user-status line. The unit includes interfaces to EIA RS232 ports at speeds of 110 to 9600 baud. The Z19 sells for $995. **Zenith Data Systems,** Glenview, Ill.

Circle No 298

Large-print terminal performs graphics

The "Director" large-print video terminal uses an ISC terminal with special adaptations and software that provide characters eight or 16 times higher and six times wider than standard display characters, in addition to ¼- and ½-in. sizes. Other features include a flashing capability and the ability to plot graphs and perform other graphic functions. Prices begin at less than $4000. **Mystic Valley Engineering Co.,** Winchester, Mass.

Circle No 299

Work station has built-in Multibus

The CD100 desk-top integrated work station includes an intelligent terminal with advanced video features, a built-in card cage that holds Intel Multibus or DEC LSI-11 Q-Bus cards and, optionally, two 5¼-in. minifloppy-disk drives. The work station is compatible with all Multibus and LSI-11 family cards and software. The unit's card cage can accommodate as many as six plug-in Multibus cards, or 14 double-height/7 quad-height LSI-11 modules. Prices start at $3195, with OEM discounts available. **Callan Data Systems,** Westlake Village, Calif.

Circle No 300

BEEHIVE
EMULATES
BURROUGHS
TD SERIES TERMINALS

now shipping MICRO 4400

We've made the best better! Among the many features of the MICRO 4440 are all of the following: 16 programmable function keys; interfaces include RS232; Burroughs TDI* and current loop; graphic line drawing capability; configurable block size; cluster or standalone operation; no controllers required; multiple serial and parallel printer interfaces; shared peripheral capability; background print capability; automatic printer queuing; configuration download capability; internal communications diagnostics; expandable RAM; time of day clock and error logging capability . . . and many, many more.

*May be trademark of Burroughs.

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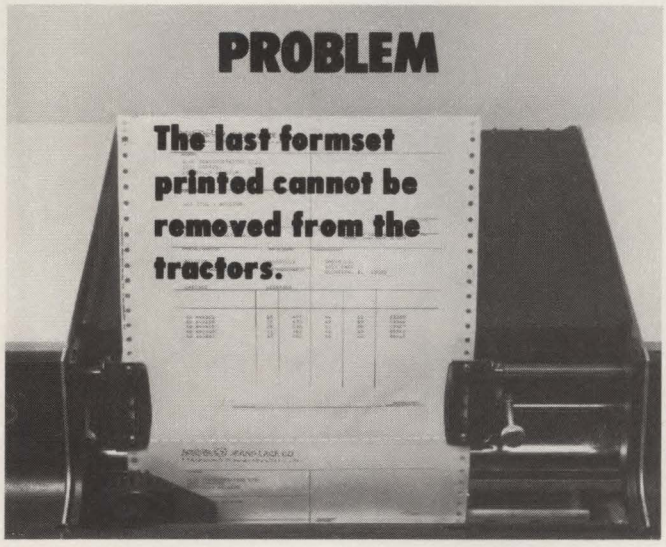
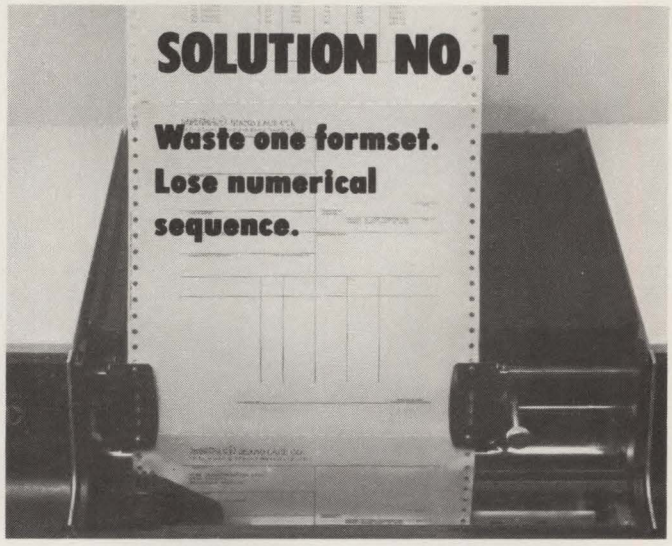
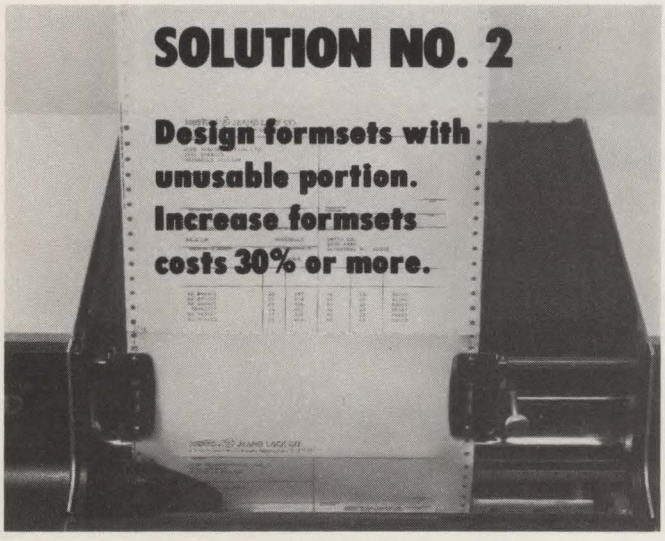
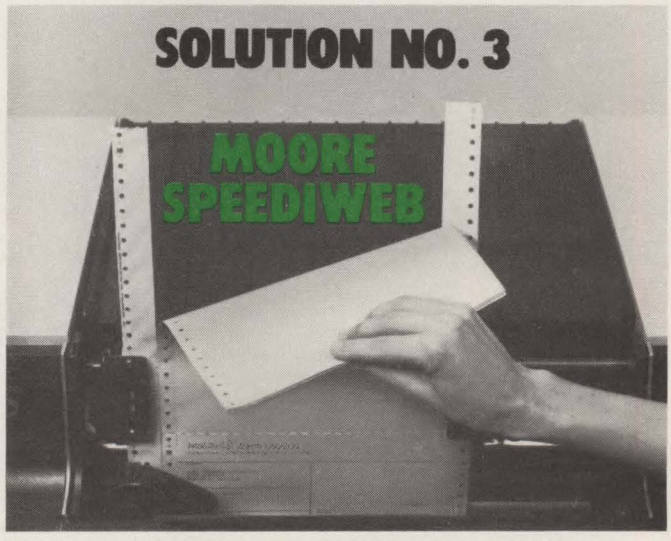
CIRCLE NO. 111 ON INQUIRY CARD

SPEEDIWEB SOLVES THE DEMAND PRINTING PROBLEM WITHOUT WASTE









Permits immediate removal of last printed formset with no waste, while margins remain in tractors to advance next one. Individual parts of the formset can be separated at any time after removal from the printer. An audit copy can be provided if desired. Available 3½″ to 11″ deep and 11″ to 16″ wide.

Gentlemen:
Please send me samples and information about Speediweb.

Name _____

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Company Name _____

Address _____

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Phone _____

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CIRCLE NO. 112 ON INQUIRY CARD

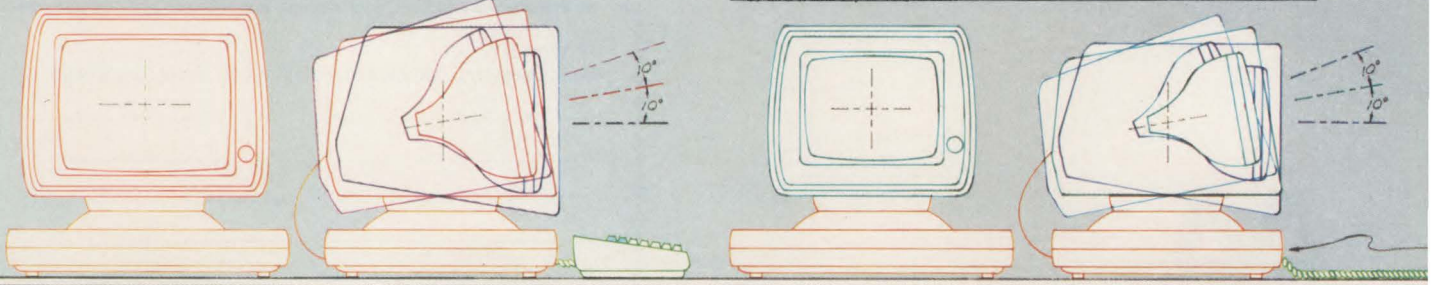
THE ZENTEC SERIES 8000 INTELLIGENT TERMINALS

The first Intelligent Terminal designed specifically for OEMs to configure and for people to use.

THE ZENTEC 8002 IS A COMPLETE INTELLIGENT TERMINAL COMPRISED OF THREE SEPARATE MODULES, THE 8201 LOGIC BOX, THE 8302 (15") VIDEO MODULE AND THE 8401 KEYBOARD.

WITH THE 8002, THE 15" CRT IS BALL-JOINT CONNECTED TO THE TOP OF THE LOGIC BOX AND PROVIDES A CONVENIENT 20° ANGLE OF TILT AND A 60° ANGLE OF SWIVEL.

THE ZENTEC 8001 IS SIMILAR TO THE 8002 WITH THE SUBSTITUTION OF A 12" VIDEO MODULE. THE NON-GLARE, HIGH RESOLUTION CRT SURFACE WITH A WHITE, GREEN OR AMBER PHOSPHOR IS OFFERED TO REDUCE OPERATOR EYE FATIGUE.



With the Series 8000, Zentec successfully re-defines the words Human Engineering. Never before has there been a more powerful, more flexible, more operator-oriented video display terminal designed expressly for OEMs and system integrators.

The first thing you see on the CRT is the almost completely glare-free surface for reduced operator eye fatigue. The single knob right up front is used to turn the system on or off and to control the level of brightness. While a P31 green phosphor is standard, white or amber phosphors may be optionally provided. Character resolution and contrast go easy on the eyes, too, and wait until you see the character size on our 15" screen!

Configurability AND Flexibility
With Zentec's unique multiple-module concept, the 8000 may be easily configured with either a 12- or 15-inch CRT with full swivel and tilt, up to three snap-in printed circuit boards in the logic box for fast MTTR, and a wide variety of detachable keyboard styles. A single PCB is standard with the 8000, and the OEM may add one or two of his own PCBs. The standard logic contains Zentec's unique mini-computer-like bus architecture under the control of a powerful microprocessor. Hardware for synchronous or asynchronous communications and printer I/O is standard. The Zentec 8000 may be configured with 16, 32, or 64KB of RAM and 4, 8, 12, or 16KB of ROM or PROM. That's flexibility!

The microprocessor-controlled detached keyboard of the 8000 is canted 11° for operator comfort and the keys may be stepped, or optionally, sculpted.

Through Zentec, all OEMs can now offer a unique private label product so finely tuned to their customers' needs that it achieves the highest level of man-machine interface. For the direct story on the Zentec 8000, call us at (408) 727-7662, or write for our brochure.

ZENTEC

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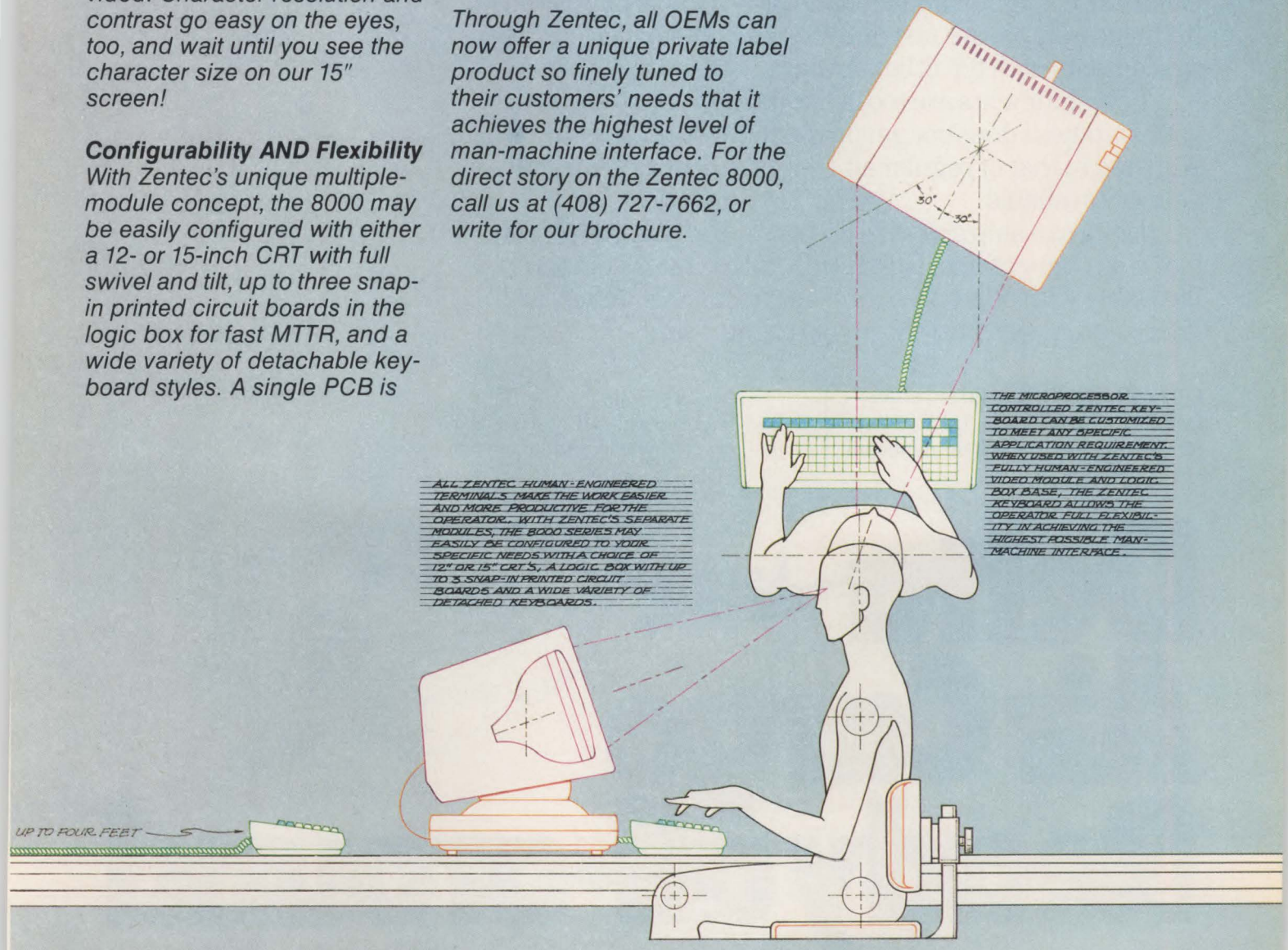
(408) 727-7662



CIRCLE NO. 113 ON INQUIRY CARD

Who's ready for top priority shipments?

Delta Air Express guarantees to get your shipment on the flight specified.

Your shipment gets into your consignee's hands sooner. Your Delta Air Express shipment gets priority boarding on all flights to help assure fast delivery. And Delta has interline agreements with ten other airlines.

Few shipments are too large and none are too small. If your shipment does not get on the flight specified, rate will be adjusted to that of regular air freight. Local pick-up and delivery available.

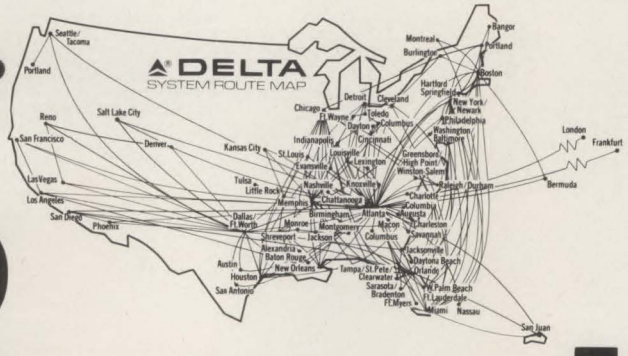
Delta can ship anywhere in the U.S. or the world, via interline connections. Delta Air Express rates compare favorably with other air express services. For details, call your nearest Delta air cargo representative.

Other Delta Air Cargo services:

Delta Air Parcel Service. Up to 25 lbs. $15 door-to-door. 10 package minimum.

Delta 3-D™ Air Freight. 40% off regular freight rates on high density shipments.

Delta Air Cargo Ready all-around

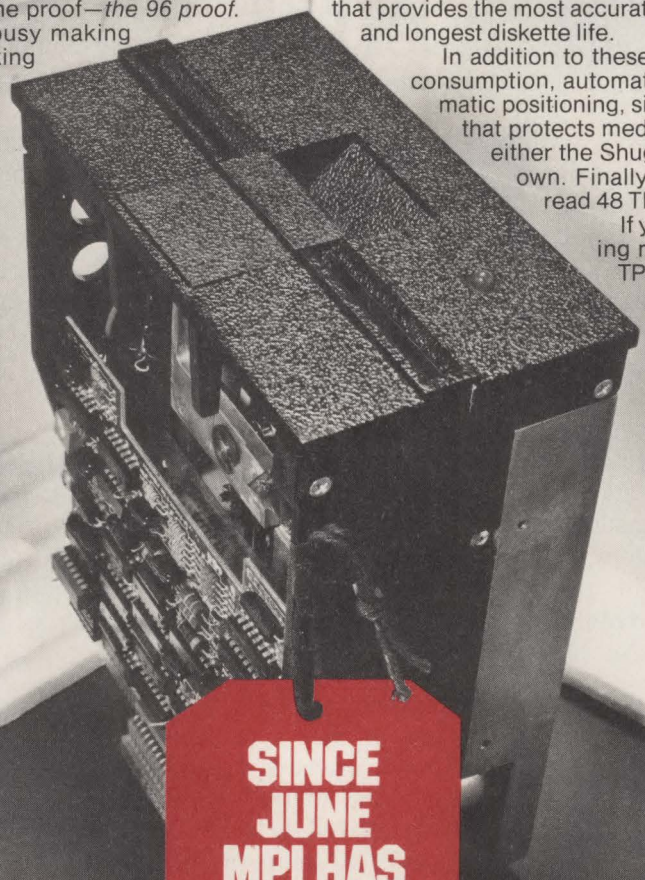


96 PROOF

It's pretty powerful stuff. But before you start to wonder if success has gone to our heads, let us assure you we're not seeing pink elephants. MPI's high performance mini floppy disk drive in the new 96 TPI configuration is a working reality. We've got the proof—*the 96 proof.*

While others have been busy making promises, we've been making deliveries. Over 2500 a month and growing fast. Response has been outstanding. But that's no surprise. Because unlike most other floppy disk drives, ours were designed for upgrading.

By tightening tolerances we doubled capacity, the design concepts are the same so you get a field proven product. You also get our unmatched package of features.



Features like a patented stepper band head positioner that's 5 times faster and virtually frictionless. A head that's centered between two parallel rods to eliminate radial positioning errors and a clutch mechanism that provides the most accurate positioning, within .0008" and longest diskette life.

In addition to these plusses are lower power consumption, automatic diskette ejection, automatic positioning, single PCB, and front door that protects media from foreign matter in either the Shugart configuration or our own. Finally, our 96 TPI drives can read 48 TPI diskettes.

If you're interested in hearing more about proven 96 TPI technology, MPI has a sales representative who will be glad to pour over details with you. Just give us a call and tell us when to set 'em up.

MPI Is 96 TPI

SINCE JUNE MPI HAS DELIVERED OVER 10,000 96 TPI DRIVES

MPI

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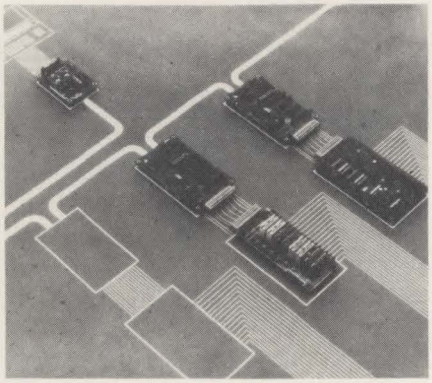
CIRCLE NO. 114 ON INQUIRY CARD

N.C.C. BOOTH 5109

New Products

data acquisition



Remote I/O system supports 127 stations

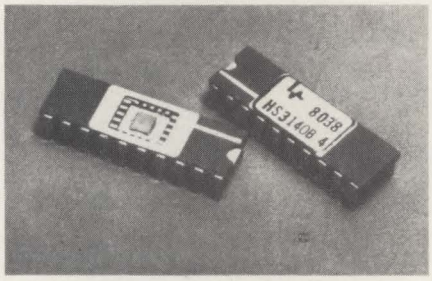
The RIOS remote I/O system operates under control of individual remote stations using ROM-stored programs, with the RIOS controller issuing all supervisory commands, or under master control by a user-supplied computer. Each RIOS remote station accommodates 16 I/O lines, or as many as 127 stations. Price is $1249, including a translator board for interfacing RIOS to a user's computer and two station modules or remote interface adapters, a mounting board, A/D and D/A converters and cables. **IR Crydom,** El Segundo, Calif. **Circle No 309**

Sanlab offers analog scanner

The SL104 10-channel analog scanner connects directly to input sensors and extracts intermixed μV signals in the presence of common-mode voltages as high as 310V. The unit accepts random combinations of grounded or ungrounded thermocouples, voltages and currents, and it references, scans, amplifies, filters and controls the selected signal. Other features include a true isothermal reference junction, automatic thermocouple break detection, zero stabilization and optional remote span calibration. **San Diego Instrument Laboratory.** San Diego, Calif.
Circle No 310

Second source to DAC-08 introduced

The AD DAC-08 monolithic D/A converter replaces the industry standard DAC-08. It has a typical current-output settling time of 85 nsec., and 135 nsec. maximum. Other features include fixed or variable reference operation, CMOS- or TTL-compatible inputs and a high-impedance current output that can drive a resistive load directly. Prices start at $2.05 in 100-unit quantities. **Analog Devices,** Norwood, Mass. **Circle No 311**



Monolithic D/A converter is linear to 14 bits

The HS3140 14-bit CMOS multiplying D/A converter integrated in a single monolithic chip has resolution and linearity of 14 bits and 0.003 percent, respectively. The converter accepts AC or DC reference voltages over a ±25V range and multiplies in four quadrants. Its digital inputs are latch-up-protected and TTL- and CMOS-compatible. HS3140 is offered in two linearity grades and two temperature-range versions. Prices range from $32 to $99. **Hybrid Systems Corp.,** Bedford, Mass. **Circle No 312**

A/D converter achieves .0087% linearity

The model ADC-881 8-bit A/D converter employs a statistical linearization technique to achieve a linearity of .0087 percent. Maximum conversion time is 1.5 μsec. Other features include ±5V analog-input range, offset binary coding, an output over-range logic signal and ±30 ppm/°C maximum temperature coefficient. Price for the ADC-881 is $445 in quantities of one to nine. **Datel Intersil,** Mansfield, Mass.
Circle No 313

Data scanner produces alarm on exceptional data

The model 1100 μp-based data scanner provides continuous alarm status monitoring of as many as 40 channels in less than 1 sec. The 3½-digit scanner compares each input to programmed high and/or low limits. Any out-of-limit condition will illuminate the respective channel alarm indicator, activate an alarm relay and output information to external recording or storage devices. The unit is remotely programmable with battery backup for fast and slow scan rates. **United Systems Corp.,** Dayton, Ohio.
Circle No 314

National Semi offers 8- and 12-bit converters

The Microdac series 8- and 12-bit CMOS four-quadrant multiplying digital-to-analog converters interface to 8080, 8084, 8085, Z80 and other μps. Both series contain two input registers that can be used in double-buffered, single-buffered or flow-through modes. Prices range from $4.50 to $17.25 in 100-unit quantities. **National Semiconductor,** Santa Clara, Calif.
Circle No 315

Monolithic ADC offers 5½-digit resolution

The AD7555 monolithic CMOS integrating analog-to-digital converter offers 4½- or 5½-digit resolution. Other features include low scale factor drift of ±0.2 ppm/°C, 50-mW maximum power dissipation, automatic calibration capability and multiplexed BCD outputs for displays. Prices start at $19.95 in 100-unit quantities. **Analog Devices Semiconductor,** Wilmington, Mass. **Circle No 316**

THE 8" WINCHESTER WITH 23 MB CAPACITY, SA4000 INTERFACE

...AND THE MOST RELIABLE NAME IN DISK DRIVES.

This remarkable new 8-inch Winchester disk drive, from Fujitsu, has a great deal going for it! Like immediate availability. Selection of megabyte capacity. Competitive OEM pricing. And a choice of two standard interfaces.

You can get an 11 MB and a 23 MB drive with SA4000 interface (LSI embedded controller will be available July '81), or a 48 MB and a 84 MB drive with SMD interface—all with very fast access times. And as if that weren't enough, they also have beltless, direct drive DC spindle motors; integral data separators; absolute-filtered drive enclosures and actuator shipping restraints. What more could you ask?

We know! When can we get one? The answer is right now—there's no waiting! For an evaluation unit, or product literature, contact the Marketing Director, Fujitsu America, Inc., 2945 Oakmead Village Court, Santa Clara, California 95051. Telephone 408-727-4300, Telex 171-182, TWX 910-338-0047.

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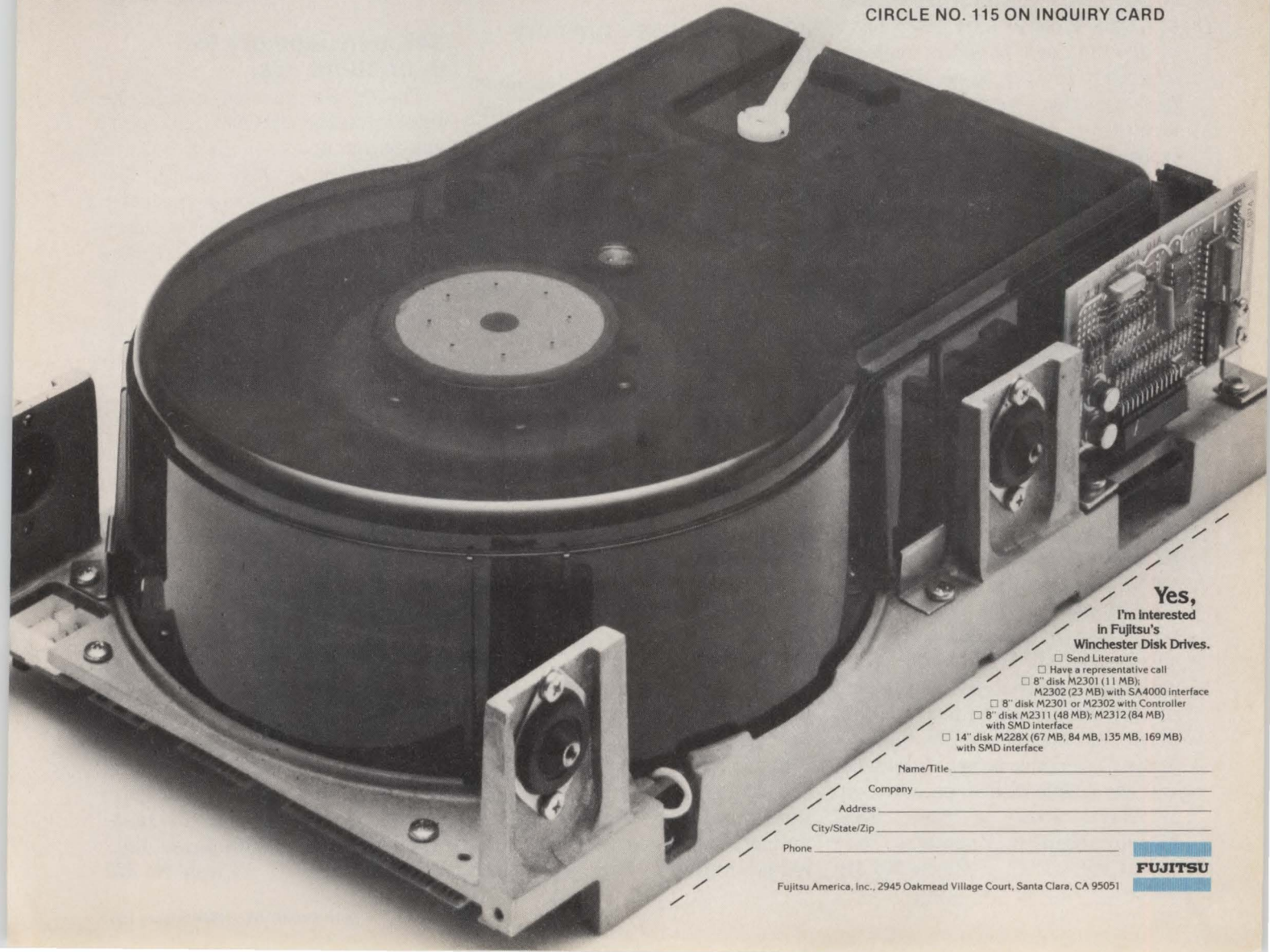

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- ☐ 8" disk M2301 or M2302 with Controller
- ☐ 8" disk M2311 (48 MB); M2312 (84 MB) with SMD interface
- ☐ 14" disk M228X (67 MB, 84 MB, 135 MB, 169 MB) with SMD interface

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New Products

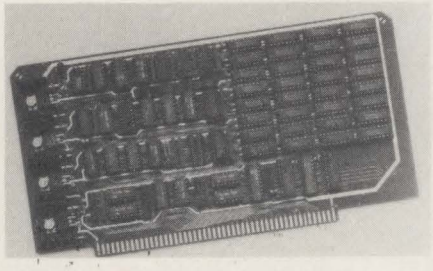
memories

Memory modules are HP1000-compatible

The PINCOMM HPS (standard-performance) and HPSH (high-performance) memory modules for HP1000 minicomputers provide 512K- and 256K-byte storage using 64K RAMs, or 128K- and 64K-byte storage using 16K RAMs. Features includes an off-line switch, a run LED indicator and a dual in-line, six-position switch. In 128K-byte versions, the HPS sells for $1680, the HPSH, $2100. **Trendata Corp.,** Santa Ana, Calif. **Circle No 317**

Dynamic RAM is S-100 compatible

The S-100-compatible model 2065 64K-byte dynamic RAM board has a 4-MHz CPU and supports memory expansion to 512K bytes through a bank-selection system. On-board circuitry provides processor-transparent refreshes with an 8080 or a Z80 CPU. Price is $700. **California Computer Systems,** Sunnyvale, Calif. **Circle No 318**



Memory board features extended addressing

The MB10 4-MHz, 16K-byte static RAM memory board supports the S-100 bus and includes extended addressing, which allows the use of multiple boards in the same configuration with as much as 16M bytes of memory. The unit is jumper-selectable to any I/O address and has enable/disable on power-up or reset. Price is $399. **SSM Microcomputer Products,** San Jose, Calif. **Circle No 319**

Memory controller handles 16K and 64K RAMs

The Am2964B dynamic memory controller, a bipolar LSI device, provides address multiplexing, refresh address generation and RAS/CAS control for 16K or 64K dynamic RAM systems. Input latches hold as many as 18 address bits—8 bits for row address, 8 bits for column address and 2 for decoding. A three-input, 8-bit multiplexer selects one of two 8-bit address latches or an internal 8-bit refresh counter, and presents the RAM address at the DMA's output. The unit sells for $16.25 in 100-unit quantities. **Advanced Micro Devices Inc.,** Sunnyvale, Calif. **Circle No 320**

Intel introduces memory for VAX-11/780

The MU-5780 add-in memory module for Digital Equipment Corp. VAX-11/780 computers comes in 512K- and 1024K-byte versions. The unit operates at speeds determined by the VAX-11/780 memory controller, with which it is hardware- and software-compatible. Typical read cycle and access times are 530 nsec. and 250 nsec., respectively. In three- to five-unit quantities, the 512K-byte MU-5780 is $4350; the 1024K-byte version sells for $8400. **Intel Corp.,** Sunnyvale, Calif. **Circle No 321**

Memory system has on-board control logic

The CI-6800-2 dynamic memory system for Motorola EXORcisor I and II and Rockwell system 65 is available in 16K-, 32K-, 48K- or 64K-byte configurations. The system allows maximum processor throughput with the use of hidden refresh control logic on-board. Data access time is 225 nsec., and cycle time is 400 nsec., allowing the unit to operate as a static RAM at clock rates higher than 1.5 MHz. Single-quantity prices range from $565 to $750. **Chrislin Industries, Inc.,** Westlake Village, Calif. **Circle No 322**

Harris introduces 4K CMOS PROM

The HM-6641 4096-bit fuse link CMOS PROM employs CMOS self-aligned silicon gate-processing techniques. The unit includes three output enable controls, two active-low and one active-high, and a separate chip-enable control. The HM-6641 is packaged with a standard 24-pin pinout similar to 512 × 8 bipolar PROMs and 2K × 8 NMOS EPROMs. Price is $28.71 in 100-unit quantities. **Harris Semiconductor,** Melbourne, Fla. **Circle No 323**

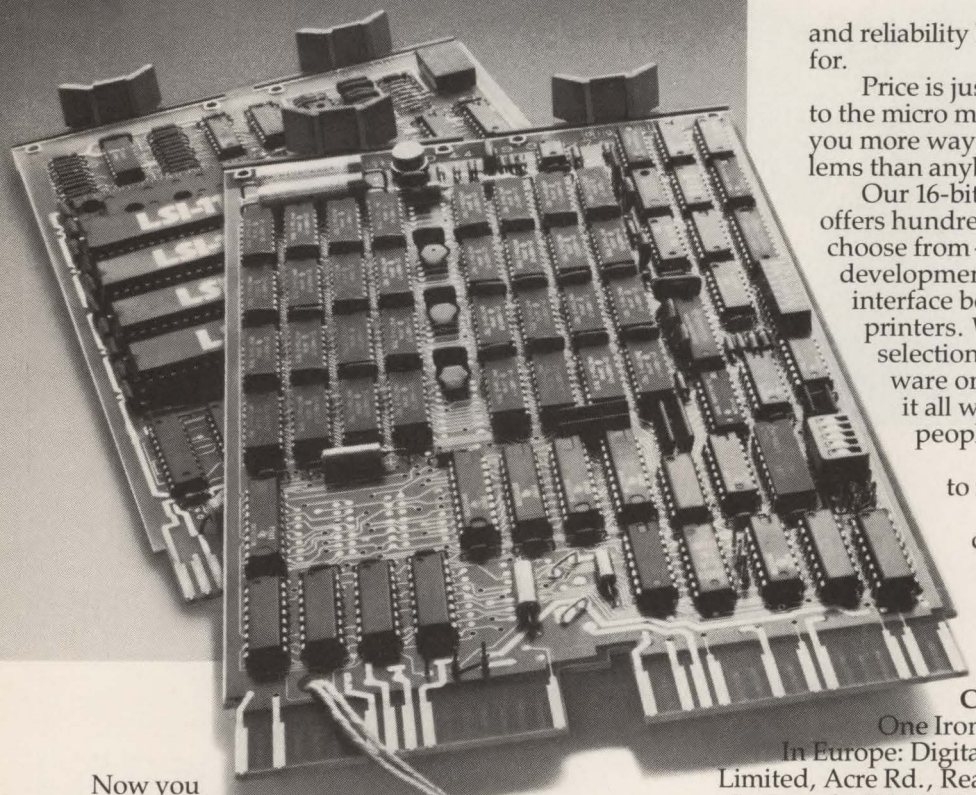
64K-byte memory for 8- or 16-bit μcs

The CI-8080 memory module for Intel's Intellec MDS 800, SBC 80/1Z, SDK-86 and BLC 80/10 μcs has 32K to 64K bytes on a single board. The system allows maximum processor throughput with the use of on-board refresh control logic. Data access time is 270 nsec., and cycle time is 400 nsec. Power consumption is less than 7w. Single-unit prices range from $565 to $750. **Chrislin Industries, Inc.,** Westlake Village, Calif. **Circle No 324**

STD BUS memory mixes EPROM and RAM

The ST4202 STC BUS EPROM/RAM memory card includes eight card sockets and supports the 2508, and 2516 (2716) EPROM, the 2732 EPROM, the 4016 RAM and the 4801 RAM. The unit also offers selectable memory expansion enable and front-end decoding. The ST4202 card will operate at speeds as high as 4 MHz. The basic card sells for $175 in single-unit quantities. With 2516 EPROM devices, price is $395. **Applied Micro Technology, Inc.,** Tucson, Ariz. **Circle No 325**

The world's best selling board sets are now selling for less.



Now you can get selected LSI-11/23 and LSI-11/2 board sets from Digital at the lowest prices ever.

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So the more memory you buy from Digital, the more you'll be saving.

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For more information, call our toll-free LSI-11 Hotline at **800-225-9220.** (In MA, HI, AK and Canada, call 617-467-7000.) Or send the coupon. **Digital Equipment Corporation,** MR2-2/M65, One Iron Way, Marlboro, MA 01752. In Europe: Digital Equipment Co. Limited, Acre Rd., Reading, RG2 OSU, England. In Canada: Digital Equipment of Canada, Ltd. Or contact your local Hamilton/Avnet distributor.

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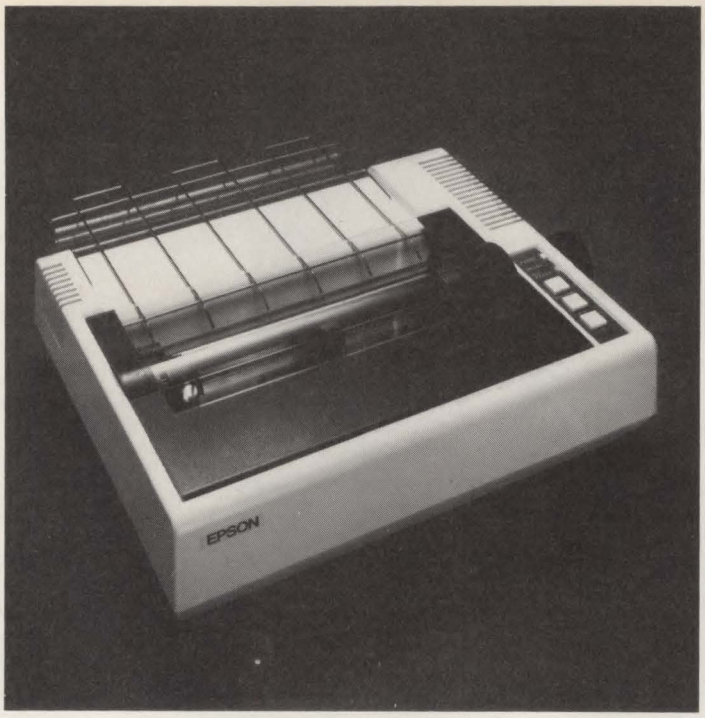
CIRCLE NO. 116 ON INQUIRY CARD

The MX-80. It not only does everything, it does everything well.



Epson.

This is the new Epson MX-80 dot matrix printer. It does just about everything you could ask a printer to do. Quickly. Quietly. Reliably. In fact, for OEM installations, the MX-80 may be the single best, all-round printer you can buy. But that's not the best reason to buy it.

The MX-80 prints bidirectionally at 80 CPS in a user-defined choice of 40, 80, 66 or 132 columns. And if that's not fast enough, its logical seeking function minimizes print head travel time. The MX-80 prints 96 ASCII, 64 graphic and eight international characters with a tack-sharp 9x9 matrix. For a long time. Epson printers are known for reliability and the MX-80 is no exception. But that's not the best reason to buy it either.

The print head has a life expectancy of up to 100×10^6 characters, and when it wears out, just throw it away. A new one costs less than $30 and the only tool you need to change it is attached to the end of your arm. The MX-80 is compact, weighs only 12 lbs., and the whole unit, including the two stepper motors controlling carriage and paper feeding functions, is precisely controlled by an internal microprocessor. But even that isn't why you should specify the MX-80.

The best reason is this: because Epson makes more printers than anyone else in the world, we can afford to sell each one for a little less. So you can get one Epson MX-80 Printer for less than $650. And more than one for even less than that.

That's what we call a small price to pay for a printer that does everything well.

The world's first disposable print head. When it wears out, just throw it away. A new one costs less than $30, yet it's so simple, you can change it with one hand.

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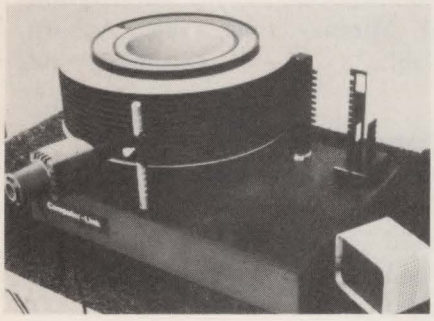
CIRCLE NO. 117 ON INQUIRY CARD

accessories and supplies



Disk inspector assures precision

The model 666 granite-based disk inspector/cleaner detects dust, fingerprints, defects and other abnormalities that could cause data loss or other damage. The unit's stainless steel spindle holds disks parallel to the plate within 0.0001-in. Spindle axial run-out is less than 0.00005-in. **Computer-Link Corp.**, Burlington, Mass.

Circle No 326

Terminal enclosures minimize noise

This enclosure minimizes noise from word- and data-processing machines, Telex and computer terminals. The enclosure's interior and exterior panels are transparent and covered with plastic laminate to prevent warping. Prices start at $275. **Vitech Inc.**, Edira, Minn.

Circle No 327

Caddy designed for WP/DP centers

The Forms Caddy can handle all form sizes in data- and word-processing installations. It carries boxes of forms from storage areas to installations, and changes forms at printers. A pull rod controls movement. **Mead-Hatcher Inc.**, Buffalo, N.Y.

Circle No 328

Product enhancements improve disk durability

The Datalife enhancements for the vendor's 5¼- and 8-in. floppy disks include longer-lasting lubricant, improved liner, thicker and more uniform oxide coating, advanced burnishing techniques, reinforcing hub rings, stricter and more extensive testing standards and a revised certification program. The improvements reduce head wear, eliminate slippage, reduce errors, prevent pinching, aid registration and allow better alignment repeatability. **Verbatim Corp.**, Sunnyvale, Calif.

Circle No 329

design aids

Bubble memory board is preassembled

The TBB5990, a preassembled and tested magnetic-bubble memory prototyping board, contains two 92K-bit bubble-memory devices, providing 23K bytes of nonvolatile storage. Other features include a 44K-bps data-transfer rate and an average access time of 4 msec. Page size is 18 bytes, and the board supports single and multipage transfer. Price for the 7½- × 13½-in. board is $995. **Texas Instruments Inc.**, Dallas, Texas. **Circle No 330**

Work station provides voice recognition

The Voice Experimenter's work station enables users to experiment with easily changed computer voice response, isolated-word speech recognition and spoken-phrase recognition. The work station includes software and two PC boards for use in an Intel Intellec μp development system. Price for the two boards and software, including voice response and the two types of recognition, is $7500. **Technology Service Corp.**, Santa Monica, Calif. **Circle No 331**

Unit programs logic array devices

The IM3030 universal logic array programmer can be interfaced with a CRT to provide program development for defining output levels, product terms and sum terms. Operating modes include EDIT of device terms, DISPLAY terms, PROGRAM logic device and others. Other features include menu-driven software, dual RS232 ports, switch-selectable baud rates from 110 to 9600 and selectable 20-mA current loop. The programmer is priced at $1595; prices for modules start at $595. **International Microsystems, Inc.** Auburn, Calif. **Circle No 332**

Zehntel introduces in-circuit testing capability

The Data Director testing device, used in conjunction with the vendor's Troubleshooter 800 in-circuit inspection system, tests LSI devices that require sequential stimulus of enable, clock and other control lines, and manipulation of data and address buses. The Data Director includes a controller and an operating system, plus one or more driver/receiver (D/R) cards. It sells for $10,000, plus $2000 per 16 pins. **Plantronics/Zehntel,** Walnut Creek, Calif. **Circle No 333**

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CIRCLE NO. 120 ON INQUIRY CARD

New Products

design aids

Board kit performs S-100 prototyping

This S-100 prototyping board kit for memory, CPU, I/O, A/D and disk controllers includes a prototyping area that accepts standard DIP-size ICs or sockets on .300- and .600-in. row spacing, a filtered ±V bus bar distributed, a kluge area for discretes and easy access to all S-100 signal and voltage lines. The kit, including three regulators, three heat sinks, filter capacitors, two bus bars and a user's manual, sells for $49.95 in quantities of one to 10. **I/O Technology,** Canyon Country, Calif. **Circle No 334**

Development system includes 8085A-2 CPU

The ZX-85 single-board development system includes an 8085A-2 CPU, clocked at 10 MHz, a boot/monitor in EPROM, 64K bytes of MM5290 RAM controlled by an 8202A DRC, two RS232 channels with 8251A USARTs, a timer and two 8259A interrupt controllers. Price is $2660. **Zendex Corp.,** Dublin, Calif. **Circle No 335**

Logic analyzers combine for 64 channels

The PI-616 logic analyzer, for hardware debug applications, collects data in a 16-channel × 1000-word data memory at rates as high as 50 MHz. The unit can be configured with a waveform recording option that adds high-speed digital oscilloscope functions to the instrument. The PI-648, for analysis of software and hardware interactions, can collect 48 channels of synchronous data in a 250-word memory. The PI-648 is priced at $7400, and the PI-616, at $8000. **Paratronics, Inc.,** San Jose, Calif. **Circle No 336**

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New Software

Data base system runs under CP/M

The Information Master information-retrieval program works with text files that are created on a computer running under the CP/M operating system by a text editor or user program. The main program maintains a dictionary of as many as 1500 key words that are indexed, and searches the index on Boolean combinations of key words. Retrieved data can be displayed, printed or written to another file. Price is $37.50. **Elliam Associates,** Woodland Hills, Calif.

Circle No 337

Electronic mail system intended for Series/1

The Message/1 electronic mail system for the IBM Series/1 minicomputer is intended for transmission of administrative messages, reports, interoffice memos, orders and reservations. Messages can be composed, edited and stored in "mailboxes" in the Series/1. Mailboxes are privately accessible, protected by a user name and password. The package supports local and remote asynchronous ASCII terminals, for interactive or batch entry of messages. **Systar Corp.,** San Jose, Calif.

Circle No 338

Package updates System 34 software

This software-documentation package for the IBM System 34 includes 12 reports. A user can insert the package into a job stream after program modifications have been made, and receive a set of updated documentation. Features include table of contents; descriptions of procedures, files and programs with narrative; a screen/program cross reference; the ability to "explode" procedures to enable programmers to see the files that the procedures use; and a procedure/program cross reference. Price is $1200. **Mann Data, Inc.,** Newton Upper Falls, Mass.

Circle No 339

System provides record retrieval

The BT-80 single-user record-retrieval system, based on the B-Tree index-organization technique, is designed for use in PL/I-80 applications where single- or multi-keyed access to data records is required. BT-80 facilities are accessed from PL/I-80 or assembly language applications programs via two BT-80 procedures that handle data file and index maintenance. The package includes utilities to access commonly needed facilities at the command level. **Digital Research,** Pacific Grove, Calif.

Circle No 340

Program provides project management

Milestone, an interactive project-management package, runs on computer systems using the CP/M UCSD Pascal operating system. Using critical-path network analysis techniques, the program displays the results of scheduling changes on a terminal screen and automatically maps each job on a time scale that shows which tasks are critical. Introductory price is $295. **Organic Software,** Livermore, Calif.

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Cross assemblers intended for Intel and Zilog μps

These cross assemblers for Intel 8080/8085, 8086/8088 and Zilog and AMD Z8002 μps include a macro assembler that generates relocatable object code, a linking loader and a formatter/downloader that transmits assembled programs to the vendor's MicroSystem Emulator, Analyzer or Designer for program execution and debug. The systems support DEC PDP-11 and LSI-11, DG Nova 1200 and Eclipse, HP 1000 and 3000 and TI 99/10 minicomputers. Price is $1500. **Millennium Systems, Inc.,** Cupertino, Calif.

Circle No 342

The Convention Center's huge 183,000 square-foot Stetson Hall, with a 35-foot ceiling height, will house CITE exhibits and meeting rooms.

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Atlantic City Convention Center
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Get an early start on Wednesday and Thursday with "Early Bird Rap Sessions" at 7:30 a.m., with coffee to open your eyes to new solutions to your business problems! More conference sessions follow, just a few steps from the exhibit floor, until 11:00 a.m. when the exposition opens! All of mid-day is reserved to explore the show, until "Wrap-Up Sessions" begin at 4:00 p.m. when the show closes, focusing on some of the product and market issues you have seen in "three dimensions" at the show booths! Friday morning sessions bring down the curtain on an integrated show and conference experience!

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Brochure describes press-fit backplanes

PDQ/DSC DEC-compatible press-fit backplanes are detailed in a brochure. The illustrated booklet describes card files, DEC-style logic modules and accessories and a plastic protector cover that permits power harness entry while protecting the wire wrap and pins. **Stanford Applied Engineering,** Santa Clara, Calif. **Circle No 346**

Catalog details printer systems

Details of 27 printer system models are provided in a catalog. The booklet covers chain/train, band, drum, belt and matrix printers. The publication explains service capabilities, controller/interfaces, communications buffers, accessories, delivery and installation. **Digital Associates Corp.,** Stamford, Conn. **Circle No 347**

Catalog covers digital panel meters

A line of miniature digital panel meters is described in a brochure. The eight-page publication details configurations of standard and ruggedized DPMs for cabinet, rack or portable applications. The brochure also examines process-control digital panel meters, alarm provisions and battery operation. **Velonex,** Santa Clara, Calif. **Circle No 348**

Pamphlet details breadboarding materials

A line of professional electronic packaging and breadboarding products is detailed in a brochure. The 12-page, illustrated catalog describes μc interface boards, plugboards, motherboards, cases, tools, wiring terminals and kits. The brochure also provides part-numbers and prices. **Vector Electronic Co.,Inc.,** Sylmar, Calif. **Circle No 349**

148-page catalog describes manual switches

A line of manual switches is described in a 148-page catalog. The publication details lighted pushbutton switches and indicators, unlighted pushbuttons, toggle switches, rockers, rotary selectors and interlock switches. The guide also contains application and ordering information, a selection guide, mounting drawings, cutaways and expanded views. **Micro Switch,** Freeport, Ill. **Circle No 350**

New Literature

Publication describes interconnection products

A line of electronic interconnection components and packaging assemblies is listed in a catalog. The 70-page booklet details interface boards; metric boards; ECL, Schottky and LSI panels; IC sockets, headers and adapters; high-density plug and socket assemblies; custom circuit board designs, manufacture and wire-wrapping capabilities; and card cage and backplane assemblies. The catalog also lists accessories, tools and services. **Garry,** New Brunswick, N.J. **Circle No 351**

Bulletin examines strip-chart recorders

The MR series single- and dual-pen strip-chart recorders are described in a brochure. The four-page publication details input ranges, chart speeds, manual paper-positioning and electric-remote pen lift. The booklet also lists specifications, recording accessories and warranty information. **Pedersen Instruments,** Walnut Creek, Calif. **Circle No 352**

Pamphlet details digital oscilloscope

The model 3001 processing digital oscilloscope is detailed in a brochure. The 10-page publication describes the system's A/D resolution, internal and peripheral storage capability, output annotation and operating diagnostics. The pamphlet also examines waveform acquisition and display and waveform processing, and provides an overview. **Norland Corp.,** Fort Atkinson, Wis. **Circle No 353**

Pamphlet details programmable controller

The model SK-1506 μp-based controller and the model 8K programmer are detailed in a bulletin. The illustrated pamphlet examines internal control relays, timers and counters, optically isolated inputs and outputs, power supply, read/write memory and UV EPROM for program memory. **Entertron Industries,Inc.,** Buffalo, N.Y. **Circle No 354**

Selection guide details wire-wrap panels

A line of wire-wrappable packaging panels and packing systems is detailed in a brochure. The four-page booklet describes computer interface panels; horizontal card cages; and ECL, Schottky and Universal panels. **Augat Interconnection Systems,** Attleboro, Mass. **Circle No 355**

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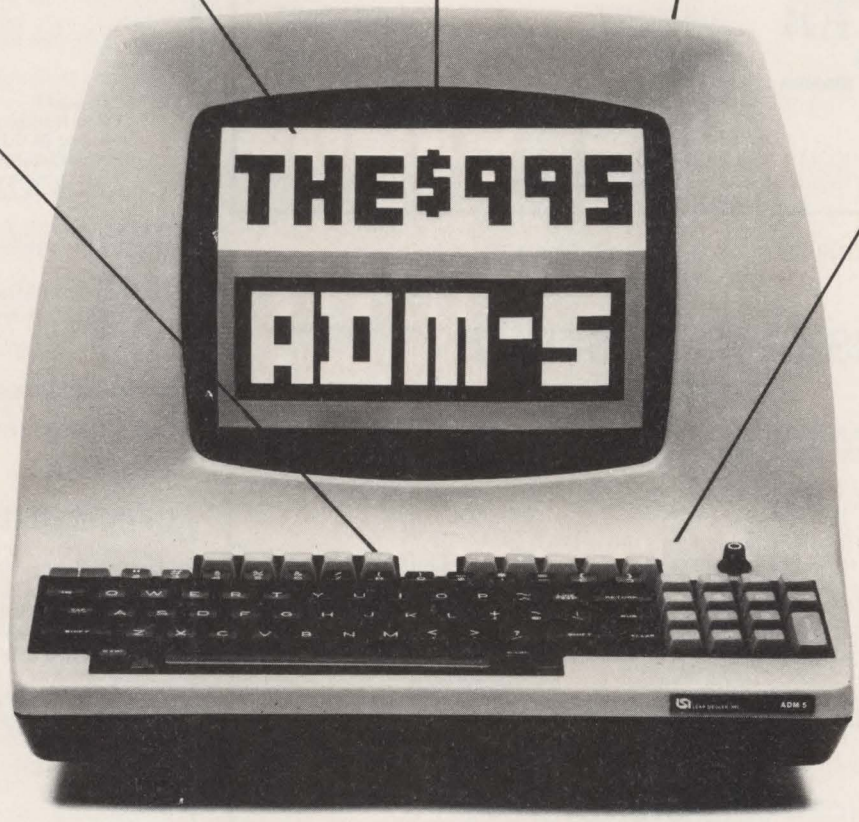

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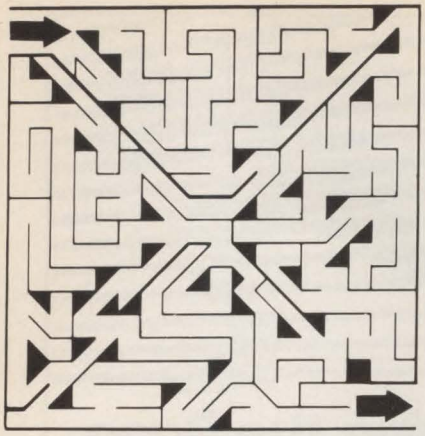

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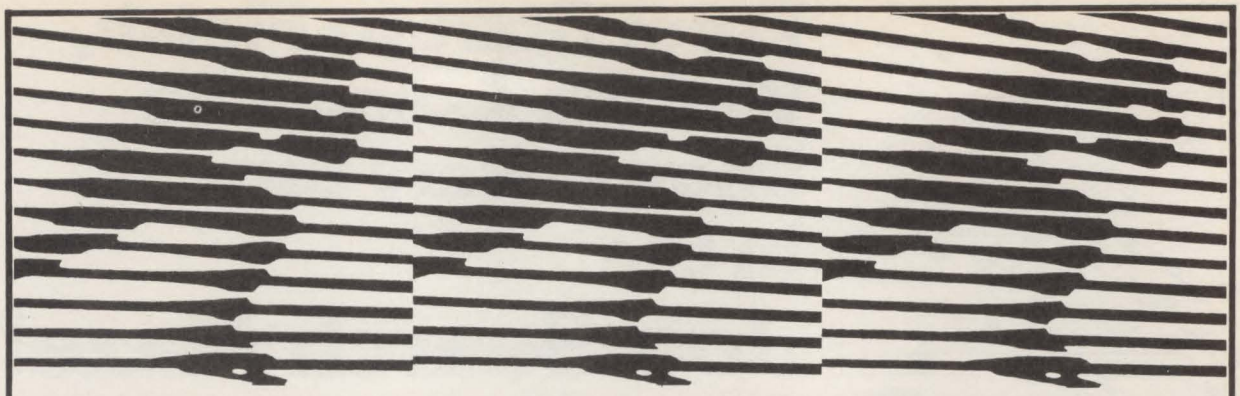

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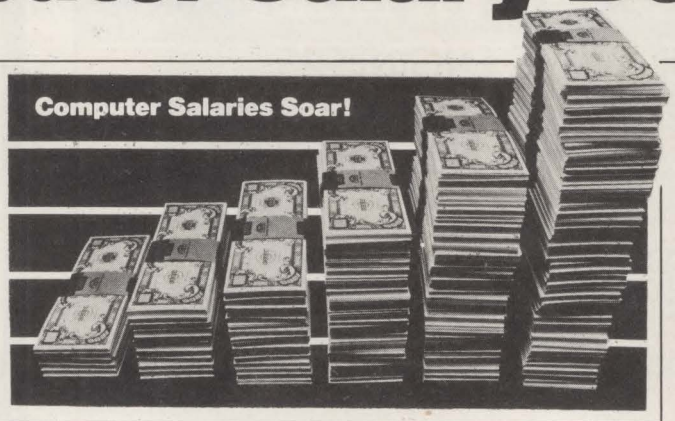

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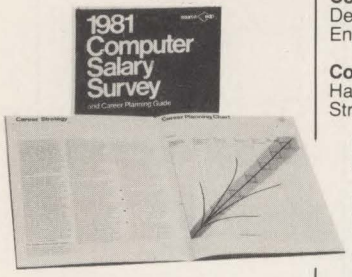

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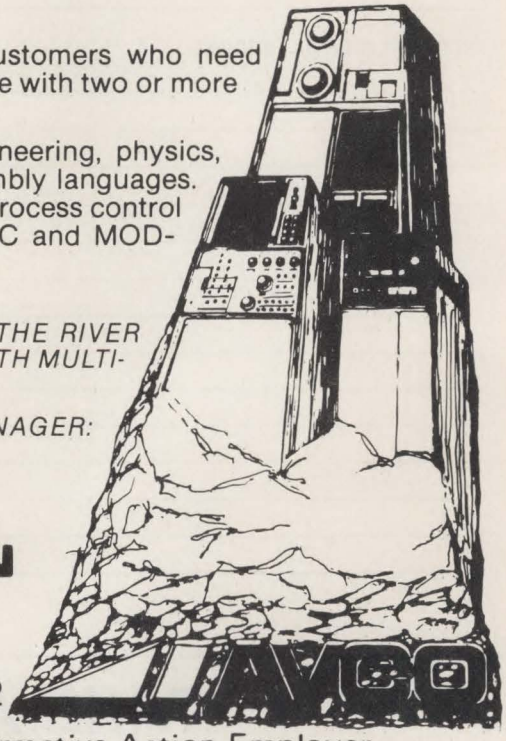

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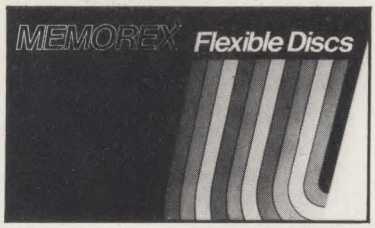

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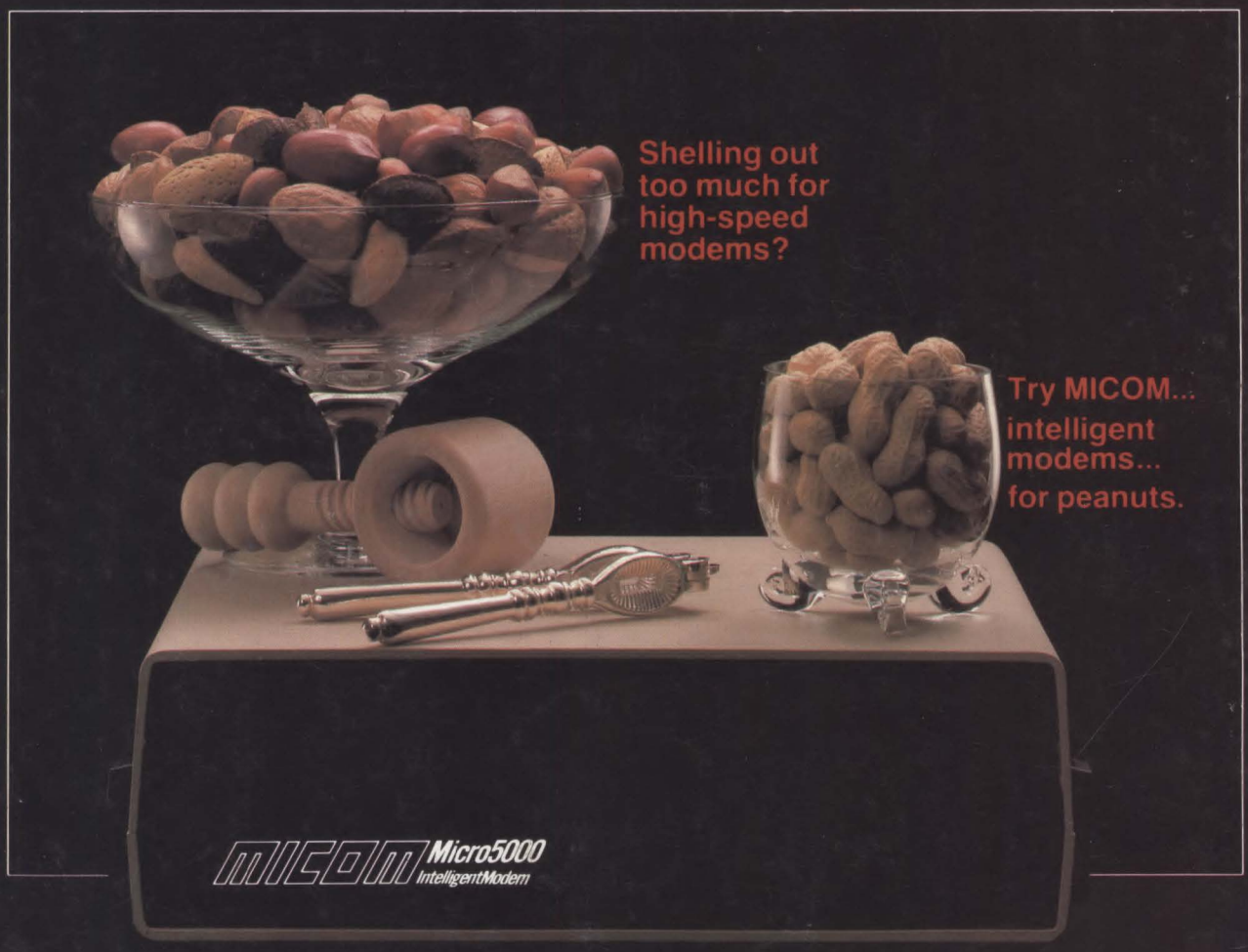

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