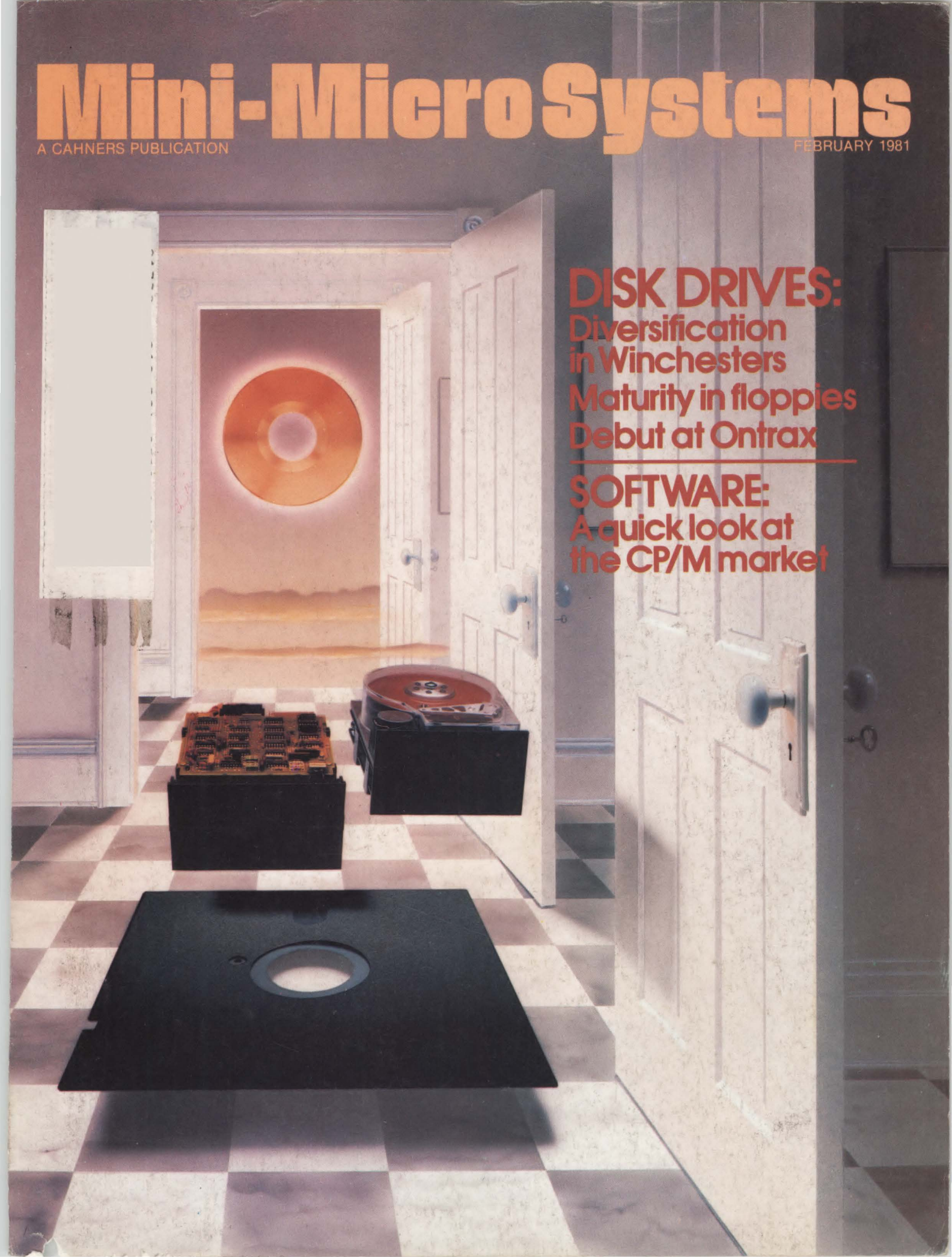
Mini-Micro Systems

A CAHNERS PUBLICATION

FEBRUARY 1981



DISK DRIVES:
Diversification in Winchesters
Maturity in floppies
Debut at Ontrax

SOFTWARE:
A quick look at the CP/M market

THE INDUSTRY STANDARD

BULK CORE BULK SEMI

ALSO FROM DATARAM
JUST ANNOUNCED
PDP 11/44 MEMORY

Add a new dimension of speed and reliability to your minicomputer with economical, high-capacity BULK MEMORY from Dataram.

The world leader in minicomputer-compatible disk emulation systems. Dataram's wide range of disk emulations — twice as many minicomputer interfaces as anyone else! — brings the proven performance of BULK MEMORY to your application requirement.

Dataram's BULK CORE and BULK SEMI systems operate at speeds which are orders of magnitude faster than the mechanical disks which they replace, and do it with the reliability inherent in all-electronic devices. What's more, BULK MEMORY provides up to 8.0 MB in a 15¾" chassis, and offers dual-port capability to enable BULK MEMORY to be shared by two host minicomputers.

If you have a minicomputer and are looking for a way to get more for your storage dollar, Dataram has a BULK CORE or BULK SEMI system ready to work for you. If your minicomputer is not listed below, tell us about it. We'd like to add your name to our growing list of BULK MEMORY users.

MEMORY FROM THE LEADER

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DATARAM CORPORATION

Princeton Road
Cranbury, New Jersey 08512
Tel: 609-799-0071 TWX: 510-685-2542

	DEC® PDP®-11	DEC LSI-11®	DEC PDP-15	DATA GENERAL NOVA®	DATA GENERAL ECLIPSE®	ROLM 1602	PERKIN ELMER	MODCOMP	HONEYWELL 316 and 516
BULK CORE	✓	✓	✓	✓	✓	✓	✓	✓	✓
BULK SEMI	✓	✓	✓	✓	✓		✓		
DUAL PORT	✓	✓		✓	✓				

Canada: Ahearn & Soper Ltd., Alberta, British Columbia, Ontario, Quebec • **Finland:** Systek OY, 737-233; **France:** YREL, 956 81 42 • **Hungary/Poland/Rumania:** Unitronex Corporation, WARSAW 39 6218 • **Italy:** ESE s.r.l., 02/6073626 • **Netherlands:** Technitron b.v., 020-45 87 55 • **Sweden:** M. Stenhardt AB, (08) 739 00 50 • **Switzerland:** ADCOMP AG, 01/730 48 48 • **United Kingdom:** Sintrom Ellinor Ltd., (0734) 85464 • **West Germany:** O.E.M.-Elektronik GmbH, 07 11-79 80 47 • **Australia/New Zealand:** Anderson Digital Equipment, (03) 543 2077 • **India:** Industrial Electronic Instruments, 79281 • **Israel:** Minix Computers & Systems Ltd., 03-298783 • **Japan:** Matsushita Electric Trading Co., Ltd., 03 (435) 4501

CIRCLE NO. 1 ON INQUIRY CARD

First and For Most.

Innovation comes first with TI's 780 Series.

State-of-the-art technology is what makes TI's *Silent 700** 780 Series Electronic Data Terminal Family ideal for almost any application. These versatile terminals are real innovators when it comes to improving productivity and reducing communications costs.

Every model in the four-member 780 family features speedy 120 character-per-second thermal printing, TI's field-proven reliability and virtually silent performance.

The attractive, desktop Model 781 Receive-Only Printer and the compact 783 Keyboard Send-Receive Data Terminal are lightweight champions. For high output demand printing, the 781 RO speeds through the toughest printing tasks and features a 1545-character receive buffer to prevent data overflow. Along with its speedy capabilities, the reliable 783 features a full upper and lower case keyboard for simplified local or remote data entry in commercial input/output applications.

Imagine data terminals that not only offer you speed and versatility, but intelligent modems as well. Both TI's Models 785 and 787 Portable Data Terminals, weighing only 17 pounds each, are a smart choice. With their built-in intelligent modems, these responsive terminals can improve your communications efficiency.

The portable 785 offers an internal originate-only dual modem, and is capable of providing communications via its built-in acoustic coupler over normal phone lines with remote Bell 113A or Vadic 3400 modems. With the 787's unique triple modem, compatibility with Bell 103A, Bell 212A or Vadic 3400 modems allows you to achieve multi-speed communications via direct connection to a standard telephone data jack. And, both terminals feature automatic modem selection to determine the correct modem type, while automatic speed selection insures optimum transmission rates.

For any application requiring speed, input/output capabilities or intelligent modems, TI's 780 Series offers you innovation at it's best.

TI is dedicated to producing quality, innovative products like the *Silent 700* 780 Series Electronic Data Terminal Family. And TI's hundreds of thousands of data terminals shipped worldwide are backed by the technology and reliability that come from 50 years of experience.

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

For more information on the 780 Series Electronic Data Terminal Family, 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.

We put computing within everyone's reach.

TEXAS INSTRUMENTS
INCORPORATED

In Canada, write Texas Instruments Incorporated, 41 Shelley Rd., Richmond Hill, Ontario L4C 5G4, (416) 884-9181. In Europe, write Texas Instruments, M/S 74, B.P.5, Villeneuve-Loubet, 06270, France, (93) 20 01 01. In Asia Pacific, write Texas Instruments Asia Ltd., 990 Bendeemer Rd., Singapore 1233. Telex RS 21399, or phone 2581122.

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CIRCLE NO. 2 ON INQUIRY CARD

INTRODUCING

the DSD 880.

A DEC®-compatible disk system combining eight-inch Winchester and flexible disks.

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

- significantly lower initial and total life-cycle costs
- the reliability of a Winchester, with 7.5 Mbytes, emulating RL01
- the removability of a flexible disk, with 1 Mbyte, emulating RX02
- valuable saving in rack space (5¼" vs. 21" for dual RL01)
- unique "hyperdiagnostics" enabling fast and easy troubleshooting to the modular level
- built-in bootstrap eliminating the need for an expensive DEC bootstrap board and saving a backplane slot
- one half-quad backplane slot vs. two quad boards for the RLV11
- versatile interface card for easy integration with any LSI-11 backplane, unlike DEC's RLV11 interface that needs a special backplane and cannot be used with the VT 103 terminal

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

Data Systems

The Intelligent Alternative to DEC Disk Systems

To get more information on the DSD 880, call or write:

Corporate Headquarters:
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San Jose, CA 95131
Tel: (408) 946-5800
TWX: 910-338-0249

Western Region Sales:
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Santa Clara, CA 95050
Tel: (408) 727-3163
TWX: 910-338-0249

Eastern Region Sales:
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Norwood, MA 02062
Tel: (617) 769-7620
TWX: 710-336-0120

International Sales:

Australia: Melbourne (03) 543-2077, Sydney (02) 848-8533; Canada (416) 625-1907; Denmark 01/83 34 00; Finland 90/88 50 11; France 03/956 81 42; Israel 03/298783; Italy 02/4047648; Japan: Osaka (06)323-1707, Tokyo (03)345-1411; Netherlands 020/45 87 55; New Zealand 4/693-008; Norway 02/78 94 60; Sweden 08/38 03 70; Switzerland 01/730 48 48; United Kingdom 01/207-1717; West Germany and Austria (089) 1204-0.

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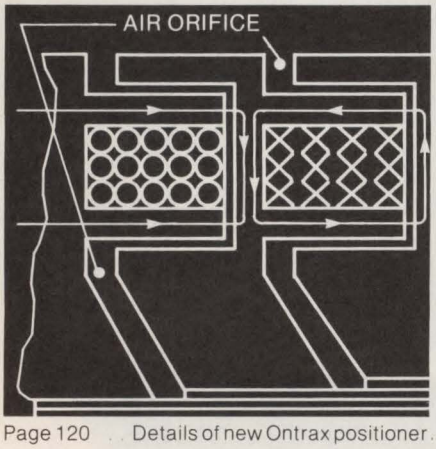
CIRCLE NO. 3 ON INQUIRY CARD

Three new Winchester-disk drives from Shugart Associates offer as much as 10M bytes in a minifloppy-sized package (see p. 107). Cover art by David Jensen, designed by Gail Tavares, courtesy of Shugart.

Page 24 . . . Micro-Winchester race heats up



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KENNEDY

SERIES 5300 DISK DRIVES

Series 5300 drives are fixed media, high performance units utilizing advanced Winchester disk technology.

Available in one, two, or three platter versions, the unformatted data capacity can be as high as 70M bytes—all in 7″ of rack space.

Track density of 300 Tpi is made possible by prewritten servo tracks utilizing one disk surface, thus assuring accurate head alignment under all circumstances. High data density results from use of advanced media and write compensated MFM recording.

Maximum seek time is 70 msec, rotational speed, 3000 rpm, and data rate — 1.0 MB/sec.

The tightly sealed disk compartment allows Series 5300 drives to be used in environments unsuitable for conventional drives.

Other Series 5300 features include: NRZ-MFM data encode/decode circuits; daisy chaining of up to 4 drives; address mark detection; built-in power supply; small, easily replaced circuit cards and a standard interface.

Series 5300 is sophisticated in concept, yet like all Kennedy products, is simple in design for greater reliability, improved performance and lower cost.

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(213) 357-8831 TWX 910-585-3249

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KENNEDY · QUALITY · COUNT ON IT

Breakpoints

HIGH-END PROCESSOR IN DEVELOPMENT AT DATA GENERAL

A sibling of Data General Corp.'s MV/8000 32-bit minicomputer is reportedly in advanced testing at the company's R & D facility in Research Triangle Park, N.C. Industry sources say there are several working prototypes of a computer—code named FHP. The name stands for Fountainhead Processor, after the company's basement apartment in Westboro, Mass., where the project began five years ago. There is also a working operating system and some data base software. FHP is believed to have been the initial high-end entry for the company, but its complexity slowed ambitious development goals, and the MV/8000 was introduced first, even though FHP's development started nine months earlier.

FHP is an advanced-architecture, multiple-CPU computer with a new instruction set that is not based on that of earlier Novas or Eclipses. It can, however, emulate those instructions to maintain some level of compatibility at the price of performance degradation. There is no implicit word length, because FHP is bit-addressable in a range from one to a virtually unlimited number of bits. The number of bits used is determined by individual compilers, so that a 16-bit wide Eclipse system can be emulated. FHP may mark Data General's first move away from traditional minicomputers; it may compete with low-end mainframes and its performance is expected to open new markets for the company in distributed data processing and commercial transaction processing. FHP's estimated price is at least $500,000, and its hardware is said to be similar in complexity to that of the IBM System/38.

The company has used off-the-shelf compiler components, including code generators and parsers. Hundreds of man-years are believed to have gone into the software development. Although the product is not yet complete, there are no technical barriers; unrealistic completion goals are said to have delayed its introduction.

A Data General spokesmen declined comment on FHP development.

16-BIT μP FAMILY SEES FIRST SILICON, GETS SECOND SOURCE

First wafers of the NS16032 16-bit μp came off the line at National Semiconductor's Salt Lake City plant in mid-December and are now undergoing evaluation and debugging. The complex, 84,000-mil² die is the first of the MS16000 family of CPUs and peripherals that will stretch from a minimum low-cost system to a 16M-byte powerhouse that features mainframe computer-processing power. The company expects the 16032 to be ready for customer sampling by June.

At the same time, National announced an agreement with Fairchild Semiconductor, Mountain View, Calif., to second source the NS16000 family. The nonexclusive agreement covers only masks and design rules, with each company using its own high-density MOS process. National's part of the exchange involves the NS16032 CPU and systems-oriented devices; Fairchild will cover the dedicated-peripheral circuits. Both firms will develop a joint program to design future 16000 products. A source at National says Fairchild was chosen for its strong manufacturing capability and parent company Schlumberger's known commitment to R & D. The agreement, however, does not preclude National from picking another U.S. source. The company is also planning on another European source in addition to Eurotechnique and several in Japan.

NETWORK-CONTROL SYSTEM WILL DEBUT AT INTERFACE

Moving to catch up with the competition, Codex Corp. plans to announce its first programmable network-control system at the Interface data communications show next month. The system will, among other functions, gather statistics on network performance, thus enabling network managers to spot equipment and line failures before they occur. Powering the system will be an Eclipse S-140 minicomputer made by Data General Corp. Codex already has a network control system in its product line, but that system is hard-wired. Arch-rival Paradyne, Inc., has marketed a programmable system for more than a year.

SMART WINCHESTER WILL REPLACE STC'S 2700

Look for Storage Technology Corp. to market another μp-based "intelligent" Winchester as a follow-on to its recently cancelled 2700 series 14-in. OEM drives. STC will continue to

Breakpoints

support the thousands of 2700s already installed. A source at the Louisville, Colo., systems and peripherals company says the concept of relocating certain applications programs from CPU to disk has been proven and will be retained in the firm's next OEM offering. When the device will appear, as well as several details of the proposed hardware, is indefinite. Reportedly, the new offering will be in the 100M-byte-and-higher range, and may incorporate either 3370/80 thin-film technology or conventional 3350-style ferrite read/write heads. Also indefinite is whether the drive will use 14- or 8-in. media.

INTEL FILLS 16-BIT BOARD LINE

On the eve of introducing a 32-bit μp as the high end of its product line, Intel is moving to fill the performance gap in its 16-bit product range by introducing the iSBC 86/05 single-board computer. The new member employs an iAPX 86/10 μp and an optional iSBC 337 multimodule numeric data processor that enables performance speeds as high as 110,000 Whetstones per sec. That's a 67-percent increase over the company's high-end 86/12A board, but with the tradeoff of less memory and a less sophisticated multitasking executive (iRMX 88) instead of the full-blown iRMX 86 operating system offered with the 12A. At a single-unit price of $1790, the iSBC 86/05 is priced between Intel's 8-bit iSBC 80 series boards, which start at $560, and the high-end 86/12A, which sells for $2620. License fee is $2000, considerably lower than the $7500 charged for iRMX 86, and it's even lower than the $3000 iRMX 80 software offered with the iSBC 80 series.

CINCOM TO OFFER TRANSPORTABLE DEVELOPMENT SYSTEM

Look for Cincom Systems, Inc., Cincinnati, to offer a minicomputer version of its Series 80 Mantis applications development system, which currently runs on mainframes. Mantis uses a high-level, English-like language. Programmers can create screens and files on-line, write programs, test and debug applications, document systems and place systems on security menus. The first minicomputer version, which is more than a year away, will run on Digital Equipment Corp.'s VAX superminis. The company claims Mantis decreases post-installation software changes, because users can tailor applications as they write them. Mantis may also provide a high level of software transportability between a variety of minicomputers, a company spokesman says.

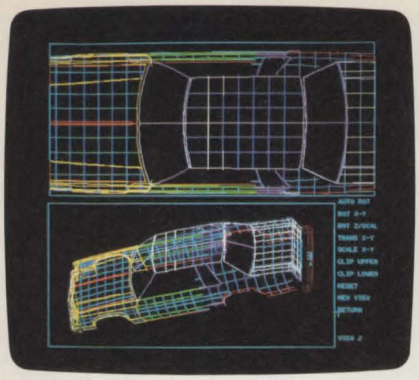
START-UP NOVELL UNVEILS NEW PRODUCTS

An Orem, Utah, start-up called Novell Data Systems this spring will introduce a 150-cps matrix printer and three as-yet-unnamed Z80 and CP/M-based business systems. Initial offerings include the Image 800 stand-alone printer, which will sell for approximately $8000, including a CRT, two floppy-disk drives and a printer. The firm will also introduce two communications-oriented systems that will implement the company's Novell-Net protocol under M68000 control.

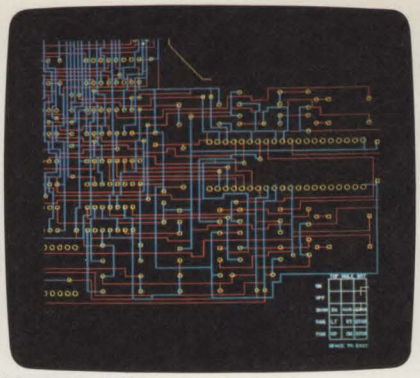
RANDOM DISK FILES

All **Caldisk** floppy-disk production facilities in Anaheim, Calif., have been shut down and relocated to Provo, Utah, headquarters of parent company Billings Computer Corp. . . . Look for a line of single- and double-sided, 100-tpi, 5¼-in. floppy drives with lead-screw actuators to be unveiled by Caldisk at this year's National Computer Conference. Also under consideration is a 3-in., double-sided, reversible (single-head) floppy-disk drive, and either a 5¼- or 8-in. Winchester. The company will decide which fixed-disk drive to use by the end of the second quarter.

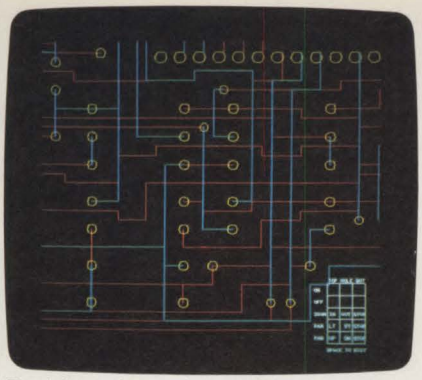
The first of a series of "extended" 14-in. Winchesters, an 80M-byte Marksman drive, will appear at the **Century Data Systems'** booth at NCC . . . Meanwhile, **Storage Technology Corp.** is moving to ensure a healthy supply of oxide-coated Winchester media by partially funding **Media Technology Corp.**, a Sunnyvale, Calif., start-up. The new firm will produce 3370-caliber 14-, 8- and 5¼-in. disks for both STC and outside customers. First product can be expected by year-end.



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

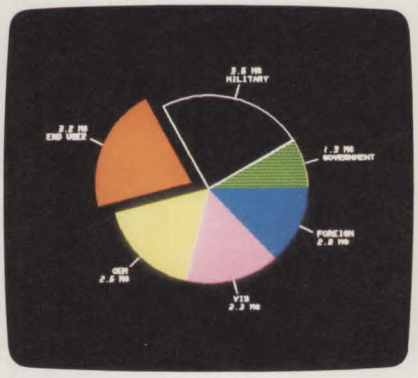


You can define your image in a 4096 x 4096 virtual space, with up to eight colors.

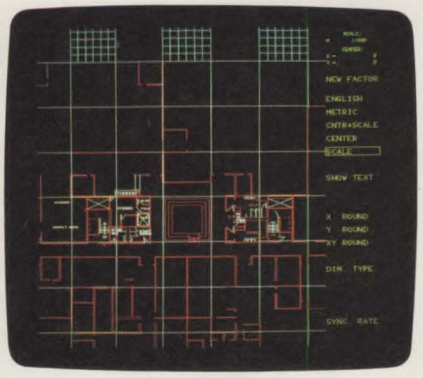


Real-time dynamics enable you to pan throughout this space, then zoom in with true scaling for added detail.

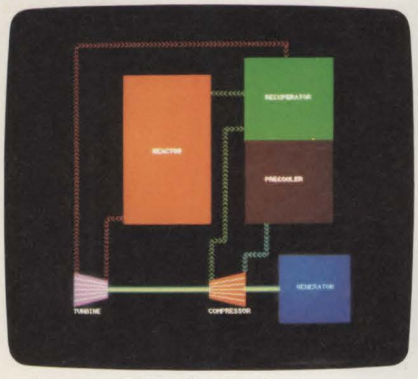
And our new system introduces you to low-cost, FORTRAN-based WAND software.



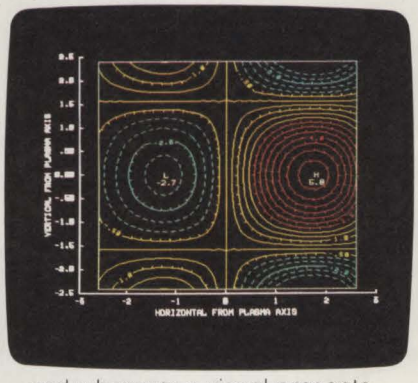
The Whizzard 6250 harnesses the power of Megatek technology for your business applications...



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



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



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

So imagine yourself at the Whizzard 6250 keyboard. Computer creativity has never been so affordable.

Imagine...all this technology for far less than you imagined.

At Megatek, we strive to set the standards for technology in computer graphics. Now we've set a new standard for value, too. Introducing our new Whizzard 6250 system.

It gives you graphics power you would expect from Megatek. For far less than ever before. You get the drama of full raster color. High resolution. Sophisticated dynamics implemented in hardware. Local vector memory. Double buffered bit planes. And the performance of advanced digital vector generation. Plus an RS-232 interface, standard.

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

CIRCLE NO. 5 ON INQUIRY CARD

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.

You don't have to take our word about Maxell Floppy Disk quality.

Ask the people who made your system.

Maxell Floppy Disks are either expressly specified or recommended by many major disk drive manufacturers. We're also relied upon by a growing number of 8" and 5¼" Floppy System owners. They find our Floppy Disks do everything possible to bring out the maximum performance of their systems. And they find our disks do this consistently.

Are we better than others? Will a box of ten Maxell Disks always contain ten disks that produce high performance results every time? We think so. We certify each one. We maintain extraordinary quality control. So they all meet or exceed the most critical industry standards.

But please ask the manufacturer of your system to double check our recommendation. See your computer products supplier. Or write to us for more information. We recommend dealers write to us about the opportunities Maxell Business Products offer.

maxell®

BUSINESS PRODUCTS DIVISION

Maxell Corporation of America, Business Products Division, 60 Oxford Drive, Moonachie, N.J. 07074 Tel: (201) 440-8020

CIRCLE NO. 6 ON INQUIRY CARD

PDP11/23®
ARRAY PROCESSOR SYSTEM

FIRSTAR™ PDP11® FPS®

FIRST COMPUTER CORPORATION INTRODUCES A NEW CONCEPT IN COST EFFECTIVE HIGH-SPEED ARITHMETIC PROCESSING SYSTEMS

First Computer Corporation, one of the world's largest System integrators, has married Digital Equipment Corporation's advanced PDP-11/23 Computer Systems with the new Floating Point System's FPS-100 Arithmetic Processor. This complete packaged Array Processor System provides the power to tackle tough computational problems which were previously the domain of the "Super Computers".

SUPER COMPUTER COMPUTATIONAL SPEED

The FPS-100 is capable of up to eight million floating point operations per second with an effective throughput of up to forty million operations per second.

PROVEN ARCHITECTURE + REAL-TIME ENHANCEMENTS = UNBEATABLE PERFORMANCE

The FPS-100 is based on the proven parallel pipeline architecture of the FPS AP-120B. New enhancements such as extensive Real-Time capabilities provide maximum computational efficiency with a minimum host computer interaction. The cost-performance of the New FIRSTAR System is unbeatable in the universe.

EXTENSIVE DEVELOPMENT SOFTWARE – SAVES PROGRAMMING COST

With every FIRSTAR System you can select from an extensive library of easy to use software consisting of an Assembler, Debugger, Simulator, Utilities, Math Libraries, Signal Processing Libraries, Image Processing Libraries, and Host Executives. It's easy to start using your FIRSTAR System quickly.

NEW SUPER-100 MULTI-TASKING REAL-TIME SUPERVISOR

This new Real-Time Supervisor permits the execution of multiple Real-Time tasks on a priority basis. SUPER-100 can virtually place the FPS-100 in a stand-alone multi-tasking mode for the processing of multiple streams of input data with a minimum of host computer dependency.

CHOICE OF DEC HOST COMPUTER OPERATING SYSTEMS

Select the Digital Equipment Corporation Operating System which best matches your application needs. FIRSTAR is available with either the RT-11 Real-Time Executive or the RSX-11M Resource-Sharing Executive. All Operating Systems are fully supported by Digital.

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CIRCLE NO. 7 ON INQUIRY CARD

TI Announces E a Growin

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

If you're looking for ways to get more out of your computer systems, Texas Instruments has got some great things in store for you. Introducing the new members of our DS990 family—the DS990 Models 7, 9 and 29. Powerful computer systems that put the bite on disk storage costs.

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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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CIRCLE NO. 8 ON INQUIRY CARD

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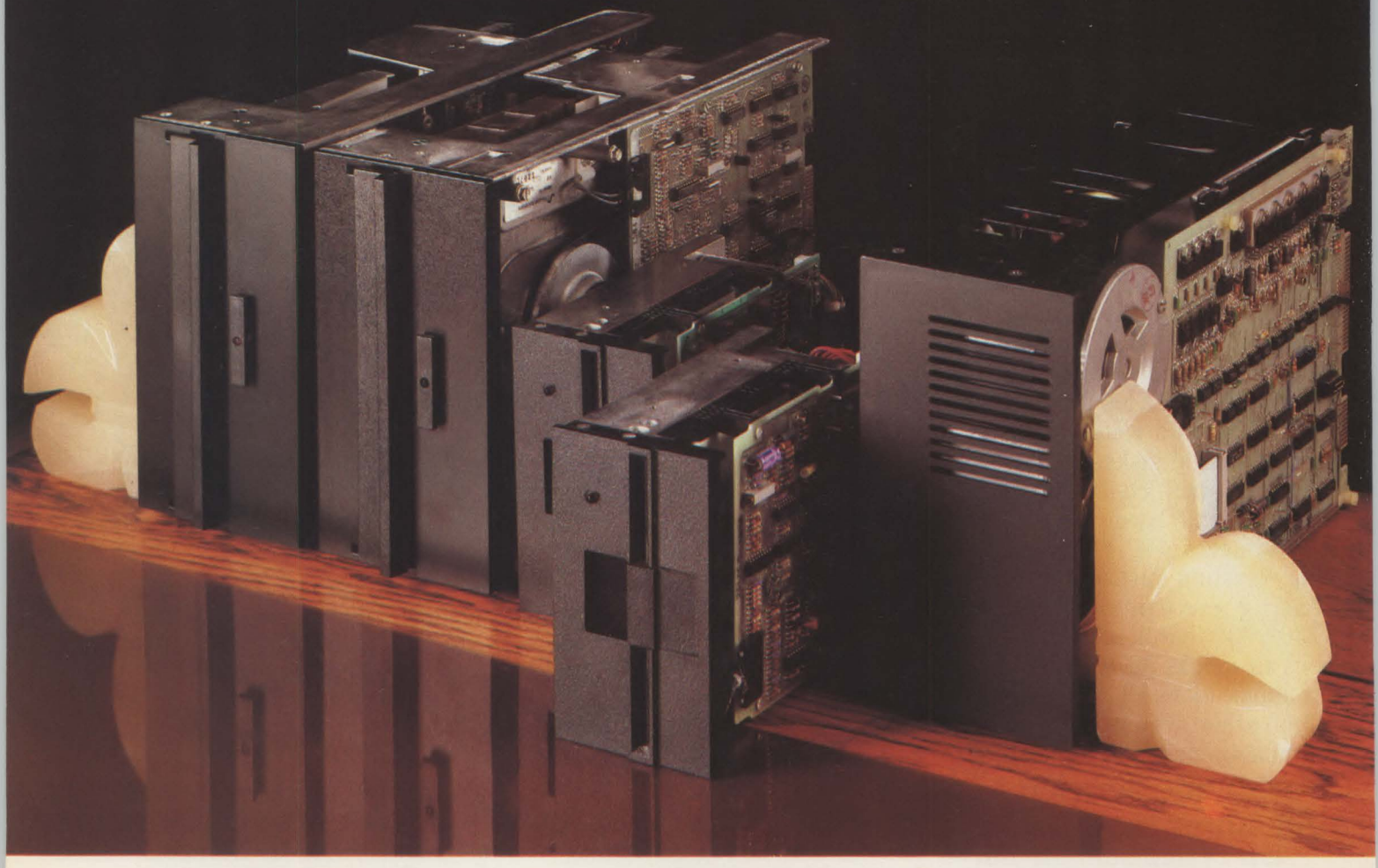

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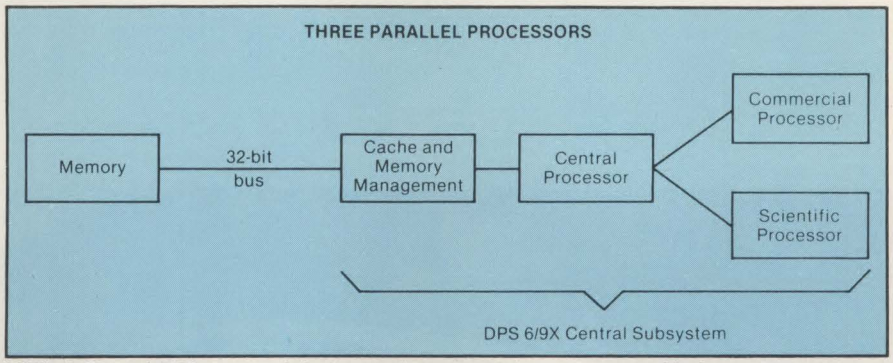
CIRCLE NO. 9 ON INQUIRY CARD

Honeywell tries again to crack supermini market

When its initial entry into the supermini market faltered more than 10 years ago, Honeywell Information Systems, Inc., abandoned that business in favor of mainframe computers. Then in 1976, the Waltham, Mass., company made a second move into the minicomputer market with the 16-bit Level 6, and now has reentered the supermini market with two DPS series computers announced in December. At the same time, HIS introduced eight DPS 16-bit minicomputers, four of which can be upgraded to 32 bits, and entered the office systems market (see "Honeywell enters office automation market," p. 17).

The superminis—DPS 6/92 and DPS 6/96—reportedly bear no resemblance to the earlier models, the 632 and 832, which were introduced in the mid-1960s. The earlier superminis were part of the acquired resources of Computer Control Co., a Framingham, Mass., minicomputer company. They were virtual memory minicomputers with segmentation, says Gardner Hendrie, a former employee of Computer Control and now vice president of engineering at Stratus Computer, Inc., Natick, Mass.



HIS's 6/92 and 6/96 superminis *house three parallel processors, with the commercial and scientific processors functioning as "slaves."*

THE SUPERMINIS: IS NEW TECHNOLOGY NEEDED?

Some of the pizzazz of high-performance features and use of the latest technologies in superminis may be lost on commercial users, who seem to care more about whether their applications are done than about how they are done. Scientific users may be wooed by new technologies, such as gate arrays, programmable array logic (PAL) chips and large virtual address space. But Honeywell Information Systems, Inc., chose not to use those technologies in its new 32-bit machines. Instead, the company focuses on complete software compatibility with earlier minicomputer products, and is stressing superior COBOL performance. HIS might use new technologies in future products, says Ross Belsen, vice president of engineering at HIS's small systems and terminals division.

"Flashy technologies are important if they do the job better for users," says Efrem G. Mallach, technical staff member. But, he adds, there is no reason for HIS to use them yet.

While the superminis from Digital Equipment Corp. and Data General Corp. have a total virtual address space of about 4G bytes, the HIS superminis are set up in much the same manner as the IBM 370, Mallach explains. The 16M bytes of real memory on the DPS 6/96 is backed by 2M bytes of user address space in 31 segments. Mallach contends that amount is enough for any program. Of the 31 segments, 15 hold as much as 128K bytes of information, and 16 hold 8K bytes.

The DPS minicomputers use a transaction-processing monitor, which is available separately. "That monitor 'knows' the sequence of routines, and thus does not require gigabyte address space that uses a memory manager to bring in that information on a statistical basis," Mallach says.

Large virtual memory is not a problem with HIS products, adds Hank Haugland, manager, Level 6 marketing, because HIS already has large mainframes installed. "We could grow into more virtual memory. (But first), we want to make sure the new products are on a very stable hardware and software technical base."

HIS is using gate arrays in some of its processors for other products. "Not everyone has the scale of operations for economic production of custom gate arrays," says David Stein, executive vice president of the Gartner Group. He adds that it is not necessary to use array logic to get good performance in a small system. HIS's Megabus is structured so that gate arrays and/or PALs could be incorporated without redesigning the machine, says HIS's Haugland. He explains that there are three processor areas on the Level 6 Megabus. The independent processors include the arithemetic logic unit (ALU), scientific instruction processor, commercial instruction processor, cache memory and the memory management unit (MMU). Peripheral processors include mass storage, magnetic tape, unit record and disk processors. The third area includes multiline communications processors.

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CIRCLE NO. 10 ON INQUIRY CARD

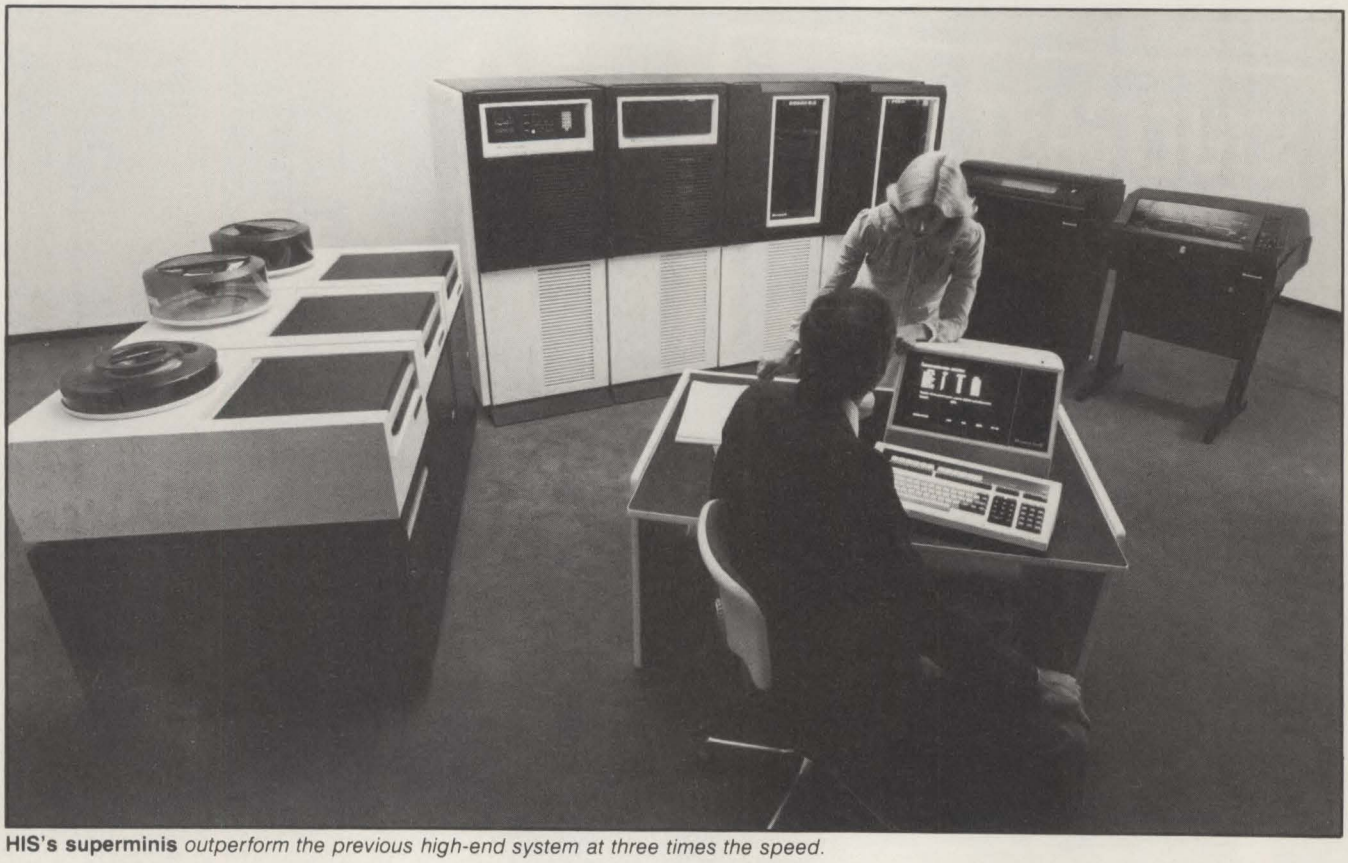
One reason the earlier superminis failed is that Honeywell's budget for minicomputer operations was severely constrained. HIS had acquired General Electric's Series 6000 mainframe business, and most funds were diverted into that merger. After the merger, the minicomputer line was discontinued. Another reason, says Efrem G. Mallach, a technical staff member at HIS small systems and terminal division, is that "Most of the applications, markets and price/performance characteristics were close to the Series 6000; there was too much overlap."

One observer thinks the market of the 1960s was not ready for a supermini. "With Computer Control, HIS had a shot at being one of the first supermini companies in the mid-'60s, (but) HIS must have decided the time was premature for a 32-bit machine, which it was," says David Stein, executive vice president of the Gartner Group, a Greenwich, Conn., consulting firm. He adds, "Because of an aging (Level 6) product, HIS wants to broaden its market. The 32-bit computer makes a lot of sense. Commercial applications typically do not run well on 16-bit machines. The 32-bit line picks up in areas where 16-bit machines are marginally competitive, and adds new markets." Stein does not expect HIS to make any quantum jumps in the market, but, he says, the new products will keep them strong.

The DPS series includes 10 models. The low-end models—DPS 6/30, 6/32, 6/34 and 6/38—range in memory capacity from 128K to 768K bytes, and in price from $28,800 to $75,000. All four models have 16-bit word lengths. The mid-range models—DPS 6/48, 6/54, 6/74 and 6/76, all 16-bit machines upgradeable to 32 bits—are priced from $72,200 to $175,000. The 6/74 and 6/76 include cache memory.

The high-end 32-bit systems—DPS 6/92 and DPS 6/96—have main memory capacity from 1M byte to 16M bytes, and range in price from $300,000 to $600,000. The 6/92 can handle 64 communication lines, has a maximum of 4M bytes of memory, and 2G bytes of mass storage. The 6/96 handles 112 communication lines, maximum memory is 16M bytes, and mass storage is 3G bytes. Shipments of 16- and 32-bit models are scheduled for first and fourth quarters, respectively.

The mid-range systems that will be used in commercial applications perform approximately two times better than Level 6 models at a price about 20 percent higher, says HIS's Mallach. He says models 6/30 through 6/96 include: a 12:1 increase in COBOL performance over the Level 6, a 14:1 increase in the number of work stations, for a total of 112, a 32:1 increase in main memory from 0.5M bytes to 16M bytes, a 40:1 increase in FORTRAN peformance and a 300:1 increase in mass-storage capacity from 10M bytes to 3G bytes. COBOL and FORTRAN statements run three



HIS's superminis *outperform the previous high-end system at three times the speed.*

HONEYWELL ENTERS OFFICE-AUTOMATION MARKET

Honeywell Information Systems, Inc., Waltham, Mass., announced its entry into the office-automation market in December, following on the heels of Prime Computer, Inc., and other companies. While most companies offer word-processing systems for secretarial needs, HIS is targeting professionals and managers. Prime's product is also intended for executives (MMS, June, 1980, p. 16).

The HIS products are based on the DPS 6 and Level 6 hardware, software and peripherals, and combine word processing, document distribution, data processing and communications. The Administrative System/4 shared resource system software can run on DPS 6/30 or DPS 6/32 hardware. It supports as many as four CRT displays, two letter-quality printers, one synchronous communication line, 10M or 26M bytes of fixed- and removable-disk storage and disks for off-line document filing. Administrative System/16, runs on the DPS 6/38 or DPS 6/48 systems. It supports as many as 16 CRTs, six letter-quality printers, two synchronous communication lines and 1000M bytes of storage. Prices of the System/4 and System/16 are $3000 and $5500, respectively, and annual software support is $810 and $1485. Both products are available this quarter.

The WP 6 word-processing application facility was also introduced. It can be used on DPS 6 or model 43 and above Level 6 systems, and can be combined with any software based on HIS's GCOS 6 Mod 200 or Mod 400 operating systems. That product sells for $5000, and annual software support is $1350. WP 6 software interchanges and reformats text- and data-processing files.

HIS is targeting Level 6 users in government, industry and commercial organizations that need office-automation tools in offices where data originate.

times faster on the superminis than on the previous high-end Level 6, model 57, and at the same price, says Mallach.

HIS will continue to support its existing customer base and market the Level 6. "Our worldwide customer base represents the cornerstone of our future direction. Our first priority is on meeting the needs of large- and medium-sized customers," says company president Stephen G. Jerritts. HIS is targeting $2 billion in revenues this year.

The company has not incorporated state-of-the-art technologies such as gate arrays or programmable array logic chips, as other supermini manufacturers have. The Level 6 is not hardware-upgradeable, but software is totally compatible, the company claims.

HIS says it offers an unparalleled degree of hardware and software compatibility between 16- and 32-bit DPS 6 products (see "Is new technology needed?" p.13). "The 16-bit architecture used in Level 6 products has incorporated several of the features normally found in 32-bit systems. These include long memory address, double-word and triple-word instructions and an expandable Megabus, which is the key to field upgradeability and compatibility," says James R.

MINIBITS

WESTERN DIGITAL OFFERS COMMERCIAL ADA SYSTEM

Western Digital Corp., Newport Beach Calif., announced what it claims is the first commercially available μp that executes Ada high-level language programs. Ada—functionally a superset of Pascal—is an effort by the U.S. Department of Defense to establish a standard government language. Western Digital will run the software on its Ada Microengine, part of the company's ME1600 family of μc modules. Ada was developed by TeleSoftware, Inc., San Diego, Calif., which intends to market and publish Ada-based software commercially. The initial Ada release, called TSI-Ada, is scheduled to be shipped second quarter. It is a subset of the Department of Defense's Ada and supports most Ada features, including separate compilation, tasks and exceptions and identifier loading. Generics and representation specifications will not be included. The host processor is a UCSD Pascal system, which houses at least 120K bytes of main memory. Later this year, an interpreter will be available for Ada compilation and execution on the Motorola 68000, Zilog Z8000 and Intel 8086 16-bit μps.

HIGHER CAPACITY QUANTUM DRIVE TO BE SHIPPED

The first upgrade of Quantum Corp.'s Q2000 line of 8-in. Winchester-disk drives, the four-platter, 40M-byte Q2040, is now being shipped from the San Jose, Calif., firm in production quantities, say company sources. The drive has the same form factor, power requirements and interfacing as Shugart Associates' 5M- and 10M-byte SA100 drives and is compatible with the SA1400 controller announced by the Sunnyvale, Calif., Xerox subsidiary last spring. Like other Q2000 drives (MMS, November, 1980, p. 14), it uses a proprietary torque motor as an actuator with servo information embedded on each disk surface. Price for the new model is set at $2100 in 500-unit quantities.

BAY AREA HOUSING COSTS WILL SOAR

Housing prices in the San Francisco Bay Area—already among the highest in the nation—could go even higher, further compounding the personnel-recruitment problems facing many firms in the area. According to a study sponsored by a business group called the Bay Area Council, the average price for a home in San Francisco and surrounding towns could hit $600,000 by 1990, compared to $109,000 today and $25,500 10 years ago. Nationwide, the average price for a home today is $62,000, says the council. One factor contributing to the jump in prices, the report notes, is a Bay Area housing shortage. Now estimated at 65,000 units, the shortage will reach 350,000 by 1990 if trends continue, says the Council.

Pompa, vice president and general manager of HIS's small systems and terminals division. All DPS 6 models operate on the GCOS-6 operating system, which also is used in Level 6 systems.

System compatibility is the strongest point of the DPS 6 in distributed data-processing applications. Users "want to be able to put a $30,000 system in a small location, a $300,000 system in a larger one, and run the same programs bit-for-bit on those two systems and everywhere in between," says Mallach.

The superminis can be used in both commercial and scientific applications, and include two processor boards for each application. Two boards with cache memory and a memory-management unit, plus an extended Megabus connector board are standard. Bus throughput is 13M bytes per sec., twice previous throughput rates. No emulation modes are required to execute 32-bit functions. HIS has added 32-bit registers to the 16-bit registers resident in the system to allow 16-bit software to run on the 32-bit systems with no change.

"It's interesting that you can pull (out) some boards on the 16-bit machine and make a 32-bit machine. That's not a bad deal," says Ed Zander, manager of general systems marketing at Data General Corp., Westboro, Mass. Any controller from a HIS 16-bit minicomputer can be plugged into the 32-bit bus without adapters, multiple buses or duplicate controllers, Mallach says. Zander believes the DPS series is a "repackage" of the Level 6, but he says the high-end DPS computer is a "reasonable performer." He admits that HIS is a formidable competitor and that it has a lot more presence in the large end-user commercial market than Digital Equipment Corp., DG or Prime Computer, Inc. DG's MV/8000 supermini sells for $130,000 to $150,000, without software.

Terry Carlton, assistant vice president of Kidder Peabody & Co., Boston, expects "that competition in the commercial 32-bit market will heat up" as a result of the HIS machines. He explains that more commercial software is available than there was several years ago, especially in COBOL, because some companies, including DEC, Prime and IBM, have made efforts in software development to protect their commercial customer bases.

Carlton ranks HIS among the top five minicomputer vendors in dollar sales, along with Wang, Prime, IBM and DEC. He does not include DG among competitors, because DG does not yet offer a 32-bit COBOL for its MV/8000 supermini. But that COBOL is expected to be announced in the first half of 1981, DG's Zander says. "HIS has done a good job in the minicomputer segment in the last three years, and it's not letting that product line die. It will continue a renewed commitment in that area," Carlton says. HIS views its main competition as IBM's 4331 and DEC's VAX 11/750 and 11/780. The company expects to sell several thousand DPS models. *—Lori Valigra*

Wang rounds out WP line with stand-alone Wangwriter

Since IBM entered the low end of the word-processing market in June with the introduction of the Displaywriter, industry observers have been expecting a response from Wang Laboratories. And although the Lowell, Mass., company's Wangwriter does not include a spelling dictionary and other innovative features included in the Displaywriter, Wang nonetheless entered the stand-alone market with a roar: the Wangwriter sells for less than the Displaywriter ($7500 vs. $7895 in single units). Wang had 500 orders in hand at the time of introduction. The Wangwriter is available immediately in several large cities, and shipments will begin to others in April. Displaywriter deliveries have stretched beyond 42 weeks.

Five other announcements accompanied the Wangwriter: a mini-diskette work station, which allows information to be transferred to and from the Wangwriter to a higher-end office information system (OIS), a remote cluster facility that permits OIS terminals to perform data-processing functions when they're remotely connected to a Wang VS computer system and three communications software enhancements. Communications include IBM SNA/SDLC support for the VS computers and an IBM 3271 bisynchronous emulation package

The Wangwriter, *with its lower price, will compete with IBM's Displaywriter in the stand-alone word-processor market.*

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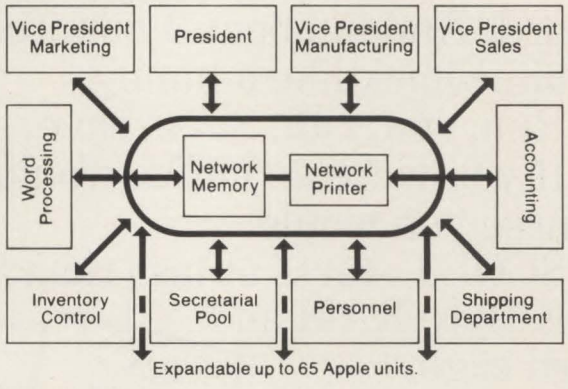

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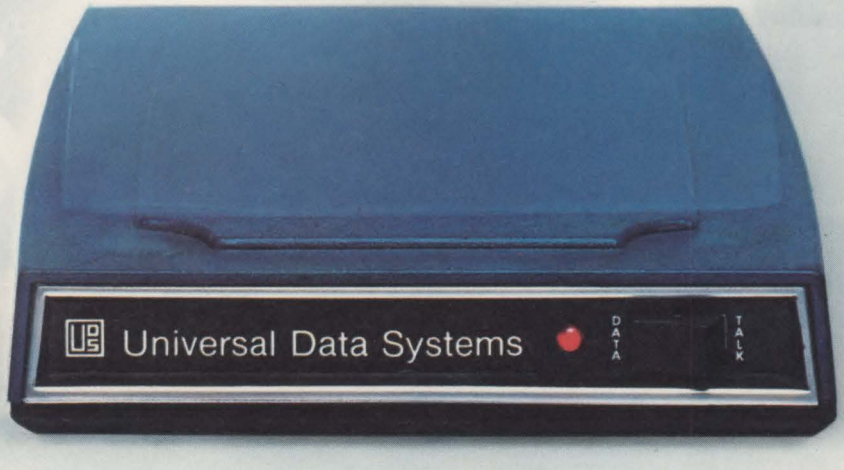

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for the 2200 series of small business computers. Wang also intends to develop software that will enable the Wangwriter to be a distribution point on the Mailway electronic-mail network. The company intends to develop a broadband local area network (see "Wang chooses not to adopt Ethernet for local networking," p. 40).

A Wangwriter with a 96K-byte memory consists of a CRT display, a detachable keyboard and a printer console. The printer console houses a 20-cps Wang daisy-wheel printer; a 5¼-in., dual-sided, double-density minidiskette drive; and system electronics. The minidiskettes store as much as 60 pages of information. Software is bundled in with the system.

Wangwriter offers more complete word-processing software than did the initial Displaywriter. IBM enhanced its product after its introduction (MMS, December, 1980, p. 14) and before deliveries began with mathematics, global search, merged files and automatic rearrangement of columnar information. The Wangwriter does not include spelling verification, as does the Displaywriter.

The Wangwriter is more limited than the Displaywriter, says Patricia Seybold, editor of the *Seybold Report on Word Processing*. "The Wangwriter is essentially a low-end, dead-end product. It can be enhanced by connecting it to other systems (such as a larger OIS system), but not in and of itself. More terminals cannot be added to share a printer." She adds that its memory is limited to 96K bytes, while the Displaywriter houses 1M byte of information, and is more of a "building-block" product. Seybold is disappointed that the Wangwriter does not have a direct-cable connection to the OIS, which would enable it to be used as an autonomous work station. Because its diskettes are not directly compatible with those of OIS, a transfer medium—the minidiskette work station—must be used. The work station is priced at $6200 and will be available in May.

But, Seybold adds, Wang needed a low-end product. Further, the company has aggressive pricing and a sales force dedicated to low-end products. But in the final selection process, Seybold says, the two word processors are roughly equivalent, and the choice will be between which company to go with, not which product.

The Wangwriter will compete against the Displaywriter and electronic typewriters, says Carl Masi, Wang's vice president of marketing support. In that sense, Wang is addressing a broader market than is the Displaywriter. "The Wangwriter doubles our entire potential served market from $2 billion to $4 billion this year," says Masi. He says more than 8 million prospects exist for a product like the Wangwriter. Wang will sell to small departments and branch offices of major accounts, such as Fortune 1000 customers. That business will represent 60 percent of Wang's market thrust over the next few years. The company will manufacture more than 10,000 Wangwriters this year. The Wangwriter will impact System 5 (a low-end model priced from $10,000 to $15,000) sales to stand-alone users, reports John F. Cunningham, vice president of field operations.

Although this places Wang in competition with companies such as Lanier Business Products, Inc., Atlanta, which dominates the stand-alone market, there is room for several companies. Wang will pursue major accounts, while Lanier, CPT Corp. and others pursue medium-sized companies, says Seybold. "The competition is not as devastating as it might seem," she says. —*Lori Valigra*

TI goes 'full line' with the OPTI 940

While best known as a kingpin of the semiconductor industry, Texas Instruments Inc., also is a market leader in computer terminals. Indeed, TI ranks third—behind Teletype Corp. and Digital Equipment Corp.—in printing terminals, according to a recent report by Venture Development Corp., a Wellesley, Mass., market-research firm. Now TI has moved to become an even more formidable market contender by introducing its first CRT display terminal, the OPTI 940.

Rod Canion, terminal product line manager at TI's terminals and peripherals division in Cyprus Grove, Texas, says the announcement will significantly strengthen TI's competitive position by enabling the company for the first time to wield the marketing advantages that accrue to a "full-line" supplier of both CRT and printing devices. Those advantages are considerable, Canion claims. For example, as a full-line supplier, TI will be able to offer customers the convenience of "one-step shopping" and single-vendor support. In addition, Canion says, TI's volume customers will be able to boost their discount rates by combining CRT and printing terminal purchases.

"We're also offering customers the background and experience of an established computer terminal manufacturer," says Canion, who points out that TI has been in the business since 1969, when it introduced its first thermal printer, the model 720. Since then, TI has

delivered more than 800,000 printing terminals, he says.

As its initial CRT product, TI has introduced a "smart" terminal having a local-editing capability and sophisticated keyboard and display features. While the 940 does not have any features that are unique in themselves, Canion says, the terminal is unique in its breadth and choice of features, which are geared to maximizing operator productivity. Moreover, at $1895, the terminal is priced competitively with such

The OPTI 940 CRT display terminal *makes Texas Instruments a "full-line" supplier of both CRT and printing devices.*

comparable smart CRTs as the Digital Equipment Corp. VT-132, the Lear-Siegler ADM-42 and the Hazeltine Executive 80-30, Canion points out. Prices on these terminals range from $1815 (Executive 80-30) to $2450 (VT-132).

Because of its pricing and features, Canion expects the 940 to do well in the smart CRT terminal market, which he claims is the fastest growing segment of the terminal market. That claim is substantiated by Barry Gilbert, an industry analyst with International Data Corp., a Waltham, Mass., market-research firm. Gilbert estimates that some 60,000 non-IBM-compatible smart terminals were shipped in 1979, and he expects that figure to grow at a 20 percent annual rate to 300,000 shipments by 1983. In contrast, he says that shipments of dumb terminals will decline at a 9-percent-a-year rate over the next three years.

Gilbert attributes the growing popularity of smart CRTs to their declining prices, which he says makes them cost-effective for a widening base of terminal users. Dumb CRTs have also benefited from the use of integrated circuitry, which is largely responsible for the drop in CRT prices. However, Gilbert says, many users feel that the productivity gains attainable with smart CRTs outweigh their higher cost compared to dumb terminals.

With the CRT market becoming increasingly crowded and the differences between terminals less obvious, users are looking beyond price and features, Canion says, to such considerations as terminal maintainability and vendor support. Canion claims that TI will score high on both points. He points out, for example, that the 940's innards have been reduced to three modules—tube, electronics and power supply—through the use of custom integrated circuits. Thus, Canion says, a repairman's problem is reduced to isolating, with the help of built-in diagnostics, and replacing one of only three components.

As for support, Canion says that TI has a nationwide network of 160 field-service centers, with at least one office in every major metropolitan area. He says TI will guarantee 24-hr. service to any site located within 100 mi. of a major city.

TI plans to market the new terminal to OEMs and end users through its own sales force. In addition, Canion says, the 940 will also be stocked by the company's network of authorized distributors.

While Canion says that the 940 will strengthen TI's hold on its existing printing-terminal customers, many of whom also require CRT terminals, he maintains that TI is also committed to CRT terminals as a business in its own right. "We intend to become a market leader, with a full line of CRTs," Canion says, adding that future announcements will expand that 940 into a family of products having a broad price and performance range.

Initial deliveries of the 940 are slated to begin in the second quarter this year. *—Paul Kinnucan*

Rotating Memory Systems joins micro-Winchester ranks

The field of 5¼-in. Winchester-disk drive manufacturers continues to grow. The latest entrant in the race is Sunnyvale, Calif.-based Rotating Memory Systems, Inc., whose RMS 500 family makes its debut this month.

However, the RMS drives are the first 5¼-in. devices to use a rotary actuator head positioner, moving away from the usual split-band mechanism.

Jack Swartz, co-founder and vice president of engineering, says that the RMS drives' head positioner is based on a pivot-swing arm actuator driven by a stepper motor, located under the drive's chassis. This unusual setup, Swartz explains, reduces the number of bearings required for the positioning mechanism, thus reducing friction and increasing inherent reliability. "We've also been able to lower the cost of building the positioner, because we've reduced the number of parts," he adds. The effect of the stepper motor's magnetic field on

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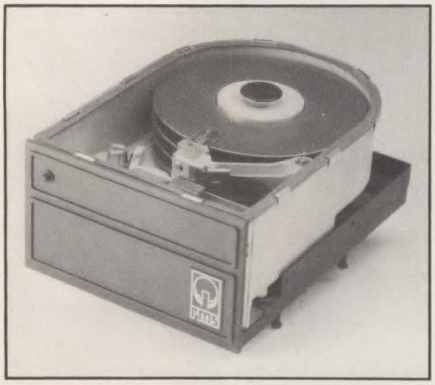


Four-platter model 512 *5¼-in. Winchester packs more than 12M bytes of data into a package the size of a minifloppy-disk drive. Upper photo shows fully encased drive; lower photo shows spindle, disks and swing-arm actuator for the read/write heads. Note the vertical mounting of the stepper motor used to drive the actuator (upper right).*

the disk media is probably lessened as well, Swartz says, because of the motor's location.

The drives will be compatible with Seagate (née Shugart) Technology's ST500 micro-Winchester, the pioneer 5¼-in. drive. Specifications of the RMS 500 include 3600-rpm rotational speed, 7700-bpi recording density, a 215-tpi track density and 5M-bps transfer rate—equal to that of the ST500, Swartz says.

Track-to-track access time is 3 msec., but average access time is 70 msec.—closer to a Shugart Associates SA1000 8-in. drive. Access time for the ST500 is 170 msec. Swartz says only that there is "quite a bit of control logic associated with the high access time."

Capacities of the three models in the series range from 3.18M bytes for the single-platter RMS 503, through 6.38M bytes for the two-platter RMS 506, to 12.72M bytes for the top-of-the-line, four-platter RMS 512.

Co-founder and vice president of marketing Mike Kirby says that the company expects to begin delivering evaluation units of the drives by next month. Production volumes are anticipated by the second quarter of 1982.

RMS's production schedule—considerably later than Seagate's—doesn't worry Kirby, who thinks the market will take all the 5¼-in. drives his firm, Seagate and any other maker can deliver. "The industry will not be able to build enough drives to meet the demand," he says.

RMS hopes to deliver 5000 to 7000 units by year-end. Kirby expects the company to ramp up to 20,000 devices.

In 500-unit quantities, the RMS 503 sells for $700, the RMS 506 sells for $900, and the RMS 512 sells for $1200. —*Larry Lettieri*

IMI enters 5¼-in. market with thin-film Winchester

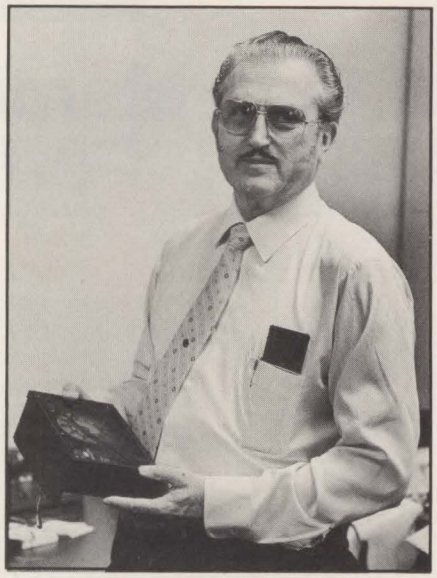
The pioneer in the OEM Winchester-disk-drive market is thinking even smaller these days. International Memories, Inc., Cupertino, Calif., will formally announce its entry into the 5¼-in. Winchester derby this month (MMS, July, 1980, p. 6).

Designated the 5000 Series, the 7M-byte, two-platter drives are undergoing evaluation at a number of small business computer houses, and can be expected to be used in word-processing systems by year-end, says Frank Iazetta, marketing vice president at IMI.

Like executives at other suppliers of 5¼-in. Winchesters, Iazetta is anticipating large-scale production runs. "We plan to move 3000 drives a month by June. Production could hit 6000 per month by December," he says.

Iazetta adds that IMI could ship even more 5000 Series drives if demand warrants. "We are set to build 12,000 units a month," he says, referring to the company's recently opened facility in Medford, Ore., "but we don't see that level of customer activity yet." Next year, Iazetta says, IMI plans to ship 10,000 units per month.

To expedite the incorporation of the 5000 Series drives into both new and existing systems, IMI has used the de facto mechanical standard for this type of device—the envelope dimensions of Shugart Associates' SA450 double-sided, 5¼-in. floppy-disk drive. Interfacing standards will be identical to those found on



IMI's Al Hasler and the Series 5000 5¼-in. Winchester. *The 7M-byte drive incorporates thin-film media and interfacing to Shugart's SA1000 8-in. device as well as to IMI's 7710, the first 8-in. Winchester announced for the OEM market.*

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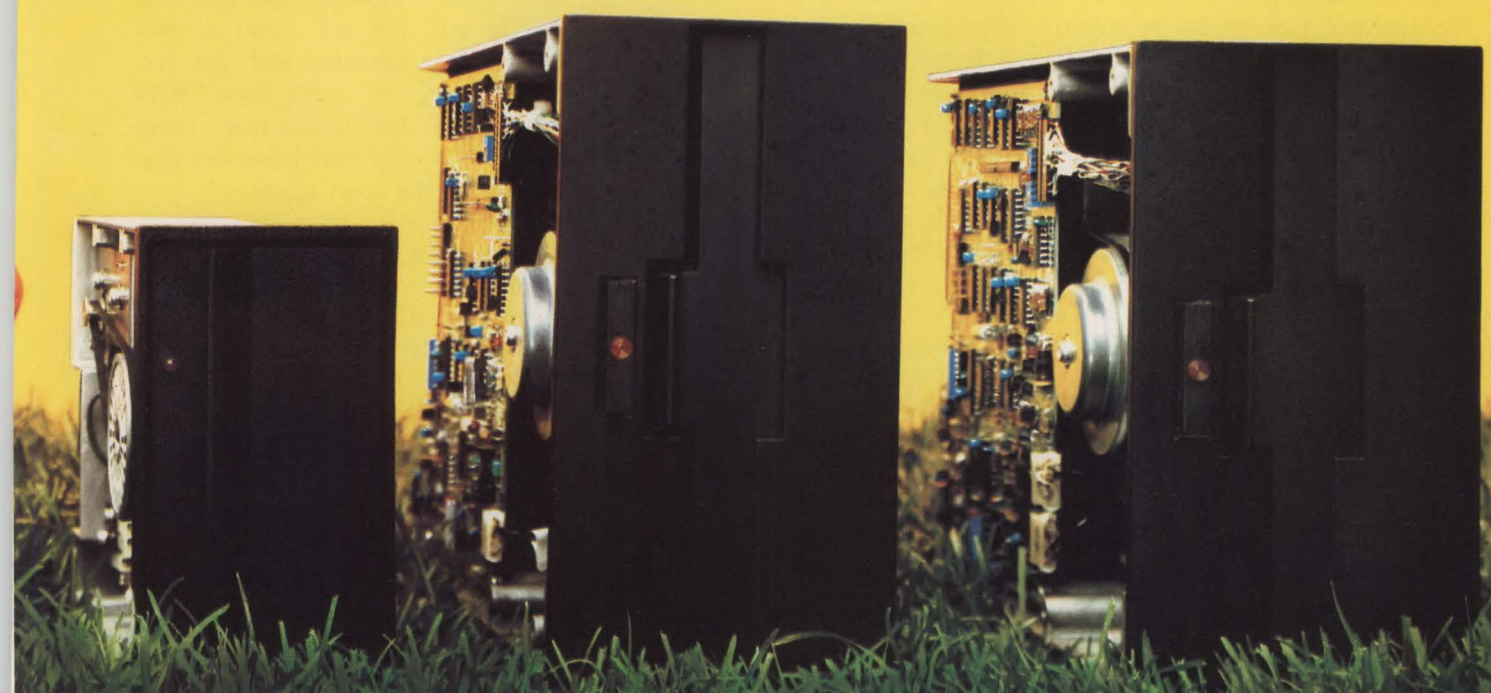

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Shugart's 5m- and 10M-byte SA1000 8-in. Winchester, and to those incorporated into IMI's line of 8-in. hardware.

Absent from the 5000 Series drives, however, will be an SA450 floppy-disk interface. "It's too slow," explains Al Hasler, co-founder and engineering vice president at IMI. "In effect, it turns the Winchester into a floppy-disk drive." Also absent from the new hardware will be the oxide-coated media common to 5¼-in. Winchesters offered by Seagate Technology, the first company to introduce a 5¼-in. Winchester, Tandon Corp. and Shugart Associates (MMS, January, p. 20).

Instead, the 5000 Series will use thin-film media, a technology these vendors have avoided, and one that has appeared so far only on the higher-capacity Irwin International 510 (MMS, November, 1980, p. 45), and the low-end New World V-1TF. "Ampex has committed itself to manufacture this media in quantity," Hasler says. "If they meet their goals, then we'll go to thin-film media 100 percent."

According to Hasler, IMI's decision to go to thin-film was almost preordained. "It's easier to handle and offers higher recording densities," he explains. Moreover, he adds, should a shortfall of thin-film media develop, his firm is prepared to fall back on other vendors, or to use conventional oxide-coated disks, if required. "We have evaluated both thin-film and oxide-coated media in the 5000 Series drives," he says, "and in many cases our customers didn't know which was which."

Apparently, this did not concern them, Hasler notes. Nor were IMI's customers for evaluation drives concerned over the fact that the firm was prepared to sell OEM drives with media that is not the same size used on the other 5¼-in. Winchesters.

Disks used on the 5000 Series drives will have an outside diameter (OD) of 133 mm. and an inside diameter (ID) of 63.5 mm. as opposed to the 130-mm. OD, 40-mm. ID media used on other small Winchesters. Hasler says IMI's move to a larger ID was prompted by design considerations. "There are two things desirable in a drive—a solid spindle and magnetic shielding," he explains.

To get the former, IMI moved the drive bearings up the middle of the spindle, a design that mandated media with a larger ID. In the process, Hasler says, IMI was able to fit in a magnetic shield. "Never before has the media been in such close proximity to a magnetic source," he adds, referring to the DC spindle motor used on the small Winchesters. "We had to be concerned with long-term magnetic degradation of data."

In a disk drive, he continues, such degradation can take place over a period of months, and does not directly affect file data, which is being constantly updated. It does affect permanent data, such as the information needed for error recovery, sector headers and the like. And in higher-capacity drives, it can affect servo data. "In these drives, magnetic degradation could impact the ability of the drive to stay on track," he says.

Hasler admits that preserving servo data is not a consideration for 5000 Series users because the drive, like most other 5¼-in. Winchesters, uses an open-loop actuator system driven by a stepper motor and a split-band positioner.

Future IMI hardware could be another matter, however. "We plan to bring these Winchesters up to 20M bytes," Hasler explains. "But to do so, we will need a new positioning scheme, and we will have to rely on servo data." IMI's plans call for closed-loop servo systems tied to microsteppers that will drive the head actuator.

Pricing for the 5000 Series 5¼-in. Winchesters is set at $780 in 1000-lot orders and includes formatter. Production versions of the new drive are scheduled for delivery by the end of the quarter.

—John Trifari

IMI's DRIVE SPECIFICATIONS

Drive	Series 5000	7710
Unformatted capacity	6.91 bytes	11.3M bytes
Transfer rate	7.6M bits/sec.	5.2M bits/sec.
Positioning times:		
Track/track	12 msec.	10 msec.
Average	100 msec.	50 msec.
Maximum	300 msec.	100 msec.
Rotational speed	4800 rpm	3600 rpm
Recording density	8730 bpi	5868 bpi
Track density	200 tpi	300 tpi
Number of platters	2	2 (one servo surface included)
Platter size	133 mm. × 63.5 mm.	200 mm. × 63.5 mm.
Dimensions	3.25 × 5.75 × 8.0 in.	5.50 × 8.57 × 19.25 in.
DC voltages	+ 12VDC; + 5VDC	+ 24VDC; ± 12VDC; ± 5VDC
Price (each, in lots of 1000)	$780	$1775

IMI's 5000 Series 5¼-in. *Winchester compared to the company's earlier 7710 10M-byte 8-in. hardware.*

5¼-in. drives expected to impact 8-in. market

Even before most vendors gear up for high-volume production of 5¼-in. Winchester-disk drives, many industry observers are predicting a significant impact on low-end 8-in. hardware—which did not begin to be shipped in volume until mid-1980.

"The sales life of 5M- and 10M-byte 8-in. Winchesters will be

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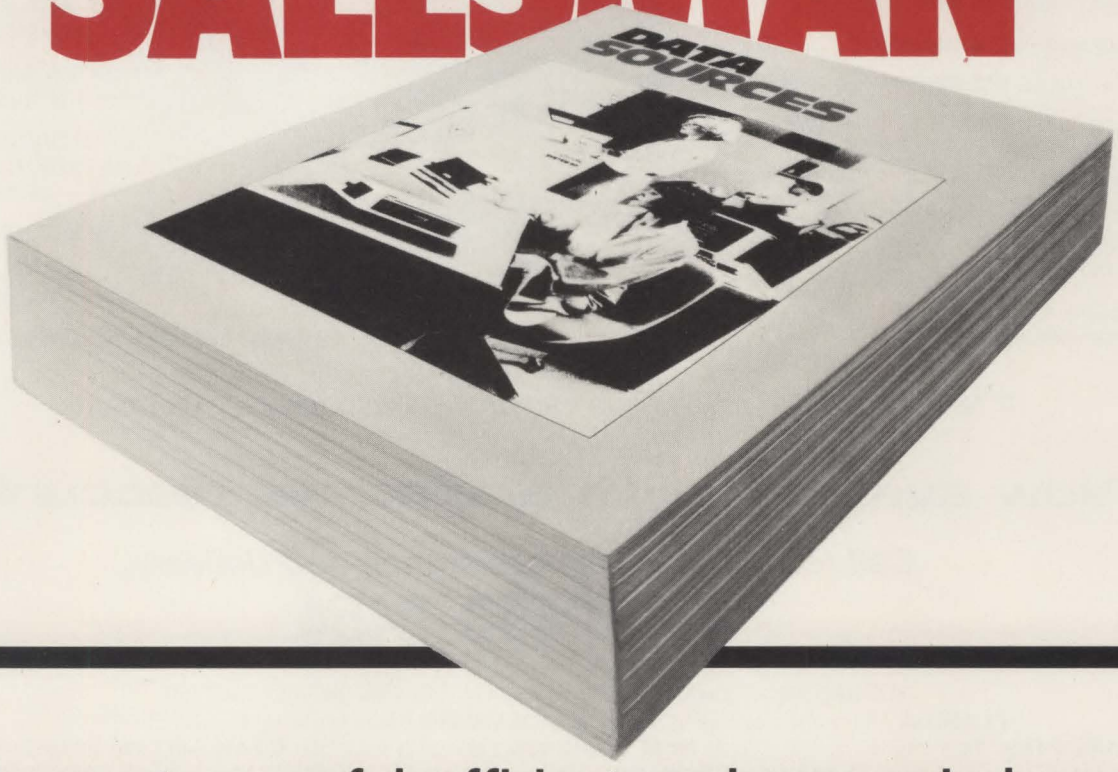

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CIRCLE NO. 18 ON INQUIRY CARD

shortened when these smaller drives start moving out in volume," says Santa Barbara, Calif., industry analyst Ray Freeman Jr. "But in the short term, 8-in. drives will continue to attract orders."

Finis Conner, executive vice president of Seagate Technology, Scotts Valley, Calif., the first firm to introduce a 5¼-in. Winchester (MMS, April, 1980, p. 79), feels that the impact of the smaller drives may be more severe, however. "Systems designers are now holding up plans to use 8-in. drives and are now waiting for evaluation quantities of 5¼-in. hardware," he claims. "We shipped 1000 evaluation ST-506 drives in 1980 alone after being in business only a little more than a year," he says. "Last month we moved 1000 units, and we are already sitting on a $20-million backlog."

One reason for the booming interest in 5¼-in. drives a scant year after their announcement, Conner says, is a set of well-defined controller standards. "Initially, there was a proliferation of 8-in. hardware vendors following the announcement of the first drives," he explains, "and each had his own controller standard." As a result, controller houses did not develop any product until a de facto standard emerged when Shugart Associates unveiled its 5M- and 10M-byte SA1000 drives in 1979, followed in May, 1980, with the announcement of the SA1400 controller (MMS, May, 1980, p. 5).

In contrast, a standard for the 5¼-in. Winchesters has already been set, Conner continues, with almost all vendors—including Seagate—working toward an SA1000-compatible interface. "As a result, we have close to 15 vendors doing controller work for these smaller drives," he claims, "including some who are working on LSI versions.

Industry analyst Andrew Roman, Newark, Calif. agrees that 5¼-in. Winchesters will have a sharp impact on lower-end 8-in. drives. "These smaller devices could potentially wipe out the market for 8-in. hardware in the under-20M-byte range completely," he says. "There is an incessant demand from systems builders for small, high-capacity auxiliary storage even if the cost per megabyte is higher than that for larger, 8- and 14-in. devices."

One immediate result of the 5¼-in. Winchester's entry into the OEM market, he goes on, will be the upward migration of 8-in. drives. "Low-end hardware this size will move upward into the 20M- to 40M-byte range," he says. "Quantum Corp. has already anticipated this trend (see "Higher capacity Quantum drives to be shipped," p. 17); Shugart Associates, whose SA1000 will be severely impacted by its own SA600 5¼-in. device (MMS, January, p. 20) is also planning to move its 8-in. hardware up to that capacity by adding additional platters."

International Memories, Inc. (IMI), the first firm to develop and market an OEM 8-in. Winchester, recently unveiled its 5000 Series 5¼-in. hardware (see "IMI enters 5¼-in. market with thin-film Winchester," p. 26) and plans to push the capacities of its older 8-in. hardware as well. Frank Iazetta, marketing vice president at the Cupertino, Calif., peripherals house, says IMI sees its smaller hardware putting a clamp on any significant future sales of its 8-in. hardware at the low end, with two exceptions. "There are some customers who will require the higher performance offered by an 8-in. drive. Others will stay with the older devices because that's what they started off with at a time when IMI was the only supplier of 8-in. hardware," Iazetta says.

He concedes, however, that both categories will constitute "residual sales," and that IMI's plans include pushing the older hardware into markets now served by low-cost 14-in. drives in the Shugart-SA4000 class. "We have a 40M-byte version of our original 11M-byte 7710 8-in. drive available at the same cost as this larger hardware," he says.

Others feel that the coming impact of 5¼-in. Winchesters may not be as severe as anticipated. "It's not a question of choosing one or the other," says Jim McCoy, marketing vice president and co-founder of San Jose, Calif.-based Quantum Corp., the first company started specifically to build 8-in. Winchesters. "These drives are going to different markets. There is very little overlap."

McCoy says the market for these drives is largely a function of the form factor of the systems into which they are installed. "This is a key point when it comes to making a choice between these two types of drives," he explains. "If you need a drive that is physically smaller, you have little choice." McCoy sees small Winchesters as the natural partners of 5¼-in. floppy-disk drives and systems.

"As a result, we're not overly concerned. We're looking at production runs of 4000 8-in. drives a month this year," McCoy says.

Jim Porter, Mountain View, Calif., industry analyst and publisher of *Disk/Trend Report*, also takes a cautious view of the 5¼-in. Winchester's impact. He notes that for at least the next few years, systems design will not be much affected, given the number of configurations set up to handle 8-in. hardware. "But," he says, "two or three years out, when multiterminal desk-top systems become available, this picture may change."

Conner maintains that the impact of the 5¼-in. drive will be felt sooner as production gears up. The end of 1981, however, might be a more appropriate time to make that analysis. Porter says U.S. vendors will ship 57,000 8-in. drives with capacities lower than 30M bytes to

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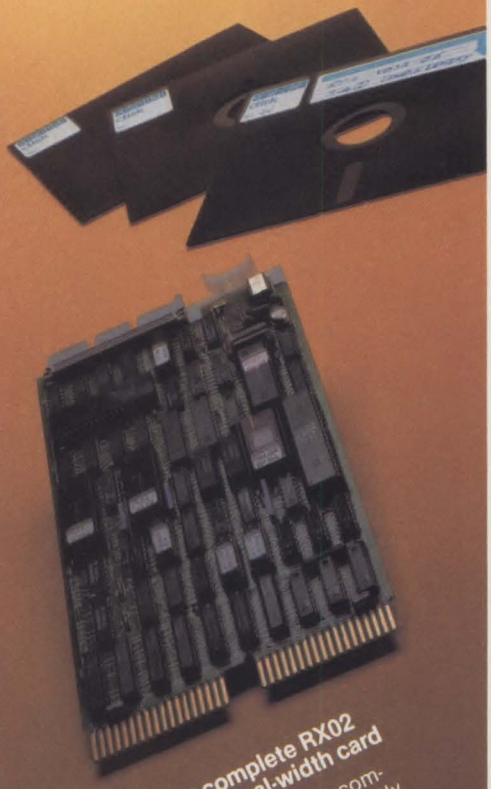

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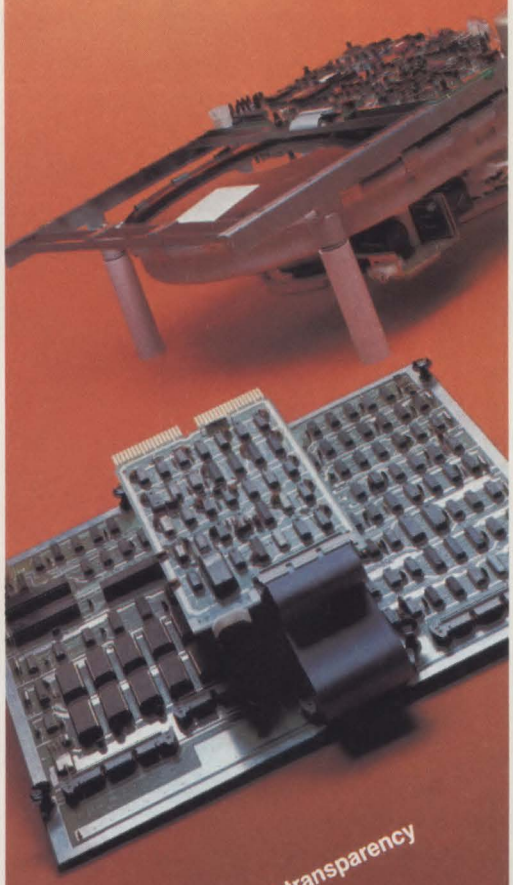

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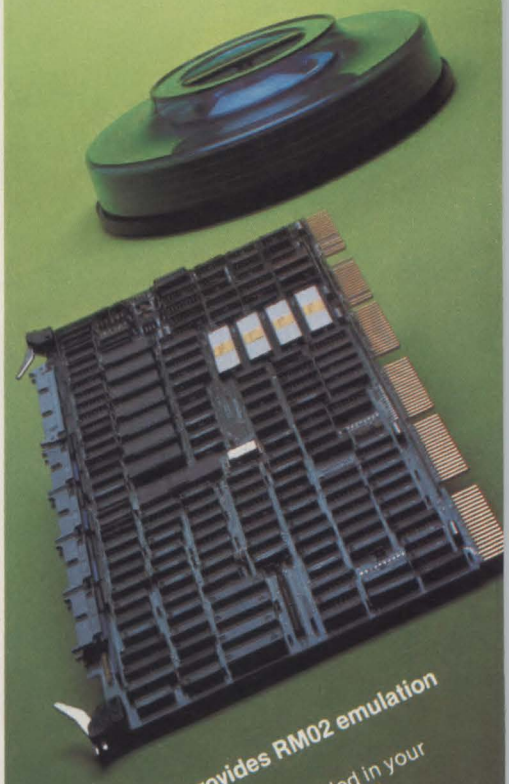

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the OEM market, and overseas suppliers will provide 17,600 devices. Conner says volume production of 5¼-in. hardware at Seagate will begin around the third quarter of this year, and that by year-end, 50,000 drives will be in customers' hands. —*John Trifari*

ISI designs touch screen kit for DEC VT 103 users

To first-time computer users, working with a keyboard terminal can be frustrating and overwhelming. But that task can be made easier by using a touch-screen kit for the Digital Equipment Corp. VT 103. Users of that kit will be able to access a data base by the touch of a finger.

The kit, announced this month by Interaction Systems, Inc., Newtonville, Mass., includes a touch-screen glass, a Q-bus-compatible board that fits in one slot of a VT 103 six-slot card cage and connector cables. The screen mounts on the VT 103 video screen, and the VT 103 keyboard can be used. The kit's board contains a 1K-byte PROM and a 1K-byte RAM. Optional interfaces are RS232, TTL serial ASCII and 8-bit parallel. Single-unit price is $795, and 100-unit price is $495.

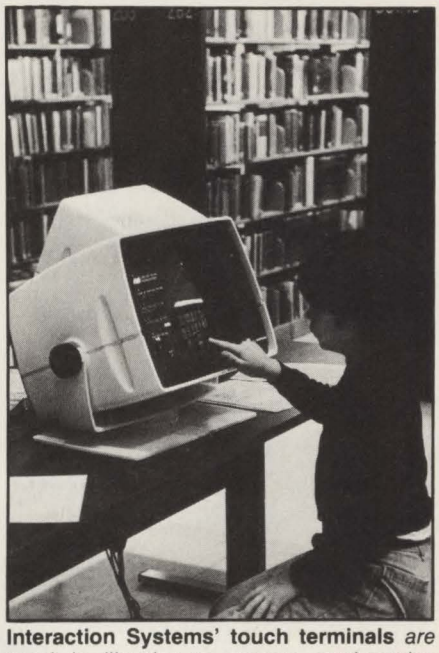
"There is a growing desire (among manufacturers) to simplify the means of interacting with computers and to broaden the number of computer users," says ISI president Walter A. Winshall. Winshall says the kit can be incorporated into any computer system that is regularly used by the general public, such as a library system for card-catalog information. He claims the touch-terminal market is potentially larger than the keyboard-terminal market, which he estimates to be 800,000 units a year.

"The competition in touch has not yet begun," says Winshall. Other companies offer touch models, including Carroll Manufacturing Co., whose touch system is used with the Xerox 5700 printing system (MMS, November, 1980, p. 26). But, Winshall says, the main competition will come from large-volume keyboard-terminal manufacturers that have not yet entered the market.

Touch terminals offer better reliability and a lower price than keyboard terminals because touch terminals contain fewer electromechanical parts. The ISI touch screen incorporates what Winshall says is superior technology over that of other touch terminals on the market (see "Touch alternatives, p. 37). The touch screen is activated by a human body's capacitance, an electrical phenomenon that is detected by sensors. The screen has 32 sections, which are covered by a transparent conductive coating. At the edge of the screen, connected to each area, are sensors, which connect to a Z80 μp that determines which area was touched.

The touch screen is very sensitive and accurate. For example, if a user inadvertently touches two areas simultaneously, only the area touched first by a precise spot on a fingertip will be activated. The activated area is then highlighted, and the user hears a beep acknowledging that the correct section was touched.

The system was developed at ISI, a company that began operations last September. Original financing came from CL Systems, Inc., a



Interaction Systems' touch terminals *are used in libraries to access card-catalog information.*

TOUCH ALTERNATIVES

Capacitance is a relatively new method in touch technology. There are three main alternatives:

- One of the oldest methods is the use of a "soft screen," which indents when touched and essentially functions as a switch, explains Walter A. Winshall, president of Interaction Systems, Inc. Control Data Corp.'s Plato and Solid State Technology, Inc.'s Proteus use this method. Winshall says the approach is more expensive than capacitance, and it poses reliability problems because it requires more mechanical parts.
- An even more expensive approach is the use of infrared light beams, which are placed along one edge of a CRT screen opposite photodiodes. Touching the screen interrupts the beam. Carroll Manufacturing Co. uses this technique, which Winshall says requires continued field service to keep the receptors aligned.
- The third alternative is sound waves. The area touched is identified by the time required for the wave to bounce back to the side of the screen. Winshall says sound is the most expensive approach to use when designing a touch-screen kit. One problem is that dirt on the screen surface can disperse a wave and give false readings.

Capacitance does not require mechanical switch devices. There are no receptors to be realigned, and dirt does not affect its sensors. Room temperature and humidity are recalibrated every 1/1000 sec. on a moving average to keep the terminal in stable operation. The screen must be touched for at least a fraction of a sec. before the desired field is activated. This prevents foreign matter from activating the screen.

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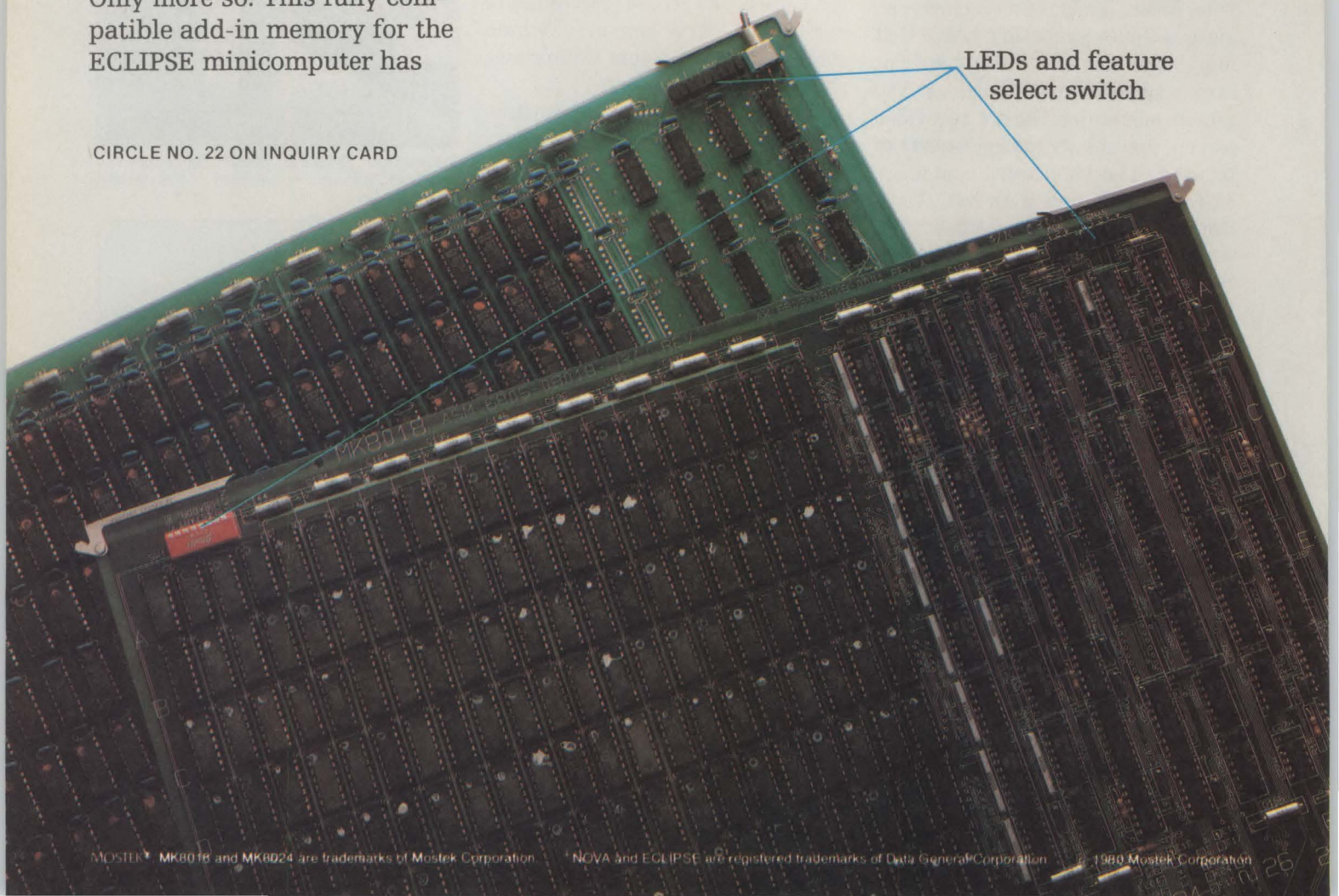

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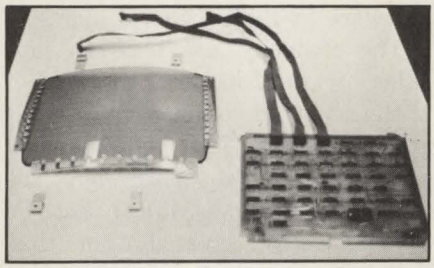
Newton, Mass., systems house that markets library-automation systems. CLSI was also the first big customer for a complete custom ISI touch terminal and has ordered 1000 units, to which it will add library software. The idea for custom kits sprang from that order.

Winshall does not expect to encounter the user resistance faced by some manufacturers of flat keyboards. Some of those manufacturers have returned to raised keyboards to which their users were accustomed. "Most people haven't seen a touch terminal, so there are no preconceived notions," Winshall explains. Users of raised keyboards had ideas about what they wanted from a flat keyboard.

But touch terminals from ISI will find their way into first-time user environments. One application is automobile sales, says Steven J. Puchkoff, vice president of marketing at ISI. Potential buyers could find the price of options without a salesman's intervention.



Interaction Systems' custom touch-terminal kit *includes a screen, a printed circuit board and connectors. The screen mounts on top of existing terminal screens.*

Another potential application, he says, will be executive offices. Executives who have been reluctant to use typewriter-like keyboards would be more willing to use a touch terminal.

ISI intends to become the leading supplier of public-use terminals over the next five years and is offering $1 million common stock to raise capital. —*Lori Valigra*

TI slashes prices to capture home market

How much is a moderately affluent consumer willing to pay for a computer to help balance the checkbook, teach the kids new math and keep the family entertained with video games on cold winter nights? After 18 months in the fledgling home computer market, Texas Instruments Inc., has found that the acceptable price lies closer to $500 than to $1000. So in early December, the company's consumer products division slashed $300 from the $950 list price of its TI 99/4 home computer in an effort to boost the unit's sales, which have been lackluster, industry sources say.

TI dealers, some of whom had been selling the 99/4 for less than the list price, are predictably pleased with the price reduction. "It's a step in the right direction," says Mike Flynn, director of consumer marketing at Team Central, Inc., in Minneapolis. He says that since the price cut, retail sales of the 99/4 have been doing "a little better." Other dealers also report a perceptible improvement in 99/4 sales since the price reduction.

At the same time, TI moved to broaden the 99/4's software base by announcing a low-cost development system aimed at independent software developers. TI officials hope the development system will encourage independent firms to develop and market software for the TI 99/4 as they have for such competitive systems as the Apple and the Radio Shack TRS-80.

Industry observers point out that software is critical to success in the home market as in the business market, and they attribute the success of Apple Computer to the large base of software developed for the company's computers by indepdent software firms. "People don't buy the Apple because it's the best computer on the market, but because it has the best software available," says Alan Hald, president of The Phoenix Group, the country's largest retail computer distributor.

Whether intentionally or not, TI's marketing strategy for the 99/4 until now has discouraged independent software developers, most of whom are small-shop operations, from developing software for the 99/4. For one thing, until recently, the computer ran on plug-in ROM modules that required an independent software firm to make a large initial investment just to have its software burned into the ROM modules. An independent that wanted to supply software in ROM-module form initially had to order at least 1000 units from TI. In addition, a developer had to invest in a $40,000 minicomputer system to develop software for the 99/4 because the machine's assembly language and graphics programming language are inaccessible from the 99/4's keyboard. In other words, the 99/4 itself could not be used as a development system.

In short, the ROM-module approach was prohibitively expensive for all but the very largest companies, such as Milton Bradley, which has marketed some of its computer games in that form.

To lower the cost for independents to develop software for the 99/4, TI has now introduced a floppy-disk-based development system that sells for less than $5000. The system includes version 4.0 (the latest version) of UCSD Pascal.

Another drawback that discouraged independent software houses

from developing software for the 99/4 was that the computer ran only BASIC—a relatively primitive high-level language. The new development system will enable software firms to write application software in Pascal, which is fast becoming the most popular language for developing μc application software.

TI has also taken other steps to broaden the 99/4's software base. Last summer, the company hired 150 high school and college students to convert programs developed by independent firms to TI's version of BASIC, and then returned the converted software to the original developers for marketing. In addition, TI sponsored a contest to promote the development of software by high school students.

The company also believes slow sales are due, in part, to the fact that the home computer market is still embryonic. The problem is not just price. "Two years ago the market did not exist at any price," a TI spokesman says. Rather than flow with the tide, which has seen Apple, Radio Shack, Commodore and other competitors in the personal computer market shift their emphasis to business and professional users, TI has remained committed to the home market. Indeed, the company has attempted to foster its development through a series of educational seminars.

Some dealers, however, say that TI has not done enough consumer education. "It would like to see TI do a lot more consumer advertising," says Warren Winger, chairman of the CompuShop retail chain in Richardson, Texas. —*Paul Kinnucan*

Wang chooses not to adopt Ethernet for local networking

In the midst of the excitement over the December introduction of the low-end Wangwriter word processor (see "Wangwriter makes its debut," p. 18), Wang Laboratories quietly announced a strategy for local area networking. Rather than adopt Xerox Corp.'s much-publicized Ethernet baseband standard (MMS, February, 1980, p. 53), the Lowell, Mass., company chose to go it alone and develop a digitally encoded broadband cable network.

With that choice, Wang opted for the ability for simultaneous transmission of data, word, facsimile, audio and image signals instead of being limited to one of these at a time as in the Ethernet single-channel encoding approach. Details of the Wang network will be revealed later this year.

"It is important to tailor the (cable) wire to the information sent," says Frederick A. Wang, vice president of market planning and development. He explains that while Ethernet's 10M-bit-per-sec. data rate is good for data, it is not adequate for mixing high- and low-speed transmissions. While facsimile, voice and video information should travel at high speeds, lower-priority information, such as office-room-temperature checks, should travel at lower speeds. "We do not want to send all the information in one 'tube' (cable line),

WANG VS. XEROX ON NETWORKING

The two approaches to local networking proposed by Wang Laboratories and Xerox Corp. have common roots: both use CATV-type coaxial cable, and both are broadband networks—that is, they have a 300-MHz bandwidth. The fundamental difference is in the encoding used. Wang will digitally encode its broadband so that multiple communications channels are available. Xerox's Ethernet encoding enables only one channel to be used.

"Xerox uses broadband cable, but the encoding doesn't allow it to be used as broadband," explains Greg Hopkins, an associate department head at Mitre Corp. who specializes in local networks. That encoding allows only one signal on a wire (cable), making it a baseband network.

Ethernet uses 10M-bit-per-sec. signaling. This means about 100 MHz of the 300-MHz bandwidth is used so that transmissions are not distorted, explains Ron Johnson, strategic business unit manager for network systems at Xerox.

The problems with Ethernet's baseband network arise when it attempts to move different types of information, such as voice, images, data and video, simultaneously. The Wang approach allows for a data channel at one frequency, and an audio distribution system at another frequency within the 300-MHz range, Hopkins says. He adds that Ethernet could support data and voice on the same line, but the information would have to be digitized first.

Another problem surfaces in Ethernet's inability to handle real-time video. Ethernet can handle still-frame video, because information on a screen is digitized in non-real time and then transmitted. For example, Ethernet cannot scan live video on a TV screen. However, there is no technical barrier to prevent Xerox from going beyond its 100-MHz limit to incorporate video by dividing the 300 MHz. The company has not chosen this approach. Johnson sees no indication that Wang will use video in the near future, and questions why Wang would choose broadband. But Mitre's Hopkins counters that video is necessary to office automation in applications such as teleconferencing.

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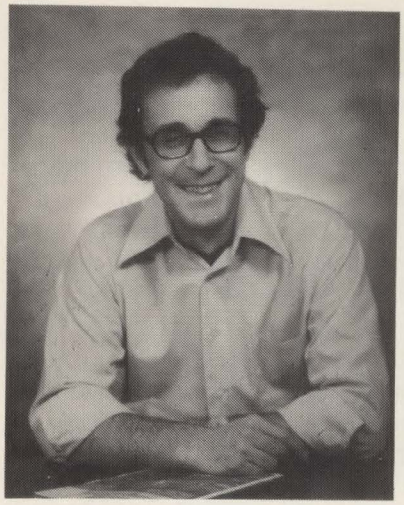

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because a temperature check may hold up a high-speed channel." He says broadband has a number of individual tubes, rather than just one, to handle the variety of information sent.

"Had Ethernet had an answer to the video and audio issues, we might not have done what we did," Wang says. "Xerox eventually will explain how to handle audio on Ethernet. We are not in a position to be able to speculate what another vendor might do."

"Wang is making a mistake (by using broadband)," counters Ron Johnson, strategic business unit manager for network systems at Xerox Corp., El Segundo, Calif. "First, it is extremely expensive to build a sales and service capability for that type of system integration." He explains that it costs time and money to rotate salespeople out of the field for training on the broadband network.

A second problem Wang will face is addressing a user base with non-compatible equipment that requires interfaces. "There is a tremendous base of existing equipment, including word processors and minicomputers, that people want to continue to use. A vendor not trying to cooperate with the industry to establish a standard may offend the end user now," says Johnson. Xerox, Digital Equipment Corp. and Intel Corp. are encouraging industry standardization on a proposed network based on Ethernet (MMS, July, 1980, p. 17). Johnson adds, however, that the Wang network can be linked to Ethernet through a gateway.

Others feel that Wang is "progressive and far-reaching." Greg Hopkins, an associate department head who specializes in local networking at Mitre Corp., Bedford, Mass., explains that time-division and frequency-division multiplexing techniques can be used in broadband networks essentially to put many Ethernets on one system. "Real-time video is out of the question" on Ethernet, he says, because the video must first be digitized and then put on the line, and that activity will take up the entire channel. Conversely, he says, broadband cable typically houses 300 MHz of usable information, and each video channel may require only a portion of that bandwidth. Color television occupies just 6 MHz of bandwidth.

Xerox's Johnson admits that video is the only limitation on Ethernet. "The only area of trouble is with video transmission from scanned images like live television, which requires 20 MHz to 30 MHz of bandwidth. You must move above the 100-MHz bandwidth we now use. Xerox has no plans to do that." He says, however, that Ethernet is running TV transmissions at Xerox's research center. He adds that voice can fit within the 10M-bit-per-sec. signaling rate of Ethernet.

"Video requires options beyond the capabilities of Ethernet. But (a company must) then deal with high interconnect costs that average $1000 per work station, and with a multiplexing capability," cautions Donald H. Brown, director, small systems, at the Gartner Group, Inc., a Greenwich, Conn., consulting firm. Brown questions how this cost can be justified in a work station that will sell for $2500 to $3000 in three years. "The costs (of broadband) will swamp the basic unit (work-station) cost." Ethernet, he points out, carries an interconnect fee of $250, which will fall to $100 in 1983.

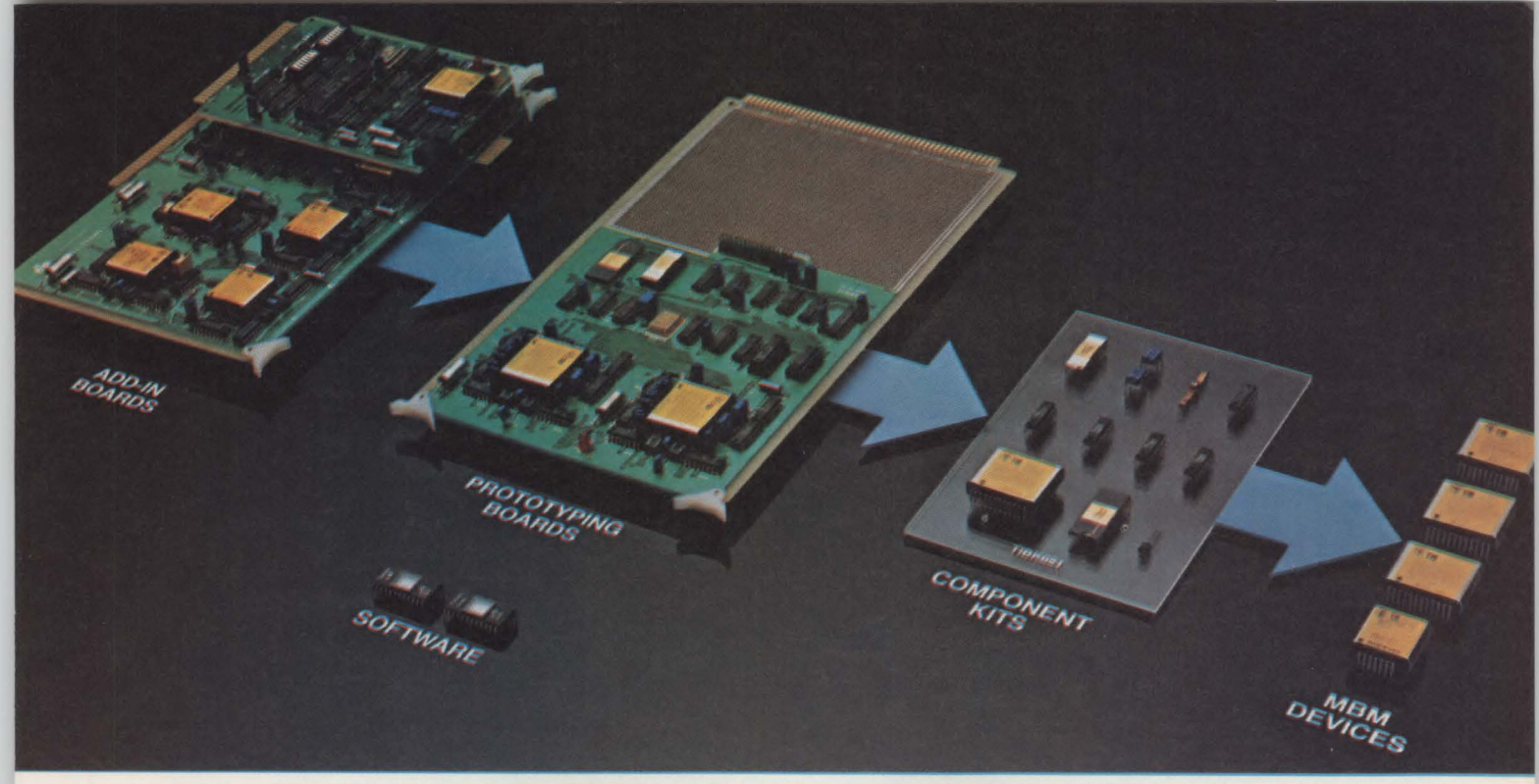
Fred Wang says a typical work station is priced at $10,000, but with the Wangwriter, that price will decrease to $7500. On systems with 200 to 300 terminals, broadband cabling costs will be minimal. Brown says there is probably room for both the Wang and Xerox approaches as long as Wang's broadband can link to Ethernet.

Wang initially will employ the broadband networking in larger systems, but it eventually may be used with the Wangwriter, which is an extension of high-end OIS systems. "We will begin with the VS and OIS systems and try to create a level of compatibility between them. They are our major shipped systems," says Wang. The company is working on compatible file structures between the two. The broadband communications will be available on both systems in six to 18 months.

The company is also considering developing an inexpensive interface for the broadband. Mitre's Hopkins says broadband equipment traditionally has been more expensive than that for narrower bandwidths, but the price is decreasing. Wang is also evaluating packet switching, which can lower transmission time. Speeds for the broadband are not announced, but the bandwidth will be 300 MHz, Wang says. Several ideas for the cabling, which is based on CATV technology, are patentable, specifically, how the broadband works.

If Wang receives a patent, the company probably will license the patent in a manner similar to that of Ethernet. But Wang will face the problem of locking out users if the license is high-priced, says Gartner Group's Brown. "We have not made too many conscious decisions on the license," says Fred Wang. "We are not sure if we will build interfaces or others will. We will not have solely Wang products (on the network). That would cripple us." The move has left some observers apprehensive about Wang's ability to put together its broadband network soon enough to be acceptable. Brown sees the move as a criticism of what is lacking in Ethernet—not as a product alternative—because specifications of Wang's broadband have not been released. But with or without a patent, Wang will offer its broadband network.

—Lori Valigra



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OEM (9900, 8080, Z80)	TBB5010	128
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MULTIBUS‡	MBB80*	92
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CIRCLE NO. 27 ON INQUIRY CARD

Calendar

SHOWS & CONFERENCES

FEBRUARY

23-26 Computer Science Conference, St. Louis, Mo., sponsored by the Association for Computing Machinery and the Computer Science Departments of many universities. Contact: Orrin E. Taulbee, Director, Computer Science Employment Register, Department of Computer Science, University of Pittsburgh, Pittsburgh, Pa. 15260, (412) 624-6475.

24-25 Ninth Annual Midwest Digital Equipment Exhibit, Minneapolis, Minn. Contact: Kim Shobe, Product Marketing, Loonam Associates, Inc., 7720 Bush Lake Rd., Minneapolis, Minn. 55435, (612) 831-1616.

24-26 Nepcon West '81, Anaheim, Calif. Contact: Industrial & Scientific Conference Management, Inc., 222 W. Adams St., Chicago, Ill. 60606, (312) 263-4866.

26-27 Louisiana Computer Exposition, Lafayette, La., sponsored by the student chapter of the Association for Computing Machinery, the Computer Science Department and the Computer Center of the University of Southwestern Louisiana. Contact: William R. Edwards, Program Chairman, Computer Science Department, University of Southwestern Louisiana, P.O. Box 44330, Lafayette, La. 70504, (318) 264-6284.

27-28 International Conference on Aspects of Document Preparation Systems, Lausanne, Switzerland, sponsored by the Swiss Chapter ACM, IEEE, AFCET, INRIA and GESO. Contact: Prof. J.D. Nicoud, Program Chairman, Bellerive 16, CH 1007, Lausanne, Switzerland.

MARCH

8-11 TI-MIX 1981 Symposium, New Orleans, La., sponsored by Texas Instruments Minicomputer Information Exchange. Contact: TI-MIX, M/S 2200, P.O. Box 2909, Austin, Texas 78769, (512) 250-7151.

14 PACS Computer Games Festival, Philadelphia, sponsored by the Philadelphia Area Computer Society and LaSalle College Physics Department. Contact: Stephen A. Longo, Ph.D., Physics Department, LaSalle College, Philadelphia, Pa. 19141, (215) 951-1255.

16-18 1981 Federal Office Systems Expo, Washington, sponsored by National Trade Productions, Inc. Contact: Michael Pomponio, Exhibits Chairman, National Trade Products, Inc., 9301 Annapolis Rd., Suite 206, Lanham, Md. 20801, (301) 459-1815.

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) 558-3617.

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.

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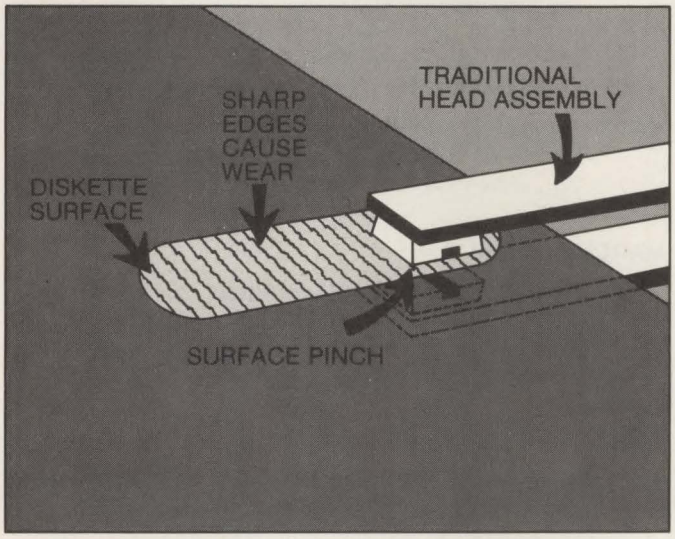

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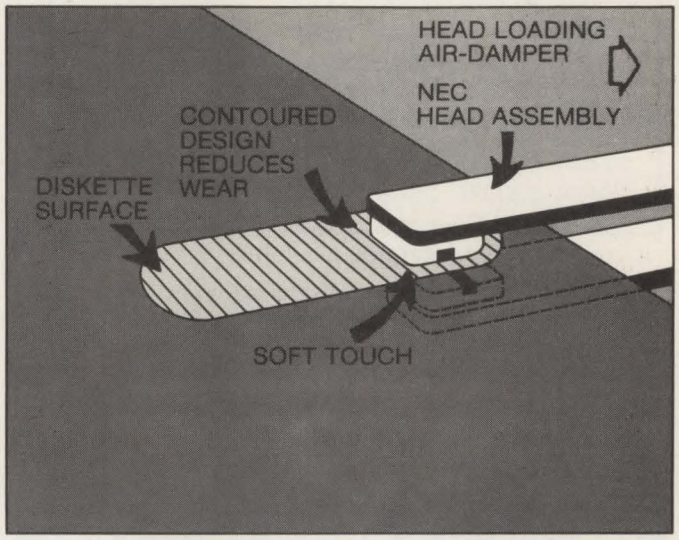
NEC diskette drive



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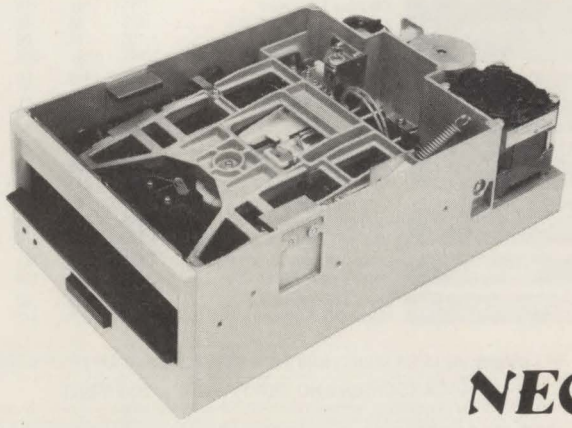

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	TI820 KSR Printer	2,195	211	117	80
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	737 W/P Desk Top Printer	895	86	48	32
	704 RS232-C Printer	1,795	172	96	65
	6081 High Speed Band Printer	5,495	527	293	198
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	DT80/1L 15" Screen CRT	2,295	220	122	83
	DT80/5 APL CRT	2,095	200	112	75
	DT80/5L APL 15" CRT	2,595	249	138	94
LEAR SIEGLER	ADM3A CRT Terminal	875	84	47	32
	ADM31CRT Terminal	1,450	139	78	53
	ADM42 CRT Terminal	2,195	211	117	79
HAZELTINE	1420 CRT Terminal	945	91	51	34
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	1552 CRT Terminal	1,295	125	70	48
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	Letter Quality RO, 55 CPS	2,895	278	154	104
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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 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.

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.

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.

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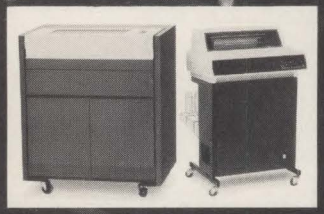

If Antonio Stradivarius had created violins the way many companies today make their products, and had he expanded to make tubas and bassoons, his name would be as obscure as the other unknown manufacturers of the 18th century. But, his objective was never to produce the greatest variety at the lowest possible cost. His was craftsmanship. And specialization. Antonio Stradivarius stuck to what he did best.

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Data Printer The Craftsmen.

CIRCLE NO. 32 ON INQUIRY CARD

Access tries to sort out chaos in software market

Few companies have waded through the morass of applications software written by independent programmers to sort out the good programs and market them. One company that is capitalizing on software developed by others is Access Communications, Inc., Wellesley, Mass. Under the direction of Allen Kluchman, Access will publish software submitted by independent authors, to whom the company will pay a royalty.

Software publishing has its drawbacks, such as piracy of the product and the effort required to sort the good programs from the bad. But it also has advantages, and programmers, publishers and users all benefit. Independent programmers can take advantage of marketing expertise and wider distribution channels that publishers provide. Publishers save money on software development. And users can get more documentation and support.

Access's Visicalc *superset includes a user-training module that translates heat values in the rectangle into the lower graphic grid. A variable in the rectangle can be changed to see what happens in the grid.*

Kluchman, a former employee of Data General Corp., is aiming the programs at the DG minicomputer base with an as-yet-unnamed business modeling applications package. Access's package is a superset of the popular Visicalc software available on Apple computers. The package, which will carry a lifetime license fee of $500 to $1000, with annual updates, is available through distributors and dealers.

The Computer Store, Inc., Burlington, Mass., a test site for the software package, expects to license an estimated total of 500 packages the first year. It distributed more than 1000 copies of the Apple Computer version of Visicalc, which sells for an average of $150 per copy. Visicalc is marketed by Personal Software, Inc., Sunnyvale, Calif., an early entrant in the software-publishing business.

Kluchman "is making order out of chaos," says Joel Skolnick, vice president of finance at the Computer Store. "There is a lot of software out there, but it must be organized." He says the Access package, which was developed by Concentric Systems, Inc., is of higher quality than many he has reviewed, primarily because of its

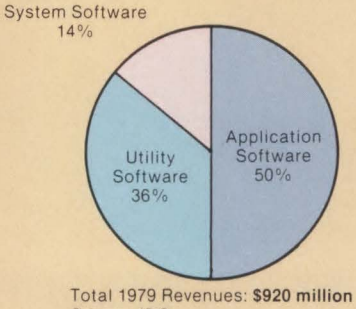
RISING COMPUTER SHIPMENTS ARE A BOON TO SOFTWARE

The dramatic growth in computer shipments brings with it even more growth for independent packaged software, according to a report by International Data Corp., a Waltham, Mass., market research firm. IDC predicts computer shipments will jump from $22.6 billion in 1979 to more than $42 billion in 1984. During that period, independent packaged software will grow four-fold, from $920 million in annual revenues to $3.5 billion, a growth rate of 29 percent per year.

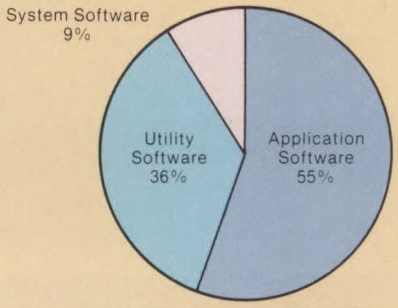
That market received its first boost in 1969, when IBM decided to unbundle its software. "The lack of quality software from manufacturers, in conjunction with the increasing costs of in-house development, has resulted in the growing implementation of independent packaged software as a more economical alternative," says Cary Morrill, research analyst for the study.

Applications software, which accounted for half of the independent software market in 1979, will grow at a compound rate of 32 percent to $1.8 billion in 1984. Utility software, with revenues of $335 million in 1979, will top $1.1 billion by 1984. Systems software will grow more moderately, at an annual rate of 19 percent through 1984.

The high cost of in-house development has spurred a trend toward acquisitions by larger companies of both software companies and packages. Hardware vendors—including IBM, Wang Laboratories, and NCR—also have recognized the revenue potential of software and are competing with some independents.



Total 1979 Revenues: **$920 million**
Source: IDC



Total 1984 Revenues: **$3.34 billion**

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Balancing your I/O performance objectives against your company's cost objectives can be a vexing challenge. STC is ready to help you resolve the dilemma with the most comprehensive offering of tape subsystem products and capabilities ever offered to the OEM.

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The 1900 Tape Family provides a choice of 9 basic subsystem configurations. So you can pick the precise combination of speeds, densities and features to complement your processor and your customers' applications. The chart on the right will help you start sizing up the appropriate model.

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

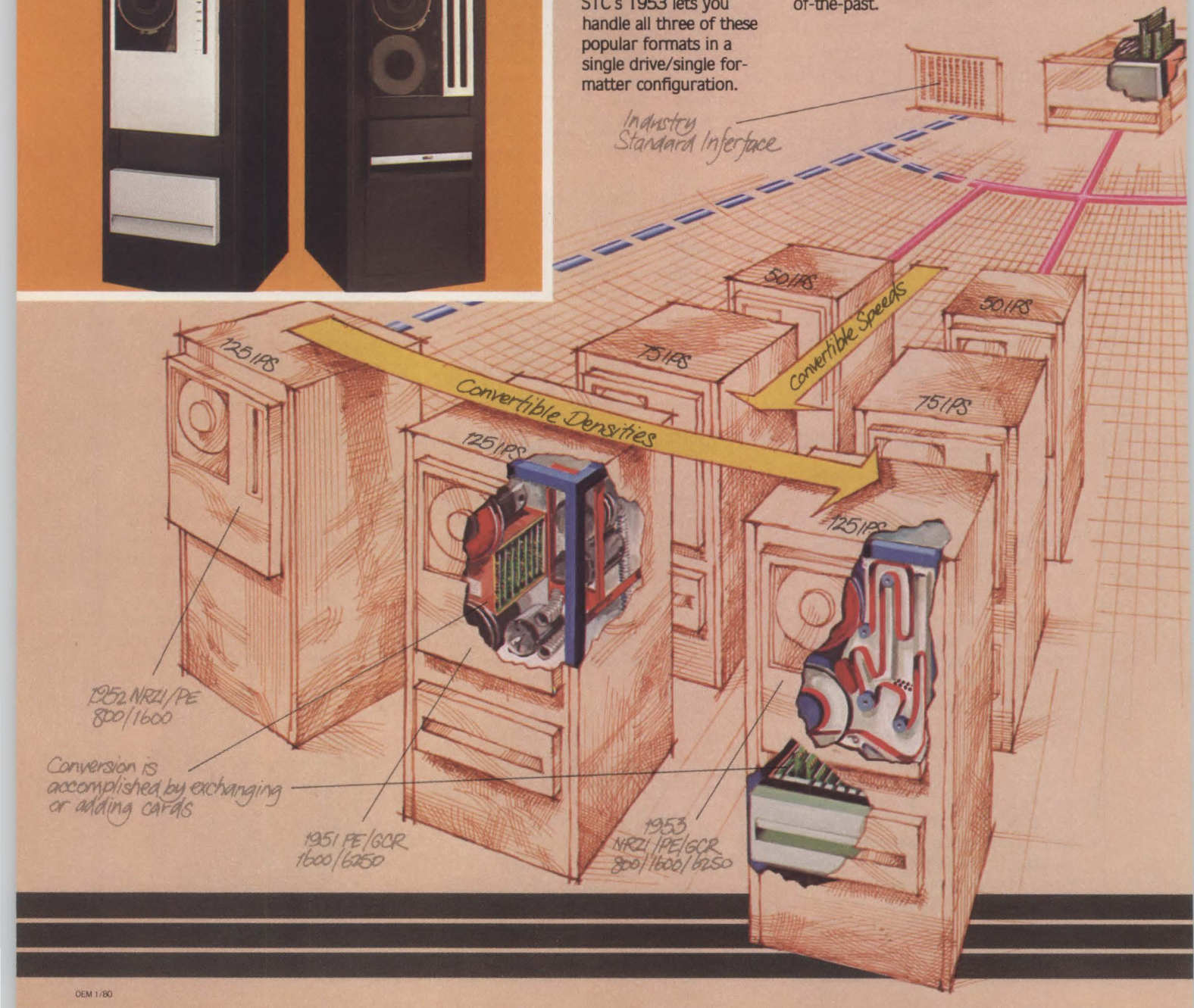
NRZI (800 bpi) and PE (1600 bpi) give your customers the ability to process archival data and to exchange information with systems lacking GCR capability. STC's 1953 lets you handle all three of these popular formats in a single drive/single formatter configuration.

Controlling Factory Costs

If your company markets a line of systems to meet a variety of customer requirements, the STC 1900 can simplify your engineering and cut your costs.

The 1935 Formatter/Control Unit will handle up to four 1950 and 1920 Series Drives, intermixed in any combination of speeds and densities. That means a single hardware interface and a single set of operating system drivers and utilities can accommodate all the configurations in your marketing mix.

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



Practicality says design to cost. gives you both.

And for the ultimate in flexibility, 1900 subsystems provide a convenient growth path. With a few simple card changes, your field engineers can convert speeds and densities, on-site, in a matter of minutes.

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To assure fast, effective field service, STC provides you with the most comprehensive diagnostics in the industry. The 1900 Diagnostic Software features more than 180 routines including functional, reliability and artificial stress testing. Field experience has shown the package will deliver 95% fault detection and 70% isolation to one of three cards.

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Support for Success

When you specify STC 1900 Subsystems you have the resources of the world's largest tape system manufacturer behind you. Depending on your needs you can draw on STC's engineering, marketing, or training departments for expert implementation assistance.

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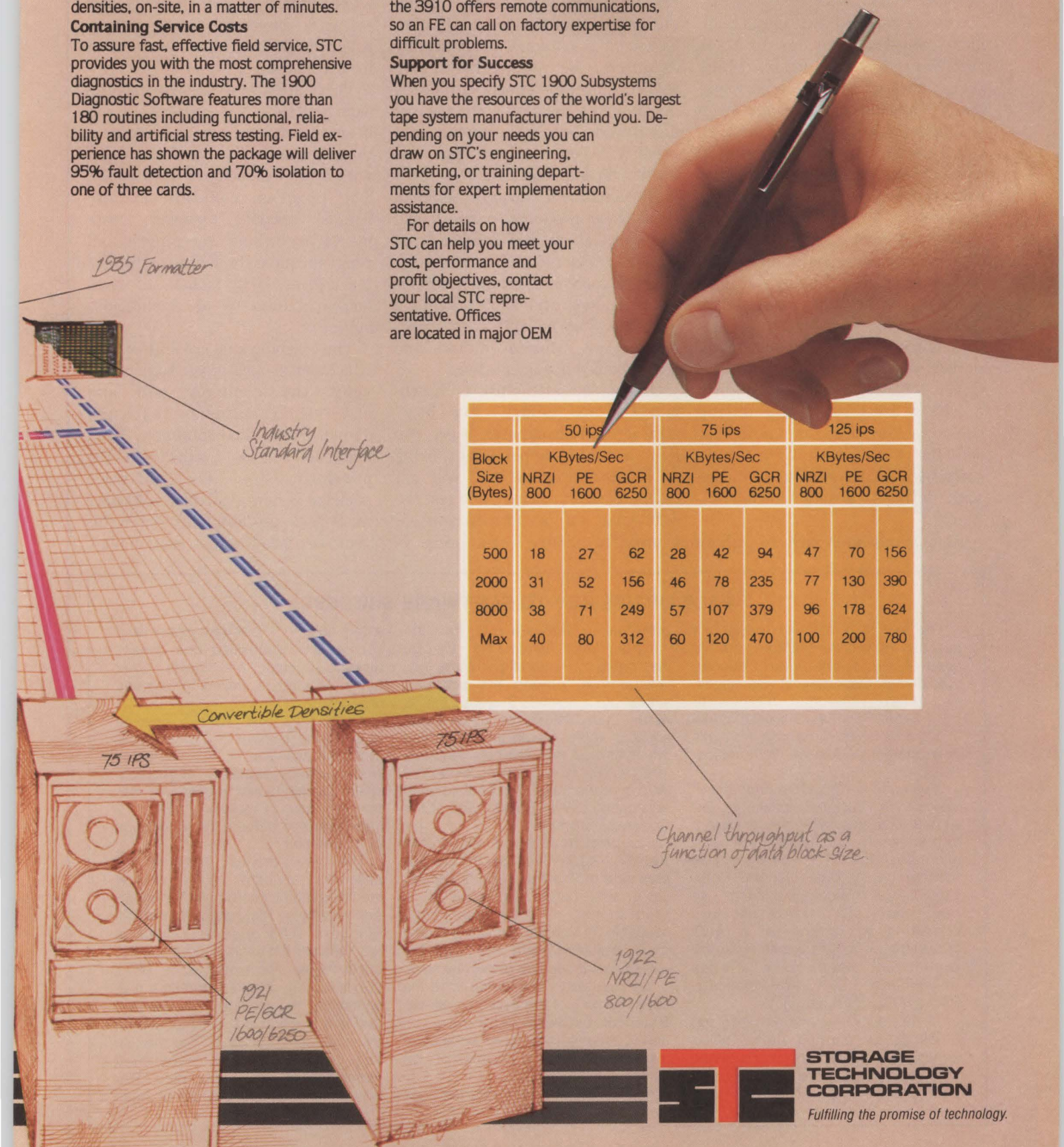

Block Size (Bytes)	50 ips KBytes/Sec NRZI 800	PE 1600	GCR 6250	75 ips KBytes/Sec NRZI 800	PE 1600	GCR 6250	125 ips KBytes/Sec NRZI 800	PE 1600	GCR 6250
500	18	27	62	28	42	94	47	70	156
2000	31	52	156	46	78	235	77	130	390
8000	38	71	249	57	107	379	96	178	624
Max	40	80	312	60	120	470	100	200	780

Channel throughput as a function of data block size

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CIRCLE NO. 33 ON INQUIRY CARD

extensive user documentation (see "Ease of use key to software success," p. 54).

OEM-developed software, Skolnick contends, tends to lack sufficient documentation, which saves money for its developers. Many minicomputer manufacturers sell their equipment through third-party OEMs, who develop small client bases with tailored software that the OEMs can support indefinitely, he explains. But those OEMs don't realize that. "If you sell 1000 (good) packages at $100, you make more money than by writing a tailored program for one installation and supporting that."

Skolnick sees Kluchman's approach as similar to that of West Coast software firm MCBA, which markets five basic accounting packages for minicomputers that sell for $1000 each. The MCBA software is developed in-house and includes strong documentation.

Kluchman's approach to selling software is a good one, says Adam Osborne of Osborne and Associates, Inc., Berkeley, Calif., which publishes software in books. Developing software is extremely expensive, he says. "For every software project launched, there is only a 25-percent chance of developing a good, marketable product. Allen Kluchman put that burden on someone else."

Kluchman will acquire some of those good products, enhance and generalize them, and market them through dealers and distributors. He says good user documentation is twice as expensive as developing a program, but he will keep prices down by volume sales and standardized documentation.

One added attraction is Kluchman's "try before you buy" strategy. Minicomputer users can go to a store by appointment, bring in a business plan that will get computerized in 20 min. and test the software on a minicomputer. Computer Store's Skolnick is betting that those users will also buy other equipment or supplies while in the store. And he will teach software buyers how to use a program for about $200 per person for six hours.

There are also extensive teaching aids built into the software. Each licensed software binder contains a tutorial manual and two floppy disks with a total capacity of 1.4M bytes. The program contains on-line, English teaching modules. Documentation includes the copyrighted program and code. For an additional fee, Access will include a WATS hotline staffed by an applications engineer.

The teaching aids are only part of Kluchman's strategy. Later this year, the company will add audiovisual material that will demonstrate the software. That material will be available at the purchase site. The software package is now available, and three more packages will follow later this year. In a two-tier distribution plan,

EASE OF USE KEY TO SOFTWARE SUCCESS

The key to a software package's success is not its features, but its ease of use, claims Adam Osborne, president of Osborne and Associates, Inc. Allen Kluchman intends to provide both features and ease of use in the first product offering from his new company—Access Communications, Inc.

Kluchman will market a superset of Visicalc, a business package designed for Apple personal computers and known for its "friendliness" and interactiveness. The package will operate on all Data General Corp. Nova-based minicomputers that use DOS, RDOS, ICOS, MP/OS and AOS operating systems. He is also considering adapting the software for Digital Equipment Corp., Texas Instruments Inc., and Hewlett-Packard Co. minicomputers.

"If he solved the human interface problems by copying us or doing better, and solved quick response time, the product will probably sell well," says Dan Bricklin, vice president of Software Arts, Inc., the company that wrote the Visicalc distributed by Personal Software, Inc.

Kluchman claims his product, written by Concentric Systems, Inc., is better than Visicalc because it can address more memory, has added functions and has self-help features. The product is undergoing extensive testing at the Laventhol and Horwath accounting firm in Boston, and at the Computer Store, Inc.

The program is a true superset of Visicalc, says Joel Skolnick, vice president of finance at the Computer Store, who began his career as a programmer. It has everything available on Visicalc and more. Some initial problems with the software already have been corrected, he says.

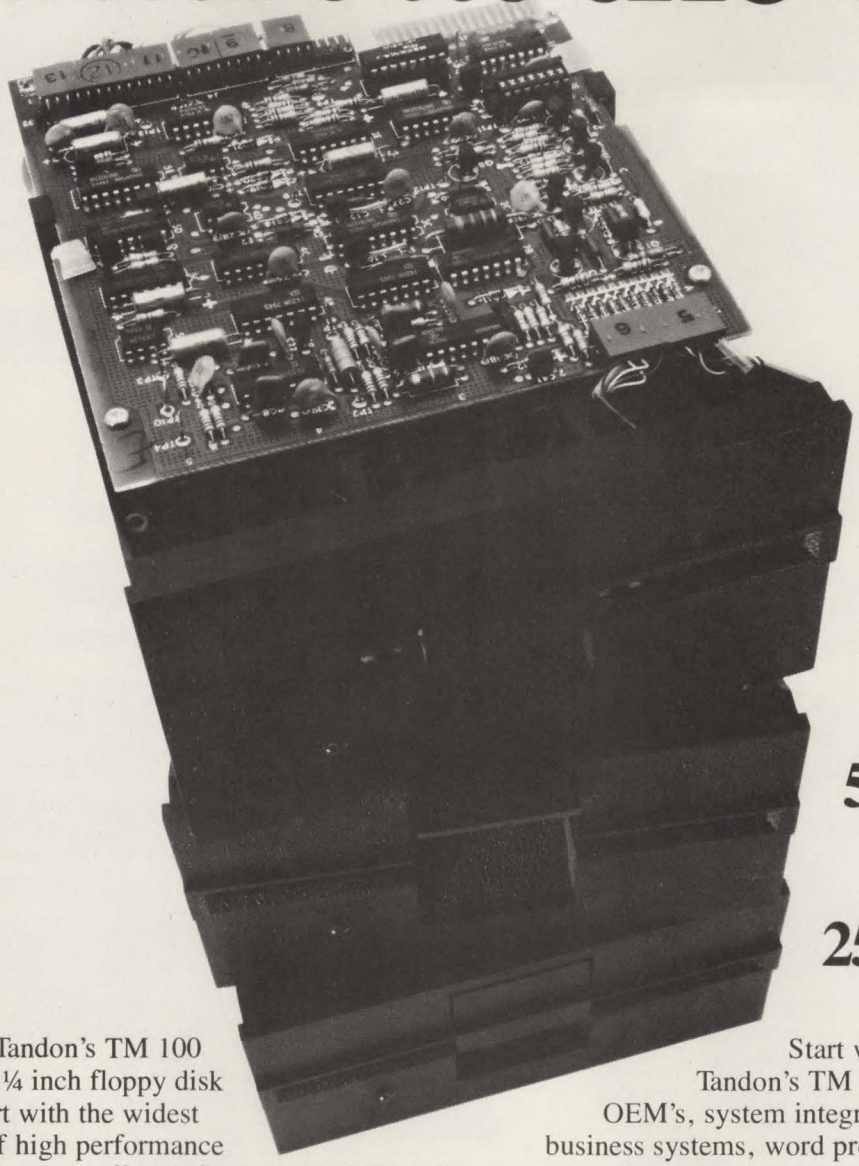
Visicalc stores only what is in the main memory of the Apple computer, Skolnick explains. The program makes the memory "look" like a large blackboard with a matrix of 63 columns × 254 rows.

In contrast, Access's product uses a 256-column × 256-row matrix, and can use a DG dual-sided, dual-density diskette system that holds 500K bytes. Visicalc is limited to 100,000 characters.

Additionally, the Access product doubles the number of mathematical functions available on Visicalc to 10. And it can move blocks of information, while Visicalc, which moves information by row or column, takes 10 instructions to move a 10 × 10 block of information.

The new product uses a DG assembly language. While Visicalc identifies matrix coordinates by letters and numbers, the superset uses all numbers. The superset includes modules to train users and for specific applications. For example, to do a business plan requires loading a disk containing the module into memory, and that function is superimposed on the superset of Visicalc. The module has dependent and independent variables, so that users can tailor information and relationships of data.

Start at the top



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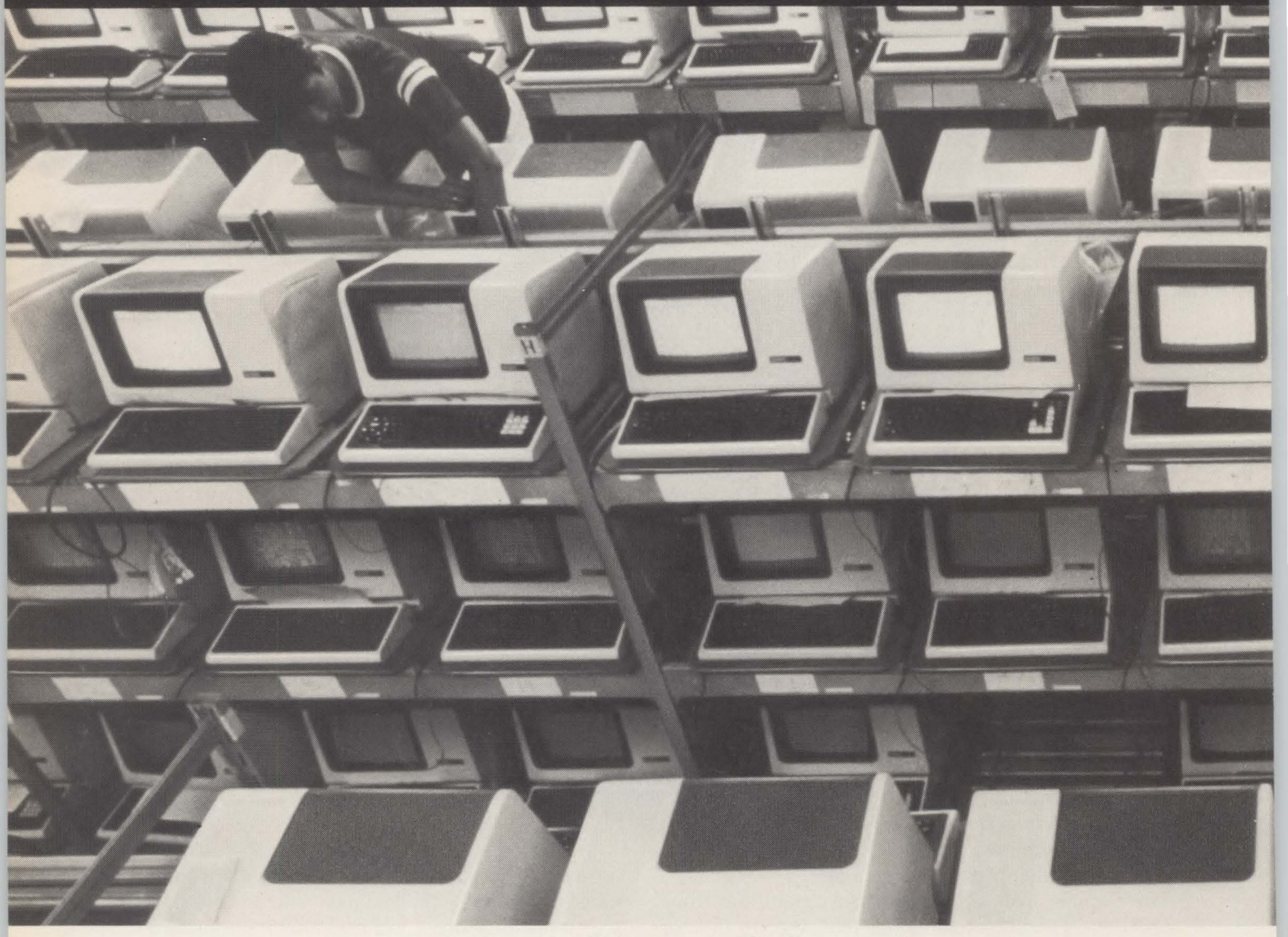

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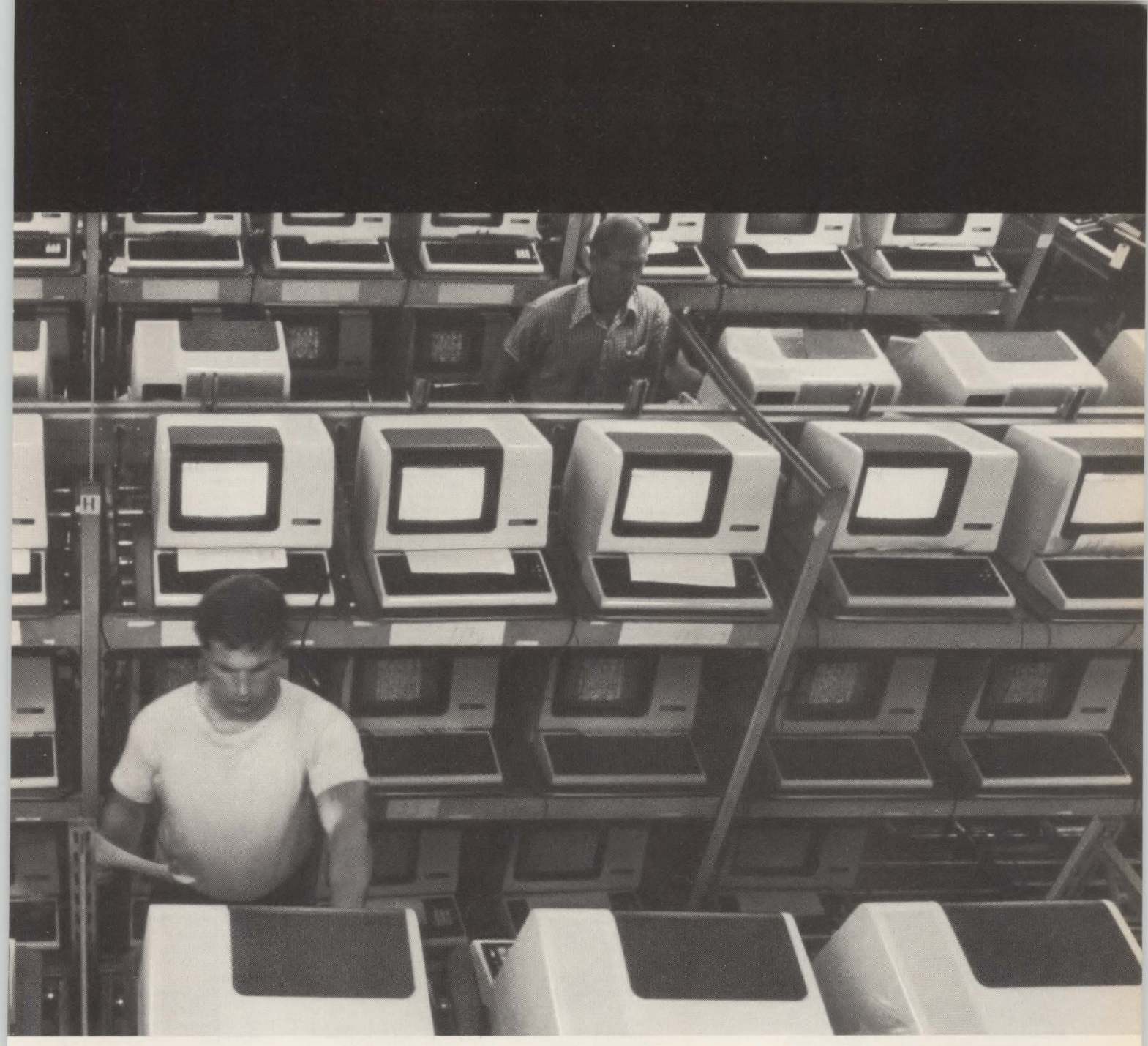

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Access will give distributors and dealers incentives in the form of rebates, to sign licensing agreements. Kluchman will thus retain some control over the software and its use. The license from the dealer will include provisions to put the software on any media required by the end user. Kluchman plans to have six distributors—five U.S. and one Canadian—and 60 to 70 DG retailers this year.

Although profit margins built into each marketing level are not yet determined, Kluchman expects them to be similar to those of hardware. Access's margins would average 50 percent, distributors' about 10 to 20 percent, and dealers' between 30 and 35 percent. Authors' royalties will range from 5 to 10 percent, depending on how much Access must add to a program.

Kluchman has a $1-million first-year operating budget. He soon will have six people working for him and is looking for three key employees: an acquisitions person to evaluate submitted software, a marketing person to designate what types of programs to accept and a manufacturing person to be responsible for the physical product and the subscription service.

Kluchman expects Access to be a $10-million company within a few years. That's not unrealistic when viewed in terms of Personal Software, which achieved a similar growth rate in its two-year existence. However, the cost of entering the market is higher than it was two years ago, cautions Daniel H. Fylstra, chairman and founder of Personal Software.

"When Personal Software entered the market, the number of personal computers on the maket was less than 100,000. Now it is almost 1 million. There were also fewer computer stores, and the cost of reaching them was lower." But, Fylstra points out that there are fewer dealers and distributors in the minicomputer business than in the personal computer industry, and that may lighten Kluchman's burden somewhat.

Personal Software was a pioneer in software publishing, and it soon found that its publishing model was inadequate. Fylstra says that model has been refined, but he won't discuss specifics except to say it "revolves around the way we organize, structure and control software development on a product. You have to achieve consistency in software packages across many authors."

Kluchman should avoid being too ambitious in his product goals, some industry observers say. "He will have a few products that are well supported," says Richard F. Brown, president of the Computer Store, adding that Personal Software has been "sort of a publishers clearing house" for software.

Osborne agrees that Kluchman should curb his ambition. "If he has limited goals and keeps the company profitable at $10 million, (he'll do all right). But if he grows it to $100 million, he'll be bankrupt in a couple of years."

BOX SCORE OF EARNINGS

This table, which appears every month, summarizes the latest earnings reports of companies in the minicomputer industry and related industries. Included are total revenues, net earnings and earnings per share for the periods indicated.

Company	Period		Revenues	Earnings	EpS
Ampex	6 mos.	11/1/80	248,828,000	12,708,000	1.10
	6 mos.	10/27/79	216,006,000	17,368,000	1.52
Analogic	3 mos.	10/1/80	19,256,837	1,698,939	.22
	3 mos.	10/1/79	14,329,970	1,147,367	.18
Cambex	Yr.	8/31/80	4,047,000	201,000	.11
	Yr.	8/31/79	8,164,000	115,000	.06
Cullinane	6 mos.	10/31/80	12,914,000	1,688,000	.59
	6 mos.	10/31/79	8,066,000	1,064,000	.39
Data Access Systems	Yr.	8/31/80	37,241,676	5,148,355	1.79
	Yr.	8/31/79	28,153,475	3,414,573	1.25
Dataram	6 mos.	10/31/80	12,730,000	1,114,000	.48
	6 mos.	10/31/79	10,295,000	1,756,000	.77
General Instrument	39 wks.	11/30/80	618,628,000	49,271,000	5.52
	39 wks.	11/25/79	513,604,000	36,660,000	4,26
Genisco Technology	Yr.	9/30/80	17,516,283	1,203,341	.94
	Yr.	9/30/79	15,204,962	1,322,408	1.11
Management Assistance	Yr.	9/30/80	303,751,000	388,000	.05
	Yr.	9/30/79	264,419,000	29,213,000	3.66
Mohawk Data Sciences	6 mos.	10/31/80	141,277,000	9,111,000	.80
	6 mos.	10/31/79	124,736,000	8,243,000	.73
NBI	Yr.	6/30/80	32,903,000	3,205,000	1.40
	Yr.	6/30/79	13,236,000	1,651,000	.91
STSC	6 mos.	11/30/80	13,137,000	803,000	.45
	6 mos.	11/30/79	9,265,000	593,000	.35
Tano	9 mos.	9/30/80	10,507,577	338,534	.85
	9 mos.	9/30/79	8,082,020	244,713	.62
Triad Systems	Yr.	9/30/80	56,513,000	5,031,000	.81
	Yr.	9/30/79	30,805,000	3,297,000	.56
Wyle Laboratories	9 mos.	10/31/80	195,677,000	5,746,000	1.01
	9 mos.	10/31/79	179,295,000	6,273,000	1.15
Wyly	9 mos.	9/30/80	62,900,000	4,200,000	.36
	9 mos.	9/30/79	86,300,000	33,000,000	2.66

Osborne cites pirated software as a major reason for limiting growth, because it takes a lot of products to keep a $100-million company alive. A large number of illegally copied products could ruin a company.

Fylstra does not consider Access direct competition for his company, as the companies are addressing different markets. He admits Personal Software also considered developing a product for minicomputers, but decided against it because gross margins weren't adequate.

"Mass distribution favors personal computers in volume and price of unit sale," Fylstra says. Kluchman may, in turn, address the personal computer market in the future. But Osborne predicts that "Kluchman will branch down rather fast because that is where the volume is." —*Lori Valigra*

Booming venture capital fosters more start-ups

Despite the recession and climbing inflation rates, venture capital funds have increased, and that's good news for start-ups and companies requiring additional capital. One of the main reasons for the availability of funds is that venture capitalists are more aware of computer technology.

Venture capital pools total about $4 billion this year. That breaks down to $1.5 billion from private firms, such as Hellman Gal & Co., Boston, $1.3 billion from the assets of small business investment companies and $1.2 billion from financial and nonfinancial corporations, says Stanley E. Pratt, editor and publisher of the *Venture Capital Journal*. He adds that monies for start-ups have increased from 12 percent of available funds in 1978 to 1979 to 30 percent in 1979 to 1980. The average amount of financing given to start-up companies has risen from $1.3 million to $1.7 million.

Venture capitalists have shown much interest in high-technology companies whose products improve productivity. Pratt says that 63 percent of available funds went to high-technology ventures, including communications and computer companies, and 18 percent went to other electronics interests, including semiconductor and test equipment manufacturers. In comparison, only 11 percent was invested in consumer products and services.

Pratt cites some major reasons for the increase in available venture money. Most important was the reduction of the capital gains tax in 1978 from 49 percent to 28 percent, which Pratt claims made investment in venture capital pools more attractive. He adds that there is an effort under way to further reduce the tax to 21 percent by early next year.

Data General backer Adler: *"A good venture capitalist wants to make money to satisfy a long-term need."*

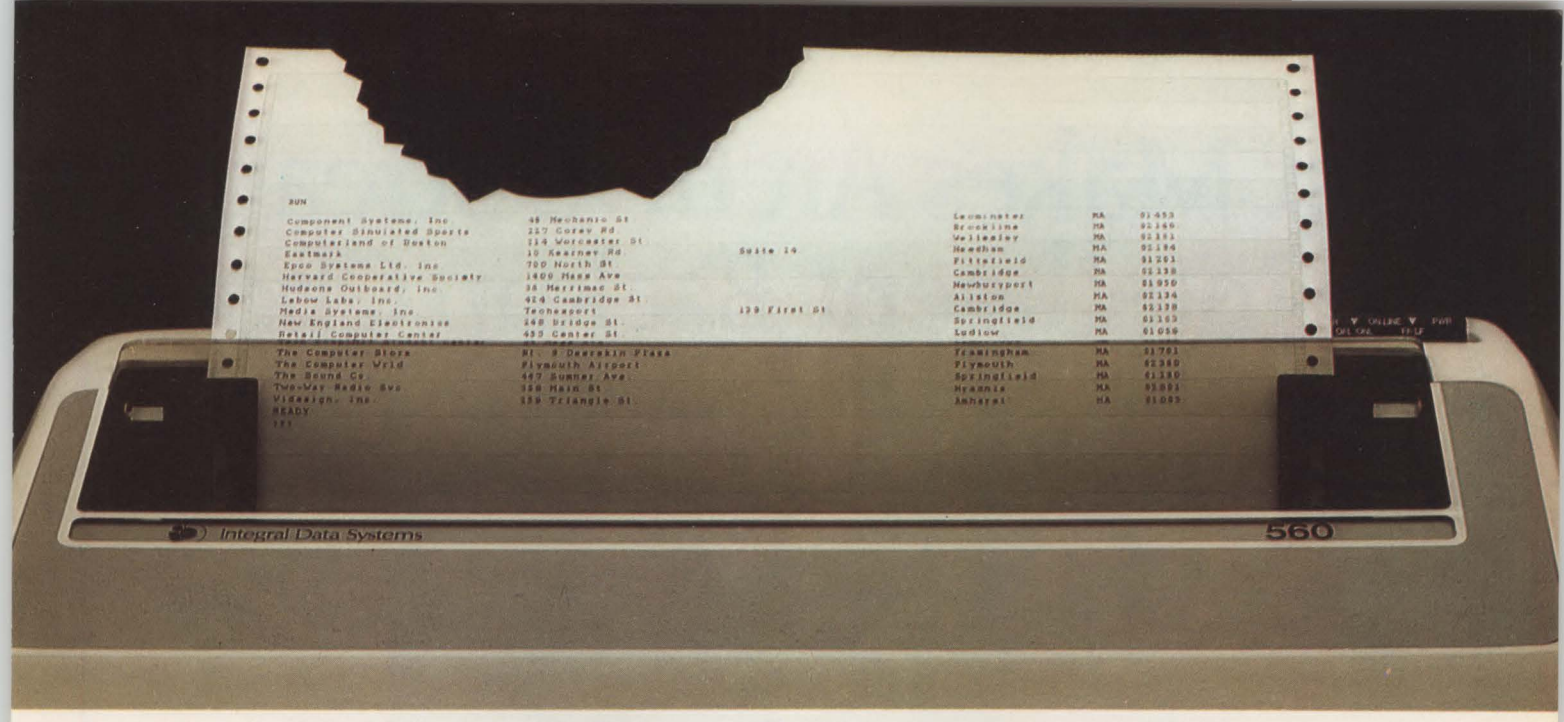
Another reason is the maturation, after five to ten years, of partnerships between venture capitalists and their ventures. Pratt says that successful venture capitalists receive an average 20 percent return on investments, a sum that essentially "legitimizes" investment in venture capital pools. Thus corporations investing pension funds, which typically are invested at a 1½-percent return rate, are turning toward more profitable long-term investments.

Third, as more money came on the market, more entrepreneurs appeared and perpetuated the phenomenon of venture capital investment. Still another factor is that venture capitalists are making money on what Pratt calls "the acquisition craze." One of the recent venture-backed acquisitions was that of Systems Engineering Laboratories, Inc. by Gould, Inc. (MMS, November, p. 51).

"The best time to make venture capital investments is in a down economy," Pratt contends. He says that in the last recession, banks charged a 20-percent annual interest rate on loans, while venture capitalists investing in a company either took straight equity without interest or charged an average rate of 12 to 15 percent.

One venture capitalist says people turn to high-technology equities to protect the value of their financial assets. "There is a general belief that the recession is over, and it is exiting with a high level of inflation," says Joe Gal of Hellman Gal & Co. He adds that high-technology companies are among the most rapidly growing in the economy.

"Technology stocks have risen (in



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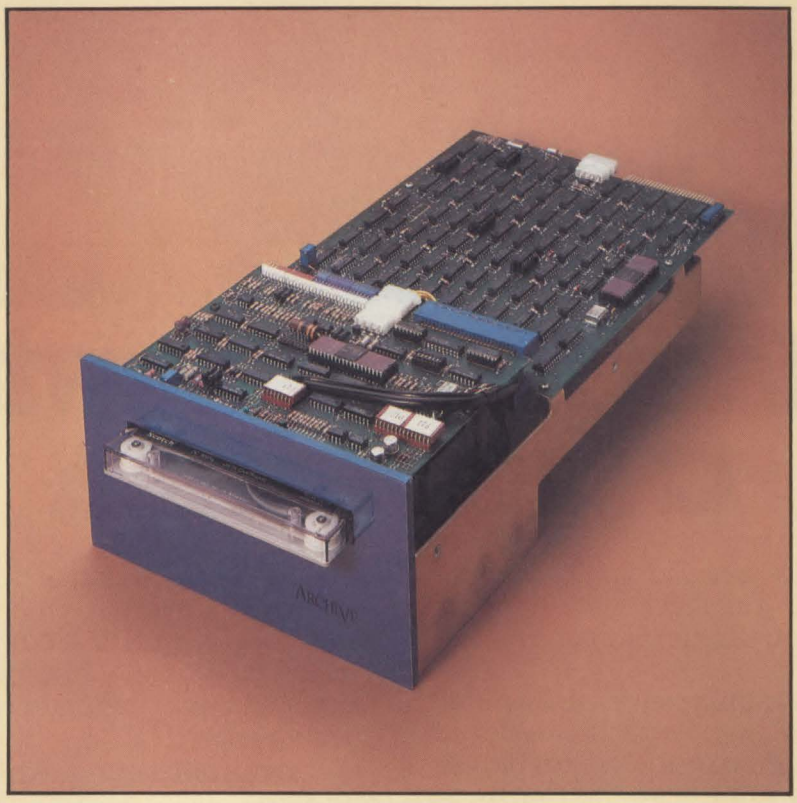

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value) more in the last several months than in any similar time period in the past," Gal contends. The total added value of all high-technology companies is $6 billion to $7 billion, but with increased demand for the stocks, high-quality technology companies are in short supply, Gal says.

Many venture capitalists agree that in making investments, experienced people are more important than products. But investors do examine a product's market potential, and usually will not support a product that must create its own market.

"Most venture capital firms, unless they're looking at a particularly good concept, prefer to invest in people with years of profit and loss experience," says Gal. Such a person is practical and business-oriented, can handle problems, can attract qualified people to the company and can accomplish things, Gal says. One recent start-up backed by Gal's firm is Apollo Computer, Inc., one of whose founders is Prime Computer, Inc., founder Bill Poduska (MMS, June, p. 53).

But, Gal concedes, "Every once in a while you get someone with the right instincts. We are very sensitive to people who may not be experienced but who are easy to work with." Venture capitalist Fred Adler took such a risk on Edson de Castro of Data General Corp. The risk paid off handsomely. Adler, now of Adler & Co., New York, turned a $100,000 investment in DG into $20 million.

"A good venture capitalist does not go into a deal just because he has money to invest. He wants to make money to satisfy a long-term need, not a short-term fad," Adler says.

Minicomputer technology and its markets were not well understood at the time that Adler took the risk on de Castro. But Adler says de Castro had "the determination to make it, to build a major company. This meant as much to him as anything in the world." He says de Castro showed a lot of motivation, was open regarding the good and bad points of the proposed product and understood the necessary product ingredients. "He envisioned LSI (large-scale integration) and looked for a computer with the most advanced semiconductor logic so there would be a flexible design." Additionally, de Castro wanted a family of machines, and he outlined their markets to Adler.

Finding an entrepreneur with such instincts can be considered lucky, but venture capitalists may now have to take more risks in judging character. One observer says venture capitalists have been spoiled over the last five years. Now, the possibility of "too much money chasing too few deals" indicates that marginal companies may emerge. But Adler says there are more good deals than ever. His company reviews about 1000 proposals a year and accepts about 15 high-technology company proposals valued at $10 million to $15 million a year.

Venture capitalists usually agree that they do not control which technologies come to market. They see companies only as investments. Yet, they are eyeing some promising markets. Gal points to some interesting emerging technologies: automatic speech recognition; hardware or software language translators, especially those coupled with speech-recognition technology; local networking; back-end processors for data-base access; and natural language-parsing systems.

—Lori Valigra

Analog Devices creates venture capital arm

A surge in the number of corporations investing in venture capital pools or developing their own venture capital arms is augmenting investment funds available to entrepreneurs from private venture capitalists, who typically fund businesses rather than technologies.

Major oil companies wishing to diversify, including Exxon Corp., have shown most interest in developing these venture capital arms. But Analog Devices, Inc., has become one of the few high-technology companies to explore this avenue (see "Booming venture capital fosters more startups," p. 60).

In creating Analog Devices/Enterprises, a new division infused with $10 million this year from Standard Oil, Indiana, Analog believes it is "having its cake and eating it, too." "We can keep growing our in-house business and develop more business five to six years down the road," says Lawrence T. Sullivan, chairman of Analog's strategic planning committee.

Analog's data-acquisition systems and components business has been growing about 35 percent a year, Sullivan says, but that growth has required more than $30 million in capital expenditures a year. To expand, Analog had to diversify while maintaining its existing business. Standard Oil, which holds a 12½-percent share of Analog, stands to gain a larger share of high-technology investment as Analog grows.

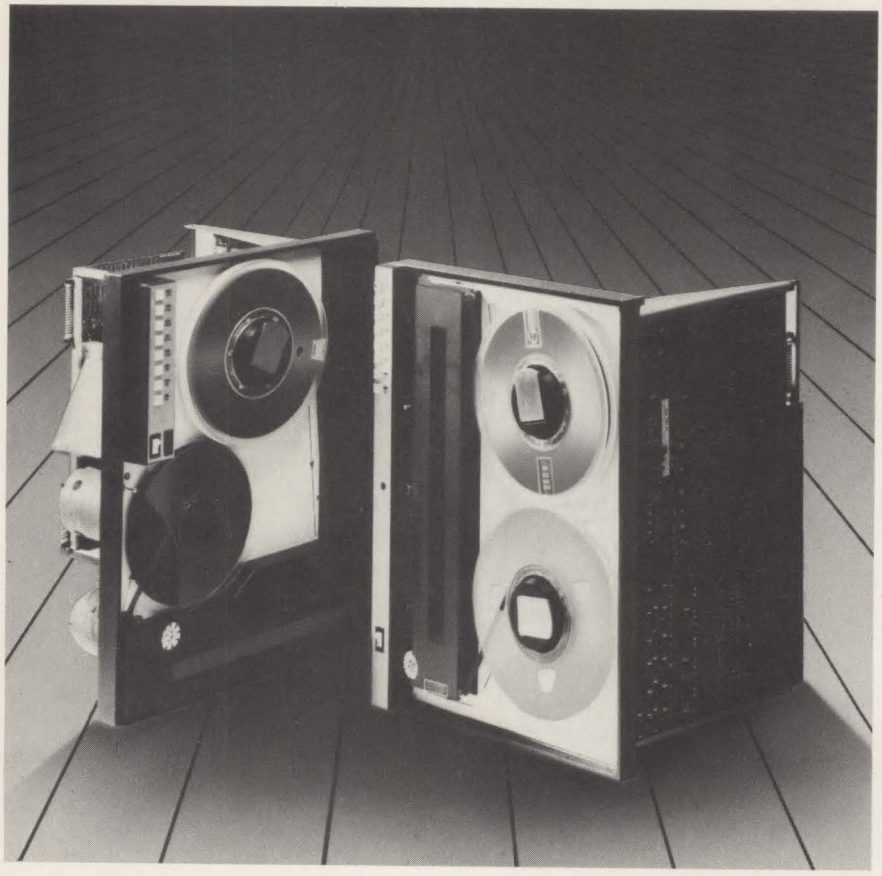
Venture monies will go to companies that fit into Analog's long-term strategies. "We want to make a minority investment of between 10 percent and 45 percent, with the intent of possibly acquiring the companies after they grow for five to six years," Sullivan explains. He says Analog is more interested in companies beyond the start-up phase and in managers with a focus on profits.

"Eight to nine years from now, Analog could have a chance at being a company that offers a lot of products, for example, products for factory or laboratory automation," he says. The company could become a system manufacturer. Sullivan says the company is interested in digital-signal processing, from the integrated-circuit level to complete systems; automatic test equipment; data-communications market niches, including instrumentation and control; and terminals with complete graphics capabilities.

Some private venture capitalists have criticized corporate venture capital arms because the corporations frequently want to acquire the venture. Some observers say that acquired companies risk losing their entrepreneurs, as was the case with many Exxon Enterprises affiliates that were acquired.

But acquirees can still grow, says Stanley E. Pratt, editor and publisher of the *Venture Capital Journal*. "The acquisition of high-technology emerging business really makes sense for major companies. Larger corporations recognize that the entrepreneurial businesses, often backed by venture capitalists, are able to identify, create and exploit market niches that build into significant business opportunities. By acquiring these innovative companies after product development and initial market penetration, but before major growth expansion, the larger company's resources can be effectively employed to accelerate growth," says Pratt. He points to the recent acquisition of Systems Engineering Laboratories, Inc., by Gould, Inc., as an example.

As a high-technology company, Analog can provide valuable guidance and advice to acquisitions and ventures, Sullivan says. Analog will back ventures in the $5-million to $50-million range. "Analog must try to convince people they can realize their ambitions and have secure growth," Sullivan says. "But they must eventually give up some measure of independence." Standard Oil will provide Analog Devices/Enterprises with $50 million over five years. —*Lori Valigra*



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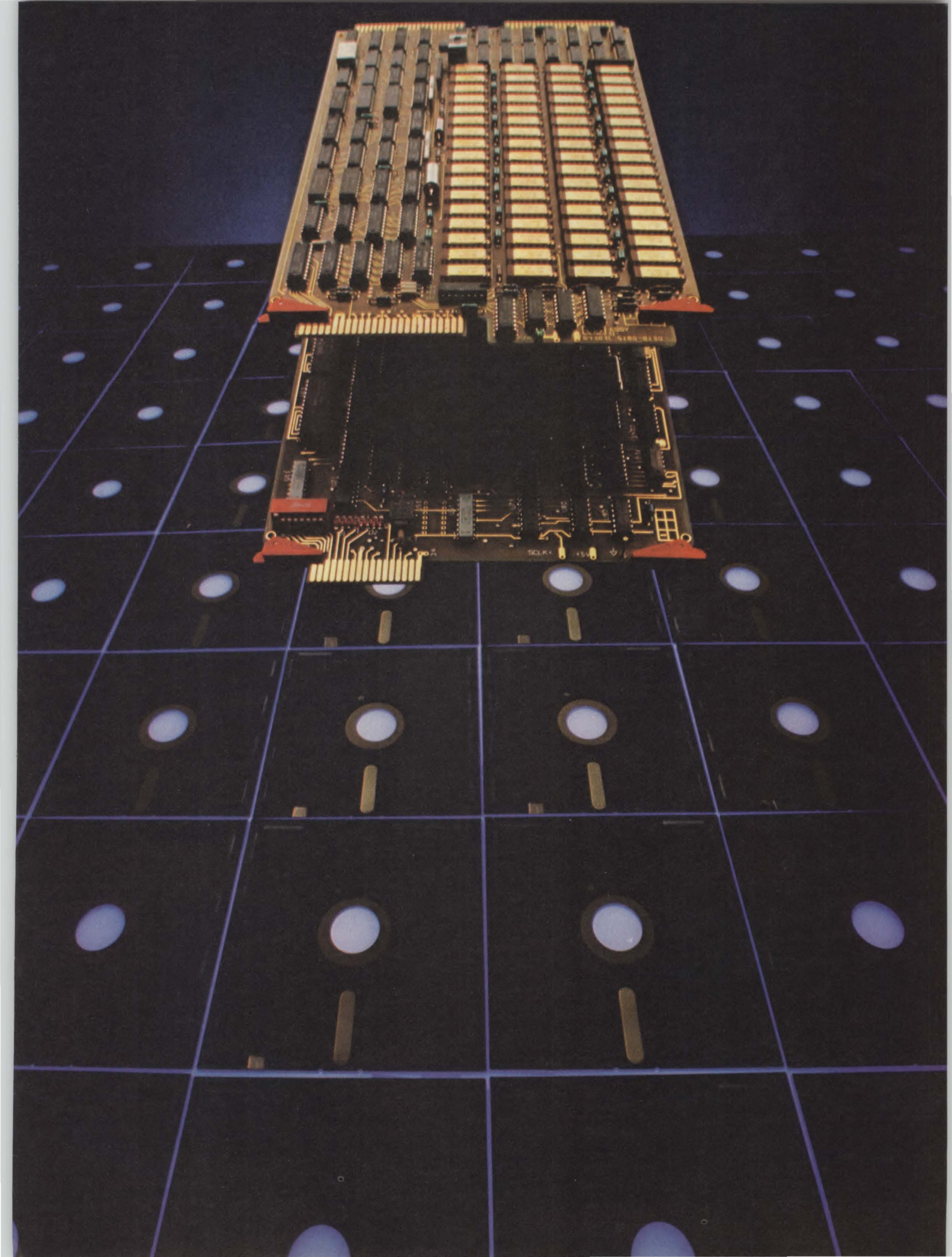

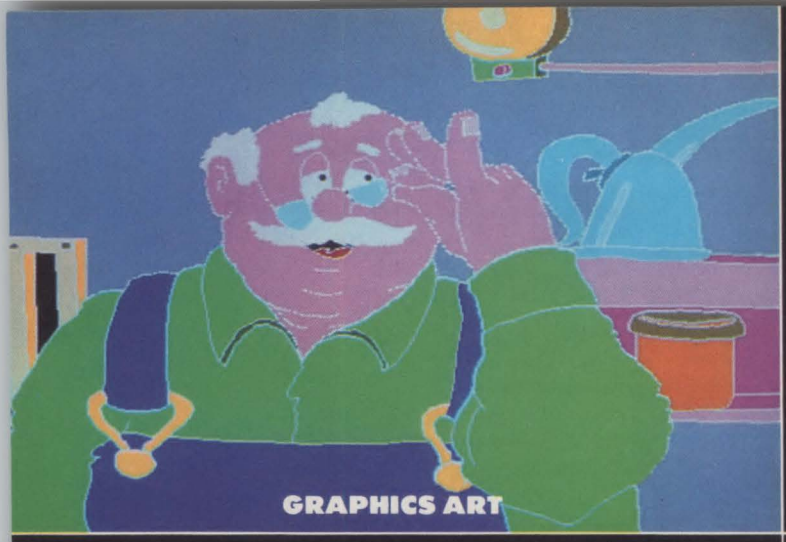

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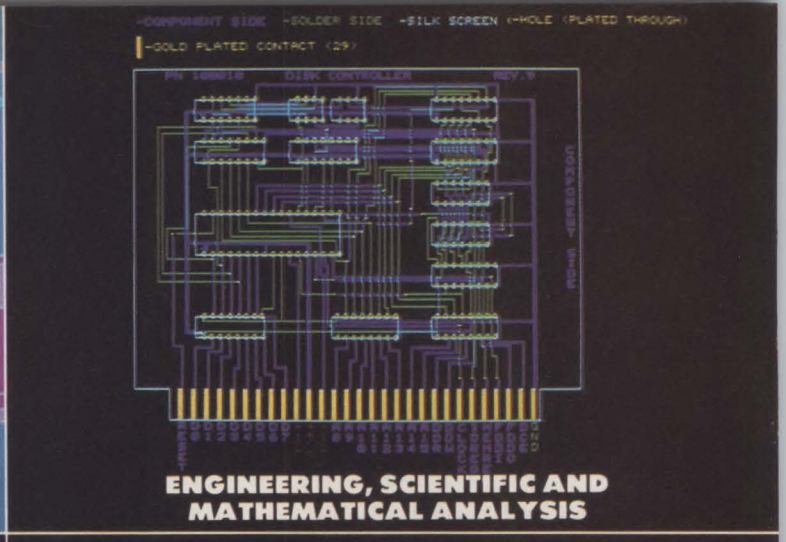

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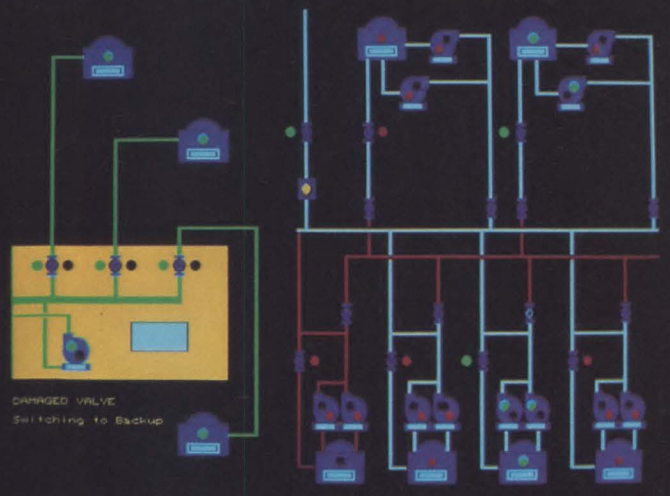

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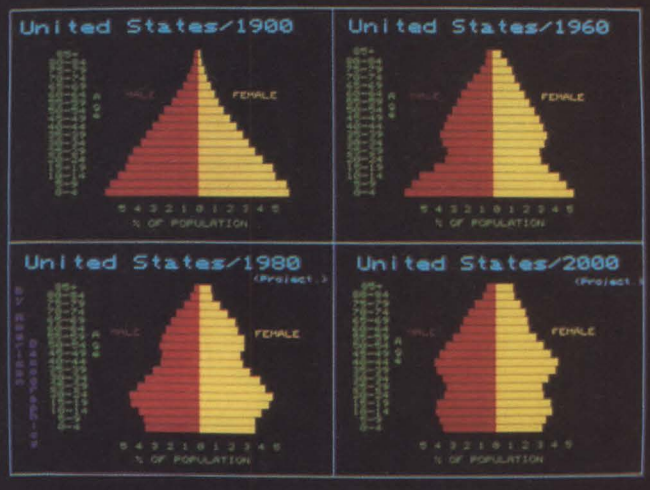

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Systems designers strive to make software friendly

Systems manufacturers have long shown a sensitivity to human factors in hardware design, as evidenced by the prevalence of tiltable displays, detachable keyboards and other features intended to reduce operator discomfort. Now they are beginning to show a similar sensitivity to human needs in software design. An indication of this is the growing number of manufacturers who are hiring psychologists to serve as consultants on system design projects.

This trend is particularly gratifying to Ben Shneiderman, author of *Software Psychology*, a recently published programming textbook that stresses human factors in software design. Although a computer scientist himself, Shneiderman long has advocated bringing the insights and methods of psychologists to bear on software design problems.

With systems spreading from the cloistered computer room to the office and home, Shneiderman believes that software design should no longer be left solely to computer professionals. "Experience has shown that computer professionals will accept and master any system no matter how horribly designed from a human point of view," Shneiderman says. "But a nontechnical user is quickly turned off by a poorly designed system."

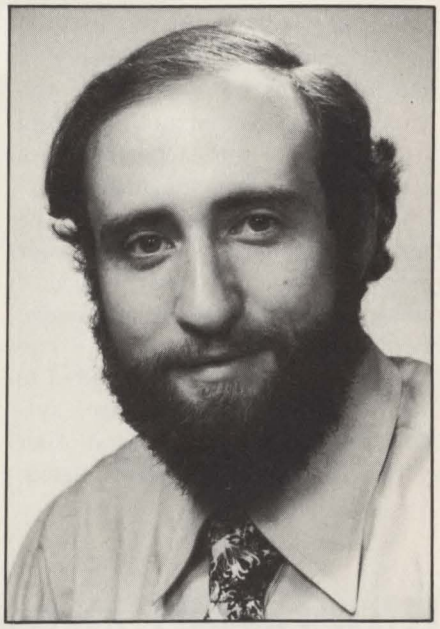
Computer professionals, Shneiderman suggests, may know a great deal about machines, and may even know something about their own thought processes, but they often are woefully ignorant of the needs and foibles of the average mortals who increasingly must use the systems they design but who have no programming experience. "The computer professional's introspection does not necessarily hold for the man in the street or the home user," he remarks.

Shneiderman's critics may question whether psychologists have a better understanding of human nature than computer professionals do. But Shneiderman argues that psychologists bring a sensitivity to human needs that has been lacking in system designers, who until recently have been more concerned with machine efficiency than with human performance.

Shneiderman sees another advantage to bringing psychologists into the picture. Computer science, he says, is now at a stage in its development analogous to that of physics before Galileo introduced the experimental method. Psychology, on the other hand, has long been accustomed to putting its theories to the test of experiment.

Shneiderman's work at the University of Maryland, where he is an associate professor of computer science, has concentrated on making software more readable and hence easier to maintain. His book summarizes his experimental findings and those of other researchers on the efficacy of various stylistic techniques intended to improve the clarity of programs.

Some of the findings contradict the cherished convictions of many software experts. For example, systematic indentation has long been advocated as a means to improve program readability. But, Shneiderman says, controlled experiments have shown that indented programs are no easier to understand than unindented ones. On the other hand, researchers have found that the simple device of inserting a blank line between logically distinct sections markedly improves a program's readability.



"A nontechnical (computer) user *is quickly turned off by a poorly designed system," notes author Ben Shneiderman.*

Controlled experiments also have punctured another long-cherished myth about software, Shneiderman says. Detailed flowcharts have long been considered the ultimate form of program documentation, and because they are laborious to produce, considerable effort has been expended to develop automatic flowcharting software. But tests indicate that it is as easy to decipher programs without detailed flowcharts as it is with them. Short block-level charts, however, do help in the comprehension of programs.

Shneiderman admits that such insights are hardly earth-shattering and that the psychological approach to human factors in system design has thus far focused on stylistic refinements rather than substantive issues. However, he believes that computer science has reached the stage where a disciplined approach is needed if progress is to be made. Moreover, he likens the experimen-

tal approach to the painstaking methods of mosaicists. "Each experiment is like a tile in a mosaic. As the tiles are pieced together, a picture begins to emerge of the factors that are important in system design from a human performance point of view," Shneiderman says.

Many tiles are still missing, he hastens to point out. He and other researchers have focused until now mainly on programming languages. He would like to see the experimental approach extended to query languages, data-base systems, interactive displays and other system elements that affect users. "The surface has barely been scratched," he says.

Shneiderman himself has recently become "obsessed" with error messages. "Most error messages are not only extremely cryptic but also hostile in tone," Shneiderman says. He adds "Tone is a very important human factor. You don't want to alienate users with poorly worded and cryptic messages."

Shneiderman believes that human error in the use of systems could be substantially reduced by making error messages specific and by banishing such negatively toned terms as "illegal" and "invalid" from the lexicon of error message writers. Such words can be eliminated by stating the exact nature of the error, he points out.

Shneiderman's theory has encountered some skepticism, but he hopes to settle the matter by his favorite method: controlled experiment. He is testing his theory about error messages on his students and is acting as a consultant for an experiment being conducted by Boeing Computer Services. "I believe such studies will show that well-written error messages do make a difference," Shneiderman says.

—Paul Kinnucan

Kluchman launches career as a software publisher

Many computer manufacturers have used software as a tool to sell hardware, rather than emphasize it as a strong product with its own profit potential. The result, some observers contend, is that computer users may pay a lot of money for products that don't do the job, are inefficient or are difficult to use.

"Software is beginning to be viewed *as a product with profit potential and therefore justifies investments for quality," says publisher Kluchman.*

Veteran minicomputer marketer Allen Kluchman is attempting to solve some of those problems by bringing minicomputer users high-quality, mass-produced, turnkey applications software at low cost. Kluchman, formerly employed by Data General Corp. and Digital Equipment Corp., will market programs obtained from independent programmers and written for DG minicomputers. His software-publishing company, Access Communications, Inc., will sell software through distributors and dealers.

In so doing, Kluchman will provide a service similar to the one that was responsible for the success of the minicomputer industry: providing a low-priced, off-the-shelf product.

"The minicomputer industry grew out of the desire to produce low-cost, special-purpose systems," Kluchman says. "Software is now where hardware was 20 years ago." General-purpose minicomputers prompted lower prices for custom, special-purpose systems. Similarly, packaged applications software likely will force expensive custom software prices to drop, he explains.

"Software is beginning to be viewed as a product with profit potential, and therefore justifies investments for quality," he emphasizes.

Kluchman knows that selling software requires providing customers with support. To that end, Access includes self-teaching aids in its software. "The factor that limits broad use of computers is not cost; it is understanding how to use them," Kluchman says.

Kluchman developed the idea of educating customers during his four years at DEC, which he joined in 1964 as manager of advertising and sales promotion for the company's PDP-8 minicomputer. He also developed the practice of fostering price and performance competition in the minicomputer industry.

Kluchman missed some career opportunities because he was so busy working. Edson de Castro, then a design engineer for the PDP-8 and now president of Data General, and three other DEC employees asked Kluchman to draft a business plan for a new product and strategy

"Quantum fully intends to be the leader in 8-inch Winchester drives by 1982."

—Jim Patterson, President Quantum Corporation

We have the very best people.
People whose impressive credentials inspired a level of financial backing seldom seen in a company so young. A management team with 110 years' experience and 20 patents in computer peripherals. The same people who developed the first generation of low-cost Winchester drives. And the second. People who have demonstrated the ability not only to design a superior drive, but to produce it. In high volume. At low-cost. So you can count on reliable delivery of high-quality drives . . . always at a competitive price!

The very best drives.
Our Q2000 series of 10, 20, 30 and 40-megabyte drives gives you up to four times the capacity of the current industry-standard Shugart SA1000, at a lower cost-per-megabyte. And all four are compatible with the SA1000 and with standard 8-inch floppy disk drives.

Major OEMs have already given the Q2000 series their highest vote of confidence: orders. To stay competitive in today's exploding market for low-cost computer systems, you need to know about Quantum 8-inch Winchester drives now.

For details, call Bob Teal, Quantum Corporation, 2150 Bering Drive, San Jose, CA 95131, phone (408) 262-1100.

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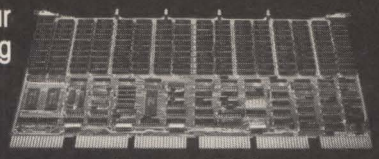
CIRCLE NO. 41 ON INQUIRY CARD

NOW, ADD MEGABYTES OF SEMICONDUCTOR MEMORY TO YOUR EXISTING PDP-11s, WITH OUR NEW EXPANSION BOARDS.

Introducing the RVM-128, our new memory expansion module for the PDP-11. The RVM-128 plugs right into a small peripheral slot of the existing backplane on any model PDP-11, ranging all the way from the 11/04 to the 11/70. The first add-on RAM memory for PDP-11s to operate at standard +5V levels, the RVM-128 takes no special power supplies or hardware changes to use. A parity option is also available.

Like its predecessors — our add-on memory boards for the LSI-11 — the RVM-128 functions identically to standard DEC memory. This provides PDP-11 users with a convenient, low-cost way to expand memory capacities for either stand-alone or bank-switching applications. Now, when you reach the PDP-11's memory space limit, you're no longer stuck. By using our on-board bank-switching capability, you can now address a virtually unlimited amount of memory. Just add as many RVM-128s as you need. Avoid the expense of either overlaying from disk or upgrading to larger, more costly mainframes.



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For even more economical memory expansion, we offer substantial quantity discounts. To get further information on our memory expansion products for PDP-11 or LSI-11 computers, call or write Digital Pathways, 1260 L'Avenida, Mountain View, CA 94043.
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DIGITAL PATHWAYS

ANNOUNCING THE NEW RESTORATION KIT FOR OLD PDP-11s.

circle 42 on inquiry card.

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—David A. Brown, VP-Engineering, Quantum Corporation

Low-cost 8-inch Winchester drives designed to be built in volume.

All too often in the disk drive industry, the procedure has been for Engineering to design the drive, then turn it over to Manufacturing and wish them luck. That's why a lot of designs that looked great on paper fell short when they got into production. And why you had to wait for volume deliveries.

And that's why Quantum made low-cost, high-volume production a priority, right from the beginning.

Our engineering group was committed not only to designing for higher capacity and better performance than the industry-standard Shugart SA1000, but to designing for low-cost, high-volume production as well.

Four times the capacity of the Shugart SA1000.

The new Q2000 series gives you a choice of 10, 20, 30 or 40 megabytes of data storage, as compared with the 5 and 10 megabytes of the SA1000. Access time is up to 28% faster. And the Q2000 series is compatible with the SA1000 and with standard 8-inch floppy disk drives.

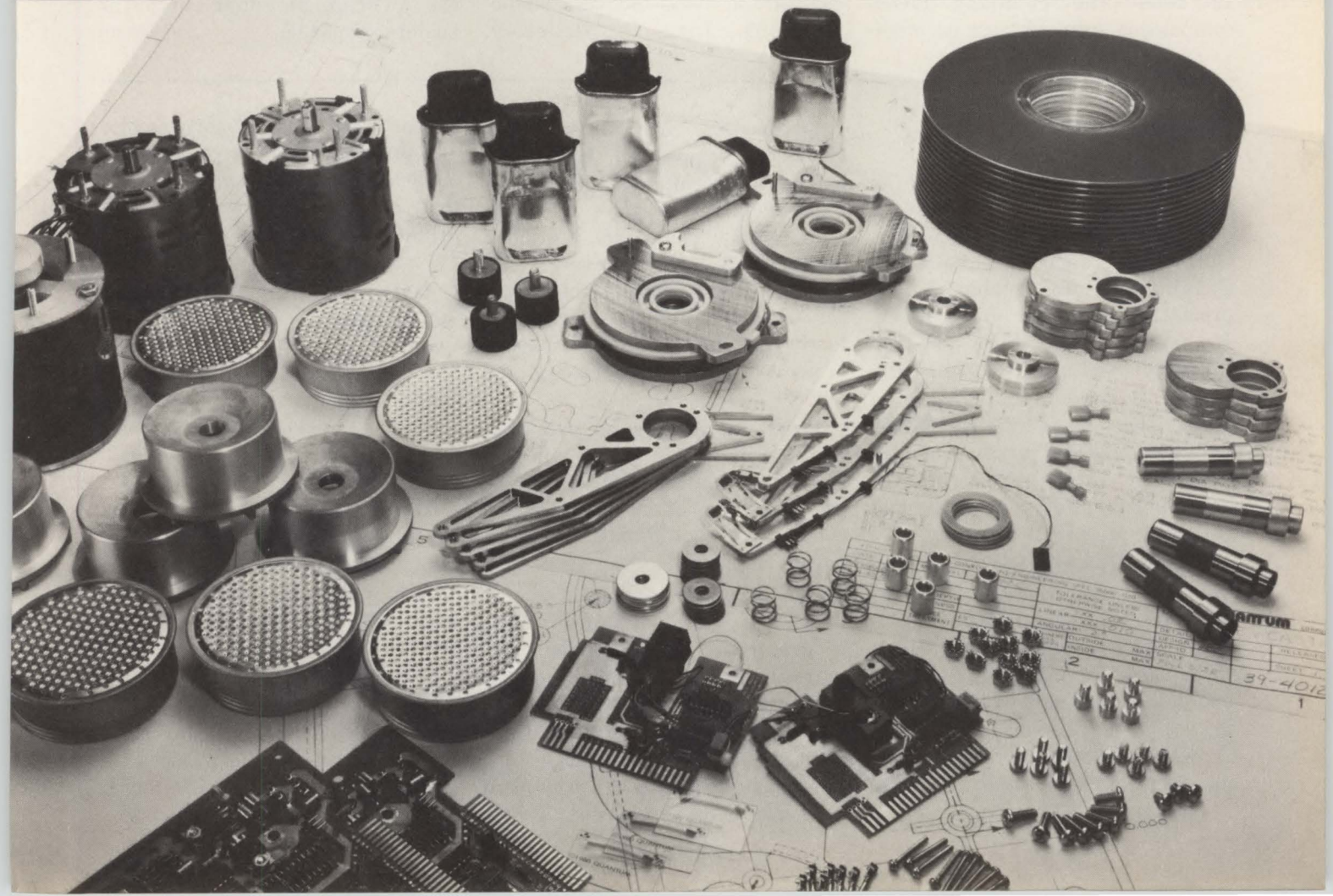
Available today in large OEM quantities.

Quantum's emphasis on manufacturability means you can get to market on schedule, with an affordable system that outperforms your competition.

Find out more about the engineering and cost advantages of Quantum low-cost 8-inch Winchester drives now. Call Bob Teal at (408) 262-1100. Or write Quantum Corporation, 2150 Bering Drive, San Jose, CA 95131.

QUANTUM *Driving down the cost of quality.*

CIRCLE NO. 43 ON INQUIRY CARD



for DEC. Kluchman was too busy to develop a plan, but the group did submit one. That plan was rejected. De Castro and the others then left DEC to form Data General.

In 1968, Kluchman nearly missed another opportunity when he rejected an offer to be director of marketing for Data General. He later reconsidered and joined the company. "The DG offer was risky, but if it was successful, it would make money fast," Kluchman says, reflecting. "And, it's fun to start a company." But before assuming his new position he made a deal with himself: "I enjoyed business and work, but if I made a certain amount of money, I would work only as much as I wanted to."

One big obstacle in marketing the new product—competition—was already established in the minicomputer industry when DG jumped in. In 1968, the company faced competition from at least 64 other manufacturers.

"DG understood the fine tuning of what must be done to be successful in the minicomputer business," Kluchman says. While other competitors fell by the wayside, DG set out to position itself as a strong number 2 contender to DEC, which had 85 percent of the market. "Other vendors didn't see that DEC was the market—that it was the IBM of the minicomputer market."

When DG had successfully launched its Nova and superNova products and held a secure position behind DEC, Kluchman kept his promise to himself: he cashed in his stock options and left. From 1972 to 1979, he lived on his Sherborn, Mass., farm and worked part-time as a consultant.

"I had a good time for seven years...but inflation ended the paradise," he says. He started a company in 1979—Access Communications, Inc., in Wellesley, Mass.—to sell software of econometric models of business. When efforts to finance the company failed, Kluchman returned to DG, helped set up the company's retail business and brushed up on the developments in the computer industry of the previous seven years.

Last fall, Kluchman reactivated Access as a publishing house for independent software and fulfilled an early career goal of being a publisher. The value he adds to the software will be merchandising, which is one of his strong points, says former colleague William D. Jobe, vice president and general manager of DG's General Distribution Division.

At Access, Kluchman will apply his aggressive marketing approach and flair for merchandising to software, basing his first product on the Visicalc personal computer business package. *—Lori Valigra*

People in the news.....

Manuel A. Fernandez was elected president, CEO and a director of Zilog, Inc., Cupertino, Calif. He succeeds **Federico Faggin,** who was appointed vice president of Exxon Enterprises, Inc., with responsibility for the Computer Systems Group.

Data General Corp., Westboro, Mass., has named **H.E. James Finke** to the new position of vice president, international market development. Finke formerly had been vice president, Europe.

Barry Rosenbaum has been promoted to the position of director of marketing at Perkin-Elmer's Computer Systems Division. He is responsible for planning, directing and controlling worldwide marketing activities. Rosenbaum previously was assistant to the general manager at the company's U.S. Computer Sales Division.

Britton-Lee, Inc., Los Gatos, Calif., has appointed **Judith B. Miller** director of sales, with responsibility for sales development, administration and customer contact. Miller formerly was employed by National Semiconductor Corp., where she served as marketing communications manager for the Microcomputer Systems Division.

Jared A. Anderson, president and CEO of Two Pi Corp., will end active involvement with the firm at the expiration of his management contract with U.S. Philips Corp., the parent company.

Carl Jeremias has joined Microdata Corp., Newport Beach, Calif., as group vice president, domestic marketing and sales. Prior to joining the company, Jeremias was employed at MAI for 12 years.

Dataroyal, Inc., Nashua, N.H., has appointed **Prentice I. Robinson** as senior vice president, a new position. He was formerly senior vice president and vice president of engineering at Centronics. Prior to that, he headed research and new product development for Wang Laboratories.

Alyce Branum has joined Summagraphics Corp., Fairfield, Conn., as director of marketing. She was formerly employed at Digital Equipment Corp., where she was a product manager and a marketing manager for several product groups.

Ken Isaac has joined Century Data Systems, Inc., Anaheim, Calif., as vice president, engineering. He replaces **Richard Charlton,** who has been appointed vice president, advanced planning and technology.

Peter L. Hertan has been appointed vice president, marketing of Nestar Systems, Inc., Palo Alto, Calif. He will be responsible for all μc product marketing and support.

"As OEMs discover the advantages of Quantum 8-inch Winchester drives, the demand grows daily. In Manufacturing, we're prepared to meet high-volume OEM commitments."

—Harold C. Medley, VP-Manufacturing, Quantum Corporation

A very manufacturable disk drive.

Quantum's 10, 20, 30 and 40-megabyte Q2000 disk drives were designed to be built in high volume at low cost.

Working as a team, Quantum design and manufacturing engineers created a drive that gives you better performance than the industry-standard Shugart SA1000, yet can be manufactured with simple, low-cost parts and fast, efficient production methods.

Low-cost, high-volume production.

To meet your low-cost, high-volume delivery requirements, we designed our manufacturing process as carefully as we designed the drive itself.

Our unique conveyorized "clean-air tunnel" combines the best of proven techniques for Winchester drive assembly. The drive is assembled on a conveyor line, so production is more efficient than with independent assembly stations. And the laminar-flow clean-air tunnel completely eliminates the need for a large, expensive "clean room," cutting production costs and increasing worker efficiency.

Specially-designed automated testing equipment thoroughly exercises each drive through all its functions, to assure highest quality while keeping labor costs down.

Every manufacturing operation is planned for easy, smooth expansion to meet growing OEM requirements.

In short, we're geared for low-cost, high-volume production of quality disk drives that we're proud to deliver to you.

Get to know Quantum now.

From manufacturing and engineering to management and customer service, Quantum has the very best people in the disk drive industry today. People who can help you plan an affordable growth path for your small computer systems.

For details on Quantum low-cost 8-inch Winchester drives, call Bob Teal, Quantum Corporation, 2150 Bering Drive, San Jose, CA 95131, phone (408) 262-1100.

CIRCLE NO. 44 ON INQUIRY CARD

QUANTUM ***Driving down the cost of quality.***

"Wow, you Kierulff guys will go through just about anything to deliver ADDS terminals on schedule!"

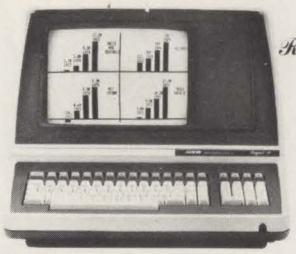
At Kierulff, our mission is to deliver ADDS terminals where you want them, when you want them.

Things are getting tough and time is running out. You've been ordered to secure a top-of-the-line terminal for your system—one that's versatile, with lots of features—and they haven't given you much time to do it. Normal OEM delivery times are out of the question. You need help and you need it now.

Single Superiority

The ADDS *Regent*® 20 delivers a lot of features you simply won't find on most low cost terminals. For example, in the "print transparent" mode, you can pass the data stream directly through to your printer without display or action by the terminal itself. Plus, the character set for any of the six Western European languages is operator selectable. Instantly.

The *Regent* 25 does all that and adds the convenience of a separate numeric keypad to speed data entry and cursor movement. And both give you a choice of dark characters on a light background or the reverse.



Regent 30

The Smart Move

The *Regent* 30, 40 and 60 give you everything you'd expect in a smart terminal—and some things you wouldn't: like a separate "terminal status" line, visual highlighting, line drawing symbols and editing functions. And both the economical *Regent* 30 and top-of-the-line *Regent* 60 offer you the added flexibility of a buffered display.

ADDS has also just introduced a complete new line of terminals—the 25/1500, 25/120 and the 40/VT—that fully emulates the CRTs produced by other major firms.

A crash course on systems distribution

Kierulff stocks the entire line of ADDS *Regent* terminals and can provide immediate, off-the-shelf delivery. We have a computerized inventory system that gives us instantaneous information on the stock in every one of our bases across the country, so when we give you a delivery date, you can bank on it. And we're right on target in other ways too. We offer a wide selection, line of credit, knowledgeable sales personnel and competitive prices.

Kierulff—we're no fly-by-night outfit!

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CIRCLE NO. 45 ON INQUIRY CARD

"Quantum 8-inch Winchester drives are setting a new industry standard."

—Jim McCoy, VP-Marketing, Quantum Corporation

Lowest cost-per-megabyte.
Quantum Q2000 disk drives are your most affordable way to upgrade from floppy disk to Winchester reliability. Because we designed every part, every function to give you highest quality at the lowest cost-per-megabyte in the industry.

Four times the capacity.
Choose from our 10, 20, 30 and 40 megabyte versions. That's up to four times the capacity of leading 5 and 10 megabyte 8-inch Winchester drives.

Full compatibility.
Interface, power supply and mounting requirements are fully compatible with industry-standard Shugart SA1000 fixed disk drives. There's no need to alter your basic system design when you upgrade to the Q2000.

Higher performance.
Average access time is up to 28% faster than the Shugart SA1000.

To stay competitive in today's exploding market for low-cost computer systems, you need to know about Quantum 8-inch Winchester drives now. For details, call Bob Teal, Quantum Corporation, 2150 Bering Drive, San Jose, CA 95131, phone (408) 262-1100.

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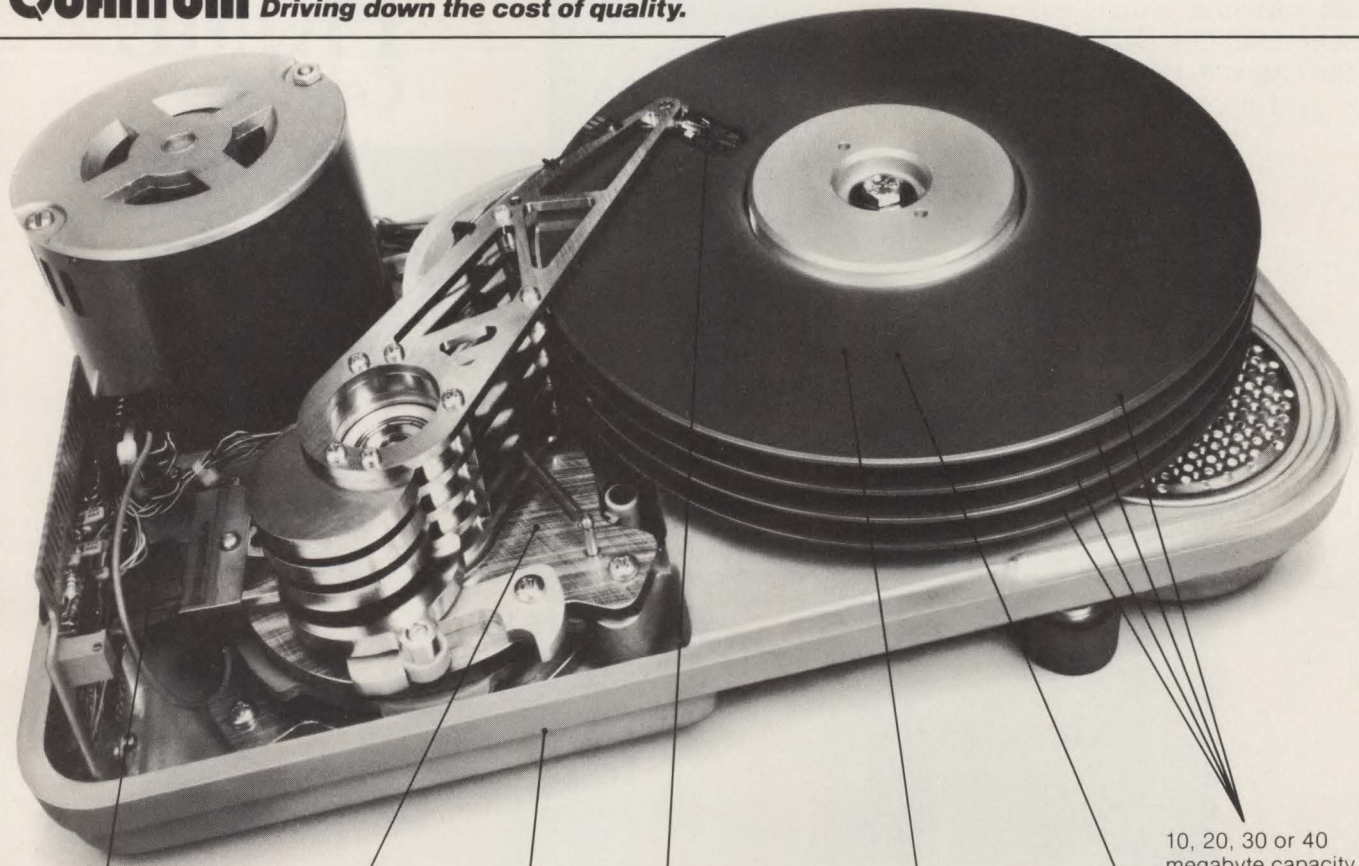

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Our small, 32 bit, 50 Series computers come packed with everything you need, including the same in-depth support and system installation that we provide with our most powerful systems. All you have to do is add your own application software.

We offer the Prime 150 and 450 in minimum quantities of five, with an unusually aggressive discount schedule. Our delivery time is one of the fastest in the industry.

And as part of the package, you get our large-system performance: up to 32 million bytes of virtual memory for each of up to 32 simultaneous users; our PRIMOS operating system that supports extensive communications and networking; and a wide range of industry-standard languages like COBOL, Pascal, PL/1 and FORTRAN.

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PRIME Computer

CIRCLE NO. 47 ON INQUIRY CARD

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Editorial Offices

Boston: 221 Columbus Ave.
Boston, MA 02116
(617) 536-7780
Paul Kinnucan

Los Angeles: 5670 Wilshire Blvd.
Los Angeles, CA 90036
(213) 933-9525
John Trifari

San Jose: Sherman Bldg., 1 Suite 1000
3031 Tisch Way
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Maturity and innovation

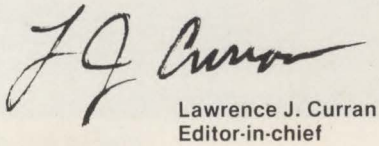
The attainment of maturity is usually a time in life that should be welcomed, but we're not sure that maturity in an industry is a good thing. In terms of years, the minicomputer industry can be considered mature, having flourished through a generation since the early 1960s. But I hope that maturity doesn't bring stagnation, as it often does to large companies. There aren't any obvious signs, though, that large companies in the minicomputer/microcomputer industry are becoming stagnant, and, indeed, there is ample evidence that innovation is still at work to create competition and keep the industry young and vigorous.

This issue includes stories about two companies that attest to the fact that innovation lives. The stories involve Ontrax Corp., a new maker of Winchester-disk drives in Sunnyvale, Calif.; and Access Communications, Inc., a start-up software publisher in Wellesley, Mass. Ontrax has a novel actuator mechanism, for which a patent is pending, that allows the drive's transfer rate to be substantially greater than the transfer rates possible with voice-coil actuator mechanisms (see "Positioning a new Winchester," p.119). The idea for the actuator mechanism was good enough to attract some key people to start a new company.

Meanwhile, Allen Kluchman, who spent several years at Data General Corp., had an idea to offer wider distribution to application software written by independent programmers, and founded Access Communications to do just that. The company will mass produce turnkey application software for minicomputers at a low cost, selling it through distributors and dealers (see "Access tries to sort out chaos in software market," p. 51).

But innovation alone isn't enough to sustain a new venture. Investment must follow, and incentive has to be present to nourish investors. The incentive is potential profit—for the company principals and for anyone with venture capital to risk.

We hark back to some thoughts from David T. Kearns, president and chief operating officer of Xerox Corp., printed last year in an opinion column in *Newsweek*. Kearns made the point that America's "dismal economic record" of the past decade was linked to a decline in research and development, innovation and productive risk-taking. We submit that the efforts of Ontrax and Access Communications are potentially productive risks that are to be applauded, and are just two instances among many that provide evidence that the computer industry, despite its maturation, doesn't lack innovation.



Lawrence J. Curran
Editor-in-chief

Letters

COUNTING ON PRECISION

To the editor:

Christopher Henrich has done a superb job of explaining the finer points of floating-point arithmetic in the article "Floating-point arithmetic: can it be trusted?" (MMS, November, 1980, p. 143). I agree that the quality of the arithmetic package depends upon the quality of each computation.

However, I remain confused about the preference of base-16 over base-2 mantissas. It seems that the high-order bits of a floating-point mantissa deserve the same attention to detail as the low-order bits.

With base-16 computation, there is always the possibility that a 1 (binary 0001) will appear as the most significant digit. Consequently, the best precision we can count on is 3 bits less than with base-2 computation using the same number of bits in the mantissa. It is usually argued that this is the price we have to pay for allowing the exponent to encompass a greater range.

In rebuttal to this argument, I point out that, in a base-2 system, only 2 more bits would be needed by the exponent to exceed the range of the base-16 system. Further, by eliminating the most significant bit of the mantissa in the base-2 system during normalization (because we know that it always equals 1 and can be recreated for each computation), we can have a base-2 system with a greater range than the base-16 system, and the base-2 system would be 2 bits more precise.

William C. Smith
Engineering Analyst
Barber-Colman Co.
Rockford, Ill.

CIRCLE NO. 48 ON INQUIRY CARD

GRAPHICS GOOF

To the editor:

The table of interactive graphics systems in your December issue (p. 78) included a potentially misleading comparison. Most companies were represented by their top-of-the-line graphics systems. Ramtek Corp., however, was represented in the table by one of its early products, the 6208A Colorgraphic terminal, which does not reflect the full range of color graphic capabilities that Ramtek offers.

The appropriate Ramtek entry for the table would have been the 9400 graphics and imaging display system. The 9400 offers 1280 × 1024-line resolution, 4096 displayable colors from a possible 16 million and writing speed of more than 16,000 vectors per sec. Monitors are available in 13-, 19- and 25-in. diagonal CRT sizes. Interactive devices include joysticks, trackballs, light pens and graphic tablets.

Special graphics features of the 9400 include context switching for as many as 16 users, virtual picture addressability (32K × 32K), decluttering, clipping, pan, zoom, entity detection and 2D spatial transformations.

For output media, the 9400 is RS170/343A-compatible for various hard-copy and video devices. The 9400 CPU has multiple processors, including the programmable Z80, providing as much as 280K bytes of RAM, 96K bytes of EPROM and a 16-bit AMD 2900 bipolar μp. The interface is 16-bit parallel to most popular minis and some mainframes. Prices range from $35,000 to $100,000.

Joseph G. Morris, Senior Vice President
Ramtek Corp.
Santa Clara, Calif.

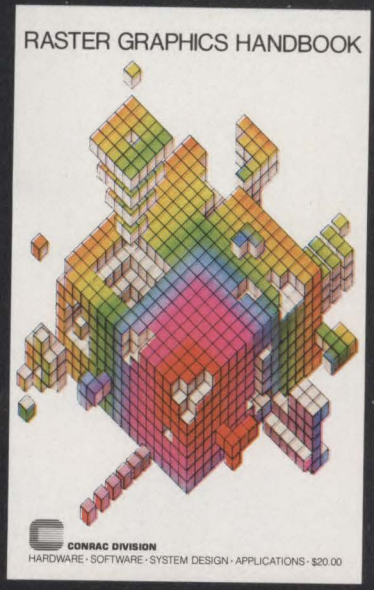
DO YOUR HOMEWORK FOR THE NEXT DECADE.

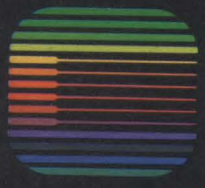
Presenting the Raster Graphics Handbook written and published by the Conrac Corporation. Only a company with experience in all video display applications, and only a company with the most extensive and competitive line of monitors could write this exciting book.

In it is everything you need to know about raster graphics. Whether you design computer systems for management decision-making, process control, cartography, image enhancement, trend analysis, or medical diagnostics, raster graphics will be the dominant information display medium of the '80's. The range of options and alternatives are limitless.

Decision-making images. Find out if you qualify for this book, send in the attached postcard, or circle the bingo number.

Catch up on your reading.





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DECISION-MAKING IMAGES

CIRCLE NO. 49 ON INQUIRY CARD

DISK DRIVES

Winchester market shifts to 5¼-in. drives

ANDREW ROMAN, Roman Associates International

The extent of Winchesters' substitution for floppies suggests that capacity has precedence over removability—and that smaller is better

A flurry of 5¼-in. Winchester introductions is overwhelming manufacturers of small computers and intelligent terminals before they've had a chance to assimilate the dozen or so 8-in. Winchesters announced last year. There are 10 manufacturers of 5¼-in. Winchesters, with as many more expected before the National Computer Conference in May.

Winchester "action" clearly is in the direction of smaller size. Winchesters offer greater capacity and reliability at the expense of media nonremovability. But the extent of their substitution for lower-density floppies—both standard (8-in.) and mini (5¼-in.) varieties—seems to indicate that capacity has precedence over removability, and that smaller is better. Add to this the acceptance of floppies and/or tape cartridges as backup and transfer media for Winchesters—thereby removing removability as a systems-level issue—and the picture becomes even clearer: Winchesters, particularly small Winchesters for small systems, are big news, and this acceptance is growing.

But if the battle for market acceptance is over, the intra-technology battle of the Winchesters is just beginning. Winchester technology is anything but static. Performance gains are being wrung daily from each of the three "standard" Winchester-disk diameters—5¼, 8 and 14 in.—and adding to the confusion is a 10½-in. drive from Fujitsu (see "10½-in. Eagle challenges big Winchesters," p. 111).

All this diversification has left systems builders gasping for breath. Under pressure to act, they have been confronted with a number of unanswered questions about this hardware, despite Winchester technology's proven track record. Many are concerned with the reliability of these drives because the

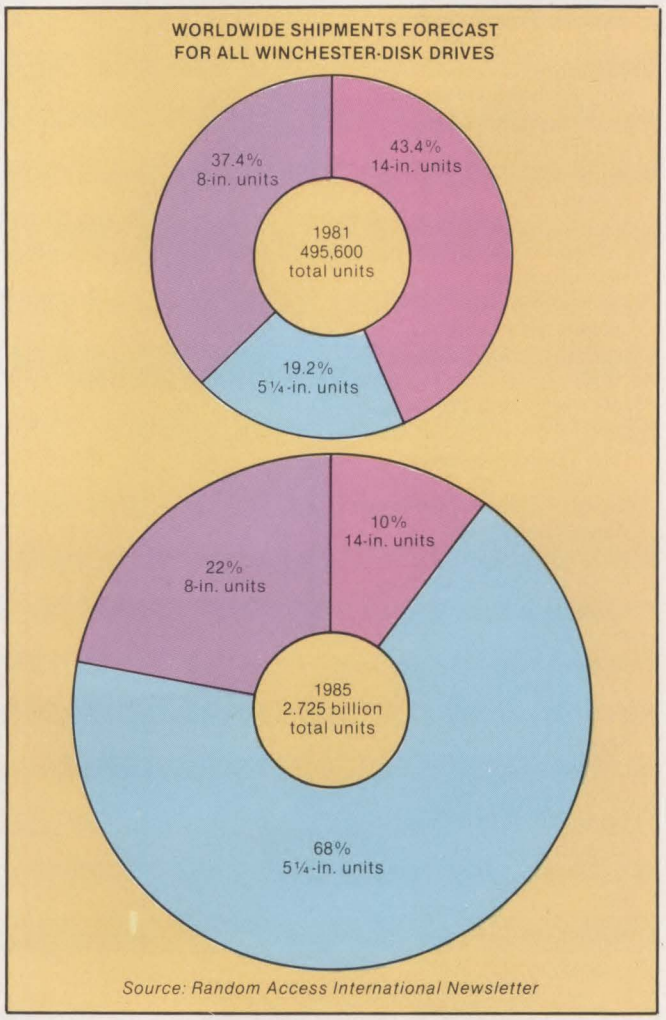


Fig. 1. Shipments forecast *shows the changing product mix of Winchester-disk drives. By 1985, two of every three Winchesters shipped will be 5¼-in. units.*

Photo of Quantum's newest 8-in. Winchester-disk drive courtesy of Quantum Corp.

WORLDWIDE MANUFACTURERS OF WINCHESTER DISK DRIVES

Manufacturer	Markets Served	5¼-in. Winchesters		8-in. Winchesters		
		Expect to Announce	Now Shipping	Expect to Announce	Now Shipping	
Ampex Corp.	O			X		
Ball Computer Products Div.	O			X		
BASF Systems	O, P	X			X	
Burroughs Corp.	C					
Century Data Systems	O					
CII-Honeywell-Bull	O, C				X*	
Control Data Corp.	O, P, C	X			X	
Dastek Corp.	O					
Data General Corp.	C					
Data Peripherals	O				X	
Data Recording Equipment, Ltd.	O				X	
Digital Equipment Corp.	C			X		
DMA Systems	O	X				
Fujitsu America Inc.	O, P, C			X*	X	
Hewlett-Packard	C					
Hitachi America, Ltd.	O, P, C				X	
Hokushin Electric Works, Ltd.	O				X	
IBM Corp.	C	X			X	
International Memories, Inc.	O		X		X	
Irwin International, Inc.	O		X			
ISS/Sperry-Univac	C, P					
Kennedy Co.	O				X	
Memorex Corp.	O, P				X	
Microcomputer Systems Corp.	O				X	
Microdata Corp.	C, O					
Micropolis Corp.	O				X	
Mitsubishi Electric Corp.	O, C				X	
NEC Information Systems, Inc.	O, C			X		
New World Computer Co.	O		X		X	
NPL	O, P, C				X	
Ohio Scientific Memory Products	C					
Olivetti Peripheral Equipment	O, C		X		X	
Ontrax Corp.	O				X	
Perkin-Elmer Corp.	O, C			X		
Pertec Computer Corp.	O				X	
Philips Data Systems	O, C				X	
Priam Corp.	O				X	
Quantum Corp.	O				X	
Rotating Memory Systems	O		X			
Seagate Technology	O		X			
Shugart Associates	O		X		X	
Siemens Corp.	O, C					
SLI Industries	O				X	
Storage Technology Corp.	P					
Tandon Corp.	O		X			
Texas Instruments	O, C	X				
3M	O, C				X	
Toshiba Corp.	O, C	X				

Markets Key: O = OEM
P = Plug-compatible
C = Captive

14-in. Winchesters				For More Information, Circle No.
0M to 100M Bytes	101M to 300M Bytes	301M to 500M Bytes	More Than 500M Bytes	
X	X			376
X	X			377
X	X	X		378
X				379
X				380
				381
X	X	X	X	382
	X	X		383
X				384
				385
				386
	X			387
				388
X	X	X	X	389
X				390
X	X	X	X	391
X	X			392
X	X	X	X	393
				394
				395
X	X	X	X	396
X				397
X	X	X	X	398
				399
X	X			400
				401
X	X			402
X		X	X	403
				404
X	X	X		405
X				406
				407
				408
				409
				410
				411
X				412
				413
				414
				415
X				416
		X		417
				418
		X	X	419
				420
				373
				374
X				421

*Unique 10½-in. diameter media

Source: Random Access International Newsletter

5¼-IN. WINCHESTER-DISK DRIVE SPECIFICATIONS

Manufacturer	Model	Total Unformatted Capacity (megabytes)	Number of Disks/ Disk o.d. (mm.)	Bytes per Track	Tracks per in./Bits per in.
International Memories, Inc.	5000 series	6.9	2/130	12,000	200/8730
Irwin International, Inc.	510	12.3	1/130	11,388	900/8000
New World Computer Co., Inc.	V-1TF	1.8	1/130	14,100	200/9000
Olivetti Peripheral Equipment	HD-561	6.38	2/130	10,417	254/7690
Rotating Memory Systems	RMS503, RMS506, RMS512	3.2, 6.4, 12.7	1, 2, 4/130	10,417	255/7700
Seagate Technology	ST-506	6.38	2/130	10,417	255/7690
Shugart Associates	SA602, SA604, SA606	3.3, 6.7, 10	1, 2, 3/130	10,417	256/7900
Tandon Corp.	601, 602, 603 601E, 602E, 603E	3.2, 6.4, 9.6 3.8, 7.7, 11.5	1, 2, 3/130 1, 2, 3/130	10,400 8300	254/7690 254/7690
Texas Instruments	TBA	6.38	2/130	10,417	255/7700

8-IN. WINCHESTER-DISK DRIVE SPECIFICATIONS

BASF Systems	6171, 6172, 6173	8, 24, 40	1, 2, 3/210	13,344	500/6542
CII-Honeywell-Bull	D164, D166, D168	60, 90, 120	2, 3, 4/266	19,200	900/4850
Control Data Corp.	9455 Lark	16.7	2/195	20,160	237/6774
Data Peripherals	DP-100 Lynx	11	1/200	13,344	478/6866
Data Recording Equipment, Ltd.	3112, 3120, 3144	11.7, 19.5, 44	2, 3/200	10,880	300/5800
Fujitsu America Inc.	2301, 2302 2311, 2312 2351 Eagle	11.7, 23.4 48.2, 84.4 473.6	2, 4/200 2, 4/200 6/266	12,000 20,480 28,160	195/6100 720/9550 880/12,790
Hitachi America, Ltd.	DK801-1, DK801-2 DK-811-2, DK-811-4	6.9, 13.9 23.5, 47	1, 2/210 2, 4/210	15,100 15,100	200/7300 480/7300
Hokushin Electric Works, Ltd.	CD8005, 8010 CD-8020, 8030	6.6, 13.2 21.2, 35.3	1, 2/200 2, 3/200	15,000 13,440	180/7475 480/6646
IBM Corp.	4963-29A 3310-A1	29.3 64.5	3/210 6/210	16,384 16,384	450/8530 450/8530
International Memories, Inc.	7710, 7720 7740	11, 20 41	3, 4/200 4/200	10,800 10,800	300/6000 600/6000
Kennedy Co.	7000 series	4, 12, 20	1, 2, 3/210	11,520	300/5280
Memorex Corp.	101, 102 201 Quark	11.7, 23.4 25	4/200 2/200	12,000 20,672	195/6100 480/8540
Microcomputer Systems Corp.	MSC-8100	6.4, 12.7, 19.1	2/200	12,500	
Micropolis Corp.	1201, 1202, 1203 1221, 1222, 1223	8.9, 26.7, 44.5 7.1, 21.3, 35.6	1, 2, 3/200 1, 2, 3/200	12,000 12,288	478/6735 478/8623
Mitsubishi Electric Corp.	2860-1, 2	7.24, 50.7	2, 4/200	13,440	480/7300
New World Computer Co.	V111-1, V111-1TF	1.8, 4.2	1/210	16,500	200/9000
NEC Information Systems, Inc.	2220, 2230	25.5, 42.5	2, 3/210		480/8800
Nippon Peripherals, Ltd.	NP-30	115	6/210	19,800	544/9000
Olivetti Peripheral Equipment	HD-830	30.1	3/200	11,264	508/6400
Ontrax Corp.	series 8	34, 68, 136	2, 3, 5/210	14,168	960/7158
Perkin-Elmer Corp.	Vanguard 8	35.1	2/200	21,320	417/10,466
Pertec Corp.	D8000	20.33	2/210	14,400	466/6600

Average Positioning Time (msec.)	Actuator Type	Data Transfer rate (kilobytes/sec.)	Interface Type	Price (OEM)	Comments
96	stepper	970	SA1000/IMI 7710	$780	New product
25	voice coil	662	Sub-ANSI	$1500	Built-in 10M-byte backup tape drive
20	stepper	848		$900	Plated disk; 8 fixed heads
170	stepper	625	floppy	$720	Faster access version available
150	stepper	625	SA1000	$750, $900, $1100	New product from new company
170	stepper	625	SA1000	$925	Industry's first 5¼-in. Winchester
75	stepper	542	SA1000/floppy	$755, $925, $1070	Just announced new product
153 230	stepper stepper	625 500	SA1000/floppy	$1400-$1600 (single unit)	New product Extended to 230 cylinders from 153
170	stepper	625	TI	N/A	Not yet announced (licensed from Seagate)
27	linear v.c.	800	SMD/ANSI	$1600, $1900 $2200	3 OEM interfaces
40	linear v.c.	920	OEM	$3085, $3355 $3625	Special 10½-in. media
50	linear v.c.	1209	SMD		8M bytes removable and 8M bytes fixed
60	linear v.c.	874	SA4000	$1400	11M bytes removable-only cartridge media
35	linear v.c.	800	OEM	N/A	Made in U.K.
70 20 18	band stepper rotary v.c. rotary v.c.	593 1229 1859	SA4000 SMD/ANSI SMD	 $8500	Floppy-drive mount High-performance unit New 10½-in. media High-performance unit
70 25	stepper rotary v.c.	889 889	SMD SMD	$1200, $1350 N/A	Stepper motor actuated by rotary cam Family compatible I/O
50 50	stepper stepper	900 800	SMD SMD	N/A N/A	Dual-spindle version also available
27 27	rotary v.c. rotary v.c.	1031 1031	IBM S/1 IBM 4331		S/34 and 8100 versions available Also 4341 version
35 45	linear v.c. linear v.c.	648 648	Command bus Command bus	$1900, $2290 $2800	40M-byte version just announced Just announced family compatibility
50	rotary v.c.	688	OEM		Floppy mounting
70 30	band stepper linear v.c.	593 1209	OEM SMD	$1560, $2028 $3200	Floppy-disk size mounting package 12.5M bytes fixed and 12.5M bytes removable
30	linear v.c.	625	SMD		
42 42	rotary v.c. rotary v.c.	720 923	OEM OEM	$1350, $1782 $2068 $1950, $2382 $2668	S-100 bus subsystem also available Also S-100 subsystems
35	linear v.c.	806	SMD	$2200, $2800	New product
28	fixed and linear stepper	988	OEM	$1100	Also 1.8M-byte version; not a sealed Winchester
30	rotary v.c.	1198	SMD	N/A	
28	linear v.c.	1031	SMD	$3600	IBM PCM version also available
36	linear v.c.	800	bidirectional bus	$4000	ANSI interface optional
25	unique linear	1152	ANSI/OEM	N/A	Unique new dual actuator; high-performance family
30	linear v.c.	1209	SMD, ANSI	low $2000	SA850 form factor; 64M-byte fixed companion drive also available
50	rotary v.c.	864	ANSI	$1980	Floppy-disk mounting envelope

8-IN. WINCHESTER-DISK DRIVE SPECIFICATIONS

Manufacturer	Model	Total Unformatted Capacity (megabytes)	Number of Disks/ Disk o.d. (mm.)	Bytes per Track	Tracks per in./Bits per in.
Priam Corp.	2050, 3450 1070	21.2, 35.3 10.8	2, 3/200 2/200	13,440 15,000	480/6670 180/7475
Quantum Corp.	Q2010, Q2020, Q2030	10.7, 21.3, 32	1, 2, 3/200	10,400	345/6600
Shugart Associates	SA1002, SA1004	5.33, 10.67	1, 2/200	10,400	172/6270
SLI Industries	Cheyenne	7.3, 22, 36.7, 51.4	1, 2, 3/200	11,200	478/6500
3M	8431/8432	10, 20	1, 2/210	17,920	219/8649
Toshiba Corp.	MK-80F-10, 30	14.5, 38.3	2, 3/210	20,160	450/8700

14-IN. WINCHESTER-DISK DRIVE SPECIFICATIONS

Manufacturer	Model	Total Unformatted Capacity (megabytes)	No. of Disks/ No. of Data Surfaces	Bytes per track	Tracks per in./ Bits per in.
Ampex Corp.	DF-980, DF-9150	83, 158.3	3/5, 4/7	20,160	478/6370
Ball Computer Products Div.	BFM 90, BFM 160	90.6, 158.6	3/4, 4/7	20,160	480/6486
BASF Systems	6150 series	141, 169	3/5, 4/6	20,160	600/6380
Burroughs Corp.	FD211, FD214	20, 80	1/2,	14,268	300/5500
Century Data Systems	Marksman M-20, 40	20, 40	1/2, 2/4	24,000	182/7545
CII-Honeywell-Bull	D166, D168	90, 120	3/6, 4/8		
Control Data Corp.	9730-80	82.9	4/5	20,160	340/6220
	9730-160	165.9	4/5	20,160	680/6220
	33801-AZ 33501-AZ 33502-AZ 9775	400 317.5 635 675	11/20 11/20 11/20 11/20	13,030 19,069 19,069 20,160	660/6350 660/6350 660/6350 660/6350
Dastek Corp.	4835-2, 3	339, 407	3/5, 4/6	40,960	694/12,772
Data General Corp.	6098, 6100	12.6, 25.2	2/2, 3/6	16,384	166/5760
Digital Equipment Corp.	RM-80				
Fujitsu America Inc.	M2283, M2284	134, 168	5/8, 6/10	20,480	680/6580
	M2252, 2253	25, 50	2/2, 3/4	20,480	300/6230
Hewlett-Packard	7910	12	2/2	8192	300/3225
Hitachi America, Ltd.	MFD-135-4, 8	3.7, 7.4	2/2, 3/4	14,500	48/5241
	DK-62-40, 80	40, 80	3/4, 5/8	15,360	300/5570
	H-8597-12	635	11/20	19,069	720/6425
Hokushin Electric Works, Ltd.	CD-6030	34	2/2	20,160	480/6430
IBM Corp.	3350	317.5	8/15	19,069	478/6425
	3370	571	7/12	31,744	635/12,134
	3375	819.7	TBA	TBA	TBA
	3380	1260	TBA	TBA	TBA
ISS/Sperry-Univac	717	110, 154	3/5, 4/7	19,968	476/6366
	8402-50, 75, 100	50, 75, 100			476/6366
	8450	336.3	8/15	21,060	478/6695
	8470	564.5	9/16	28,224	538/11,134
Kennedy Co.	5301-42, 70	42, 70	2/3, 3/5	20,160	300/6000
Memorex Corp.	601-50, 75	50, 75	3/4, 4/6	17,960	300/5636
	612-56, 84	56, 84	3/4, 4/6	20,160	300/6350
	3650	317.5	8/15	19,069	480/6425
	3652	635	8/15	19,069	960/6425
	659	677	8/15	20,160	935/6350

Average Positioning Time (msec.)	Actuator Type	Data Transfer rate (kilobytes/sec.)	Interface Type	Price (OEM)	Comments
45	linear v.c.	800	smart/SMD	$2200, $2750	Flexible I/Os optional
53	stepper	900	smart I/O	$1565	Manufactured by Hokushin
50	rotary moving coil	542	SA1400	$1200, $1500 $1800	Optional data separator PCB available for $150
70	band stepper	542	floppy I/O	$995, $1205	Floppy-compatible mechanical mounting
40	rotary v.c.	602	SMD, ANSI		Mechanics, only. OEM version also available
65	stepper		ANSI	N/A	
40	rotary v.c.	1200	SMD		New product

Source: Random Access International Newsletter

Average Positioning Time (msec.)	Actuator type	Data Transfer Rate (kilobytes/sec.)	Interface type	Price (OEM)	Comments
30	rotary v.c.	1209	SMD		
30	linear v.c.	1209	SMD	$4585/$5285	A family of drives
35	rotary v.c.	1000	SMD	N/A	
35	rotary v.c.	888	B-900	$3723/$4406	
43	band stepper	960		$1780/$2235	Intelligent version also available
30	rotary v.c.	1209	SMD	$4875	.96M- or 1.93M-byte fixed-head options available
30	rotary v.c.	1209	SMD	$6080	IBM S/1 interface version also available
25	rotary v.c.	1198	IBM 3330	N/A	3330 format PCM
	rotary v.c.	1198	IBM 3350	N/A	Native 3350 format PCM
19	rotary v.c.	1198		N/A	
25	linear v.c.	1209	SMD	$15,155	OEM version of 2X3350
25				N/A	
25	linear v.c.	2000	SMD	$6600/$7400	Thin-film heads
60	stepper	910.6	DG Nova	N/A	For DG Nova and Eclipse systems
27	rotary v.c.	1012	SMD	$4300/$4600	.65M-byte fixed-head option available
40	rotary v.c.	819	SMD	N/A	.33M- or .65M-byte fixed-head versions available
70	stepper	526	HP	N/A	For H-P 3000 series
100	stepper	875	OEM	N/A	.21M-byte fixed-head option
37	rotary v.c.	889	OEM	N/A	.144M-byte fixed-head option
20	rotary v.c.	1198	IBM	N/A	IBM PCM version; 2 independent actuators
45	rotary v.c.	1040	OEM	N/A	New product
25	rotary v.c.	1198	IBM 370		1.14M-byte fixed-head option
20	rotary v.c.	1859	IBM 4300		Thin-film heads; dual actuators
19	rotary v.c.	1859	IBM 4300		Not yet shipped
16	rotary v.c.	3000	IBM 303X	$97,650	1.4M-byte fixed-head option for IBM H series
35	rotary v.c.	1198	OEM		
35		1198		N/A	
23	rotary v.c.	1198	Univac	N/A	
23	rotary v.c.	2097	Univac	N/A	1.524M-byte fixed-head option
45	rotary v.c.	1000	SMD	$2960/$3360	Fixed- or variable-length sectors
32	rotary v.c.	885	SMD	$4175/$4740	OEM model
32	rotary v.c.	1209	SMD	$4175/$4740	SMD format and I/O
25	rotary v.c.	1198	IBM 3350	$23,760	Plug-compatible with IBM 3350
25	rotary v.c.	1198	IBM 3350	$44,250	Double-density 3350
22	rotary v.c.	1209	SMD	$12,950	OEM version of double-density 3350
30		885	microdata	N/A	0.54M-byte fixed-head option

14-IN. WINCHESTER-DISK DRIVE SPECIFICATIONS

Manufacturer	Model	Total Unformatted Capacity (megabytes)	No. of Disks/ No. of Data Surfaces	Bytes per track	Tracks per in./ Bits per in.
Microdata Corp.	7502, 7503	37.6, 62.7	2/4, 3/5	17,920	300/5636
	4721, 4722	113, 158	3/5, 4/7	20,160	478/6427
Mitsubishi Electric Corp.	M2883-40, 60	53.8, 80.8	3/4, 4/6	20,160	286/6060
	M2884-1, 2	86.1, 129.2	3/4, 4/6	20,160	480/6060
NEC Information Systems, Inc.	D-1220, 1240	41.5, 83.1	2/2, 3/4	19,968	480/6370
	D-1510	331.5	8/15	19,069	480/6400
	N-7755	635	8/15	19,069	960/6400
Nippon Peripherals, Ltd.	NP-24	280	8/15	16,736	480/5636
	NP-25	317.5	8/15	19,069	480/6425
Ohio Scientific, Inc.	3305, 3306	67, 80	3/5, 4/6	20,160	286/6122
Philips Data Systems	X1220	20	1/2	14,592	300/6540
Priam Corp.	Diskos 3350	34	2/3	20,160	480/6430
	6650, 15450	68,158	2/3, 3/4	20,160	960/6430
Shugart Associates	SA4008, SA4104	29, 58	2/4, 4/8	18,000	172/5534
Siemens Corp.	3470	420	10/19	16,384	590/6060
Storage Technology Corp.	8350	317.5	8/15	19,069	480/6425
	8650	635	8/15	19,069	957/6425
	8360	317.5	8/15	19,069	957/6425
Toshiba Corp.	MK-300F	36	2/3	16,384	318/5940

electronics and mechanics originally developed for 14-in. devices have been shrunk into packages the size of 5¼-in. floppy-disk drives.

Some also see file backup as a major obstacle to the widespread implementation of Winchester drives, while almost all systems designers ask whether today's product can be delivered in the quantities large enough to support the booming markets predicted for small business computers, low-cost graphic display systems and desk-top word processors.

Need for standards

The lack of industry standardization also is impacting the decision to build Winchester-based systems. At the OEM level, this first showed up with 14-in. drives. Faced with a lack of interface standards, independent designers showed little interest in building the formatters needed to integrate the new hardware. Meanwhile, at the OEM level, systems integrators that had previously built their own controllers as part of their value added, shied away from developing the complex electronics needed to handle the Winchester drives and the streaming-tape hardware for large-scale file backup.

As a result, many disk drive vendors, controller designers and OEMs turned to the storage module device (SMD) interface standard established several years ago by Control Data Corp. for its 3330-technology removable-pack drives as a stopgap measure. This situation continues to characterize the OEM market for 14-in. Winchesters.

The lack of standards affected 8-in. OEM devices announced in 1978 at the same time as it appeared at the 14-in. level. Many drive builders incorporated their own standards or retreated to SMD interfaces; others awaited the standardization efforts of ANSI. Still others, convinced that the 8-in. market initially would find its greatest strength at the lower end of the capacity spectrum, designed their hardware to interface with Shugart Associates' SA1400 controller announced in the spring of 1979. Standards appear to be more settled at the 5¼-in. level, however, and a significant effort is under way by independent design-

WORLWIDE SHIPMENTS FORECAST FOR ALL WINCHESTER-DISK DRIVES

(Units in thousands, sales in $ million)

	1981	1985
Total 5¼-in. units	95.0	1850.0
Total 8-in. units	185.5	605.0
Total 14-in. units	215.1	270.0
Total	495.6	2725.0
Total 5¼-in. sales	$ 90.2	$1480.0
Total 8-in. sales	795.1	1845.9
Total 14-in. sales	2473.6	3780.0
Total	$3358.9	$7105.9

Source: Random Access International Newsletter

Table 1. Forecast shows *that through 1985, Winchester-disk-drive shipments will grow a total of 61.6 percent, while sales revenues will grow a total of 25 percent to $7.1 billion.*

Average Positioning Time (msec.)	Actuator type	Data Transfer Rate (kilobytes/sec.)	Interface type	Price (OEM)	Comments
30		1175	microdata	N/A	1.2M-byte fixed-head option
38	rotary v.c.	996	OEM	N/A	.81M-byte fixed-head option available
38	rotary v.c.	996	SMD		2.42M-byte fixed-head option
40	rotary v.c.	1198	OEM	N/A	.96M-byte fixed-head option
20	rotary v.c.	1198	OEM	N/A	
20	rotary v.c.	1198	OEM	N/A	OEM model; double-density 3350
20	rotary v.c.	885	IBM 3344	N/A	IBM 3344 PCM
20	rotary v.c.	1198	IBM 3350	N/A	IBM 3350 PCM model
38	rotary v.c.	996	SMD	$2820	Formerly Okidata drives; new ownership
35	rotary v.c.	1305	SMD	N/A	Track embedded servo
45	linear v.c.	1040	bus	$2000	SMD I/O optional
45, 40	linear v.c.	1040	bus	$2530/$3340	SMD, smart I/O option
65	band stepper	887.5	floppy	$1800/$2500	Data separator option also available
20	rotary v.c.	806	OEM		1.15M-byte fixed-head option available
25	rotary v.c.	1198	IBM 3350	N/A	IBM 3350 plug-compatible model
25	rotary v.c.	1198	IBM 3350	N/A	Double-density 3350
18	rotary v.c.	1198	IBM 3350	N/A	1.14M-byte fixed-head option
40	rotary v.c.	896	OEM		.26M-byte fixed-head option

Source: Random Access International Newletter

ers to come up with the formatters that systems integrators will need to use this hardware. Most interfacing is based on Shugart's SA1400 8-in. Winchester, a move pioneered by Seagate Technology, the first company to introduce one of the smaller 5¼-in. drives. It is further anticipated that many of these formatters will be available as LSI components.

Winchester market outlook

As a result of their small size and relatively high capacity, the availability of formatters, and a good early track record from the production point of view, 5¼-in. Winchesters will experience the most explosive growth. Shipments are forecast to exceed $1.8 million units valued at $1.48 billion by 1985. This represents spectacular growth rates exceeding 350 percent per year for unit shipments.

This year's market-share leaders in the independent (OEM) market are expected to be Seagate Technology, International Memories, Inc., Shugart Associates, Tandon Corp. and Irwin International, a start-up based in Ann Arbor, Mich. (MMS, November, 1980, p. 45).

Other factors contributing to the phenomenal growth of the 5¼-in. market is that micro-Winchesters fit into the same mounting cavity as 5¼-in. floppy-disk drives, thus providing the small system vendors with a logical capacity and performance upgrade. In addition, they are readily integrated with existing operating systems and software.

As a result, almost every U.S. computer maker—from IBM to Apple Computer—is developing a 5¼-in. Winchester. Japanese suppliers NEC, Mitsubishi, Toshiba, Ricoh, Teac and Sony are also expected to announce 5¼-in. hardware by mid-year.

Impact on 8-in. drives

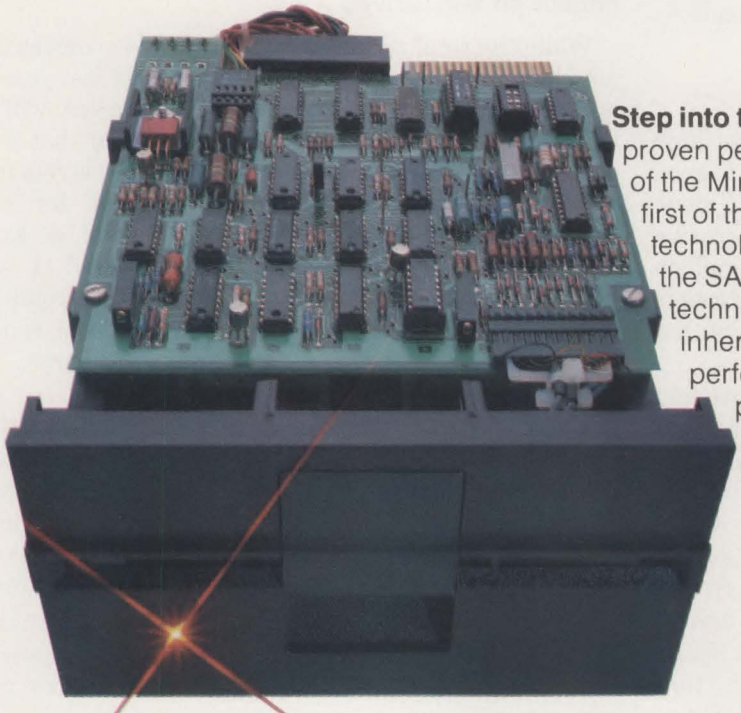
While the total numbers forecast for 8-in. drives will not change compared to what was forecast last year, it is anticipated that the low end of this market will be affected by the entry of 5¼-in. drives, and that 8-in. hardware will be pushed into the capacity levels now dominated by 14-in. devices. The forecast for 8-in. hardware is 605,000 units by 1985, valued at $1.85 billion. A total of 80,700 8-in. devices valued at $466 million were delivered last year, with IBM accounting for the lion's share. The 1980 OEM market-share leaders were Shugart Associates (a Xerox subsidiary), IMI Micropolis, BASF and Priam.

The outlook for 8-in. hardware beyond the 10M- to 20M-byte range over the next few years is for continued upward migration to the 100M- to 150M-byte range, as 5¼-in. hardware fills in the lower end of the drive spectrum. Expected to lead this upward thrust to higher capacity 8-in. devices are Ontrax, IMI, Micropolis, Control Data Corp., Fujitsu and Quantum Corp.

Ontrax just announced a family of 8-in. Winchesters with capacities of 34M, 68M and 136M bytes that incorporates a unique linear actuator (see "Positioning a new Winchester," p. 120). Two actuators located opposite each other enable overlapped seeks to be

The Minifloppy tradition. The standard is set for high-performance 96 TPI Minifloppys. And it's by Shugart. Double track and double density, the single and double-sided SA410 and SA460 Minifloppys deliver .5 or 1 MBytes of unformatted capacity on a 5¼-inch diskette. Small wonder. Designed by the company that invented the Minifloppy, the SA410 and SA460 represent the culmination of all previous 5¼-inch disk drive technologies. What you get today is the most thoroughly engineered, most manufacturable, and most reliable Minifloppy drive available. The SA410/460 are the new standard in the eighties for price, performance, and capacity.

Shugart introduces of Minifloppys.™



Step into the future. Innovation, experience, and proven performance have always been the hallmark of the Minifloppy tradition. And the SA410/460 are the first of the next generation in that tradition. Utilizing technology proven in our 8-inch disk drive products, the SA410 and SA460 use a multi-step positioning technique, thus eliminating pole asymmetry, an inherent source of positioning errors and degraded performance. The simplicity of this multi-step positioning motor and the HeliCam lead screw follower insure its manufacturability, consistent high performance, reliability, and low cost.

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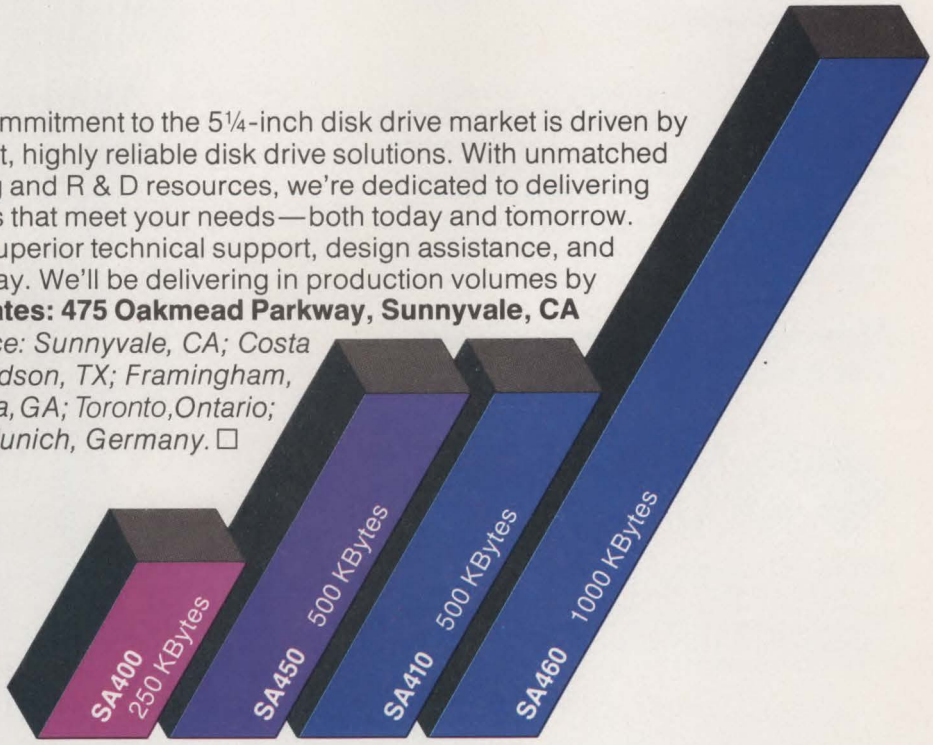
Positioned for success. Shugart's new HeliCam™ positioner delivers far greater accuracy than that of competitive actuators. The result is super precise positioning tolerances that virtually eliminate the problems of media interchange previously associated with 96 TPI 5¼-inch technology. The HeliCam solution means that you can reduce, by a significant margin, data handling errors—especially between systems in less than ideal environments.

the next generation SA410/460.

A new era starts today. Our commitment to the 5¼-inch disk drive market is driven by your requirements for low cost, highly reliable disk drive solutions. With unmatched commitments in manufacturing and R & D resources, we're dedicated to delivering innovative, standard-setting products that meet your needs—both today and tomorrow. And we back all our products with superior technical support, design assistance, and in-depth documentation. Call today. We'll be delivering in production volumes by early 1981. ☐ **Shugart Associates: 475 Oakmead Parkway, Sunnyvale, CA (408) 733-0100.** *Sales & Service: Sunnyvale, CA; Costa Mesa, CA; Minneapolis, MN; Richardson, TX; Framingham, MA; Mt. Freedom, NJ; Atlanta, GA; Toronto, Ontario; Paris, France; Munich, Germany.* ☐



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CIRCLE NO. 51 ON INQUIRY CARD

Industry-standard 14-in. Winchesters will experience a modest increase from the 165,000 units shipped worldwide in 1980 to 270,000 units in 1985. That's a 10 percent annual growth, while dollar values will rise 15 percent a year.

performed, allowing one 136M-byte drive to perform like two 68M-byte units to the disk operating system and controller. This effectively doubles throughput. IMI and BASF each introduced 40M-byte drives with access times of 35 msec. Fujitsu introduced 48M- and 84M-byte models with a very fast 20-msec. access time and a 1229K -byte-per-sec. transfer rate. Quantum's newest 8-in. family member has a capacity of 40M bytes, but strikes at the low-performance and low-cost end represented by the Shugart SA1000 series of 5M- and 10M-byte models.

Industry-standard 14-in. Winchesters will experience a modest increase from the 165,000 units shipped worldwide in 1980 to 270,000 units in 1985, a 10 percent annual growth rate. Their dollar value will increase by

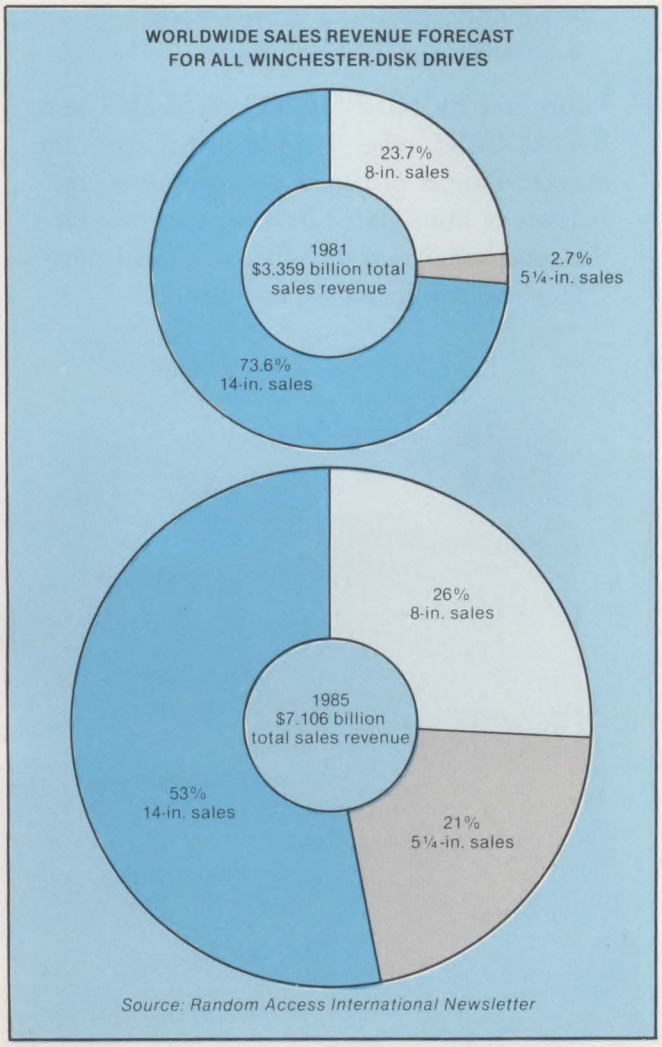


Fig. 2. Sales forecast *shows that 5¼-in. Winchester-disk-drive revenues will approach $1.5 billion.*

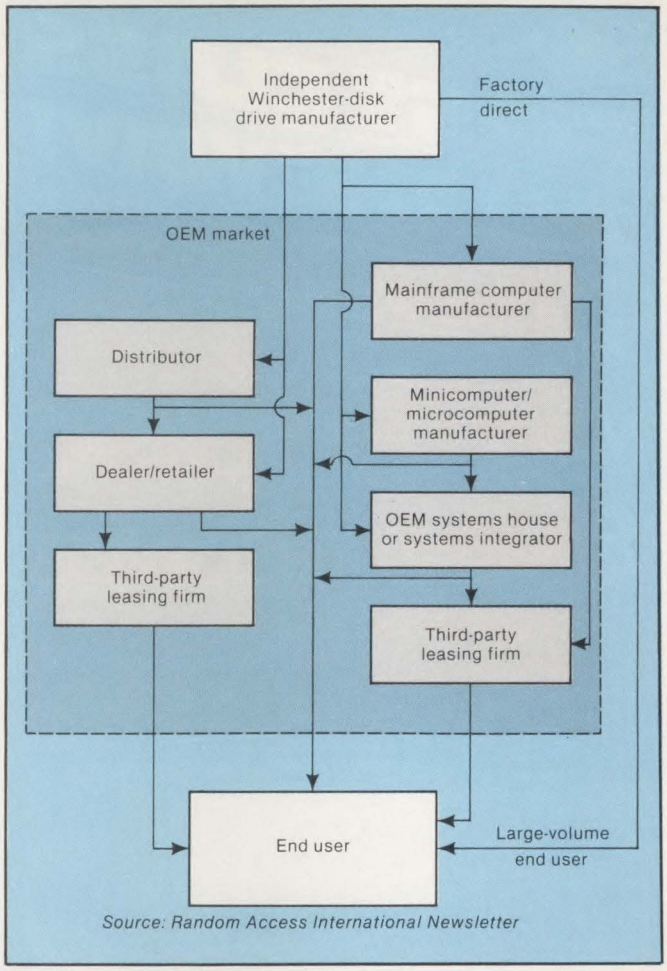
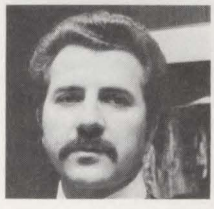


Fig. 3. Flowchart illustrates *the various OEM sales channels for Winchester-disk drives.*

15 percent annually from $1.8 billion in 1980 to slightly more than $3.8 billion in 1985. The total 14-in. Winchester market, in decreasing share order, was divided by Storage Technology Corp. (STC), CDC, Memorex, Shugart and Century Data Systems (also a Xerox subsidiary).

The 14-in. Winchester continues to evolve, and IBM's June announcement of its model 3380 "Coronado" represents the kind of breakthrough that can be anticipated. Coronado capacity is an impressive 2520M bytes (1260M bytes per spindle), average access time is 16 msec., and data transfer rate is 3M bytes per sec.

While Coronado is far and away the 14-in. capacity and performance leader, other 14-in. Winchester-disk drive manufacturers also offer significant products. Among them are CDC with the 9775 fixed module drive (FMD) at 675M bytes, STC with its 8360 at 317.5M bytes, Memorex with the 659 at 677M bytes, and ISS/Sperry-Univac with the 8470 at 564M bytes. ■



Andrew Roman is president of Roman Associates International, an independent consulting firm in Newark, Calif., that specializes in computer peripherals.

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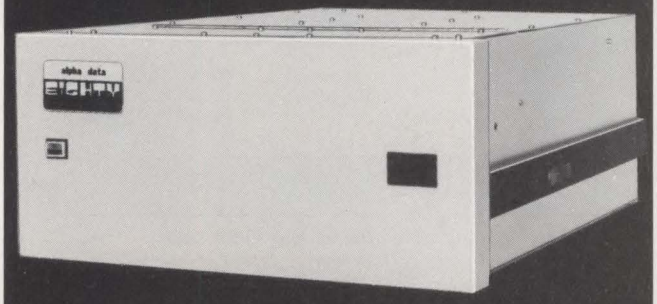

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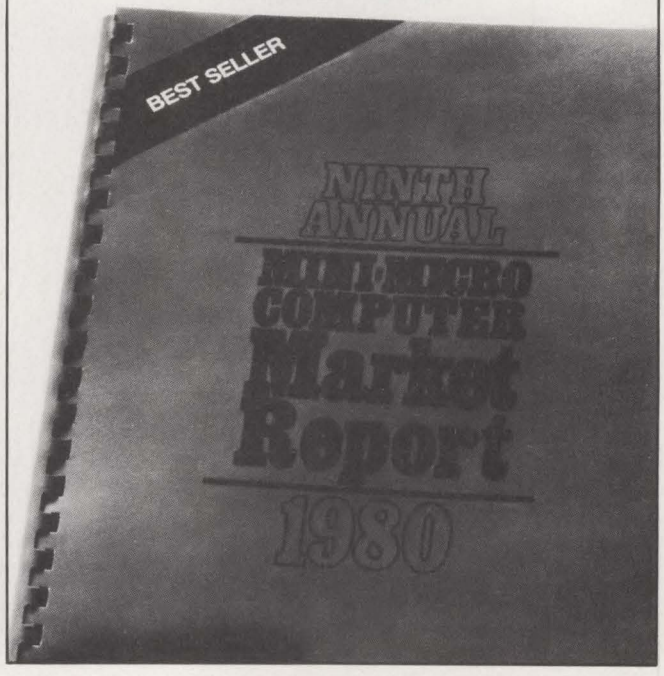
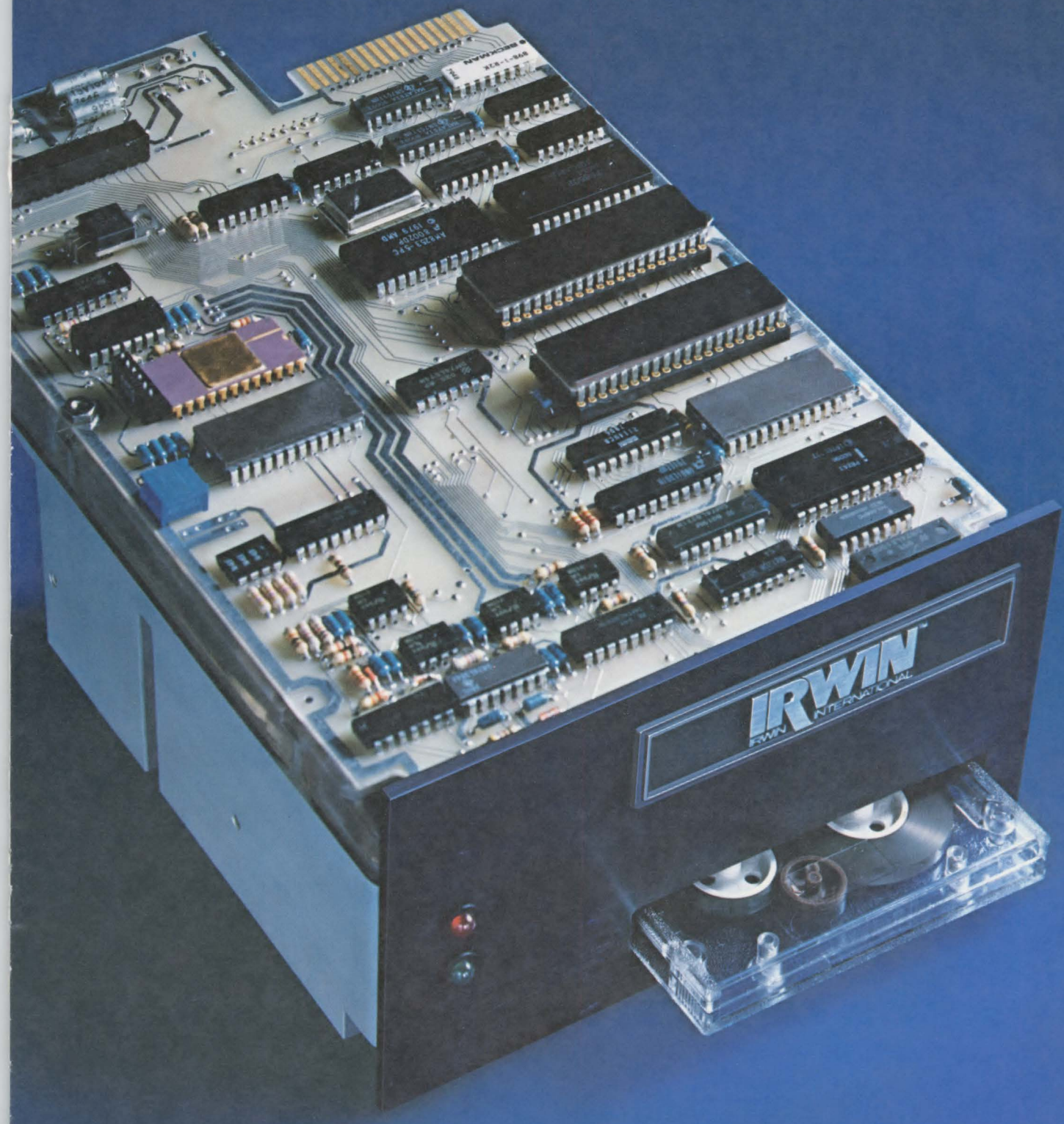


CIRCLE NO. 52 ON INQUIRY CARD

THE IRWIN 510™

5¼-INCH MICRO-WINCHESTER WITH INTEGRAL CARTRIDGE TAPE BACKUP



© 1980, Irwin International

IRWIN INTERNATIONAL announces the first micro-Winchester with integral backup

Designers of small business computer systems, distributed data processing and word processing systems need large amounts of random access storage in a physically small package.

Smaller Winchester-type disk drives are the answer, with their reduction in size from 14 inches to 8 inches and most recently to 5¼ inches. But Winchester technology means sealed, non-removable media. And that requires a removable media backup system.

As disk capacity increases, however, the relatively limited capacity of flexible media makes the minifloppy less suitable for the backup role. In higher capacity desktop systems, the magnetic tape cartridge has emerged as the optimum media for Winchester backup.

But adding a separate cartridge tape drive takes up additional space ...and adds significantly to the cost of hardware.

That's why Irwin International developed the Irwin 510™: a 5¼ inch micro-Winchester with 10 megabytes of formatted capacity (12.3 megabytes unformatted). Plus an integral cartridge tape backup. All in a compact, minifloppy-sized package. With the lowest cost per kilobyte of any small Winchester disk/backup combination.

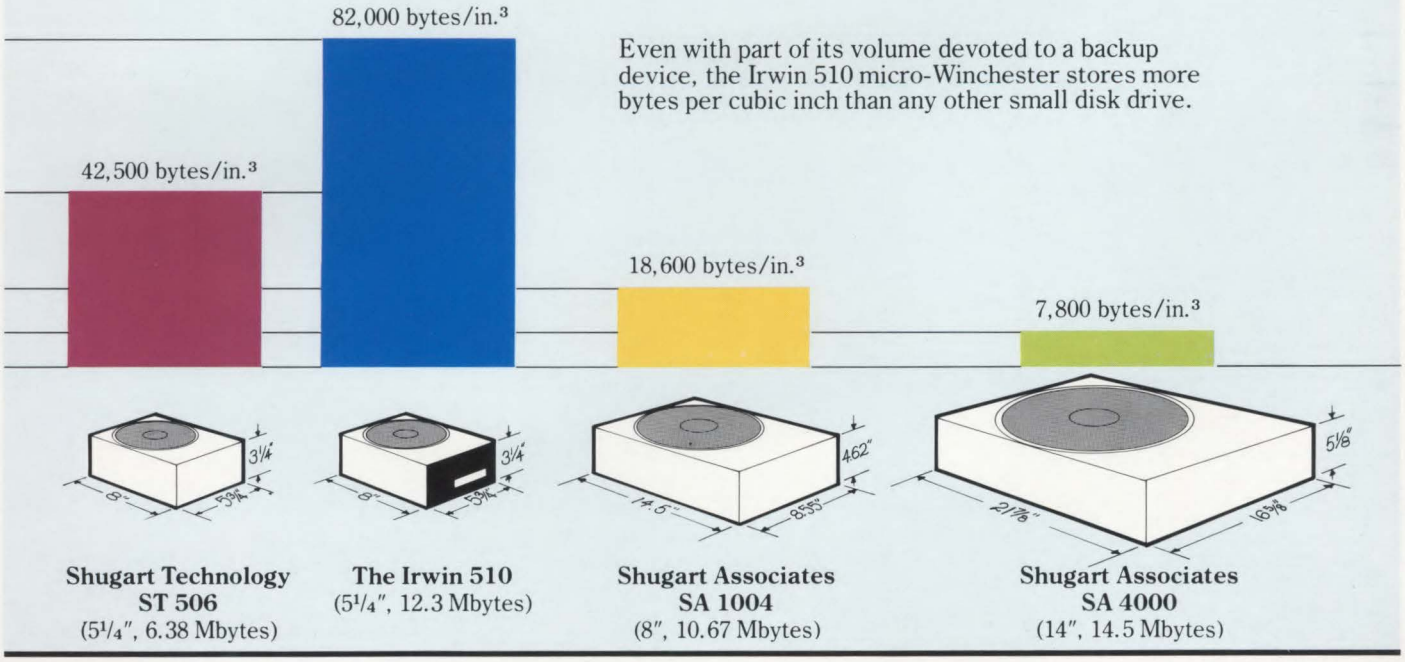
The Irwin 510 micro-Winchester creates numerous opportunities for designers of mini- and micro-based systems. It can enhance an existing system by replacing a minifloppy. Downsize a system now based on 14-inch or 8-inch Winchesters. Or help make advanced features available on totally new products.

WHO IS IRWIN INTERNATIONAL?

Irwin International was founded in 1979 by Sam Irwin, the pioneer of the "intelligent terminal" concept. Mr. Irwin founded Sycor, Inc. in 1967 and guided that company's tremendous growth through its eventual sale in 1978.

He is widely recognized throughout the computer industry as an innovative and creative thinker, capable of directing new product concepts from inception to commercial success.

STORAGE DENSITIES OF WINCHESTER DRIVES



Shugart Technology ST 506 (5¼", 6.38 Mbytes)

The Irwin 510 (5¼", 12.3 Mbytes)

Shugart Associates SA 1004 (8", 10.67 Mbytes)

Shugart Associates SA 4000 (14", 14.5 Mbytes)

THE IRWIN 510™

10 megabyte capacity

The Irwin 510 micro-Winchester provides 10 megabytes of formatted capacity (12.3 megabytes unformatted) on a 5¼-inch (130 mm.) disk platter. That's double the capacity of the first micro-Winchester, more than many 8-inch Winchesters, and almost 30 times as much as the industry-standard minifloppy.

25 ms access time

Average access time of the Irwin 510 micro-Winchester is just 25 milliseconds. That's nearly 7 times faster than the first micro-Winchester, and twice as fast as most 8-inch Winchesters. The maximum access time is only 40 ms. And a rapid data transfer rate of 5.3 million bits per second helps maximize the speed and efficiency of OEM systems.

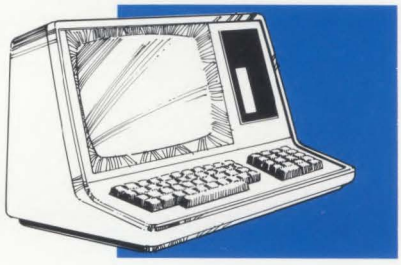
100% backup on a single tape cartridge

The Irwin 510 micro-Winchester is the first such system to combine fixed and removable media in one integral unit. The entire formatted capacity of the disk can be dumped onto one small cartridge.* So unlike floppy backup, there's no need for sophisticated software to do selective dumping... and no need for the operator to repeatedly stop and change media.

*3M DC100A or Verbatim® TC-150 Data Cartridge

Full dump in under 4 minutes

Creation of backup files with the Irwin 510 micro-Winchester is fast, as well as easy. It takes less than 4 minutes to dump (or restore) all 10 megabytes of formatted data. That's a small fraction of the time it would take to write that much information onto a series of diskettes.



The small tape cartridge is ideal for archival storage. And cartridges are interchangeable. So they can be used to transfer data from one disk to another. And even for file input/output.

Small system compatibility

The 3¼" x 5¾" x 8" dimensions precisely match the industry-standard minifloppy. The mounting holes do too. And the unit can be mounted horizontally or vertically. No AC power is required. And heat dissipation is a mere 35 watts.

Since disk drive and backup are already integrated, there's just one logically consistent interface to deal with. And that simplifies controller design. The device level interface of the Irwin 510 micro-Winchester is a subset of the proposed ANSI standard for 8-inch Winchesters.

SOME BACKUP ALTERNATIVES FOR SMALL WINCHESTER DRIVES

MODEL OR COMBINATION	PHYSICAL VOLUME	WINCHESTER CAPACITY (unformatted)	OEM UNIT COST (500 quantity)	COST PER KILOBYTE	COMMENTS
Irwin International Irwin 510 (5¼-inch Winchester with integral cartridge tape backup)	150 in.³	12.3 Mbytes	$1,500	12.2¢	Small, compact backup media; Short dump/restore time
Shugart Technology ST 506/ Shugart Associates SA 450 (5¼-inch Winchester plus separate minifloppy backup)	Disk drive 150in.³ Backup 150 Total 300in.³	6.38 Mbytes	Disk drive $ 925 Backup 325 Total $1,250	19.6¢	Minifloppy backup requires selective dumping and/or several diskettes
CDC Lark 9455 (8-inch Winchester with integral disk cartridge backup)	933 in.³	8.0 Mbytes	$2,700	33.8¢	Large, expensive backup media with uncertain resistance to contamination
Shugart Associates SA-1004/ Data Electronics, Inc. 10 Mbyte streamer (8-inch Winchester plus separate cartridge tape backup)	Disk drive 563in.³ Backup 182 Total 745in.³	10.67 Mbytes	Disk drive $1,205 Backup 415 Total $1,620	15.2¢	Two separate units. Requires more panel space than others; more interconnections than integral units

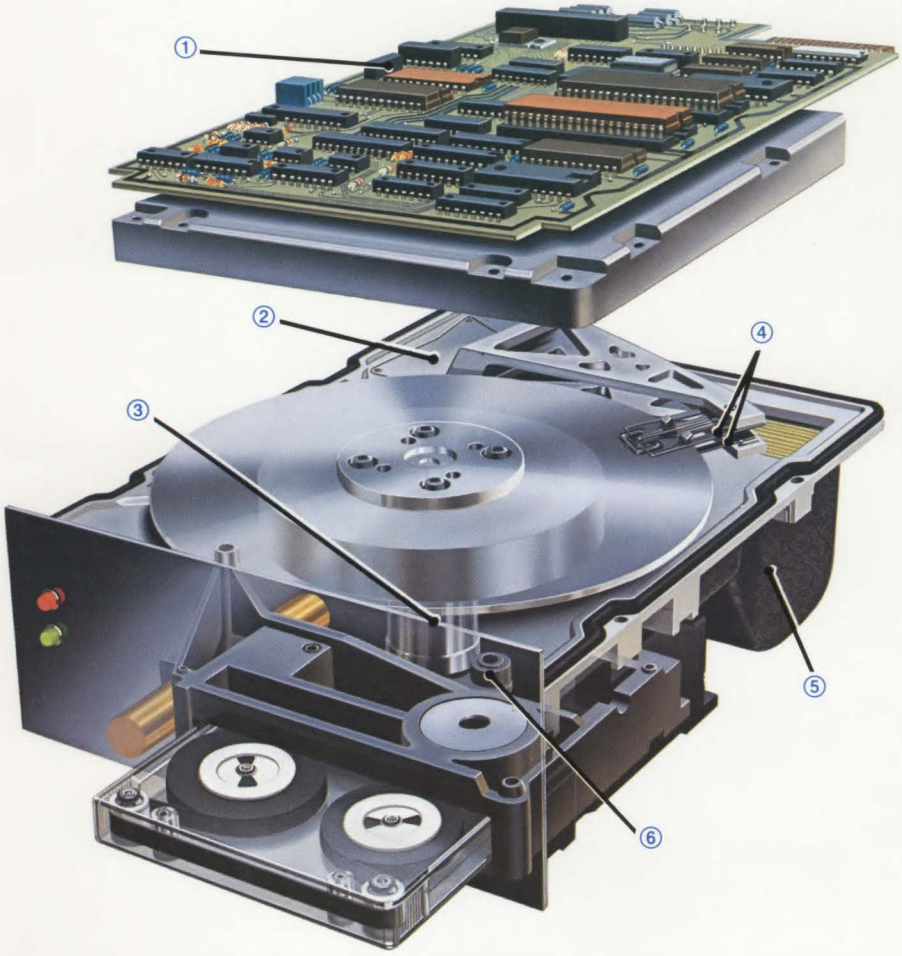
Innovative design packs a lot of performance into a small package.

Integral backup and 10 megabyte capacity... with extremely low error rates... and with MTBF conservatively estimated at 8,000 Power-On Hours (POH). All in a minifloppy-sized package. How does Irwin do it?

First, proven components and technologies are used wherever possible. Many of the basic system components are of standard Winchester design. And most of the "new" technology has been proven elsewhere on larger, more expensive equipment... with Irwin engineers finding ways to reduce size and complexity. Here, briefly, is a summary of the key design elements behind the major features of the Irwin 510 micro-Winchester.

☐ **High disk storage density** is primarily due to the "smart" servo positioner used instead of the stepper motor commonly applied to low-cost Winchesters. Location information is embedded on the disk. And a closed loop servo—controlled by a microprocessor—brings the head directly to the correct track, compensates for disk eccentricity, and keeps it precisely on track.

Furthermore, the speed of the spindle is regulated to 0.1%; and a microprocessor eliminates static error. Together, these innovations in the positioner and spindle systems allow a higher than normal track density of 900 tpi and a recording density of 8,000 bpi.



☐ **Fast access time** is also due primarily to the positioner system. First, the microprocessor control allows faster arm movement. Then the lack of seek error means that settling time is essentially zero. What's more, the disk rotates at 4,000 rpm instead of the 3,600 rpm common on larger Winchesters. So average latency is only 7.5 ms.

☐ **High tape storage density** also results from an embedded servo approach. Tape cartridges are prerecorded with Irwin servo information. So a single, positionable head can cover seven discrete track positions. And with a bit density of 10,000 bpi, the capacity of a 140-foot tape cartridge is over 10 megabytes.

☐ **Fast dump time** is possible because of the high bit density and a relatively high tape speed of 60 ips. This tape speed is practical because of the embedded servo system. The drive follows a back-and-forth path through the seven tracks, automatically sensing the BOT/EOT position.

☐ **Small size** results from several factors. The disk itself is small (130 mm. OD and 40 mm. ID). The tape deck is a special, low-profile design. And the positioner system incorporates a torque motor as part of the head arm assembly. So there's no bulky stepper motor.

① DEVICE CONTROL AND INTERFACE
② HEAD POSITIONER MOTOR
③ SPINDLE MOTOR
④ DISK READ/WRITE HEADS
⑤ AIR FILTER
⑥ CARTRIDGE TAPE DRIVE

THE IRWIN 510™ specifications

PERFORMANCE

	UNFORMATTED	FORMATTED
Disk capacity		
Per drive	12.3 Mybtes	10.0 Mbytes
Per sufrace	6.17 Mbytes	5.0 Mbytes
Per track	9,135 bytes	7,424 bytes
Per sector	315 bytes	256 bytes
Tape capacity	10 Mbytes, formatted	
Disk transfer rate	5.3 Mbits per second	
Disk access time		
Track-to-track	5 ms	
Average	25 ms	
Maximum	40 ms	
Settling time	Not applicable	
Latency	7.5 ms average	
Disk start or stop time	10 seconds	
Tape dump or restore time	4.0 minutes	

FUNCTIONAL

	DISK	TAPE
Speed	4,000 rpm	60 ips
Recording density	8,000 bpi	10,000 bpi
Flux density	8,000 fci	10,000 fci
Media size	40 mm. ID 130 mm. OD	.15 in. wide 140 ft. long
Track density	900 tpi	42 tpi
Cylinders	675	Not applicable
Tracks	1,350	7
Read/Write heads	2	1 (Read while Write)
Disk platters	1	Not applicable
Index	1	Not applicable
Recording method	MFM	MFM

RELIABILITY

MTBF (typical usage)	8,000 POH
Preventive Maintenance	Clean tape heads
MTTR	30 minutes
Component Life	
System	5 years
Tape Head	500 hours (of tape motion)
Disk error rates	
Soft	$1/10^{10}$ bits read
Hard	$1/10^{12}$ bits read
Tape error rates	
Soft	$1/10^{8}$ bits read
Hard	$1/10^{10}$ bits read

REQUIREMENTS

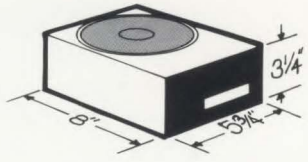
DC voltage	
Electronics	+ 12 VDC ± 5%; 0.5 amps + 5 VDC ± 5%; 2.0 amps − 12 VDC ± 5%; 0.5 amps
Motor	+ 12 VDC ± 10%; 1.0 amps nominal 3.0 amps peak
AC voltage	None required
Heat dissipation	35 watts (120 BTU/hour)

ENVIRONMENTAL LIMITS

	OPERATING	NON-OPERATING
Ambient temperature range	32° to 104°F (0° to 40°C)	14° to 140°F (−10° to 60°C)
Relative humidity range (Non-condensing)	10-90%	5-95%
Altitude	−1,000 to 10,000 ft.	−1,000 to 40,000 ft.
Vibration	1 G	3 G's

ENCLOSURE

Height	3.25 in.	(83 mm.)
Width	5.75 in.	(146 mm.)
Depth	8.00 in.	(203 mm.)
Weight	5 lb.	(2.3 kg.)
Indicator lights		
Green	Power on/disk up to speed	
Red	Tape engaged	



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Litho in U.S.A.

Small Winchesters pack big capacity

New 5¼-in. drives stress ruggedness and flexibility

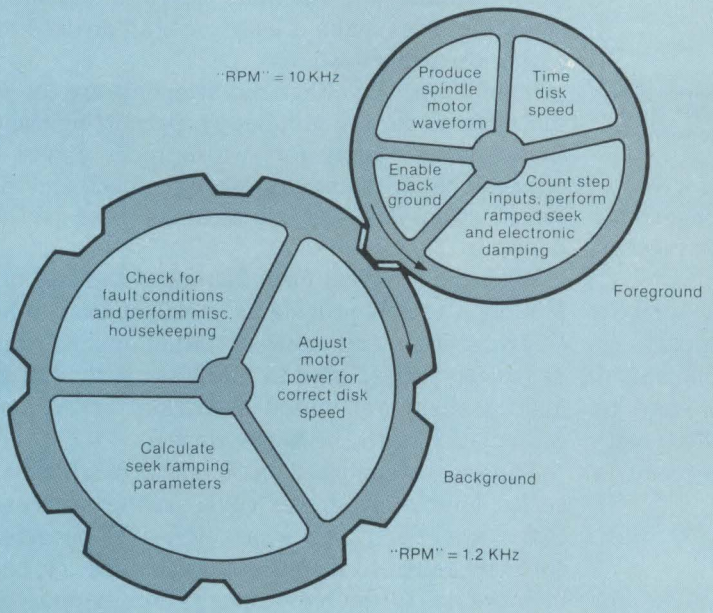
Three new Winchester-disk products from Shugart Associates offer as much as 10M bytes in a minifloppy-sized package. That much capacity in so little volume is itself enough to assure attention for the new drives. Throw in the high reliability normally associated with Winchesters, and the SA600 series first revealed last month (MMS, January p. 20) becomes more compelling.

Winchester drives, by virtue of their sealed construction, are inherently more reliable than removable disks or floppies. But Shugart has taken reliability a step further. The company's SA600 "Migid" series of 5¼-in. Winchesters, adds ruggedness and flexibility to the compact package, as well as high performance and low per-byte price.

Essential to the design of the new drives are mechanisms that protect the heads and disk surfaces. A

SA600 PERFORMANCE

All three versions of the SA600 series offer average access time of 75 msec., with maximum access time of 160 msec. Shugart claims this sets a new standard over other announced 5¼-in. Winchester products, which have average and maximum access times two to three times higher.



SA600 μp *control technique.*

This improvement in access times is made possible by a μp-controlled buffered step-mode design, which allows—among other functions—an accelerated stepping process rather than constant single-track stepping. The μp is used to ramp the stepping pulse up and down. The step pulses start out at a slow rate, and the intervals between them are shortened gradually. As the targeted track is approached, the speed decreases again. At this point, an electronic damping mechanism is used to sense the velocity of the stepper motor, and to make the motor stop at the correct track with maximum accuracy and smoothness. The result is much shorter access and settling times than in the conventional step-by-step actuation method, in which all step pulses are at exactly the same rate.

SA600 drives also offer a fast transfer rate of 4.34M bits per sec. (identical to that of the SA1000 8-in. Winchester) and a track-to-track access time of 18 msec., including settling.

DC voltage requirements are the same for the SA600 as for the Minifloppy, permitting the use of one power supply for two or more drives of both types.

heavy-duty wire frame surrounds the drive housing, and the frame is fitted with shock mounts. In addition, several features have been incorporated into the drive to ensure data integrity.

First, an integral brake/lock mechanism automatically secures both the actuator and the spindle when the drive is powered off—a particular advantage in situations in which the system is frequently moved. This lock not only prevents the media from rotating backward and damaging the heads and media, but also locks the drive's rotary actuator, which prevents the heads from skating across the media. Locking both the spindle and the actuator with the same mechanism typically is not possible with a linear actuator.

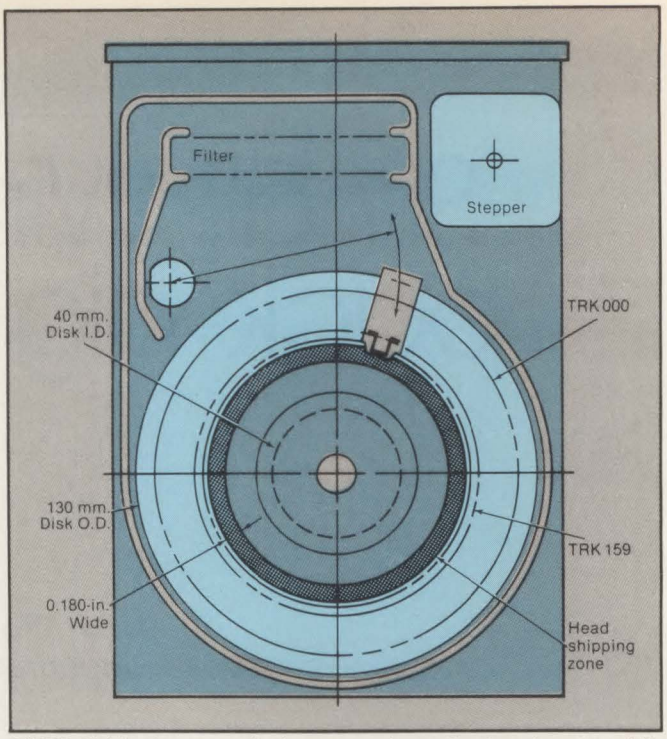
Second, an unused area of the disk surface between the data bands is designated as a "shipping zone" where the heads rest during power-off. This ensures that the data storage area of the surface will not be damaged by the heads bouncing on the disk if the drive is bumped or jarred.

Shugart Associates' new line *of 5¼-in. Winchester-disk drives offers as much as 10M bytes of capacity in a minifloppy-sized package.*

Finally, the SA600 design distributes the drive's mechanical components so that as few moving parts as possible are located within the sealed environment of the plastic bubble. This makes the SA600 easy to service, and minimizes the amount of particulate matter that can enter the sealed enclosure. The result is longer life and lower maintenance.

Flexibility

The SA600 series is available in single-, double- and triple-platter configurations with capacities of 3.33M, 6.66M and 10M bytes, respectively. Two interface



SA600 "shipping zone," *the area where the head rests while unpowered, is shown in the shaded area. Because this area is free of data, the integrity of the data-carrying tracks is assured while the drive is transported.*

design options give designers maximum flexibility when integrating the drives into systems. Both designs are patterned after Shugart's SA1000 8-in. Winchester drive interface. One provides compatibility with existing 5¼-in. Winchester drives already on the market. The other is a standard Minifloppy design that can interface with 5¼-in. floppy drives using the same control lines.

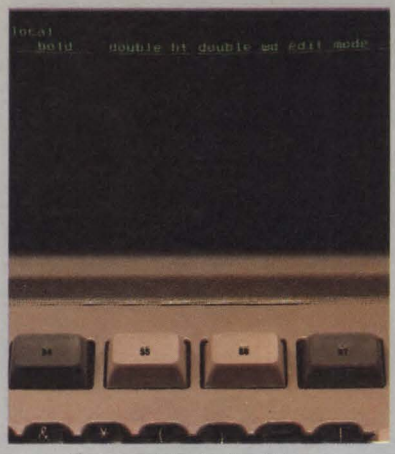
Simplifying things still more for designers developing a new system or upgrading an existing one, Shugart has made the form factor of the SA600 the same as that of the Minifloppy. Identical physical dimensions and mounting holes make it easy for both devices to reside within the same system.

In addition, DC voltage requirements are the same for the SA600 as for the Minifloppy, permitting the use of a single power supply for two or more drives of both types. Finally, the environmental, shock and vibration specifications are also identical to those of the Minifloppy.

With the identical form factors of the two products, Minifloppies now provide an excellent backup for small Winchesters. The newest Minifloppies, Shugart's SA410/460 series, offer as much as 1M byte of storage, making them well-suited as backup or I/O devices in combination with the SA600 series.

Thus, a system based on Shugart's original SA400/450 series Minifloppy drives could easily be upgraded in two ways. First, an SA600 series Winchester drive could be added to increase storage capacity; then, two or more SA410/450 high-capacity Minifloppies could be added to provide the increased backup capability required by this capacity. ■

Non-glare, high resolution screen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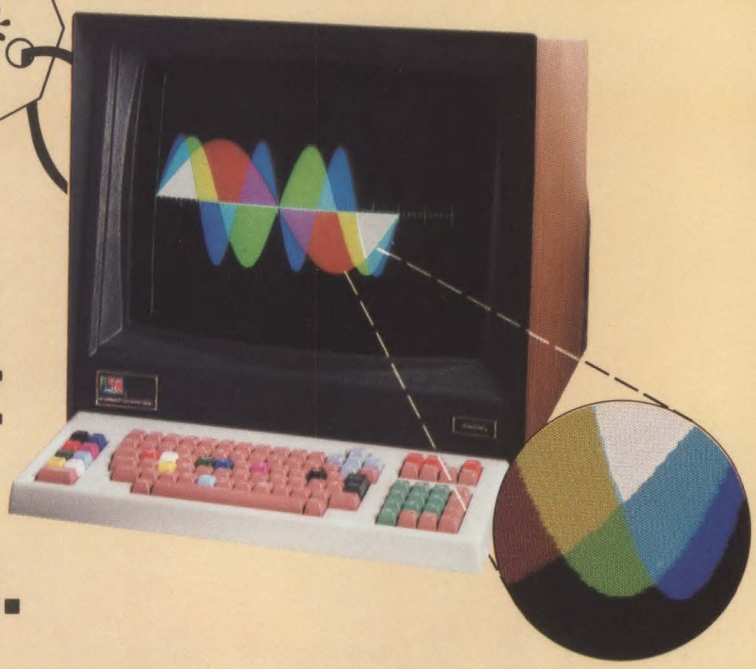
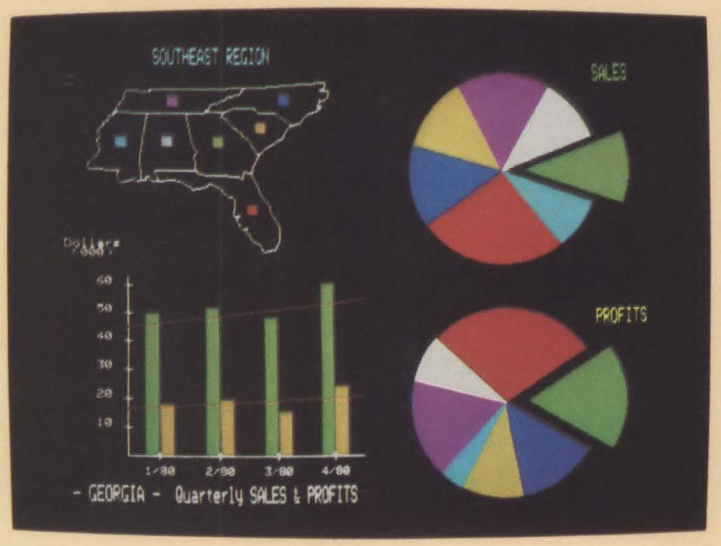


Another ISC breakthrough: Affordable dot addressable color graphics.



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DISK DRIVES

10½-in. Eagle challenges big Winchesters

Fujitsu America's new drive provides high performance for 32-bit minis

Integrators and users of minicomputer systems requiring the mass storage capacity and performance previously offered only by 14-in. Winchester-disk drives now have an alternative that is much more compact. It's the 10½-in. M2351 Eagle Winchester-disk drive from Fujitsu America. It has 473M bytes of storage and an average access time of 18 msec., making it the highest-performance disk drive introduced by an independent Winchester manufacturer to date. The Eagle includes as standard the industry-compatible SMD interface.

The new wave of 32-bit superminis requires high-performance, high-capacity, direct-access disk storage, but users of such systems also want compact packaging. By mounting two Eagles in one 19-in. cabinet, storage volume can be doubled per sq. ft. of floor space. The drives offer the flexibility of using two head-disk assemblies (HDAs) sharing the power and electronics of one drive unit because the HDAs can operate while oriented either horizontally or vertically. Backup for the Eagle can be accomplished with industry-standard ½-in. tape drives.

First of a family

The Eagle is the first in a series of high-performance 10½-in. midi-Winchesters from Fujitsu America, Santa Clara, Calif., the U.S. subsidiary of Fujitsu Ltd., Tokyo. On six platters, the Eagle offers 47.3M bytes per data surface on 10 data surfaces (Fig. 1), and a data-transfer rate of 1859K bytes per sec., which is identical to the transfer rate of the IBM 3370/3375.

Data is recorded on Eagle disks at 12,790 bpi, using

	Fujitsu M2312 8-in.	Fujitsu M2351 10½-in. Eagle	IBM 3370 14-in.	IBM 3380 14-in.
Capacity				
Per unit	84.4M bytes	473.6M bytes	571.39M bytes	2.52G bytes
Per HDA	84.4M bytes	473.6M bytes		1.26G bytes
Per actuator	84.4M bytes	473.6M bytes		630M bytes
Bytes per track	20,480	28,160	31,744	*
Tracks per in. (tpi)	720	880	635	*
Bits per in. (bpi)	9550	13,540	12,134	*
Average positioning time (msec.)	20	18	20	16
Rotational speed (rpm)	3600	3961	2964	3600
Rotational latency (msec.)	8.3	7.5	10.1	8.3
Actuator type	Linear v.c.	Rotary v.c.	Rotary v.c.	Rotary v.c.
Data transfer rate $\frac{\text{K bytes}}{\text{sec.}}$	1229	1859	1859	3000
Fixed-head capacity (M bytes)	—	1.69	—	1.4
Interface type	SMD	SMD	IBM	IBM
OEM price (100 units)	$3795	($8500)		

Fig. 1. Table shows 10½-in. Eagle *performance specifications compared to 8- and 14-in. Winchesters.*

The new wave of 32-bit minis requires high-performance, high-capacity, direct-access disk storage, but users also want compact packaging.

an MFM encoding format. Track density is 880 tpi, resulting in 841 cylinders or 16,820 tracks per drive. Areal bit density is 11M bits per sq. in. The industry-compatible SMD interface enables immediate evaluation and test by OEMs and systems houses, although at 28,160 bytes, the data format is higher than the 20,160 for an SMD.

The modular design of Eagle enables it to be configured into an optimal mounting package, which results in 300M bits per cu. ft., the highest storage density to date (Fig. 2).

The Eagle's subassemblies require only standard DC voltages; power consumption is 500W, and heat dissipation is 1650 BTU per hr.

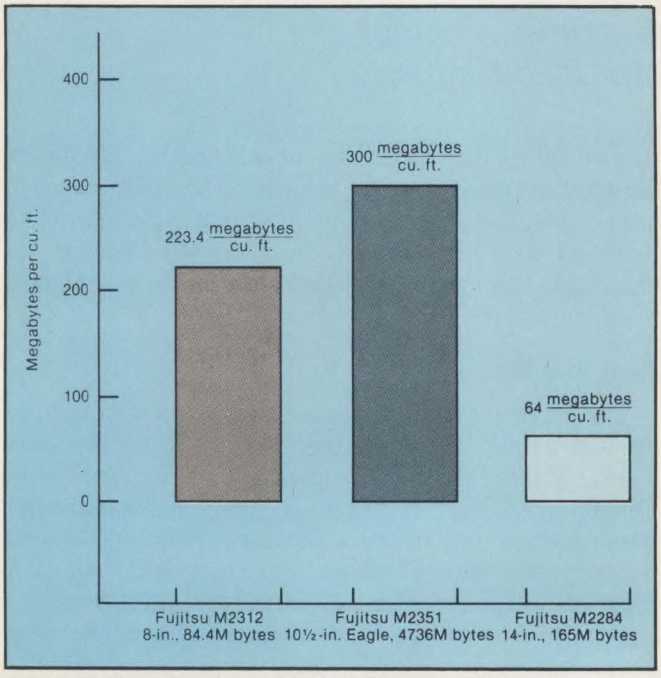

Fig. 2. Storage densities *of Fujitsu Winchester-disk drive, illustrating Eagle's compactness.*

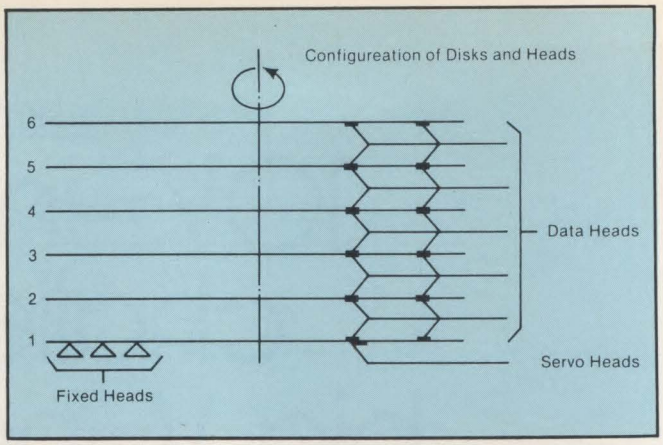

Fig. 3. Schematic shows *stacking of six 10½-in. platters, 19 read/write heads and 60 fixed heads inside Eagle's HDA.*

The M2351 optionally can be configured with a fixed head-per-track assembly that contains 60 read-write heads on the bottom platter and adds 1.69M bytes of unsectored capacity. This option permits higher-speed data access at zero seek time, and can be either factory- or field-installed by exchanging HDAs.

Priced at $8500 in 100-unit OEM quantities, with discounts available for higher quantities, the Eagle provides mass storage at $18 per megabyte, or 1.8¢ per kilobyte, but with faster access, a higher transfer rate and less bulk than any 14-in. Winchester drive. The closest competitive 14-in. Winchester is the Dastek model 4835-3, which stores 407M bytes and has an access time of 25 msec. Transfer rate is 200K bytes per sec., and density is 132.5M bytes per cu. ft. Volume is 3.07 cu. ft., and it is priced at $7400 per year in 250-unit quantities.

Designed for serviceability

The essence of Eagle technology is the use of the 10½-in. disk and an extremely fast rotary actuator using a very hard samarium cobalt rare earth magnet. This results in minimal thermal buildup off track, improved areal density and data access performance.

The Eagle's modular construction is the key to low cost and easy access to any subassembly for field

WHY A 10½-IN. WINCHESTER?

The Winchester disk-drive market is growing and diversifying. Consultant Andrew Roman, publisher of the *Random Access International* newsletter on disk and tape drives, forecasts that combined shipments of 8- and 14-in. Winchesters will grow at more than 19 percent annually, reaching $5.63 billion in 1985 (see "Winchester market shifts to 5¼-in. drives," p. 84).

But with 5¼-, 8- and 14-in. drives available, why would a supplier perceive a market need for a 10½-in. format? "Large system designers are also demanding small box size; the desk-top μc industry is not alone in establishing this requirement," says Tosh Kawaguchi, Fujitsu America director of marketing. Fujitsu R & D engineers have determined that a 10½-in.-diameter medium is more efficient than an 8-in. platter at establishing useful surface storage space. The Eagle drive also has less heat buildup; it dissipates 1650 BTU per hr. A comparable OEM drive, such as Control Data Corp.'s 400M-byte model 33502 dissipates 8000 BTU per hr., and the IBM 3350 dissipates 4400 BTU per hr.

Fujitsu's strategy with the Eagle is to provide minicomputer OEMs with cost-effective and early-delivery alternatives to the 14-in. IBM 3370, 3375 and 3380, but with the same 1859K-byte-per-sec. transfer rate—without the cumbersome size. By harnessing thin-film technology in second-generation versions, the Eagle offers higher storage capacities with data-transfer rates of 3M bytes per sec.

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

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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.

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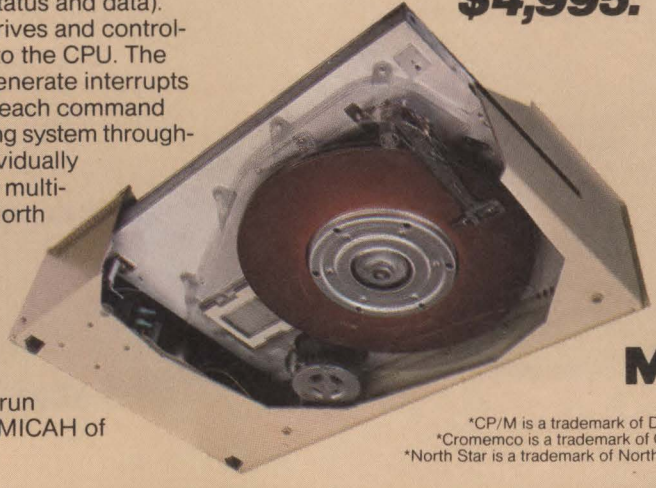
Morrow Designs' 26 megabyte hard disk system: $4,995.



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CIRCLE NO. 55 ON INQUIRY CARD

The Eagle's modular construction is the key to low cost and easy access to any subassembly for field service. The HDA, for example, can be readily removed and replaced in the field in 15 min.

service. The HDA is a sealed aluminum module that contains the six platters, 20 magnetic read-write heads, a spindle, a DC spindle drive motor and a rotary voice-coil actuator (Fig. 3). The HDA can be readily removed and replaced in the field in 15 min.

Disk-drive logic is provided by custom low-power 500-gate LSI circuits mounted on three modular, removable printed circuit boards, interconnected by a harness cable. One board contains the control logic, one performs read-write functions and contains servo analog circuitry, and a third implements the controller interface.

The power amplifier, which energizes both the rotary voice coil and the brushless DC spindle motor, is mounted on a separate subassembly. A DC power supply included with the standard drive provides the necessary logic and power voltage levels for all the electrical subassemblies. The complete disk-drive unit, with one HDA and the power supply, weighs slightly more than 100 lb. and mounts in rack space smaller than 24 in. deep.

No scheduled maintenance is required because the HDA is sealed. The recording disks are standard coated magnetic oxide, lubricated to allow start/stop contact of the heads in the non-recorded landing zone on the inner tracks. The platters have a 10½-in. outside diameter and a 4-in. inside diameter. Heads are low-mass Mn-Zn 3350 type, lightly loaded to allow contact start/stop operation and a flying height of 0.27 μm. (10.6 μin.).

The dual-port, dual-channel feature permits two system controllers to access the same disk drive. Either controller can hold the device in a select/reserve mode. The Eagle reverts to an unselected state at the controller-release command. A priority select feature is also provided as part of the interface.

Device start/stop time is 20 sec.; within 20 sec. of

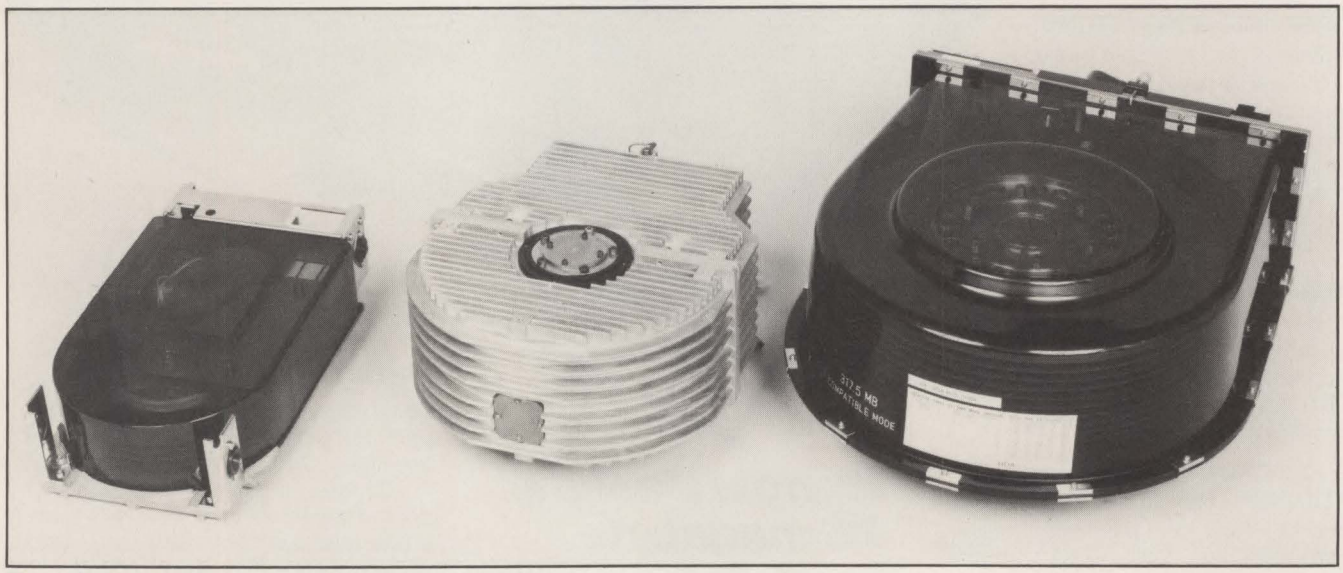

Fig. 4. Fujitsu family *of 8-, 10½- and 14-in. Winchesters.*

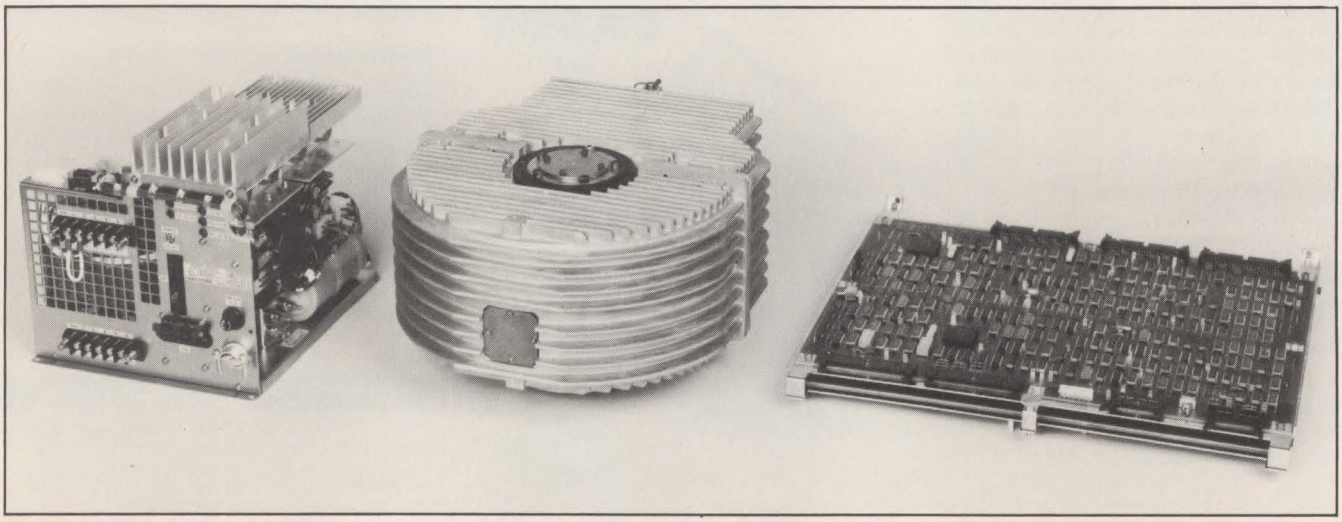

Fig. 5. The Fujitsu 10½-in. Eagle, *showing large 473M-byte capacity in a compact package.*

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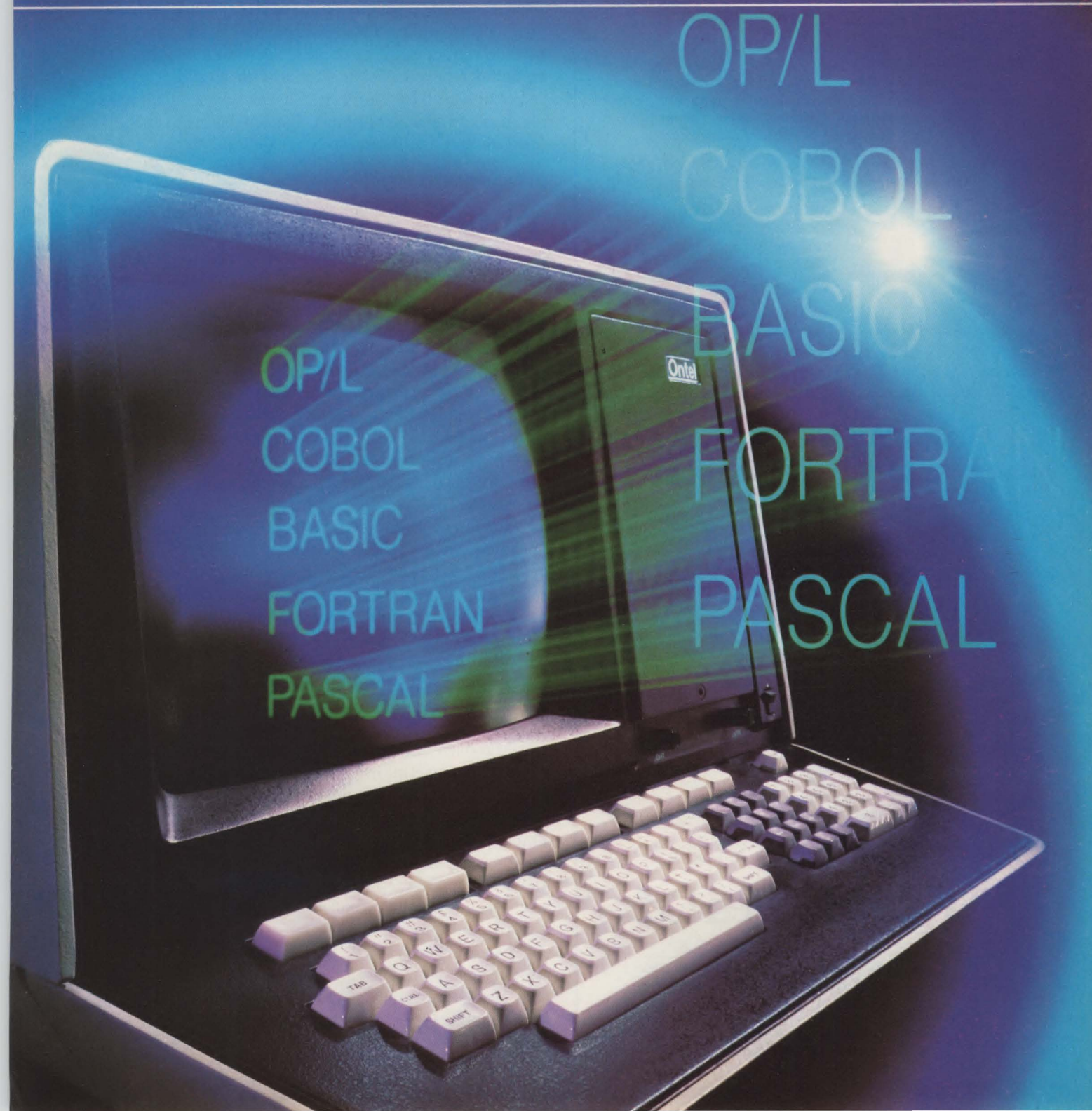

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The rotary actuator operating in the aluminum HDA yields low unit vibration during operation and low acoustical noise compared to 14-in. units. This low noise level enables drive operation in a standard office.

initial power-up, the Eagle can seek, read or write data. When power is removed, the drive's integral dynamic brake brings it to a complete halt in 20 sec.

A proven two-phase closed-loop track-following servo-control technique is used to provide accurate head positioning. Two read-write heads per data surface reduce rotary actuator seek distance and time by half compared to 45 msec. for a linear actuator, such as the one used by the Priam Diskos series. Quad heads mounted on each arm reduce the arm count to six—five for data and one for servo.

Reliability and errors

The Eagle's reliability is estimated at an MTBF of 10,000 power-on hours in typical use. The read-error rate specifications are one hard error per 10^{12} bits read, one soft error per 10^{10} bits read, and one seek error in 10^6 seeks. Operating environmental specifications are 15°C to 32°C (59°F to 90°F); relative humidity is 20 percent to 80 percent noncondensing.

Interfaces other than the SMD, such as a bit-parallel type, will be provided as needed, depending on OEM volume requirements. As many as eight drives can be daisy-chained to the same controller for low-cost expansion. User-selectable functions include soft- or hard-sectored data formats, write protect and unit address.

Data is recorded at 12,790 bpi using standard MFM encoding, with variable frequency oscillator (VFO) data separator to provide NRZ-encoded bit-serial data at the interface. The drive spindle rotates at 3961 rpm to provide data transfer at 1859K bytes per sec., and a latency of only 7.5 msec.

The rotary actuator operating in the aluminum HDA yields low unit vibration during operation and low acoustical noise—60 dBa—compared to 14-in. Winchester units. This low noise level enables device operation in a standard office environment. A typical Winchester with a linear actuator yields 64 dBa acoustical noise.

The M2315 is intended to be used with fast superminis and larger systems in which multiple users employ sophisticated disk-operating systems and data base-management systems for multitasking applications in manufacturing and production control, industrial control, test and measurement, energy management, science and engineering.

Evaluation units will be available next month and production units by the third quarter of this year. Pre-production units of the Eagle are operating now, and reliability goals of the 10½-in. design have been met. ■

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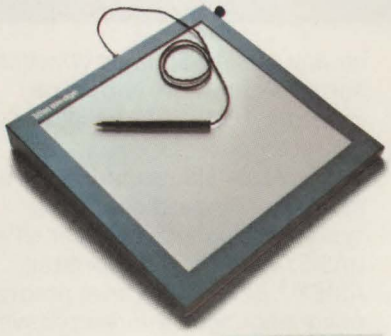

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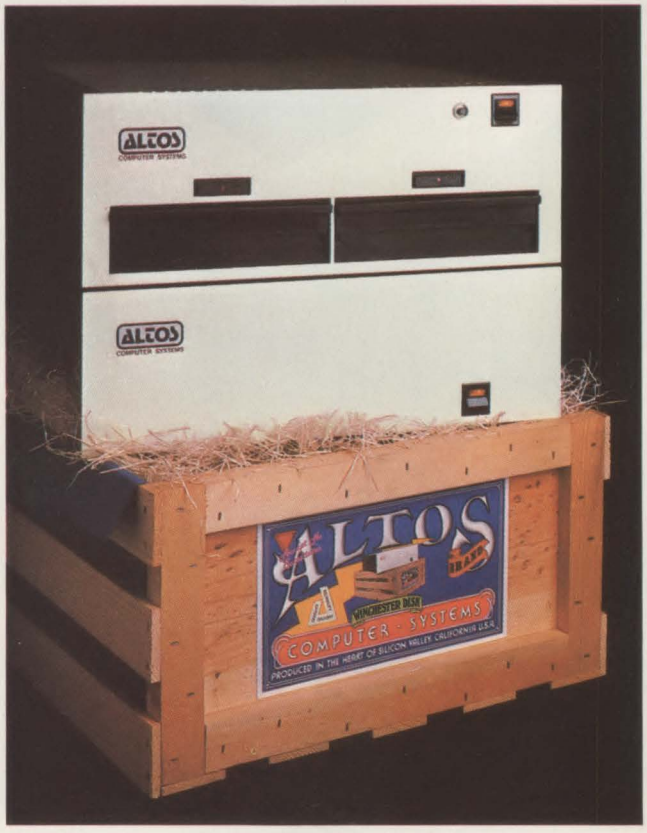
CIRCLE NO. 59 ON INQUIRY CARD

WHY OUR WINCHESTER HARD DISK BASED SYSTEMS ARE PICKED BY GROWING CONCERNS



Growing seasons. Those fruitful times when firms often find that their applications have outgrown their systems. Yet the costs of stepping up to a minicomputer can cause growing pains for many growing concerns.

Altos Computer Systems, a world leader in single board microcomputer technology, has packages of fresh ideas designed specifically for growing OEM's, the business sector, and many other end users. In fact, they're responsible for Altos' own rapid growth in the last three years.

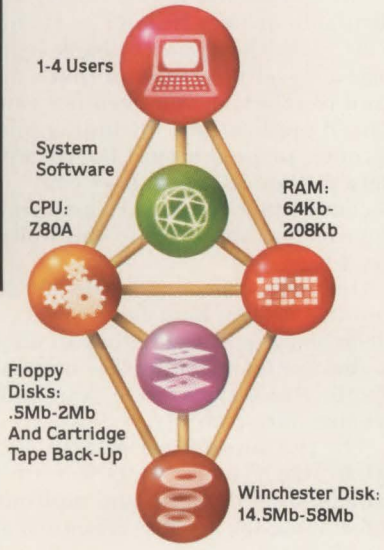
Packages like Altos' ACS8000-6 microcomputer family that's loaded with features which provide minicomputer performance at affordable microcomputer prices. The advanced, proprietary double-sized single board contains fully socketed and reliable LSI circuitry that includes: the Z80A* CPU with high speed DMA; up to 208 KBytes of RAM; the sophisticated floppy disk and Winchester hard disk controller; six RS-232C serial and two 8-bit parallel ports; and an optional floating point processor.

The Altos hard disk family will support up to four users simultaneously with 48 KBytes of RAM each, as well as up to 58 MBytes of on-line quality Shugart Winchester hard disk storage, with tape cartridge back-up. And all this at microcomputer prices.

Altos also supports three industry standard operating systems: single/multi-user CP/M,** OASIS,† and Altos' proprietary AMEX.™ Seven high level programming languages are offered which are CP/M or AMEX compatible.

Weed through the microcomputer system alternatives. No matter what your application, you'll pick Altos.

For specific details about pricing or performance, call or write: Altos Computer Systems, 2360 Bering Drive, San Jose, CA, 95131, (408) 946-6700, Telex 171562 ALTOS SNJ.



Packed with Fresh Ideas

ALTOS
COMPUTER SYSTEMS

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CIRCLE NO. 60 ON INQUIRY CARD

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

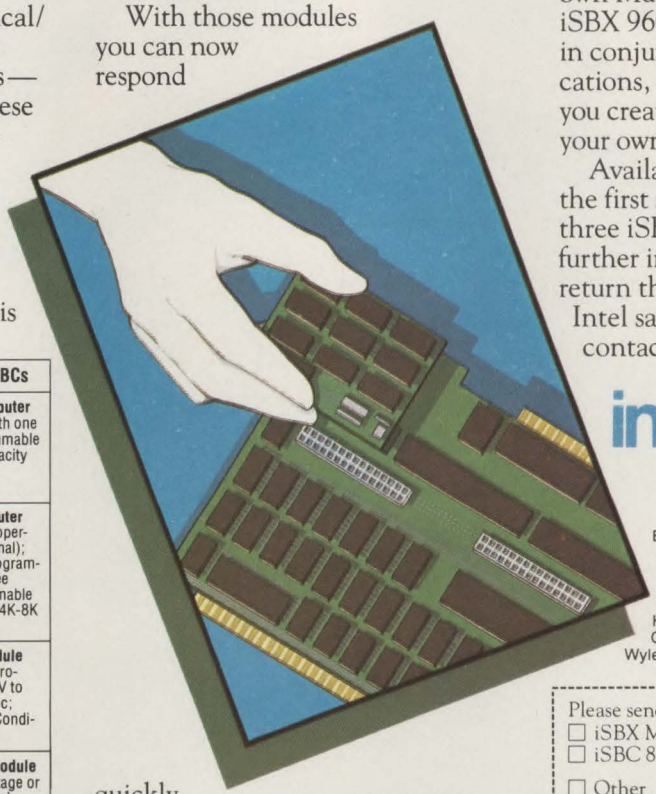
The iSBX bus—the first physical/electrical interface for direct on-board expansion of iSBC systems—assures compatibility between these systems and the emerging Multimodule product line.

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.

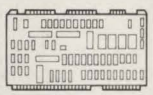
The new Multimodule family

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.

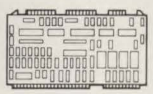
With those modules you can now respond quickly to new applications opportunities. Examples? For data acquisition from thermocouples and strain gauges, simply plug in the iSBX 311. For 4-20 ma current loop control, use the iSBX 328. In laboratory control applications, instead of an independent math processor,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

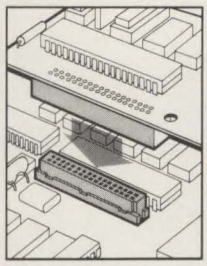
iSBX 311 Analog Input Multimodule
8 or 16 input channels, voltage protected; 12-bit resolution; ±20 mV to 5V full scale; 20 kHz samples/sec; compatible with iCS 910 Signal Conditioning Termination Panel

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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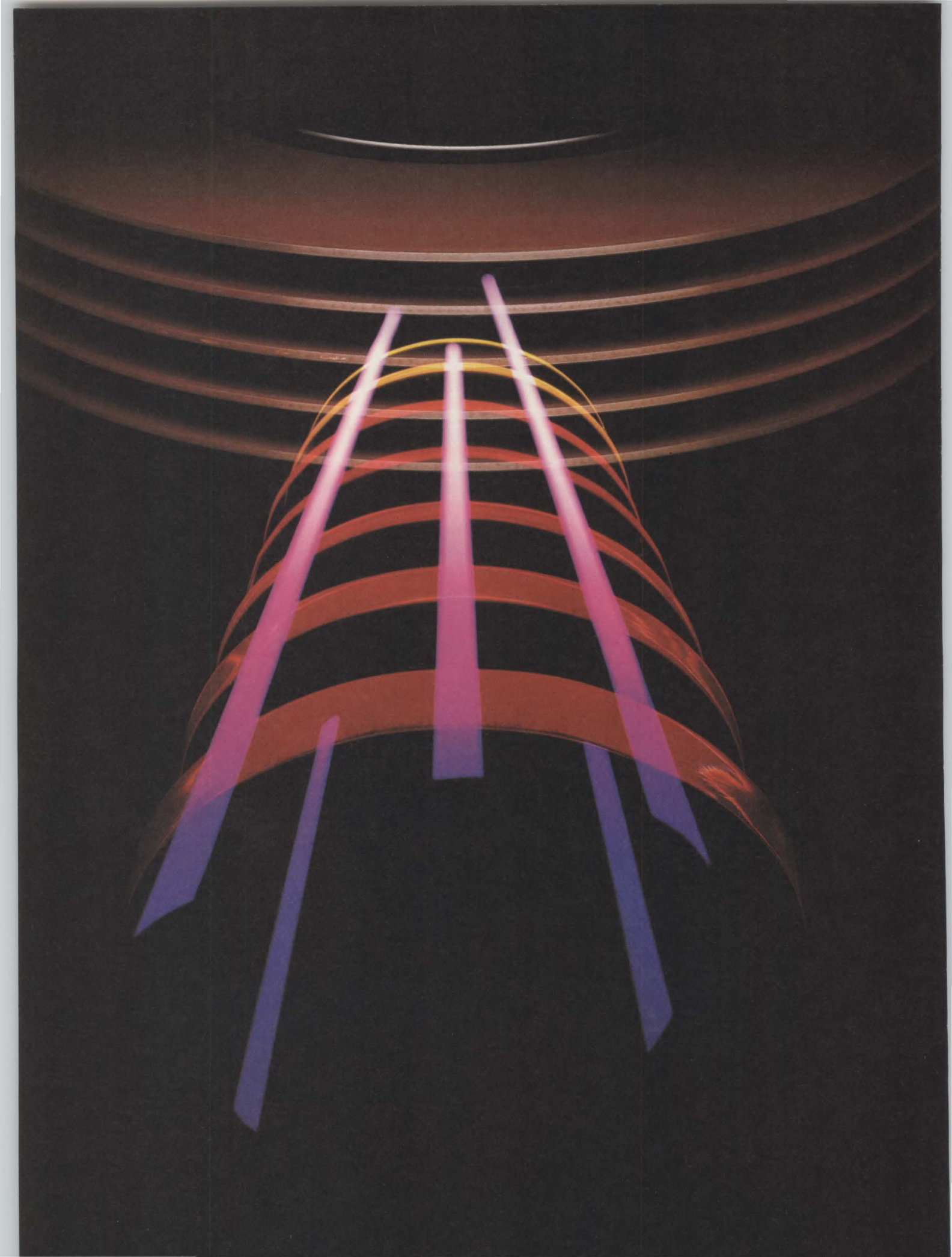
CIRCLE NO. 61 ON INQUIRY CARD



Positioning a new Winchester

DIETER SCHULZE and MAARTEN PRANGER, Ontrax Corp.

Digital actuator mechanism in Ontrax devices improves positioning accuracy while reducing cost vs. linear/rotary approach

Innovation in the form of μp control, 8- and 5¼-in. disk platters and clever mechanical packaging has helped squeeze the cost from Winchester-disk drives in the past two years, but similar innovation hasn't characterized the linear/rotary actuators in those drives. That's the shortcoming that the Series 8 drives from Ontrax Corp. overcome with a patented actuator that is simpler, less expensive and more accurate than the linear/rotary actuator it supplants (MMS, January, p. 39).

The greater accuracy of the new actuator increases the disk's capacity by increasing track density, which will also make maximum use of advanced technologies, such as thin-film read/write heads (see "Accuracy, density and thin-film heads," p. 126). The Ontrax actuator further reduces cost and complexity by eliminating the servo head and servo reference surface.

Digital positioner concept

The Ontrax positioner is a digital, as opposed to an analog, device. A series of concentric elements each travels a different preset distance, moving the read/write head that same distance, with the travel mechanically limited in each direction. Fig. 1 illustrates the concept of motion and position limits. The number of elements in the illustration has been reduced to two for clarity. Two movable elements in the mechanism are preset so that A1 +A = 1 unit of distance and B1 +B = 2 units of distance. A spring is installed so that A1 and B1 are zero distance in the absence of external inputs—with the power off. An electromechanical force can be supplied to make A or B, or both, zero distance. When the force is removed, the spring returns the elements to their original positions.

These four possibilities—no force, A force only, B force only or both forces A and B—represent four distinct positions. If B is chosen to be exactly 2 times A, the distances 0, 1, 2 and 3 can be obtained.

This concept is implemented by increasing the number of movable elements from two, used in the illustration, to nine in the Ontrax Series 8 disk drives to achieve 512 discrete locations. If each movable element moves exactly two times the distance of the previous element, the 512 discrete physical locations represent 512 equally spaced locations.

But because it is difficult to maintain manufacturing tolerances necessary to make each location precisely equidistant from its neighbors, Ontrax added a small limited-range "linear actuator" called a squeeze coil. The squeeze coil is actuated linearly over a limited range (as long as a few mils) in discrete steps of approximately 8-μin. resolution per step. The additive movement provided by the squeeze coil overcomes manufacturing tolerances and expansion errors caused by temperature changes or other physical phenomena.

With the squeeze coil added to the digital actuator, the stages of the digital actuator are chosen to be slightly larger (+X percent, −0 percent) than the "ideal" binary increment. This assures that all physical positions covered by the range of the actuator system can be achieved to an accuracy of ±4 μin.

The electromechanical force required to move an element from its initial position to the alternate position is obtained by passing a current through a coil. A mechanical force—the spring—moves the element back to its initial position when current is shut off. Fig. 2 shows the magnetic field lines for several stages. The coils are alternately phased to prevent cancellation of magnetic fields.

Damping prevents abrupt element contact

Damping is provided between elements because without it, the elements would make abrupt contact, transferring significant deceleration "g" forces to the heads. The elements are permitted to close very rapidly until they near their travel limit by controlling the size

Photo courtesy of Ontrax Corp.

The squeeze coil is actuated linearly over a limited range in discrete steps of about 8-μin. resolution per step.

of the air orifices indicated in Fig. 2. Thereafter, the trapped air between elements provides a dashpot-like cushion for the last part of the mechanical travel. Similar air-entrapment prevents high "g" forces when the spring returns the elements.

Control circuits activate elements

Individual actuator elements are activated by passing a current through the coil, with a magnetic field resulting that is proportional to the current flow through the coil. Once the element has moved to its mechanical limit, the original pick current is then reduced to a lower, hold-current level, preventing the element from being pulled back in the opposite direction by the spring. The pick-current level and duration are chosen to apply twice the force of the spring, so that the average force, and hence the time to move in either direction, is equal. Because the pick current and hold current are either on or off, a simple control circuit (Fig. 3) is sufficient. The voltage level and the coil impedance determine the pick current. A current-limiting resistor, plus the voltage level and coil impedance, determines the hold current.

An 8-bit digital-to-analog converter, with a power Darlington current booster, provides the control signal for the squeeze coil (Fig. 4).

Each actuator element is manufactured and installed within a specified mechanical tolerance. A μp in the Ontrax Series 8 disk drive calibrates each actuator element during a special initialization program to

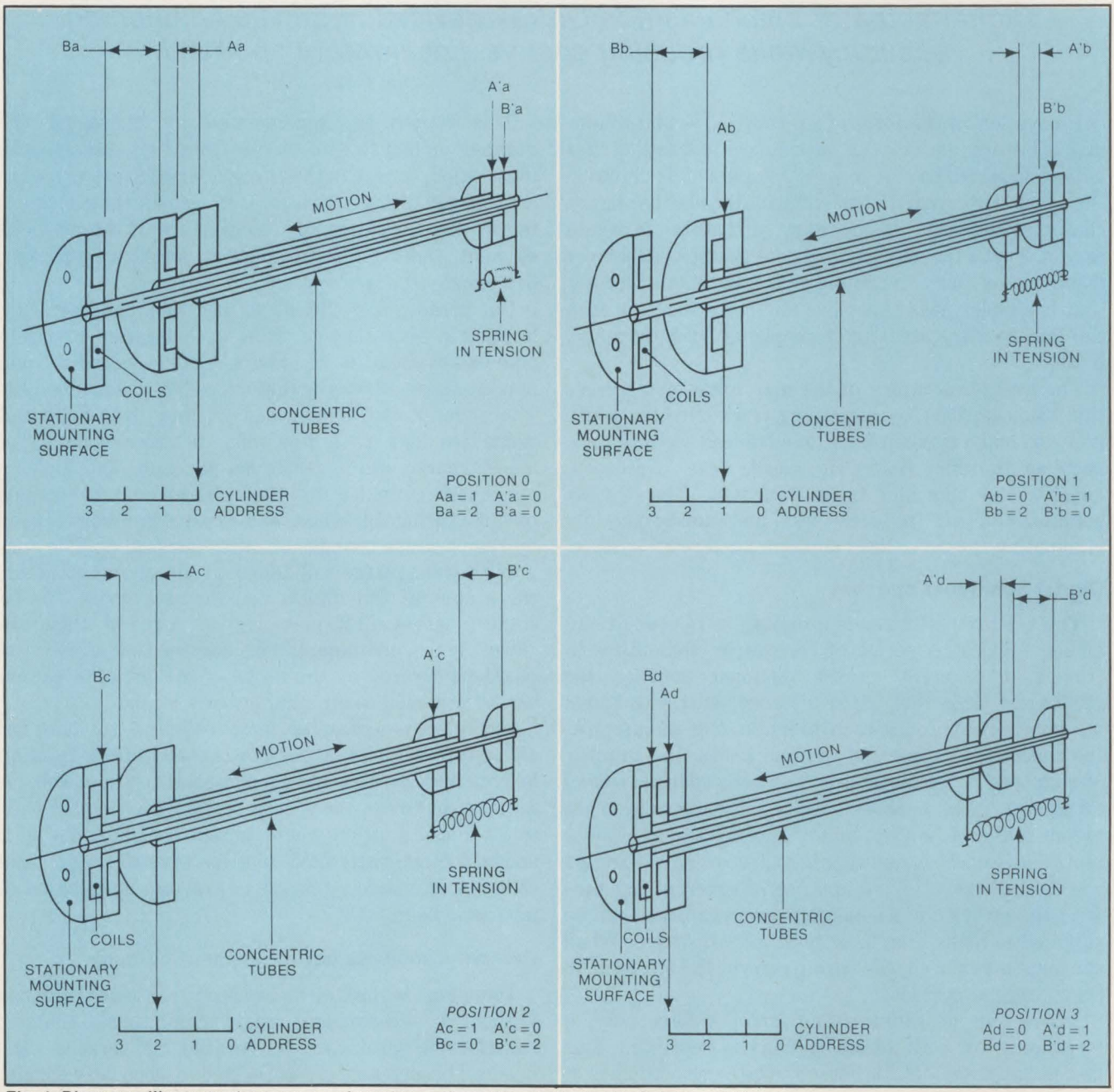


Fig. 1. Diagrams illustrate *the concept of motion and position limits in the Ontrax positioner.*

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Yes, it's INTELLIGENT! It's a new microprocessor based Cartridge Disk Drive...at an unbelievably **low** price.

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At Sperry Univac, we just added two new minicomputers to our V77 family—the V77-500 and V77-700. And provided two cost-effective, high-performance machines that can grow into V77-800s. These new minicomputers join the existing V77-200, 400, 600, and 800, and are fully compatible with our software.

The architecture of both new machines is based on the V77-800—the leader and most powerful member of our minicomputer family. So with some simple board-swapping,

'S TWO NEW MINICOMPUTERS THE V77-800.

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The V77-500 is a powerful entry-level member of the family, designed for high-performance commercial and data communications processing users. The V77-500 can handle up to one megabyte of error correcting MOS memory. And it provides an entry to a sensible growth path, since it's field-upgradable to the more powerful V77-700.

The V77-700 is designed for an even higher performance commercial and scientific data processing user, and features a new high-speed floating point processor compatible with our new, optimized ANS 77 FORTRAN compiler. And the V77-700, with a maximum memory size of two megabytes, is field-upgradable to the V77-800.

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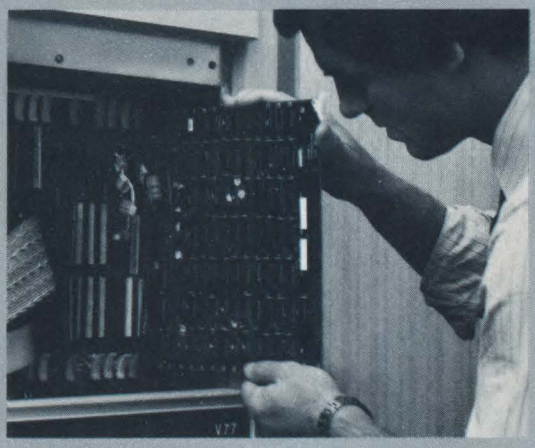
Now end-users can select the exact price/performance model for today's needs. And if you're an OEM who wants to get into vertical markets quickly, maximize your value, and expand your after-market through field upgrades, give us a call. We'll tell you all about our two new family members. And how they can grow on you.



Easy board-swapping in the field can upgrade your V77-500 or V77-700.

For more information, write to Sperry Univac Mini-Computer Operations, Marketing Communications, 17900 Von Karman Avenue, Irvine, CA 92714.

In Europe, write to Mini-Computer Operations, International Division Headquarters, London NW10 8LS, England.

In Canada, write to Mini-Computer Operations, Headquarters, 55 City Centre Drive, Mississauga, Ontario L5B 1M4.

Or call toll-free **800/854-7517** *(8:00 a.m. to 4:30 p.m. PST). In California, call 714/557-9398 collect.*

SPERRY UNIVAC

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Individual actuator elements are activated by passing a current through the coil, with a magnetic field resulting that is proportional to the current flow through the coil.

compensate for small manufacturing tolerance differences of those elements. The calibration information is stored on the disk for future positioning operations.

Architectural impact on disk drives

The linear actuator described positions incrementally to within a few μin. The Ontrax actuator is also very fast, simple and low cost, and can be used for precision positioning in other applications besides disk drives.

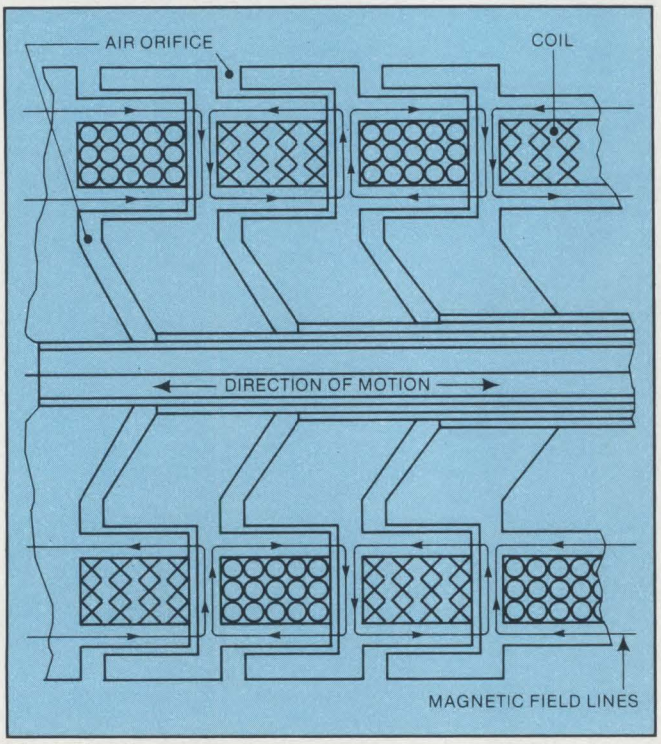

Fig. 2. The elements *are permitted to close very rapidly until they near their travel limit by controlling the size of the air orifices indicated.*

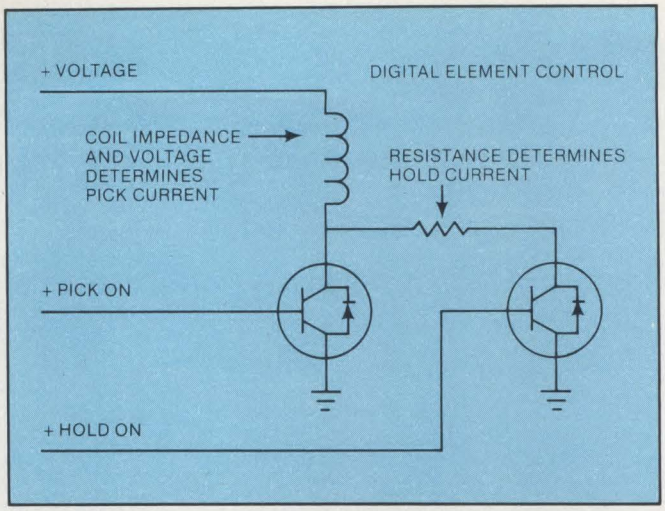

Fig. 3. Because the pick *current and hold current are either on or off, a simple control circuit is sufficient to move the Ontrax positioner elements.*

Because the Ontrax actuator provides linear positioning, it presents significant performance improvements in disk drives over commonly used rotary actuators.

Absolute positioning also permits recovery of data on badly damaged units because position sensing need not be operational to recover data. Ontrax uses an embedded servo technique to guarantee close positioning accuracy. Less than 1 percent of available data space is used by Series 8 disk drives to verify on-track position before executing write operations. This feedback compensates for mechanical expansion or contraction of the media caused by temperature changes. It is no longer necessary to dedicate a portion of a disk surface, or a complete surface, for servo position sensing and feedback. All heads, therefore, can be used for data, yielding increased data capacities, significant cost savings or both. Cost savings result because no servo head, servo arm, servo surface or servo read channel are required. Because the actuator is self-limiting and self-damped for travel at its extreme positions, it does not need the crash stops found on conventional drives.

A number of other disk drives also use embedded

ACCURACY, DENSITY AND THIN-FILM HEADS

The Ontrax Series 8 disk drive actuator eliminates most positioning errors experienced by other actuator designs. Spindle run-out remains the major positioning error. But by specifying and designing a spindle with a run-out of less than ±25 μin., the positioning error for data recovery caused by spindle run-out can be held to less than 50 μin.

High track density drives are available at a track spacing of 960 tracks per in., with a center-to-center track spacing of 1040 μin. Industry-standard heads are available with a width of 700 μin. Thus, 340 μin., or 33 percent of the available data surface, is the tolerance required to account for magnetic fringing from the heads and actuator positioning.

With thin-film head technology progressing, magnetic fringing from the heads can be reduced to a very small fraction of the head width. With the advent of thin-film heads having a width of 700 μin., center-to-center track spacing can be reduced to less than 800 μin. Then, less than 14 percent of the available data surface is used for tolerance.

As thin-film head technology advances in the next few years, it is reasonable to expect 400-μin.-wide heads that will permit track densities in excess of 2000 tpi, which the inherent positioning resolution, accuracy and stability of this positioner will accommodate.

Thin-film technology also allows for higher bit density so that the increase in tpi and bpi, plus the use of encoding techniques, will raise the Ontrax disk-drive data density per square in. by a factor of 6 to 8 for modest increases in the cost per unit by 1984.

COMPUSTAR™

INTERTEC'S NEW S2500 MULTI-USER SMALL BUSINESS COMPUTER

At last, there's a multi-user microcomputer system designed and built the way it should be. The CompuStar™. Our new, low-cost "shared-disk" multi-user system with mainframe performance.

Unlike any other system, our new CompuStar offers what we believe to be the most practical approach to almost any multi-user application. Data entry. Distributed processing. Small business. Scientific. Whatever! And never before has such powerful performance been available at such modest cost. Here's how we did it . . .

The system architecture of the CompuStar is based on four types of video display terminals, each of which can be connected into an auxiliary hard disk storage system. Up to 255 terminals can be connected into a single network! Each terminal (called a Video Processing Unit) contains its own microprocessor and 64K of dynamic RAM. The result? Lightning fast program execution! Even when all users are on-line performing different tasks! A special "multiplexor" in the CompuStar Disk Storage System ties all external users together to "share" the system's disk resources. So, no single user ever need wait on another. An exciting concept . . . with some awesome application possibilities!

CompuStar™ user stations can be configured in almost as many ways as you can imagine. The wide variety of terminals offered gives you the flexibility and versatility you've always wanted (but never had) in a multi-user system. The CompuStar Model 10 is a programmable, intelligent terminal with 64K of RAM. It's a real workhorse if your requirement is a data entry or inquiry/response application. And if your terminal needs are more sophisticated, select either the CompuStar Model 20, 30 or 40. Each can be used as either a stand-alone workstation or tied into a multi-user network. The Model 20 incorporates all of the features of the Model 10 with the addition of two, double-density mini-floppies built right in. And it boasts over 350,000 bytes of local, off-line user storage. The Model 30 also features a dual drive system but offers over 700,000 bytes of disk storage. And, the Model 40 boasts nearly 1½ million bytes of dual disk storage. But no matter which model you select, you'll enjoy unparalleled versatility in configuring your multi-user network.

Add as many terminals as you like - at prices starting at less than $2500. Now that's truly incredible!

No matter what your application, the CompuStar can handle it! Three disk storage options are available. A tabletop 10 megabyte 8" winchester-type drive complete with power supply and our special controller and multiplexor costs just $3995. Or, if your disk storage needs are more demanding, select either a 32 or 96 megabyte Control Data CMD drive with a 16 megabyte removable, top loading cartridge. Plus, there's no fuss in getting a CompuStar system up and running. Just plug in a Video Processing Unit and you're ready to go . . . with up to 254 more terminals in the network by simply connecting them together in a "daisy-chain" fashion. CompuStar's special parallel interface allows for system cable lengths of up to one mile . . . with data transfer rates of 1.6 million BPS!

Software costs are low, too. CompuStar's disk operating system is the industry standard CP/M*. With an impressive array of application software already available and several communication packages offered, the CompuStar can tackle even your most difficult programming tasks.

Compare for yourself. Of all the microcomputer-based multi-user systems available today, we know of only one which offers exactly what you need and should expect. Exceptional value and upward growth capability. The CompuStar™. A true price and performance leader!

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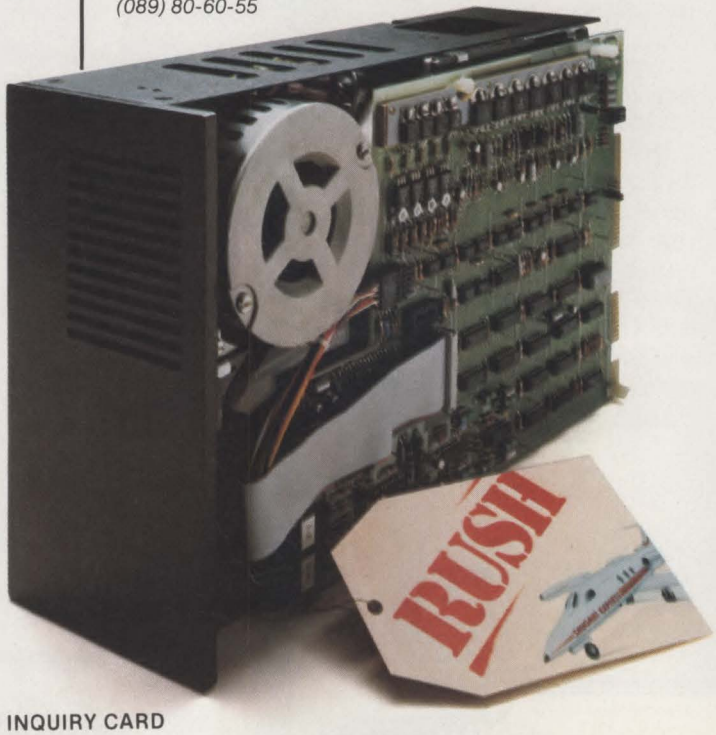

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CIRCLE NO. 65 ON INQUIRY CARD

The Ontrax positioner replaces the conventional voice-coil actuator and associated permanent magnets, resulting in lower weight and cost.

servo data as position-feedback signals, but these devices require either an external servo system, such as an optical servo, or a high sampling rate from the data surfaces, reducing data capacities because of high overhead requirements for track counting and maintaining on-track positioning. The Ontrax actuator permits reformatting at the customer location if the embedded servo information is ever damaged; in a conventional embedded-servo drive, either the drive or cartridge must be returned to the factory to be rewritten.

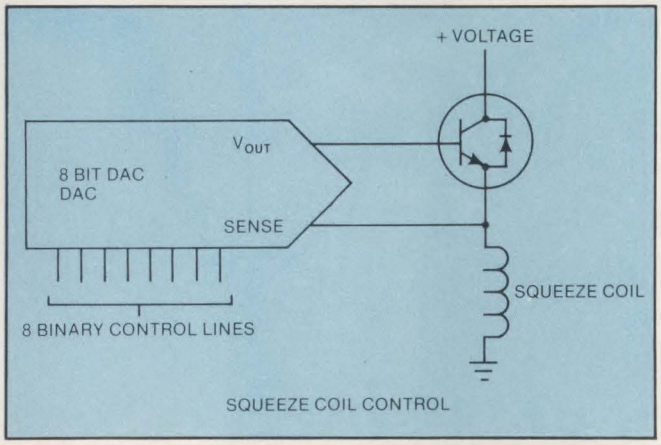

Fig. 4. An 8-bit *digital-to-analog converter, with a power Darlington current booster, provides the control signal for the squeeze coil.*

The Ontrax positioner replaces the conventional voice-coil actuator and associated large permanent magnets, resulting in lower weight and a lower-cost actuator. There is inherent current limiting even if the control drivers should fail. Conventional drives depend on active current-limiting components to prevent fire or safety hazards from occurring when the drivers fail.

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Schulze

Pranger

Dieter Schulze is vice president of advanced development at Ontrax Corp., Sunnyvale, Calif., and is the inventor of Ontrax's new positioner. **Maarten Pranger** is manager of systems and software at Ontrax.

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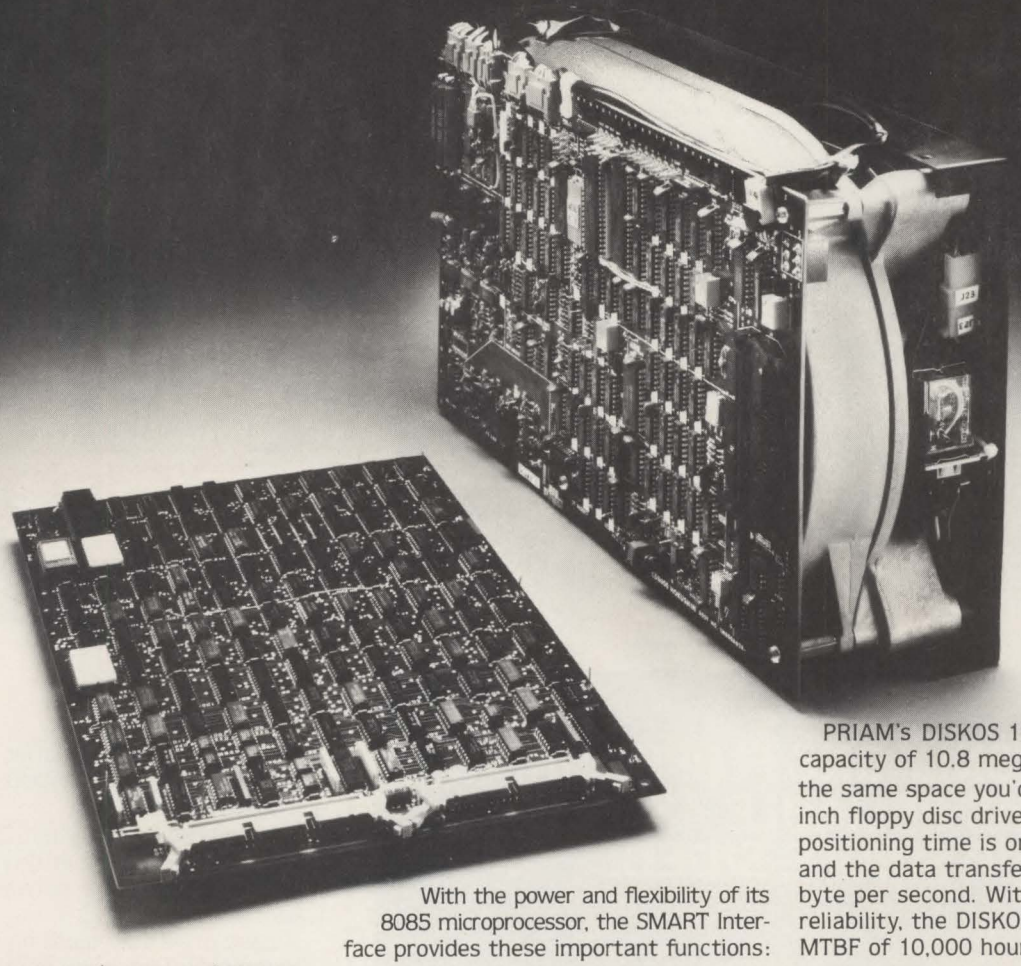

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- Automatic alternate sector assignment makes disc defects transparent to the host processor.
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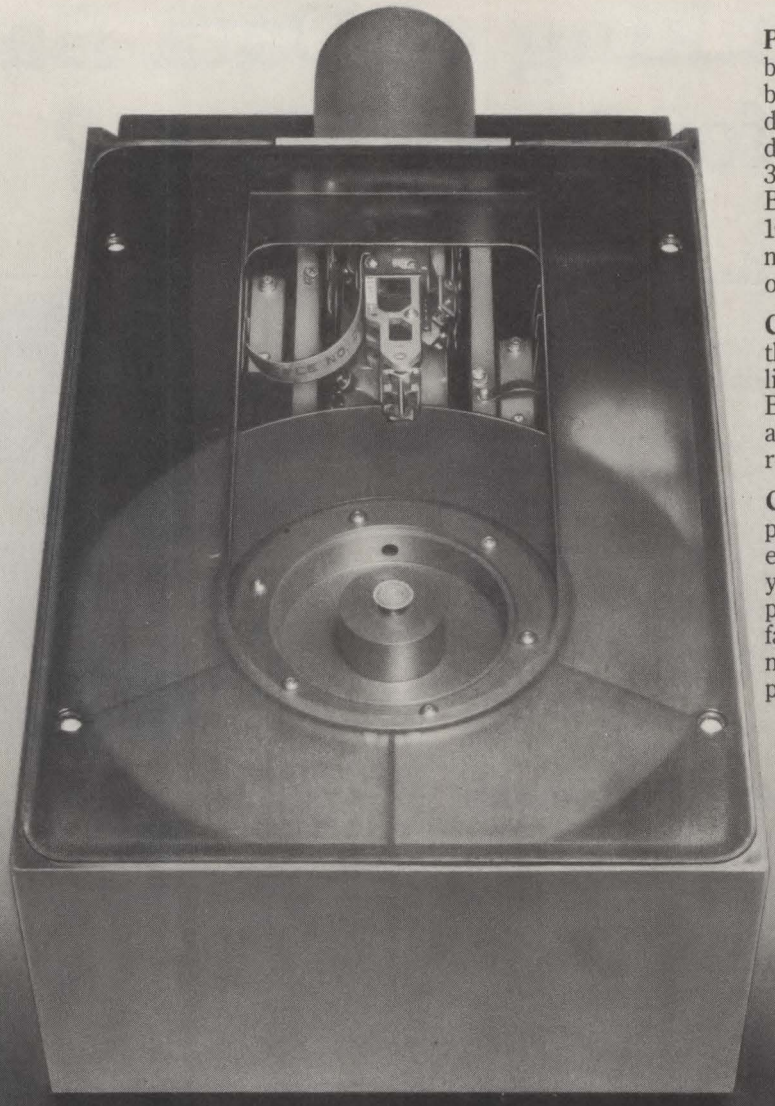

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CIRCLE NO. 69 ON INQUIRY CARD

DISK DRIVE BACKUP

To stream or not to stream...

DARELL MEYER, Kennedy Co.

OEMs need detailed knowledge of overall system, disk-drive and tape transport parameters to answer the small-disk backup question

Ever since the streaming-tape concept was developed, there has been confusion about how to use streaming tapes to back up Winchester-disk drives. At first glance, high-speed streaming appears to be an ideal way to match the high data-transfer rates attainable from disks, but a closer look shows that there is no universal solution to the backup problem. In many cases, the streaming mode is slower than a conventional start/stop transport.

The backup question involves more than matching a few transport and drive specifications; it requires detailed knowledge of overall system, drive and transport parameters (Fig. 1), along with appropriate controller design and proper memory or buffer allocation. This knowledge leads to successful Winchester backup-transport selection and mode of operation.

A streaming transport (Fig. 2) has characteristics that distinguish it from a conventional start/stop drive. It usually has two speeds—100-in. per sec. and 12.5 ips, or 100 ips and 25 ips. At 100 ips, the transport has long start/stop ramps of approximately 15 in., which means it must reposition after stopping in order to be ready to write or read again. This requires a relatively long time—about 1.2 sec. In operation, the transport writes inter-record gaps on the fly.

The streamer uses a 1600-character-per-in. data density in a phase-encoded format; future streaming transports may have densities of 3200 cpi or 6250 cpi. These speeds appear to be considerably lower than the bit-transfer rate of Winchester disks, but this isn't always true. A closer look at the disk is in order.

Disk considerations

One major backup consideration is average data-transfer rate from the disk, through the CPU, to the tape. If the tape accepts data faster than the disk and CPU supply it, long unrecorded sections of tape will result, or the transport will have to decelerate, stop and reverse to a position at which it can ramp to speed when data are available. This is not a problem with

IMPORTANT BACKUP PARAMETERES

Disk	Tape	System
Data transfer rate	Recording density Speed	Record size in bytes
Access time	Inter-record gap	Data transfer mode (DMA, system control)
Latency time	Record size	Backup function
Seek time	Tape length	Mirror
Bytes/track	Tape capacity	File restructuring
Sector size	Start/stop times	Program update
Average transfer rate	Start/stop distance	Buffer size
Utilization percentage		CPU data rate

Fig. 1. Disk, tape and system *parameters for backup transport selection.*

Fig. 2. The Kennedy data streamer transport *operates at 100 ips in the streaming mode and 12.5 ips in the start/stop mode.*

The backup question involves detailed knowledge of overall system, drive and transport parameters.

conventional start/stop drives. Data are transferred, on an interrupt basis, when "system-ready" handshakes indicate data are available for transfer from disk to tape.

To calculate average transfer rate (Fig. 3), one must consider that each sector on a disk has error-correcting characters, header bytes and synchronization bytes so that average disk use is 80 percent. With careful management, 90 percent or higher can be achieved. Further, disk data are not contiguous; they reside on numerous tracks and sectors. A typical disk sector holds 0.2K to 0.5K bytes, while ANSI standard tape record-block length is 2K bytes, which means that the CPU requires time to read an index and position the heads.

If backup is mirroring—a direct transfer from disk to tape with no file restructuring—the disk head will read one track, then move to the next track and read it. The time required will be equal to a disk revolution plus the maximum one-track access (or seek) time plus the difference between the two (actual latency time). Latency is a factor because once the head is positioned over the track, the system must wait until the index appears under the head, This amounts to a full

DISK AVERAGE TRANSFER RATE

$$\text{Disk Avg. Tr.} = \frac{B \times U}{Trev + l + Ts}$$

B = Bytes/track
U = % of utilization
Trev = Time/revolution
l = Actual latency time
Ts = Seek time

Fig. 3. To calculate average transfer rate, *one must consider that each sector on a disk has error-correcting characters, header bytes and synchronization bytes.*

DISK PARAMETERS

Data Transfer Rate	1.2M bytes/sec.
Access Time	Max. full stroke: 55 msec. Average: 30 msec. Max. one track: 6 msec.
Latency time	Max. 16.7 msec. Average: 8.3 msec.
Bytes/track	Max. 20, 160 Reference: CDC 9760 SMD

$$\text{Avg. Tr.} = \frac{20{,}160 \times .8}{16.7 + 10.7 + 6}$$

= 482.9K bytes/sec.
= 40% of max.

Mirroring mode	≈40% of burst rate ≈400K bytes/sec.
File management	≈10% of burst rate ≈100K bytes/sec.
Interleaving divide by 2	

Fig. 4. Applying the characteristics *of a fast disk to average transfer time formula reveals that the disk is relatively slower than burst transfer specifications.*

Fig. 5. The Kennedy Series 7000 *8-in. disk has 5.5-MHz transfer rates and storage capacitities as high as 20M bytes.*

revolution, less the seek time. Staggered indexes can reduce this time, but using them is frequently too sophisticated for small systems.

To see the effect of these factors, consider the parameters of an industry-standard fast disk (Fig. 4). The average transfer rate is 482K bytes per sec. or about 40 percent of burst-transfer rate.

The reason for dumping data to tape often is archival or operational, as is the case of a data-processing manager wanting to collect all records of a certain classification for future use. In payroll processing, for example, employee salaries and deduction files are stored on tape for year-end W-2-form reporting. All such records seldom are on adjacent tracks, so file management must be done before the tape dump. Hardly anyone would perform file management on a year of mirrored tape just to obtain payroll data. Thus, mirroring is not considered a normal data-processing operation, except when it is done to preserve small files.

When performing file management or data restructuring, the average disk data rate is reduced to about 10 percent of the burst rate. This gives a resulting average of approximately 100K bytes per sec., or 50K bytes per sec. if interleaving is used. This occurs because the system first must look at a directory, then must find the track and index. These figures are for a "fast" disk; 8- and 14-in. Winchesters (Fig. 5) have relatively lower data-transfer rates and higher access times. An examination of streamer data transfer rates illustrates why so many designers are having problems with the concept.

On the tape side

Record size and gap length are important in calculating a tape transport's average transfer rate. As record size increases, the relative effect of the inter-record gap decreases, yielding higher transfer rates (Fig. 6). A comparison of average disk data-transfer rates indicates that the streaming tape is often

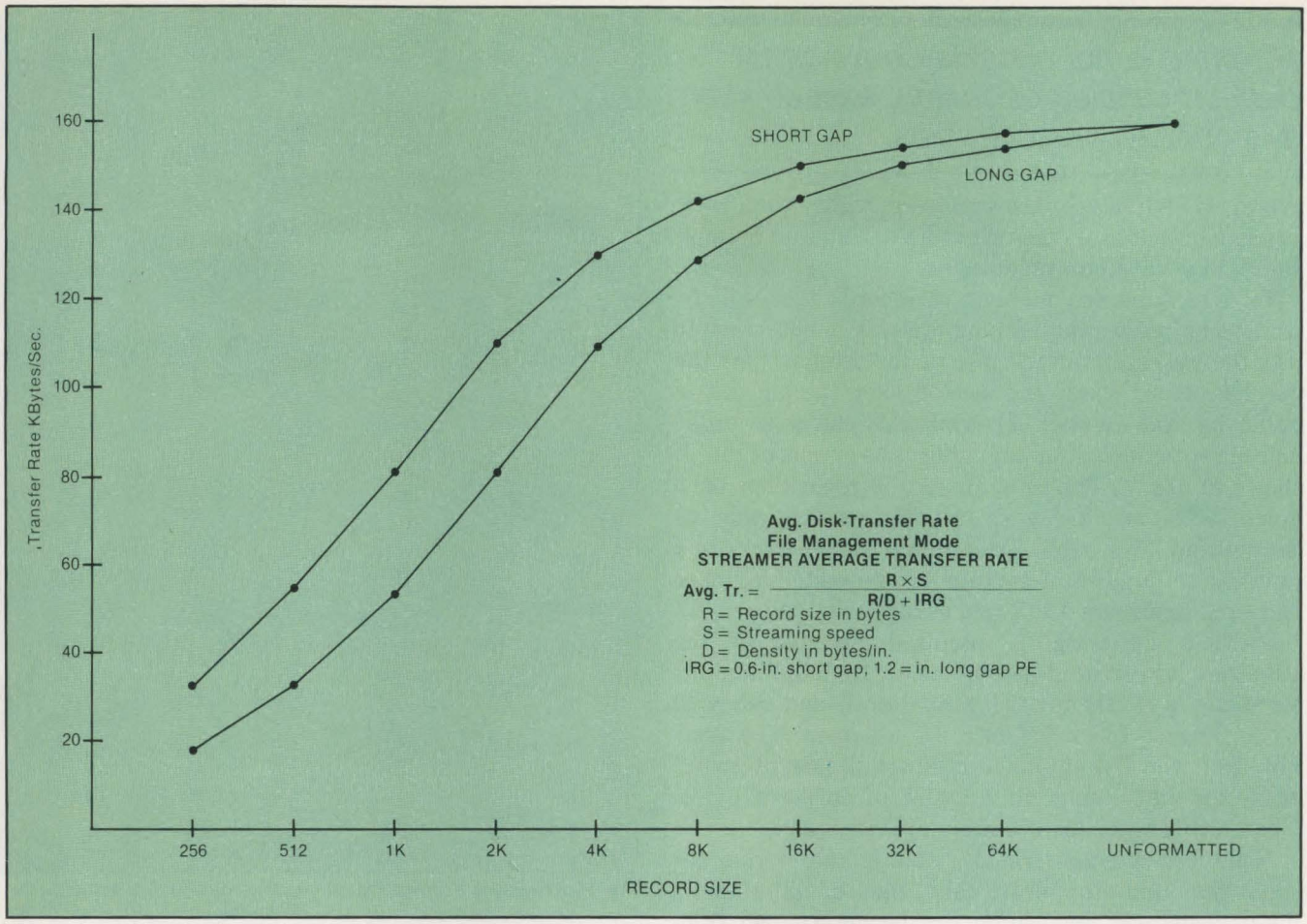


Fig. 6. Streaming-tape transfer rate *exceeds disk rates as block size increases.*

CAPACITY PER REEL OF TAPE

$$C = \frac{L \times 12}{R/D + IRG} \times R$$

L = Length of tape in ft.
R = Record size in bytes
D = Density of data in bytes/in.
IRG = 0.6-in. short gap, 1.2-in. long gap PE

Fig. 7. The relationship between tape reel size and capacity *explains the reason for the "hunting" phenomenon often associated with the IBM 8809.*

much faster than the disk, particularly when large record blocks are used. Similar calculations determine the relationship between tape reel size and capacity (Fig. 7), which explains the reason for the "hunting" phenomenon often associated with the IBM 8809. Data are not present when the transport requires them, causing the transport to stop and reposition to await the data-ready signal.

Repositioning (Fig. 8) requires about 1.2 sec. for a 100-ips transport that does not adversely affect time with a small number of repositions. Frequent repositions, however, add significantly to the time required to write a full reel of tape. Buffering is one way to match the transfer rates of the tape and drive, but it isn't easy to determine the number and size of the buffers.

Buffering considerations

One technique is to use a series of buffers in a ring configuration, with the buffers alternately filled via direct-memory-access transfers from the disk, and written directly to tape. Typically, a buffer will be filled only when it is empty and must be full before writing to tape. The buffers will operate during a read cycle to match tape-disk transfer rates. When the

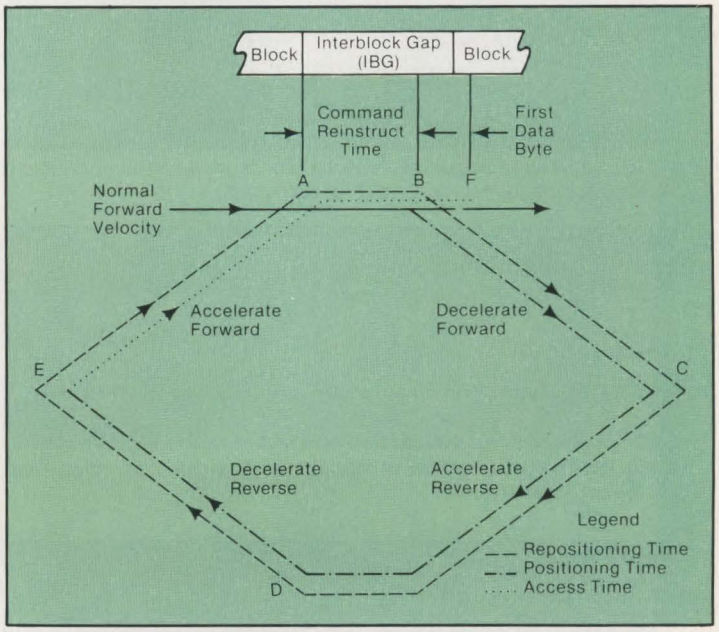


Fig. 8. During repositioning, *the streaming transport decelerates, accelerates and decelerates in reverse to a position at which it can ramp to speed before reaching the inter-record gap. Time required is 1.2 msec., and ramps are 15 in. long.*

Mirroring is not considered a normal data-processing operation, except when it is done to preserve files.

average input rate to the buffers is higher than their average output rate, the transport will stream because data will always be available.

To determine the number of records that will be written before a repositioning cycle, it is necessary to plot the average transfer rate of the streamer for the various record sizes, and also to vary the amount of buffering. The number of records that can be recorded before repositioning for any buffer size or output rate is shown in Fig. 9. The total number of repositions for a given record size and a given buffer size can then be determined (Fig. 9b). Total dump time, then, is a function of number of repositions, repositioning time and time to stream a full reel of tape (Fig. 9c).

Multiple buffering is required because of the 4.5-msec. inter-record-gap time, i.e., from the time the streamer is finished writing one block and ready to write the next block. If data are assumed to be available from the disk at an average rate of 100K bytes per sec., the CPU could fill a buffer of only 450 bytes. Therefore, two or more buffers are necessary.

When the average transfer rate is 100K bytes per sec., the time to record one reel of tape for a file-management application can be determined (Fig. 10). For records smaller than 1K byte, dual 1K-byte buffers give acceptable dump time; however the dump time skyrockets with larger records. The reason for this is that the buffers are being filled at a rate of 100K

NUMBER OF RECORDS WRITTEN WHILE STREAMING

$$N = 2 + \frac{n-2}{1-r}$$

N = Number of records that can be written while streaming defined as lowest whole integer.
n = Number of records buffered.
r = Ratio of input fill rate over output rate.

Fig. 9a. The number of records *that can be recorded before repositioning for any buffer size or output rate.*

NUMBER OF REPOSITIONS PER REEL

$$NR = \frac{L \times 12}{R/D + IRG + Ts} \div N$$

L = Length of tape in ft.
R = Record size in bytes
D = Density of data in bytes/in.
N = Number of records written
IRG = 0.6-in. short gap, 1.2-in. long gap,PE

Fig. 9b. The total number of repositions *for a given record size and a given buffer size.*

TIME PER REEL

T = NR × 1.2 sec. + 4.8 min.
1.2 sec. = Time to reposition
4.8 min. = Stream time per 2400 ft.

Fig. 9c. Total dump time *is a function of the number of repositions, repositioning time and time to stream a full reel of tape.*

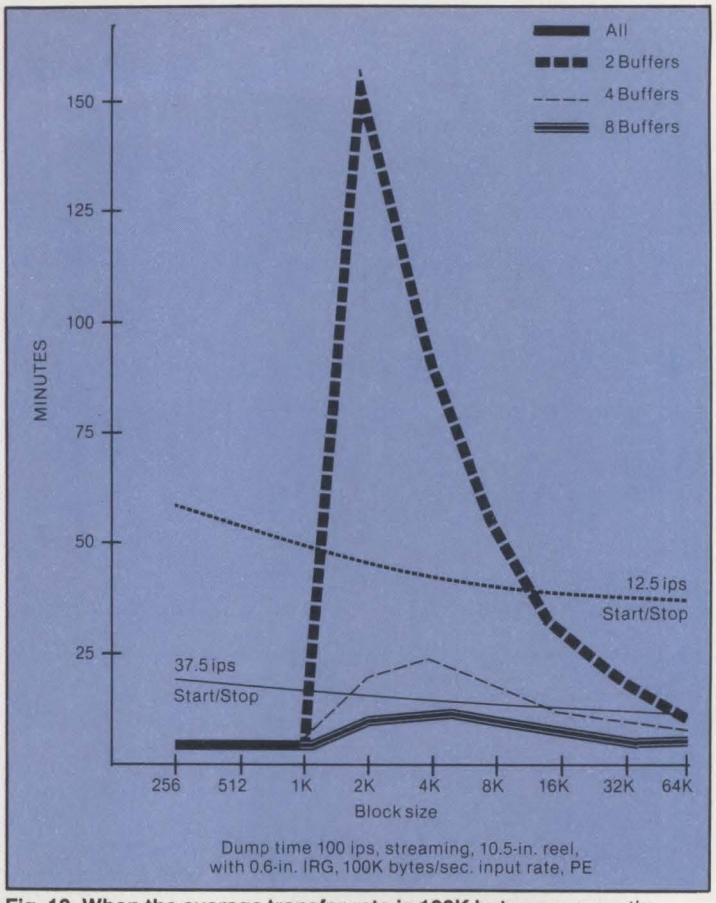


Fig. 10. When the average transfer rate is 100K bytes per sec., *the time to record one reel of tape for a file-management application can be determined.*

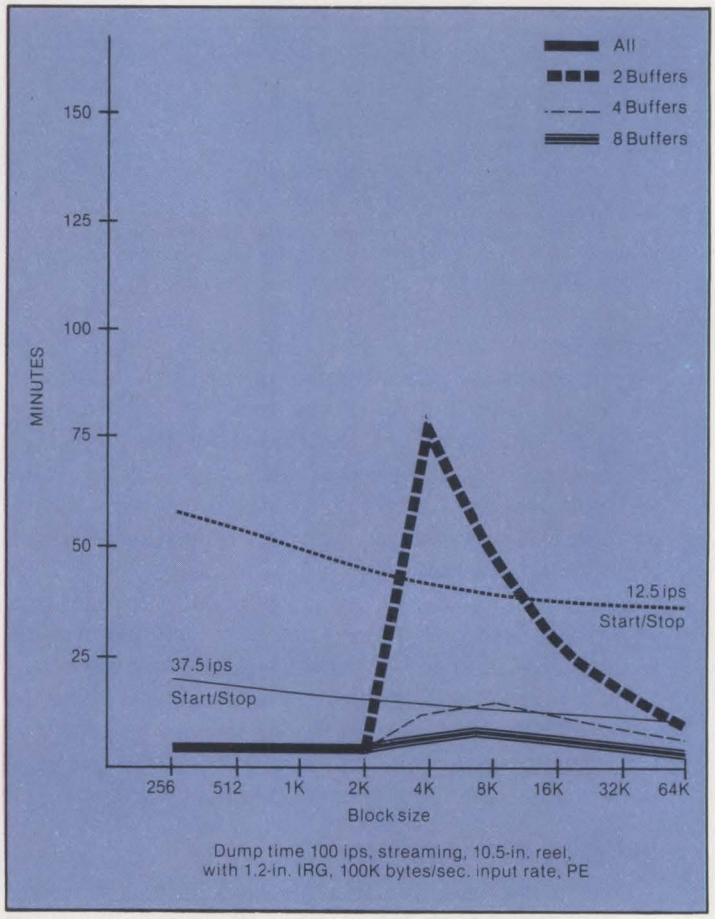
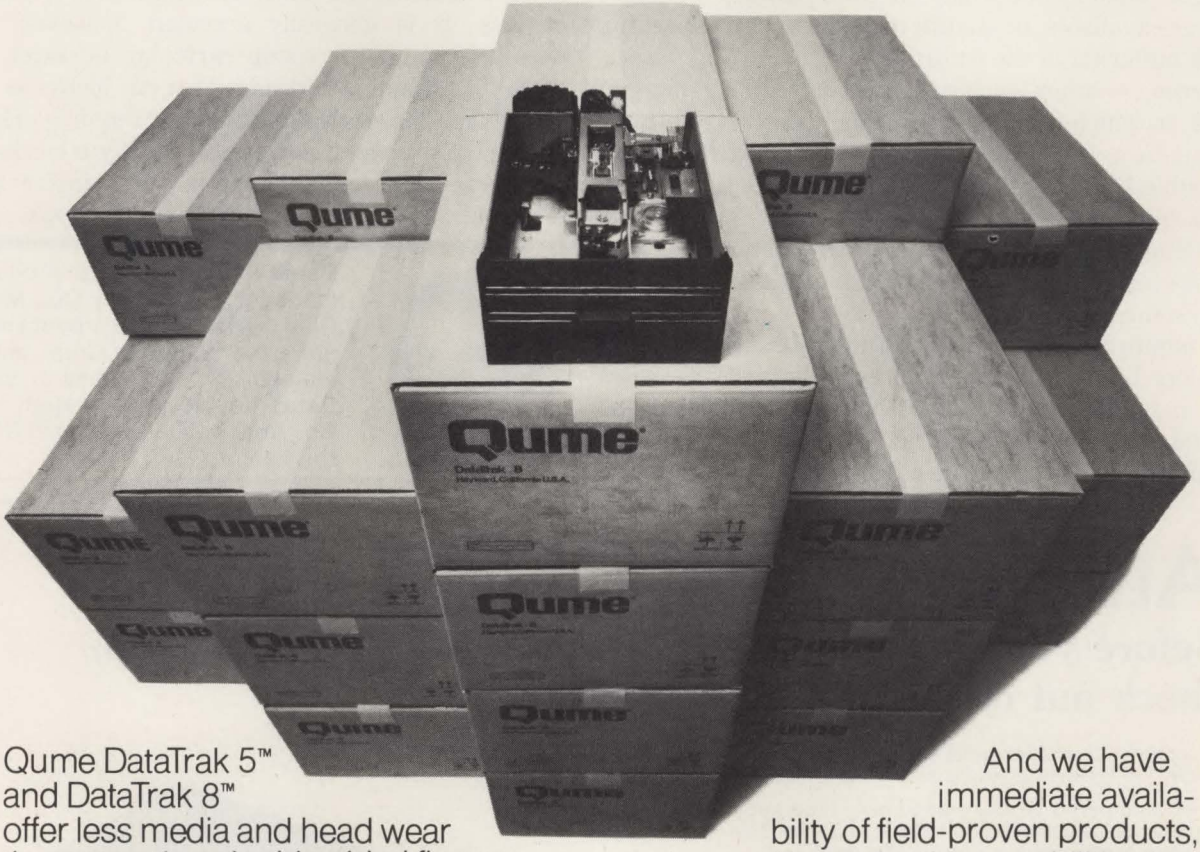


Fig. 11. Increased inter-record gap *reduces dump time.*

More tap-tap on tap.



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CIRCLE NO. 70 ON INQUIRY CARD

A number of controller design approaches are being developed that solve the apparent disparity between disk- and tape-transfer rates.

bytes per sec. and emptied at 160K bytes per sec. The streamer will stop and reposition after the second buffer is empty and wait until the first is refilled.

Four or eight buffers provide more acceptable dump times. An 8K-byte record, along with eight 8K-byte buffers, requires only 10 min. to fill a 10½-in. reel. This places severe overhead constraints on the system because small systems may not have 64K bytes of main memory available, or an OEM may not want to place this much buffering in the controller.

Hence, another approach is required. A long-gap mode, in which the inter-record gap is increased to 1.2 in., in effect, lowers the average transfer rate (Fig. 11). A double buffer is sufficient for blocks as large as 2K bytes, but at 4K bytes, a dump requires 1½ hr. The start/stop mode at 12.5 ips is clearly faster. This also implies that a streaming tape is not necessarily best for all systems.

A number of controller design approaches are being developed that solve the apparent disparity between disk and tape transfer rates. One way is to sense the number of repositions during the streaming mode. When the number exceeds a predetermined value, the inter-record gap would be increased. Another is to transfer from the streaming mode to the start/stop mode when excessive repositioning occurs.

These approaches can be combined. The controller would first increase the inter-record gap and continue to sense repositions. If they still are excessive, the start/stop mode would be selected, with the inter-record gap shortened. As a final measure, the inter-record gap can be increased, if necessary, for lower dump times.

Although this article deals exclusively with streaming ½-in. tape transports, similar reasoning can be applied to the cartridge transports associated with smaller systems and disks with capacities of 10M bytes or less. It is generally accepted, however, that a 6400-bpi, 30-ips start/stop cartridge is faster than a 7816-bpi streaming cartridge that has blocks as high as 16K bytes. The start/stop transport requires only about 10 min. to transfer 10M bytes of 32K-byte blocks, while the streamer requires 14 min. to transfer 8K-byte blocks at 28 ips, and nearly 20 min. at 50 ips.

Darell Meyer is tape product line manager at Kennedy Co., Monrovia, Calif. He has been a product manager at Pertec Computer Corp., and was a member of the technical staffs at Dataproducts Corp., High Aircraft Co., Rockwell International Corp. and the Boeing Co.

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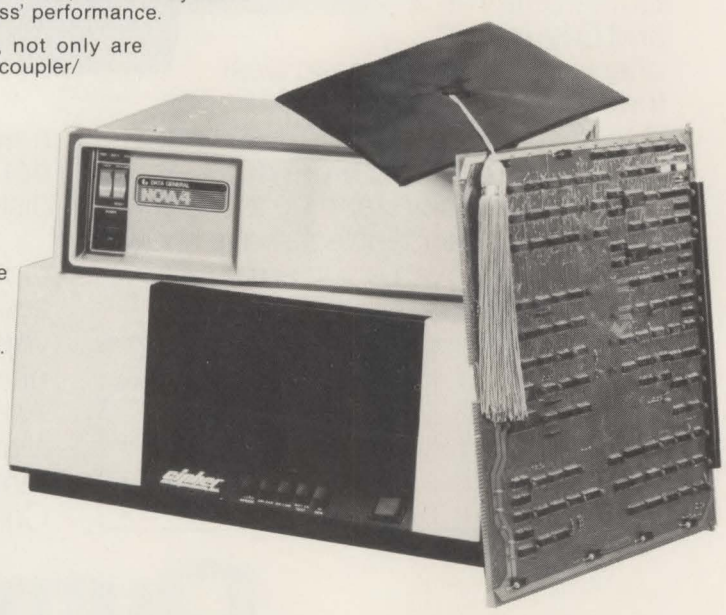

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When we invented the high track density 5¼" floppy, we gave you all the capacity of larger 8" floppies in the process—96 or 100 tpi that yield up to 1.1 megabytes per drive. And we started a movement. Now, everyone is making the high capacity 5¼" drive.

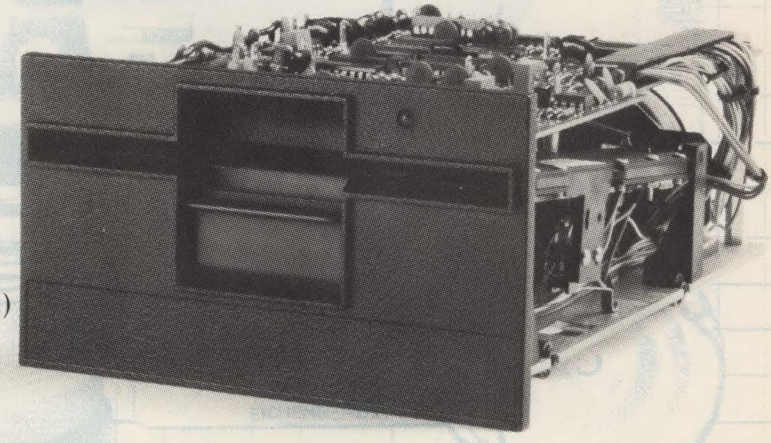
But they're just not the same as the original. Maybe that's because nobody knows as much about 5¼" floppies as we do. Or offers as much.

As a result, over 75% of the system manufacturers choose Micropolis. And over 95% of the double track density disk drives installed today are from Micropolis.

Our wide range of drives comes with a precision centering mechanism to insure accurate centering of a disk—every time (four times better than the competition). In addition, we include ceramic/ferrite double density recording heads, 10 msec track-to-track access time, stainless steel precision-ground positioning reference, and the highest quality electrical and mechanical components available. So you get high track storage capacity, fast access, lowest cost per K byte, significantly greater reliability and best of all, 3 years delivery experience of 85,000 high capacity drives.

	Maximum Capacity	# Delivered Through '79	Positioning Mechanism	Track Density	Av. Access Time (msec)
Shugart SA450	437.5K	<5,000	spiral cam	48	440
MPI B91	960K	Evaluation only	steel band and capstan	96/100	240
TEAC 50C	960K	<10,000 Mainly in Japan	steel lead screw	100	865
Micropolis 1016/1015	1,100K	60,000	steel lead screw	96/100	365

Our drive was designed from the ground up for its double density capacity, not merely redesigned from a single density unit. That's one reason we've shipped more high capacity 5¼" floppies by far than anyone else. Another is that no matter how many imitators there are, there's no substitute for the original.



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Says Emil Rechsteiner, President of Frequency Technology, Inc.

UNSTABLE AND "NOISY" POWER CAN MAKE A SHAMBLE OF YOUR COMPUTER OPERATIONS!

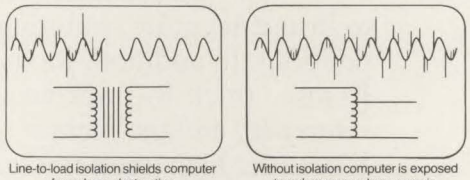
Voltage Spikes can scramble computations, wipe out data, alter programs and destroy circuits. *Brown-outs* can turn computer runs into disasters, paralyze your equipment—perhaps even your business! *"High" Line Voltages* can burn out circuits, causing interruptions and costly repairs.

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.

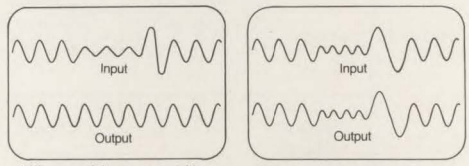


Line-to-load isolation shields computer from sharp, destructive voltage spikes.

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

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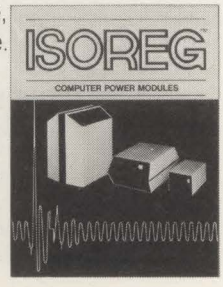

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DISK DRIVE CONTROLLERS

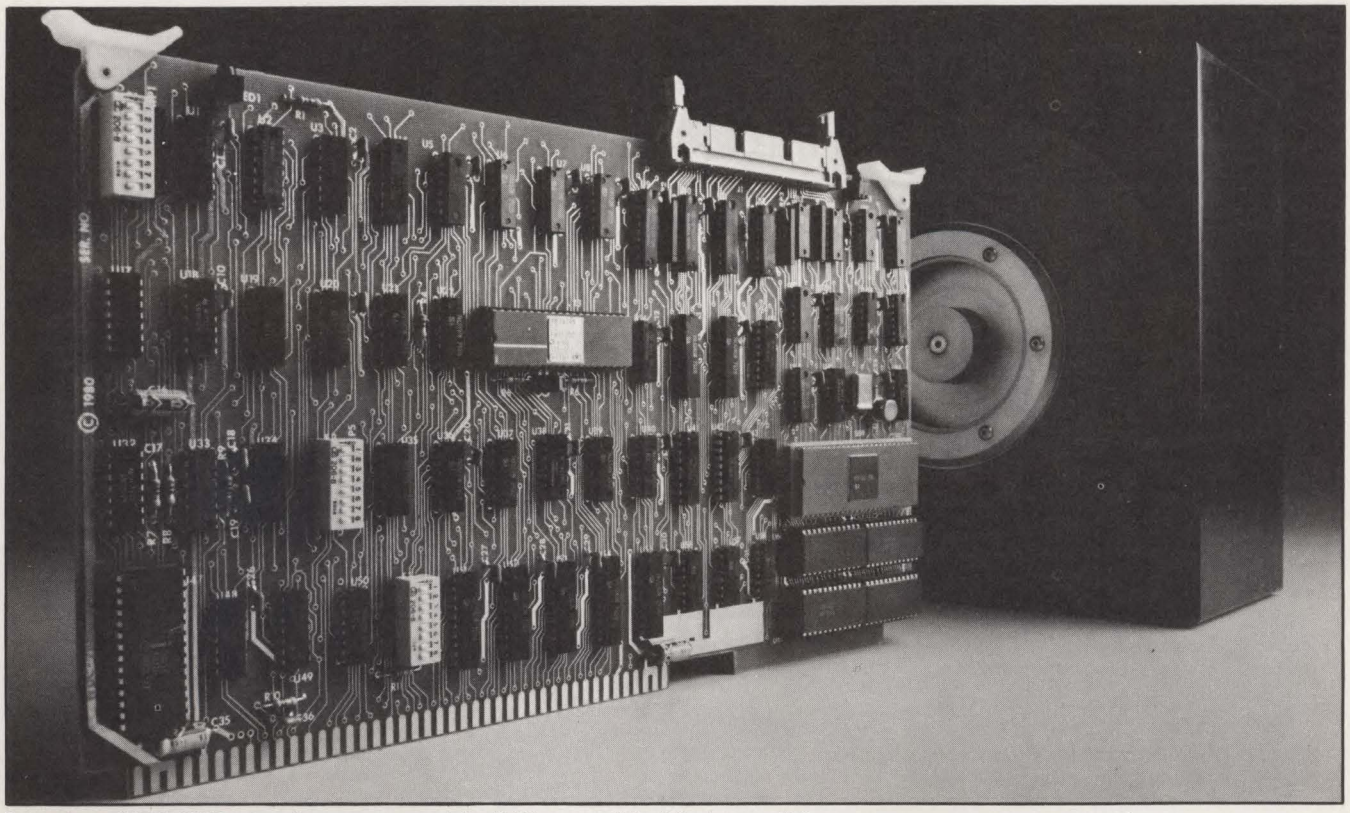
An ANSI standard Winchester controller

MICHAEL E. COPE, Interphase Corp.

New ANSI-compatible Winchester products make solo-source disk selection an unnecessary gamble

The use of 8-in. Winchester-disk drives has been hampered by the lack of a standardized interface. System integrators and OEMs, sobered by the knowledge that the leading edge of technology can often become a bloody edge, have been unwilling to risk their livelihood, and that of their customers, on the performance of any one supplier of the more than 30 announced incompatible Winchester products. In a move of unparalleled speed and industry-wide cooperation, the ANSI X3T9.3 committee, made up of drive and mainframe suppliers and controller houses, published a rigid-disk drive interface standard last Oct. 30, just a year after forming. At least three drive suppliers—3M, BASF and PRIAM—have already announced ANSI-compatible products, with most others announcing their intention to support the standard with both 8- and 5¼-in. offerings.

Interphase Corp., a privately held Dallas controller house has announced the first ANSI-compatible Winchester-disk controller, the WDC 2880, as an addition to its family of hard-disk controllers (MMS, January, p. 6). Compatible with the industry standard Intel Multibus,



Interphase WDC 2880 *controls as many as eight ANSI-compatible Winchester disks.*

Some disk manufacturers have announced 'smart' disk drives that have a substantial amount of 'system intelligence' in the drive.

the WDC 2880 is a single-board intelligent controller that can handle as many as eight ANSI-compatible drives from any manufacturer. Other controller houses are expected to follow suit before year-end.

The ANSI X3T9.3 standard defines the basic mechanical and electrical interface between the disk drive and controller. Cable and connector types are specified as a single standard, 50-pin flat cable to be daisy-chained to multiple drives. Three signal groups are fully specified to signal definitions—relative timing, direction and electronic characteristics.

An asynchronous, bidirectional 8-bit control bus, with strobes and acknowledges, carries "command sequences," such as SEEK, REZERO, CLEAR FAULT, CLEAR ATTENTION, REPORT STATUS, etc. A second signal group contains timing-dependent signals, such as READ GATE, WRITE GATE, INDEX, SECTOR MARKET, ATTENTION and BUSY. The third signal group contains NRZ-style READ DATA, READ CLOCK, WRITE DATA and WRITE CLOCK, and uses differential techniques to improve noise characteristics. All data transfers between disk/controller are serial at a rate as high as 10M bytes per sec.

A set of "mandatory" command codes for such basic functions as SEEK, REZERO, etc., are required to be the same in all drives. A set of optional command codes for such niceties as turning the spin motor on or off, system reconfiguration, track offset and write protecting certain tracks are fully specified, but may not be found in all drives. A set of undefined command codes are reserved for vendor-unique functions.

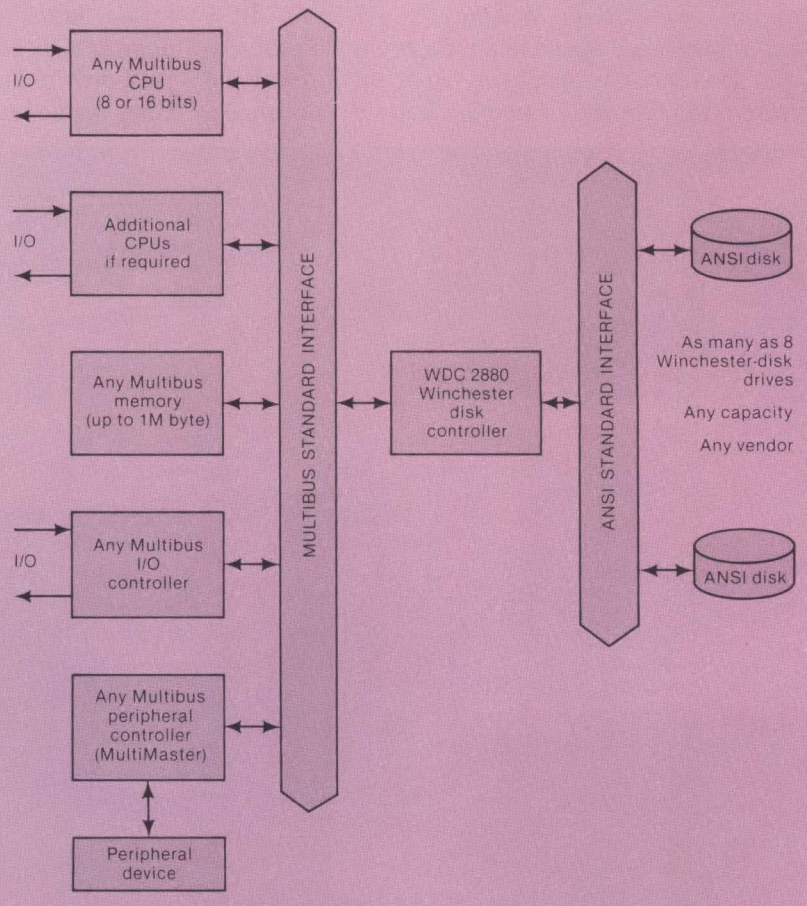
What ANSI does not specify is just as important. Such items include data capacity, seek speeds, encoding techniques, physical size, number and removability of platters, bit and track density, number and type of heads, other performance criteria, price and delivery, leaving plenty of room for competition among disk

STANDARDIZATION MEANS FLEXIBILITY

By combining two powerful standards, the Intel Multibus μc bus standard and ANSI Winchester disk standard, a system designer realizes both flexibility and modularity. Any of a number of 8- or 16-bit CPUs using 8080, 8085, 8086, Z80, Z8000 or other processors can be used, with as much computing power as the application dictates. Multiple CPUs can be combined for multiprocessing, possibly mixing 8- and 16-bit units. As much as 1M of RAM can include any mix of PROM, ROM or RAM using static, dynamic, MOS, CMOS, bipolar, core, CCD or bubble technologies. Any type of I/O, whether serial or parallel, TTL, isolated relay, opto-isolated, RS232 or RS244 is supported by Multibus products. A variety of intelligent peripheral controllers for floppy disks, tape drives, cartridge disks, communications networks and other devices is readily available from more than 50 Multibus suppliers.

On the Winchester-disk side, ANSI and the WDC 2880 will support a selection of 8- and 5¼-in. drives from 10s to 100s of megabytes with a wide range of speeds and performance characteristics. Initial offerings use fixed media, but removable media, such as the CDC Lark, will support the ANSI interface soon. A designer can select products for both the Multibus and ANSI standards without fear of system obsolescence because the WDC 2880 is inherently upgradeable.

On the software side, Interphase takes upgradeability a step further. All members of the Interphase hard-disk controller family have fully compatible software interfaces. This means that a software driver written for a cartridge-disk system with the HDC 1880 will run unmodified on an SMD 2180 for a storage-module system, and on a WDC 2880 for a Winchester-disk system.



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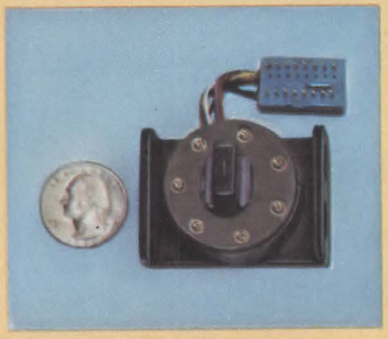
Using a tiny, seven-pin head that weighs less than four ounces, the Microline 82 and 83 produce sharp, crisp copy *and graphics* on plain paper, multipart forms. The unique head is driven bidirectionally by an elegantly simple mechanism at 80 cps in the Microline 82 and 120 cps in the 83. Short line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

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Three signal groups are fully specified to signal definitions—timing, direction and electronic characteristics.

suppliers. The idea is to be different while staying the same. Controller manufacturers must be compatible with all drives and make them all look the same to the user, except with more or less speed, capacity, etc.

The WDC 2880 controller uses all the mandatory commands and takes advantage of the ANSI-specified optional commands when they are supported in a given drive. This means that the drives look interchangeable to the user, as should be the case with any ANSI-compatible controller. But ANSI doesn't specify the nature of the controller/host interface. Speed, intelligence, ease of use, error recovery, ECC capabilities, other system-level characteristics, product and application support availability leave a wide price/performance arena for controllers.

The intelligence partition

The purpose of intelligence in a drive/controller is to off-load the time-consuming and complicated functions of disk access from the CPU, allowing it to do its real job—running application programs. The system programmer should have the disk operating software build an I/O parameter block (IOPB) and have the drive/controller do all the rest.

Some disk manufacturers have recently announced "smart" disk drives that have a substantial amount of "system intelligence" in the drive. Unfortunately this creates a dangerous single-source situation and still ignores the single most important performance-limiting factor—how to get the data into system-accessible memory in the shortest possible time without loading the CPU or system bus. A system designer often finds that his complete system architecture has been changed to match the peculiarities of a smart drive. Even if the initial system works, it is often not flexible enough to adapt to changing customer needs without complete redesign. Even worse, the disk supplier is not forced to respond to market competition once he is "designed in."

A safer and more reasonable system design uses a WDC 2880 controller in combination with any ANSI-compatible drive chosen for its capacity, performance, price and availability to fit the immediate need. The controller embodies all the intelligence and is the system's common denominator. System performance, not merely disk performance, justifies a lot of intelligence.

The WDC 2880's single board plugs directly into any Multibus system. It operates as a bus master and accesses data at maximum Multibus data rates to or from anyplace in Multibus address space, using either absolute or relative addressing modes, with either 8- or 16-bit accesses. It is driven by a common memory resident IOPB containing easy-to-use macro-level commands such as READ SECTOR, WRITE SECTOR, FORMAT TRACK, and can handle multisector and linked transactions over any track or surface boundary.

WDC 2880 FEATURES

- Single Multibus board—5v
- 20-bit expanded Multibus DMA addressing
- Dual addressing modes—absolute and memory-sector relative
- 8- or 16-bit data bus—software selectable
- Simple macro commands
- IOPB driven
- Software-compatible with SMD 2180 and HDC 1880
- Controls as many as eight Winchesters drives with the ANSI X3T9.3 interface
- Automatic error recovery
- Hardware error correction
- Overlapped seeks
- Bad-track mapping
- Multisector transfers
- Linked IOPBs
- High throughput rate (Multibus bandwidth limited)
- Diagnostic error reporting
- Software drivers for CPM and ISIS II
- Firmware-controlled for flexibility
- 62 ICs on a double-sided board for high reliability

All seeks, data verification, error recovery and other disk-control and data transactions are automatically handled in μcode without any CPU or bus integration. Hardware ECC logic recovers hard errors as long as 11 bits. Sector interleaving, ECC and a full-sector data buffer mean maximum data-throughput rates with only verified and corrected data being put into system memory, and without danger of data-overflow errors caused by intermittent heavy system-bus loading, regardless of bus priority. A bad-track-mapping feature off-loads the management of disk-surface imperfections, a messy job commonly relegated to disk-operating software.

Drive, controller and system problems are automatically diagnosed and reported using a "most-primitive-error-first" reporting system that keeps a secondary problem from masking a more primitive one. With more than 50 meaningful error codes, the exact source of the problem can almost always be pinpointed over the telephone.

WDC 2880 intelligence is in its bipolar μp, a Signetics 8X300 and a set of PROMs, enabling the controller to respond to future disk features or special customer requirements by adding new μcode, an almost-mandatory attribute in the dynamic Winchester-disk market.

The final partition factor for system designers with high potential volume is the possibility of licensing the controller design for their own manufacture, thereby reducing costs and increasing profits. ■

Michael E. Cope is president of Interphase Corp., a privately held controller house in Dallas.

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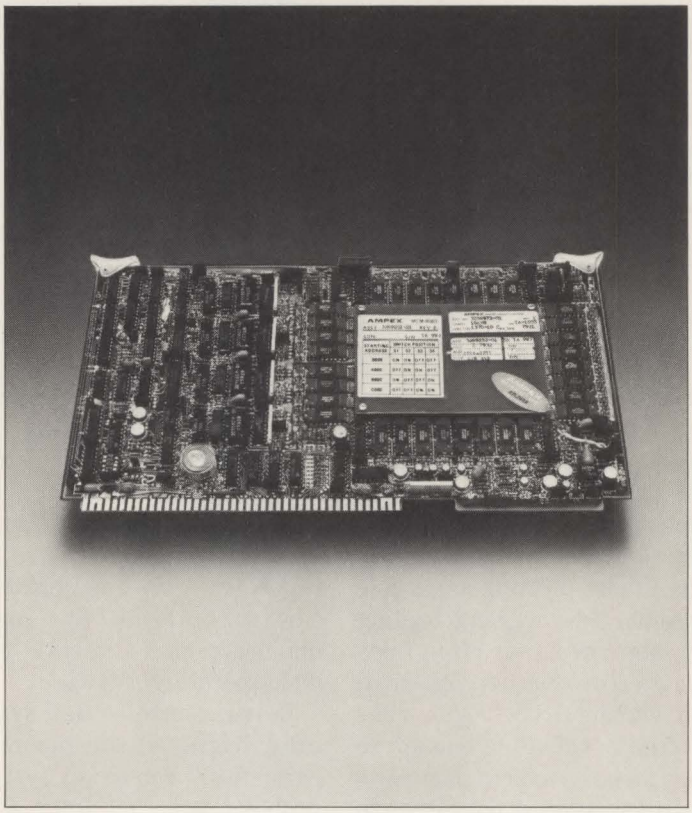
16K BYTES $885.



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Ampex MCM-8080 RAM provides 16K bytes of non-volatile memory, is Multibus* compatible, and occupies only one card slot. And all at a price that will make you smile: $885.

8080 RAM. It's just one of a complete line of Ampex computer memories.

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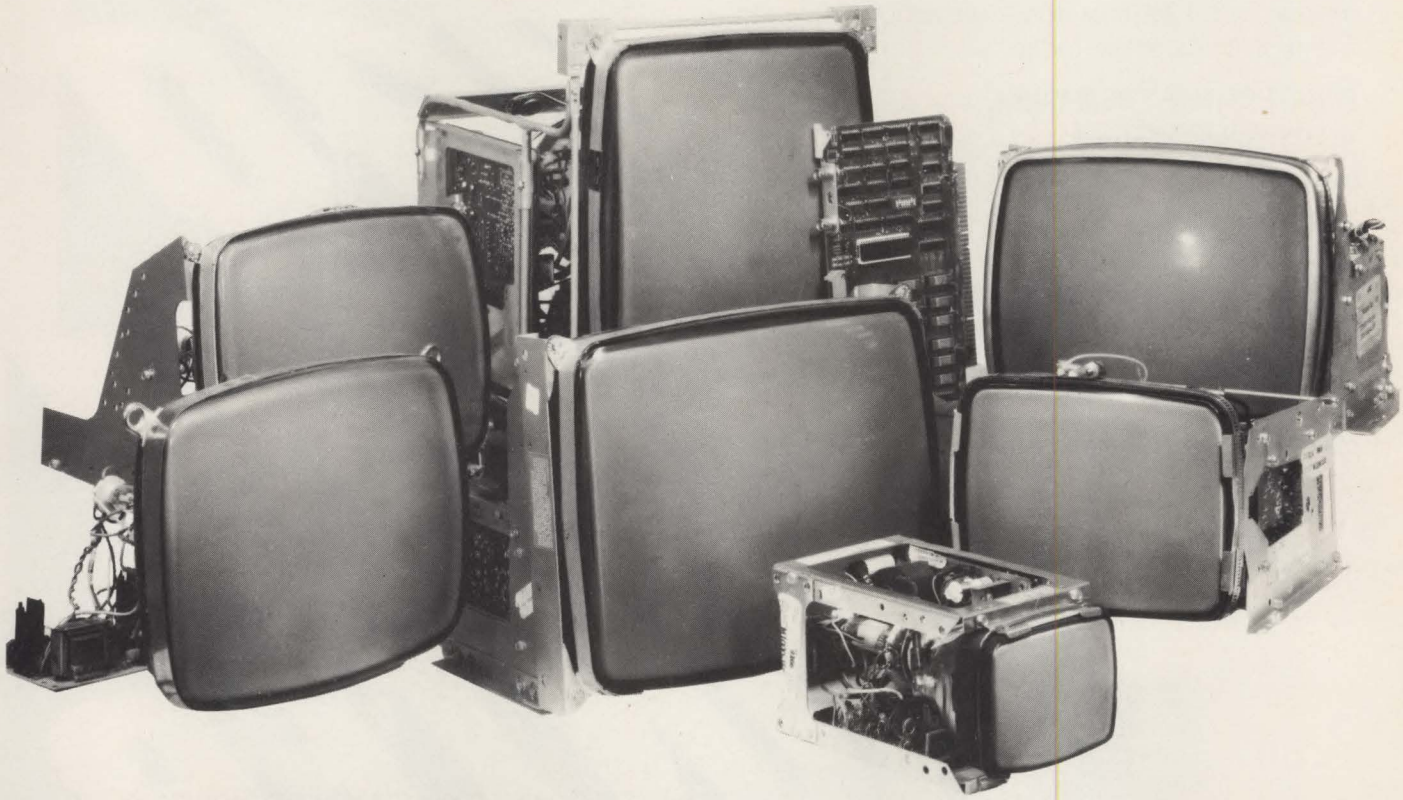

Every Motorola module, from 5″ to 23″, is available in a variety of configurations and electrical specifications to meet the most diversified customer needs. It is this flexibility—adapting basic design to individual user specs—that has kept Motorola in the forefront of CRT display technology.

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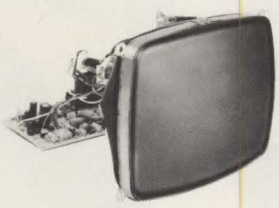

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Now you can leave your tape drive at home. Hook up our 9800R and get disk-based, on-line field processing. That takes the guessing out of field recording. You know what you've got. What's going on. Now. Not later when you may be forced into a costly repeat.

Oil exploration. Processing plants. Or unforgiving military uses. The 9800R changes the way you apply computers.

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READY-TO-USE INTEGRATED SYSTEM.

Plug the supplied interface into your CPU. And you're up and running. On-line storage with specs that give you 10,000 hours of power-on MTBF. An impressive 30 minutes MTTR. No scheduled maintenance.

Packaged in a 7¼-inch RETMA enclosure, the 9800R contains a field-proven, shock-mounted 8-inch Winchester. With a choice of 10 or 20 Mbytes of storage. Expandable. Average access time only 35ms. Embedded Z80-based controller with diagnostics. Shock-mounted switching power supply. Call Dataflux Marketing/Sales today to find out about the disk system that thrives where others can't survive.

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DISK DRIVES

Maturity marks floppy market

MALCOLM L. STIEFEL, Contributing Editor

Price competition now characterizes a business formerly typified by performance leapfrogging; Shugart sales top 500,000 units

The attainment of maturity in a product category can be easily recognized: it is usually followed by a switch from performance competition to price competition among vendors. In the case of floppy-disk drives, it is also characterized by the achievement of a significant milestone: the sale of 500,000 minifloppy units by Shugart Associates (Fig. 1), the leading vendor. Amazingly, floppies have reached this impressive level of acceptance in less than 10 years. But technological progress in floppy-disk drive performance has slowed to a crawl, as prices for drives have dropped to $200 in OEM quantities.

A maturing industry is characterized not only by price competition, but also by a gradual reduction in the number of competitors, as the efficient producers squeeze out the marginal ones. Look for this to happen in the next few years: the floppy-disk drive market will continue to expand, but there will be fewer and fewer suppliers.

The floppy market itself will be secure until the price of hard-disk drives becomes comparable with floppy prices, and that isn't likely for a while. Other technologies—such as bubble memories—that are still expected to challenge floppy-disk drives remain too expensive to compete as auxiliary small-system storage.

U.S. manufacturers will inevitably feel heat from the Orient, as Japanese manufacturers attempt to penetrate the U.S. market, but U.S. vendors don't seem worried. Dennis Ammons, marketing vice president at PerSci, Inc., Los Angeles, points out that fabrication of a floppy-disk drive involves relatively few parts and relatively little labor. Thus, the Japanese will not be afforded the advantage they realize in other product categories where lower labor costs make their units

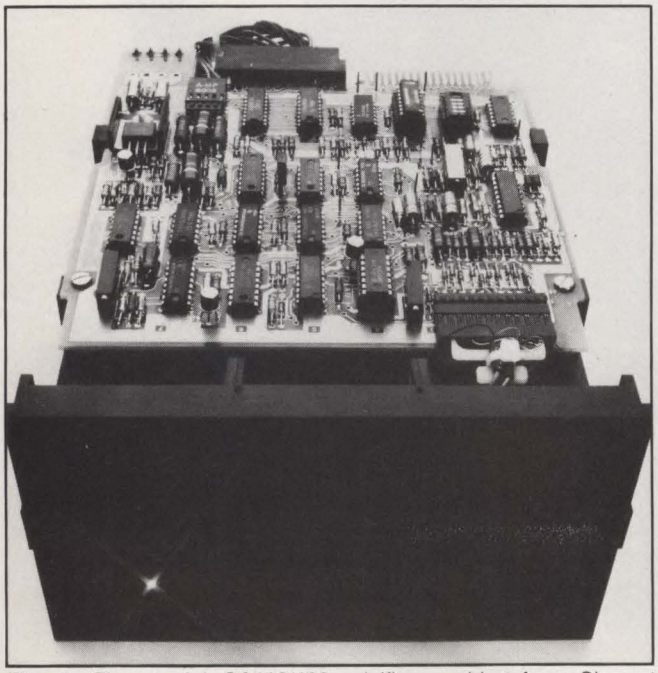


Fig. 1. The model SA410/460 *minifloppy drive from Shugart Associates.*

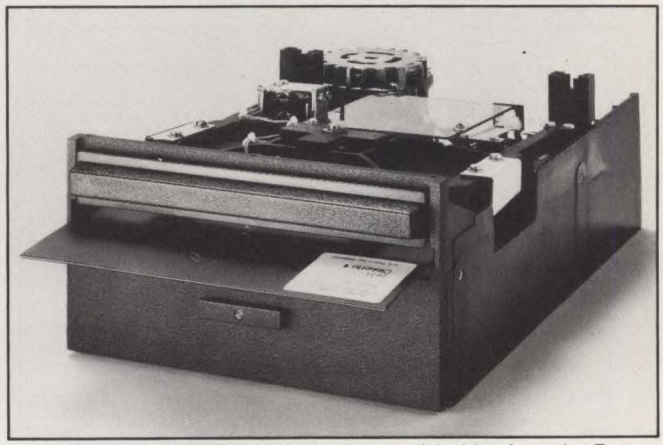


Fig. 2. The model RFD 4000 *8-in. floppy-disk drive from the Remex Division of Ex-Cell-O Corp.*

Demand for floppies continues unabated, despite the advent of 8- and 5¼-in. Winchester drives in the last two years.

more competitive with U.S. products.

The race, then, will be not to the swiftest, or the smartest, but to the most mature.

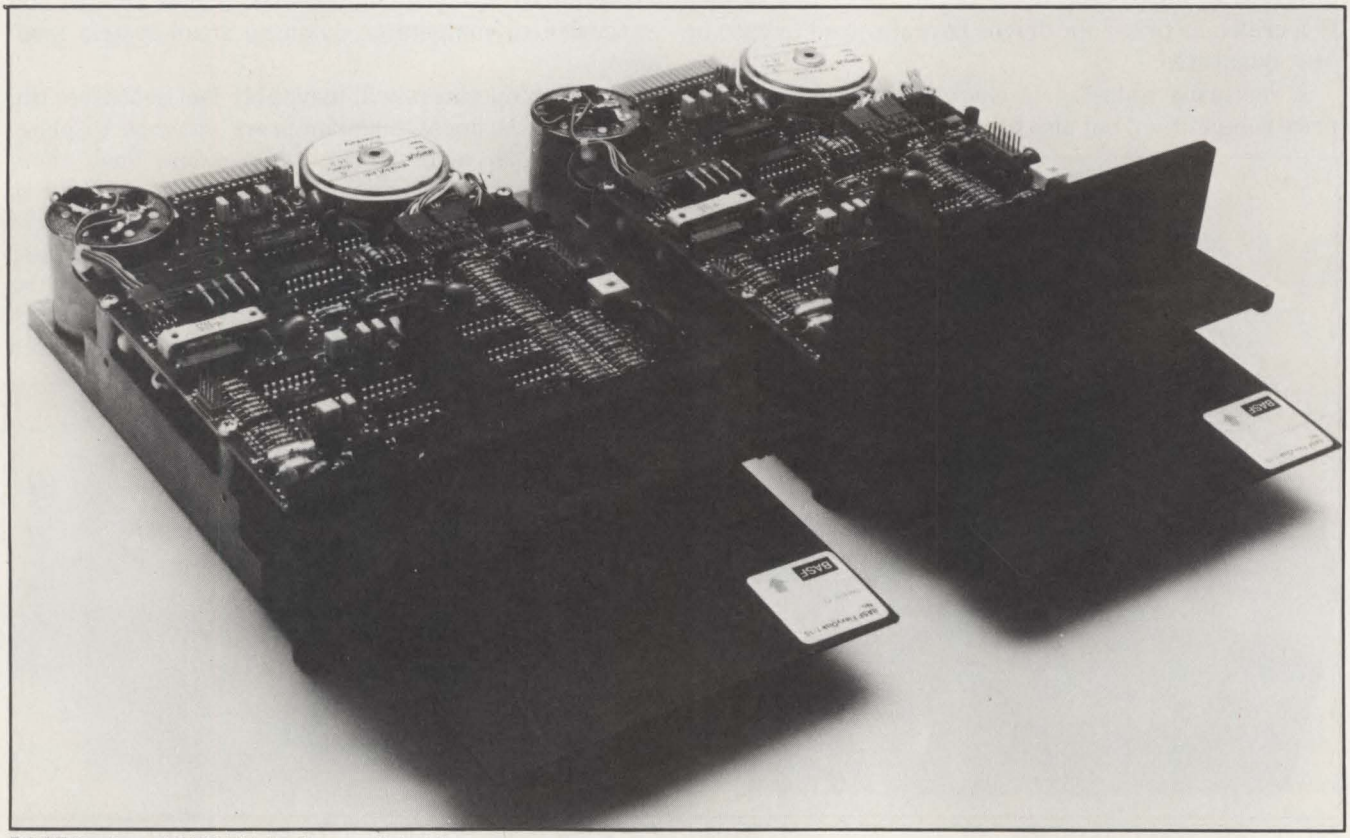
Demand for floppies continues unabated, despite the advent of 8- and 5¼-in. Winchester drives in the last two years, which has effectively sliced off part of the floppy market, In fact, the arrival of the small Winchester partly explains why floppy performance—measured in storage capacity per diskette and in access time—has not continued to show the progress exhibited in earlier years.

A Winchester is designed for high-volume use in applications demanding rapid random access. For example, the fixed-media 10M-byte Winchester can serve as virtual memory storage for a μc or a minicomputer, with average access time of 70 msec., including latency, and a data-transfer rate of 500K bytes per sec. As the accompanying product table indicates, a typical 8-in. floppy-disk drive (Fig. 2) has an average access time of 200 msec. or more, and formatted storage capacity of 1.3M bytes (1.6M bytes unformatted) in a double-density, double-sided configuration, with a data-transfer rate of 62.5K bytes per sec. These figures are not appropriate for virtual memory applications that require rapid access, rapid transfer of data and high storage capacity.

Fig. 3. Commodore Business Machines' *model 8050 contains two 5¼-in. drives.*

The floppy, however, is much better suited to data-entry and word-processing applications, in which data rates are low, response time requirements are modest, and storage capacities are fairly low. Consider a typical data-entry or word-processing application with an operator keying rate of 6000 characters (strokes) per hr. The data is keyed into a buffer, and recorded on the floppy in 256-byte increments. The interval between accesses is thus 2.5 min., and an access time of several hundred msec. will not adversely affect the operation. With a double-buffered system, an operator works without interruption while the data is being stored on the floppy.

The floppy-disk drive originally was conceived as a replacement for a keypunch, and its performance parameters were established with this application in



BASF Systems' *6106 5¼-in. floppy-disk drive.*

Whether you want streaming or start/stop, Cipher has the tape drive you need.

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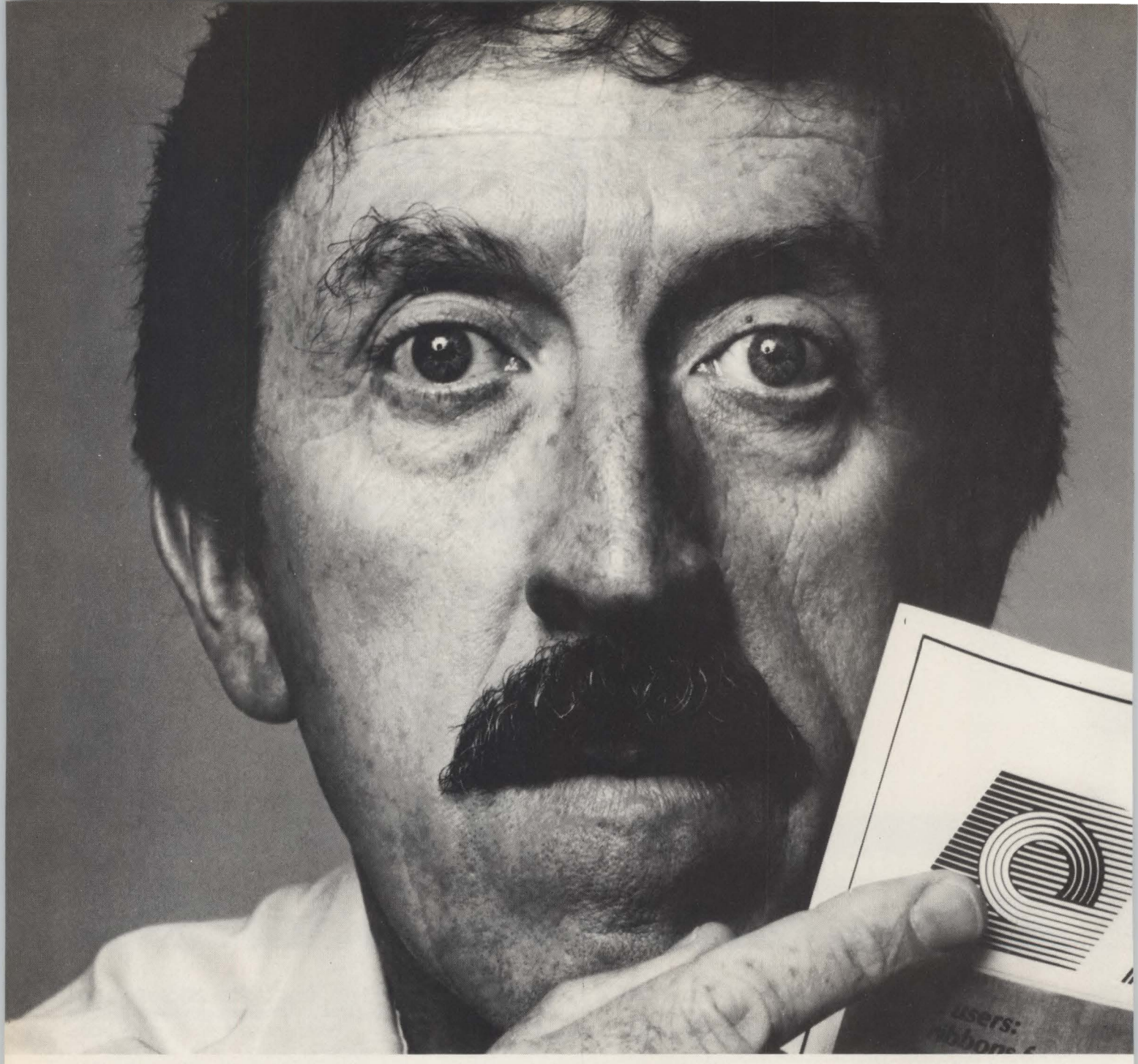

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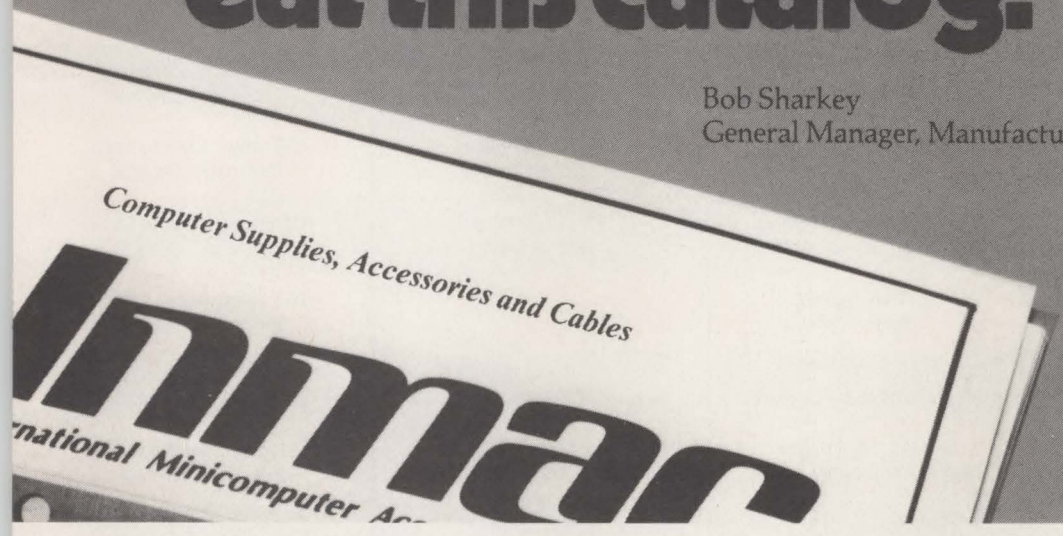

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TABLE OF FLOPPY-DISK DRIVE MANUFACTURERS

The following table is provided as a guide to evaluating vendors of floppy-disk drives. *Mini-Micro Systems'* staff prepared the table from its own sources and from information supplied by James Porter, publisher of *1980 Disk/Trend Report*, and by GML Corp., Lexington, Mass.

Manufacturer and Model No.	Data Capacity (per diskette)	Diskette Diameter; Sectoring	Access Time (including latency)
BASF Systems 6100 series	0.125M to 1.6M bytes single- and double-sided	5¼-and 8-in. diameters; hard and soft sectoring	140-192 msec. track to track; 214-340 msec. average
Burroughs Corp. 9489 series, MD 122	0.24M to 3.13M bytes single- and double-sided	8-in. diameter; hard and soft sectoring	95-222 msec. track to track; 364-410 msec. average
Caldisk 140 series, 14M series	0.219M to 1.6M bytes single- and double-sided	5¼- and 8-in. diameters; hard and soft sectoring	129-148 msec. track to track; 180-277 msec. average
Canon USA, Inc. MDD 6106; MDD 6108	0.125M to 0.5M bytes single- and double-sided	5¼-in. diameter; hard or soft sectoring	192 msec. track to track; 340 msec. average
Charles River Data Systems MF-211, FD-211, FD-411, MF-411	0.4M to 1.6M bytes; single- and double-sided	8-in. diameter; soft sectoring	134-146 msec. track to track; 220-332 msec. average
Commodore Business Machines 4040, 8050, 2031, 8060 series	0.175M to 1.6M bytes; single- and double-sided	5¼- and 8-in. diameters; soft sectoring	
Control Data Corp. 9400 series; 210-10	0.109M to 1.6M bytes; single- and double-sided	5¼- and 8-in. diameters; hard and soft sectoring	146-168 msec. track to track; 220-415 msec. average
Cyberchron Corp. CFD-211	0.4M to 0.8M bytes; single-sided	8-in. diameter; soft sectoring	134 msec. track to track; 332 msec. average
Data General Corp. 6096	1.26M bytes (formatted); double-sided	8-in. diameter; soft sectoring	135 msec. track to track; 183 msec. average
Data Master Megamaster 2, Megamaster 4	0.544M to 1.088M bytes; single- and double-sided	5¼-in. diameter; soft sectoring	133 msec. track to track; 297 msec. average
Datapoint Corp. 9381 series	0.256M bytes; single-sided		149 msec. track to track; 396 msec. average
Data Systems Design, Inc. models 430, 440, 470, 480	0.4M to 1.6M bytes; single- and double-sided	8-in. diameter; soft sectoring	134-135 msec. track to track; 209-331 msec. average
Decitek Corp. DF-8000/S, DF-8002/S	0.4M to 1.6M bytes; single- and double-sided	8-in. diameter; hard and soft sectoring	135 msec. track to track; 264 msec. average
Digital Equipment Corp. RX01, RX02	0.256M to 0.512M bytes	8-in. diameter; soft sectoring	125 msec. track to track; 273 msec. average
Hitachi America, Ltd. FDD 101A, FDD 201, FDD 401, FDD 403	0.36M to 1.6M bytes; single- and double-sided	8-in. diameter; soft sectoring	130-171 msec. track to track; 245-328 msec. average
IBM Corp. Various models for 370, System/32, System/34, System/38, Series/1, 8100, 5100 computers and terminals	0.243M to 1.212M bytes; single- and double-sided	8-in. diameter; soft sectoring	213 msec. track to track (typical); 1467 msec. average (typical)
Innotronics Corp. models 410, 420	0.4M to 0.8M bytes; single-sided	8-in. diameter; soft and hard sectoring	129 msec. track to track; 327 msec. average
Isotimpex ES 5074, Mini Floppy	0.109M to 0.4M bytes; single-sided	5¼- 8-in. diameters; hard and soft sectoring	
Memorex Corp. models 651, 550	0.312M to 0.8M bytes; single-sided	8-in. diameter; hard and soft sectoring	134-140 msec. track to track; 282-343 msec. average
Mera Metronex PLX450	0.4M bytes; single-sided	8-in. diameter; soft sectoring	203 msec. track to track; 256 msec. average

Media Compatibility	Price	For More Information, Circle No.
IBM Diskette 1, 2, 2D; BASF 601, 606; Shugart 104, 105, 154, 155	$200-$270	422
IBM Diskette 1; Special	$1750	423
IBM Diskette, 1, 2, 2D; Shugart 104, 105, 154, 155	$252-$550	424
Shugart 104, 105, 154, 155		425
IBM Diskette 1, 2, 2D	$2900-$5380	426
IBM Diskette 1, 2, 2D	$1295-$1795	427
CDC 9821/3/5; IBM Diskette 1, 2, 2D	$340-$565	428
IBM Diskette 1	$2995	429
DG 1189	$4000-$5400	430
	$500-600	431
IBM Diskette 1		432
		433
IBM Diskette 1, 2, 2D	$365-$520	434
DEC RX01K; IBM Diskette 1		435
IBM Diskette 1, 2, 2D	$450	436
IBM Diskette 1, 2, 2D		437
IBM Diskette 1		438
IBM Diskette 1		439
FD/IV; IBM Diskette 1	$450-$600	440
IBM Diskette 1		441

Floppies were less susceptible to the disasters that could befall keypunch cards, which the floppy was designed to replace.

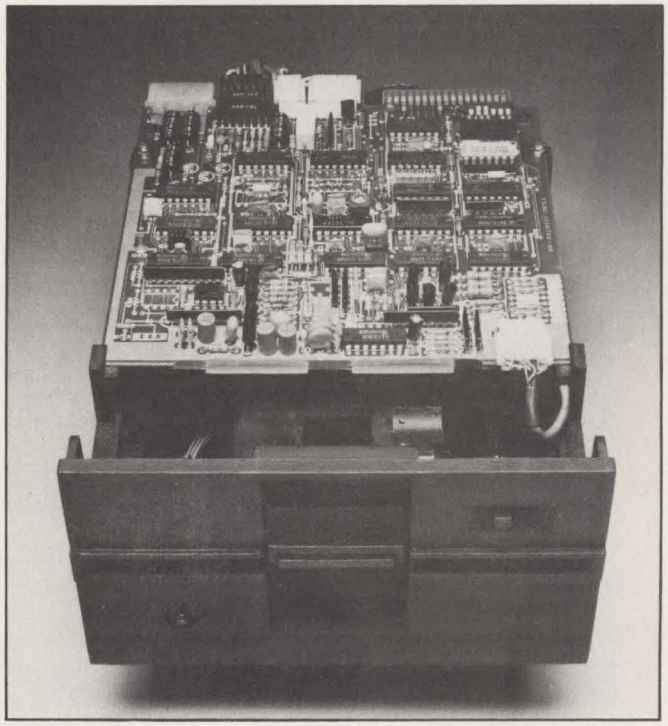
mind. The single-sided, single-density unit that IBM Corp. first unveiled had a formatted capacity of 256K bytes, equivalent to 3200 80-column card images. The diskette could replace a box and a half of cards, require less space, cost less to mail and be easier to handle.

Floppies were less susceptible—or not at all susceptible—to the disasters that could befall cards: dropping and scrambling of a deck; coffee spills; lost, folded, bent or mutilated cards. The floppy medium was more expensive ($10 for 3200 records versus $3 for 3200 cards), but the drive cost about as much as a keypunch.

Junior-sized floppies with 5¼-in.-diameter disks were introduced in 1976 to replace cassette recorders as a sequential storage medium for μcs. They had greater capacity and much faster throughput than cassette units, although the drives were much more expensive than cassette recorders: ($500 or more for floppies versus $100 or less for cassettes).

The floppy disk was quickly accepted, and, as the huge size of the market became apparent, dozens of vendors were attracted. The competition spurred R & D efforts that increased storage capacities and lowered access times. In the last few years, unit reliability has improved, but the technological race has slowed, and price competition has begun to dominate.

Most of the prices shown in the product table are unit prices for quantities of 500. In a few cases, such as the Commodore Business Machines offering (Fig. 3),



TEAC Corp.'s *FD-50 floppy-disk drive.*

Manufacturer and Model No.	Data Capacity (per diskette)	Diskette Diameter; Sectoring	Access Time (including latency)
MFE Corp. models 500, 700	0.4M to 1.6M bytes; single- and double-sided	8-in. diameter; hard and soft sectoring	136 msec. track to track; 210 msec. average
Micro Peripherals, Inc. models 51, 91, 52, 92, 41, 42	0.125M to 1.6M bytes; single- and double-sided	5¼- and 8-in. diameters; hard and soft sectoring	136-155 msec. track to track; 210-283 msec. average
Micropolis Corp. 1000 series, SBC series	0.143M to 1.170M bytes; single- and double-sided	5¼-in. diameter; hard and soft sectoring	200 msec. track to track; 307-457 msec. average
Miltope Corp. DD-400; DD-450	0.4M to 1.6M bytes; single- and double-sided	8-in. diameter; soft and hard sectoring	114 msec. track to track; 238 msec. average
NEC Information Systems, Inc. FD1160	1.6M bytes	8-in. diameter; soft sectoring	153 msec. track to track; 277 msec. average
Olivetti Corp. FDU 6102, AFD 6102, FDU 5600	0.242M to 0.284M bytes; single-sided	8-in. diameter; soft sectoring	123 msec. track to track; 410 msec. average
Parasitic Engineering, Inc. Maxi-Disk	0.29M bytes; single-sided	8-in. diameter	129 msec. track to track; 271 msec. average
PerSci, Inc. models 277, 299	0.4M to 1.6M bytes; single- and double-sided	8-in. diameter; hard and soft sectoring	133 msec. track to track; 163 msec. average
Pertec Computer Corp. FD 410, FD 650, FD 200, FD 250, FD 500 series	0.125M to 1.6M bytes; single- and double-sided	5¼- and 8-in. diameters; hard and soft sectoring	136-170 msec. track to track; 210-478 msec. average
Qume Corp. Datatraks 8 and 5	0.25M to 1.6M bytes; double-sided	5¼- and 8-in. diameters; soft sectoring	136-177 msec. track to track; 210-325 msec. average
Remex Division RFD 2000 and 4000 series; RFS 2400; models 20, 24; RFS 4800; models 40, 48	0.256M to 1.6M bytes; single- and double-sided	8-in. diameter; hard and soft sectoring	136 msec. track to track; 210 msec. average
Ricoh RD-2, RD-2D	0.225M to 0.985M bytes; single- and double-sided	8-in. diameter; soft sectoring	129 msec. track to track; 277 msec. average
Scientific Micro Systems FT0500, FT02001	0.4M to 1.6M bytes; single- and double-sided	8-in. diameter; soft sectoring	136-141 msec. track to track; 210-338 msec. average
Shugart Associates SA800, SA801, SA850, SA851, SA400, SA450, SA410, SA460	0.125M to 1.6M bytes; single- and double-sided	5¼- and 8-in. diameters; hard and soft sectoring	116-146 msec. track to track; 220-457 msec. average
Siemens Corp. FDD 100, FDD 200 series	0.125M to 1.6M bytes; single- and double-sided	5¼- and 8-in. diameters; hard and soft sectoring	125-190 msec. track to track; 199-498 msec. average
Sykes Datatronics, Inc. 7150, 7250, 9150; 9250	0.256M to 0.631M bytes	8-in. diameter; hard and soft sectoring	149 msec. track to track; 297 msec. average
Tandon Magnetics Corp. TM 100 series	0.125M to 1.0M bytes; single- and double-sided	5¼-in. diameter; hard and soft sectoring	118-120 msec. track to track; 182-195 msec. average
Tarbell Electronics VDS-II series	0.4M to 1.6M bytes; single- and double-sided	8-in. diameter	
Teac Corp. FD-100, FD-50 series	0.125M to 1.6M bytes; single- and double-sided	5¼- and 8-in. diameter; hard and soft sectoring	153-170 msec. track to track; 478-812 msec. average
Techtran Industries, Inc. MicroDisc 950, MicroDisc 951	0.2M bytes (formatted); single-sided	5¼-in. diameter; soft sectoring	225 msec. track to track; 652 msec. average

Media Compatibility	Price	For More Information, Circle No.
IBM Diskette 1, 2, 2D	$330-$490	442
Shugart 104, 105, 154, 155; IBM Diskette 1, 2, 2D	$220-$530	443
Micropolis 1081; Shugart 105	$265-$1250	444
		445
	$565	375
IBM Diskette 1		446
	$845	447
IBM Diskette 1, 2, 2D	$1050-$1600	448
IBM Diskette 1, 2, 2D; Shugart 104, 105, 154, 155	$215-$490	449
IBM Diskette 1, 2, 2D; Shugart 154	$350-$560	450
IBM Diskette 1, 2, 2D	$350-$1710	451
IBM Diskette 1, 2, 2D		452
IBM Diskette 1, 2, 2D		453
Shugart 100, 101, 102, 103, 104, 105, 107, 154, 155, 157, 150, 151; IBM Diskette 1, 2, 2D	$300-$520	454
IBM Diskette 1, 2, 2D; Shugart 104, 105, 154, 155	$210-$480	455
IBM Diskette 1		456
Shugart 154, 155, 157	$200-$375	457
IBM Diskette 1, 2, 2D	$2488-$2799	458
IBM Diskette 1, 2, 2D; Shugart 104, 105; Micropolis 1081	$200-$260	459
	$1485-$2125	460

Early problems with double-sided drives appear to have been solved, and the units are becoming the overwhelming favorites of OEMs and end users.

single-quantity prices are given. End-user prices are substantially higher than OEM prices, although the table does not indicate the number of units for which a given price applies, or the nature of the options included.

Storage capacity and size

Diskettes can be recorded on one side or on both sides, at densities as high as 10,000 bits per in. The drives are designed to accommodate the medium. The "standard" or full-sized drive, introduced in the early 1970s, uses an 8-in.-diameter diskette, with each surface holding as much as 0.4M bytes of data for single-density recording, and 0.8M bytes for double-density recording. The corresponding capacities for the two-sided disks are 0.8M bytes (single density) and 1.6M bytes (double density).

Most manufacturers of standard-sized floppy drives offer both single- and double-sided versions at single and double density. For example, Charles River Data Systems provides single-sided recording in its model FD 211, and double-sided recording in its model FD 411. Both units can handle single- and double-density recording; the host computer determines which recording density is to be used.

The disk controller formats the diskette upon command of the host computer to facilitate recording of data. Only 60 to 80 percent of the unformatted capacity is available for user data storage. The remainder is consumed by inter-record gaps, record headers, error-check codes and other overhead functions. The amount of overhead required depends on the format chosen.

Sectoring considerations

In a soft-sectored format (Fig. 4), the diskette has a single index hole; the beginning of each track is sensed when the index hole passes a photocell on each revolution of the diskette. Then the controller determines the format of data on the tracks. In the industry-standard (IBM) single-density format, for example, each track contains 26 blocks, or sectors, each holding 128 bytes of user data. Each surface holds 77 tracks, with a total of 256,256 bytes. A typical double-density format provides 512,512 bytes per surface.

Remex offers a variety of soft-sectored formats in its RFS 2400 and RFS 4800 models, in addition to the standard IBM formats, such as single-density, 256 bytes per sector, 15 sectors per track, 295,670 bytes per surface; double-density, 8192 bytes per sector, eight sectors per track, 630,784 bytes per surface.

The design and head finish of Tandon's TM-100 series permit the head to remain loaded even when the drive isn't being used.

Shugart (but not IBM) offers hard-sectored diskettes (Fig. 4a) that have 32 equally spaced sector holes lying on a circle that also passes through the index hole. The sensing of a sector hole signals the start of a sector, and the number of bytes per sector is fixed at 128 bytes in single density and 256 bytes in double density, yielding 315,392 and 630,784 bytes per surface, respectively.

Both these figures exceed the corresponding standard soft-sectored capacities. But the soft-sectored diskette remains more popular than the hard-sectored version because the mechanism is less complex—although the controller is more complex—and can be built to less stringent tolerances. Users also have more control over the formats with soft sectoring. All industry-standard drives are soft-sectored; industry observers expect that the hard-sectored units will disappear with the advent of single-chip, soft-sectored controllers.

These same observations can be extended to a 5¼-in. floppy. Primary vendors are Shugart and Micropolis Corp. Single- and double-density, and single- and double-sided versions, hard- and soft-sectored (Figs. 4c and 4d) are available. Formatted capacities range from 70K bytes in some of the older, single-sided, single-density versions to more than 700K bytes in the newer, double-sided, double-density versions.

Double-sided drives had serious problems when they first came out; many units wound up back in the factory for repairs after only a short time in the field. Recording was unreliable, data wrote through from one surface of the diskette to the other, and misaligned heads scored the media. But these problems appear to have been solved, and double-sided units are becoming the overwhelming favorites of OEMs and end users. Micropolis cites a 50-50 sales split between single-headed and dual-headed drives; PerSci claims that 80 percent of its shipments are two-sided units.

The first IBM units—and those that remain on the market—were appallingly slow, even in data-entry

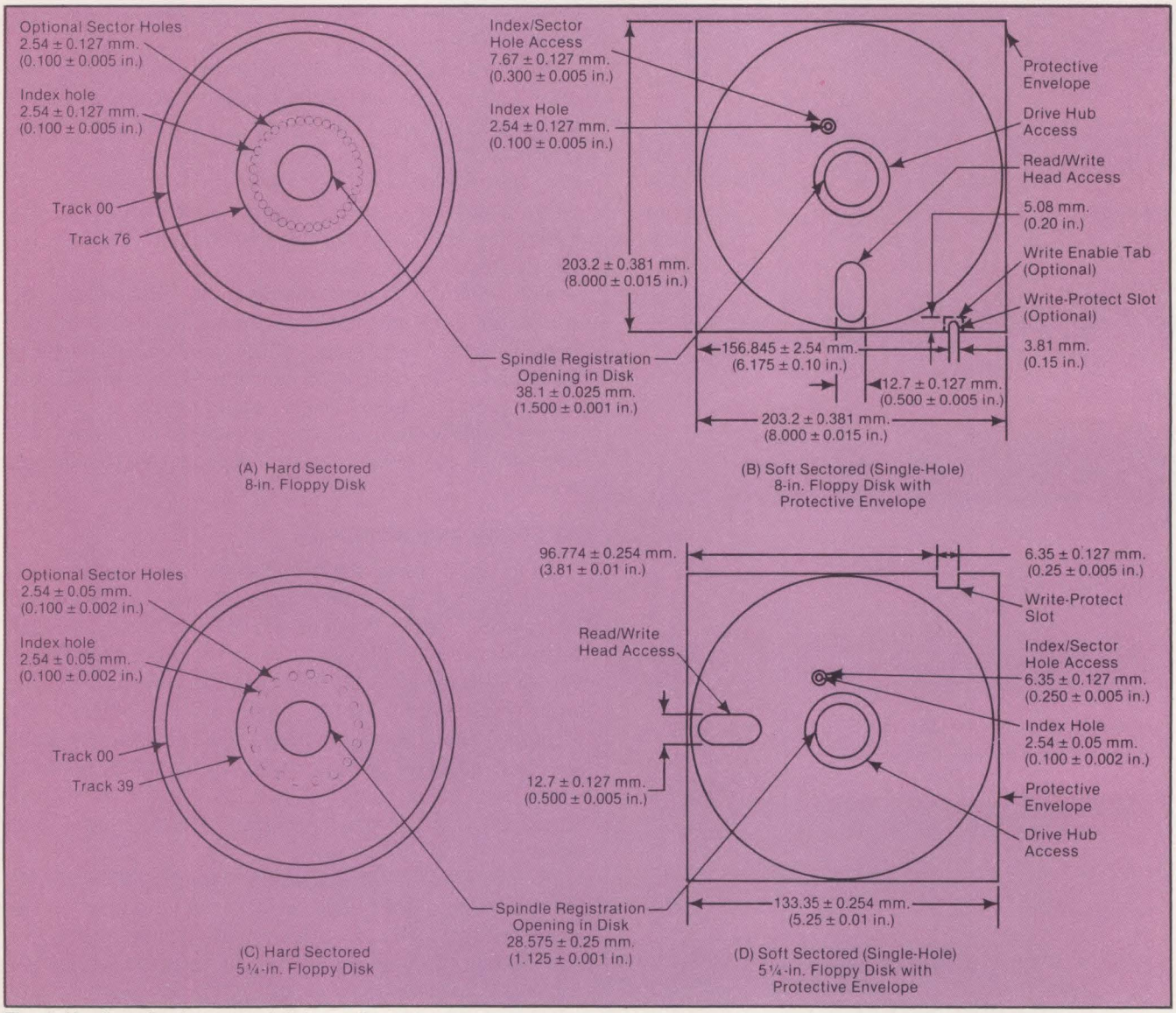


Fig. 4. Hard- and soft-*sectored diskette diagrams.*

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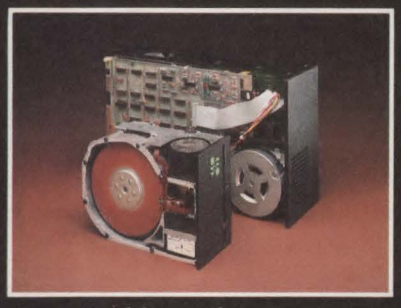
Our drive is smaller, more cost-effective and easier to back up. Some eight-inch Winchester drives require AC power. This complicates system integration and produces extra heat that can mean additional cooling. We use only 22 watts.



A better choice:
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Try our micro-Winchester with your floppy-based system.

Our drive has the same track capacity as your double density 8-inch floppy. This means minimal software conversion. You'll find it easier to trade up users, because they can use the same data base.

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Like the minifloppy, the micro-Winchester has dimensions of 5¾" by 3¼" by 8". It uses the same voltages (+12 and +5) and requires no AC power. Give your customers almost 15 times the capacity of a double-sided minifloppy at less than three times the cost.

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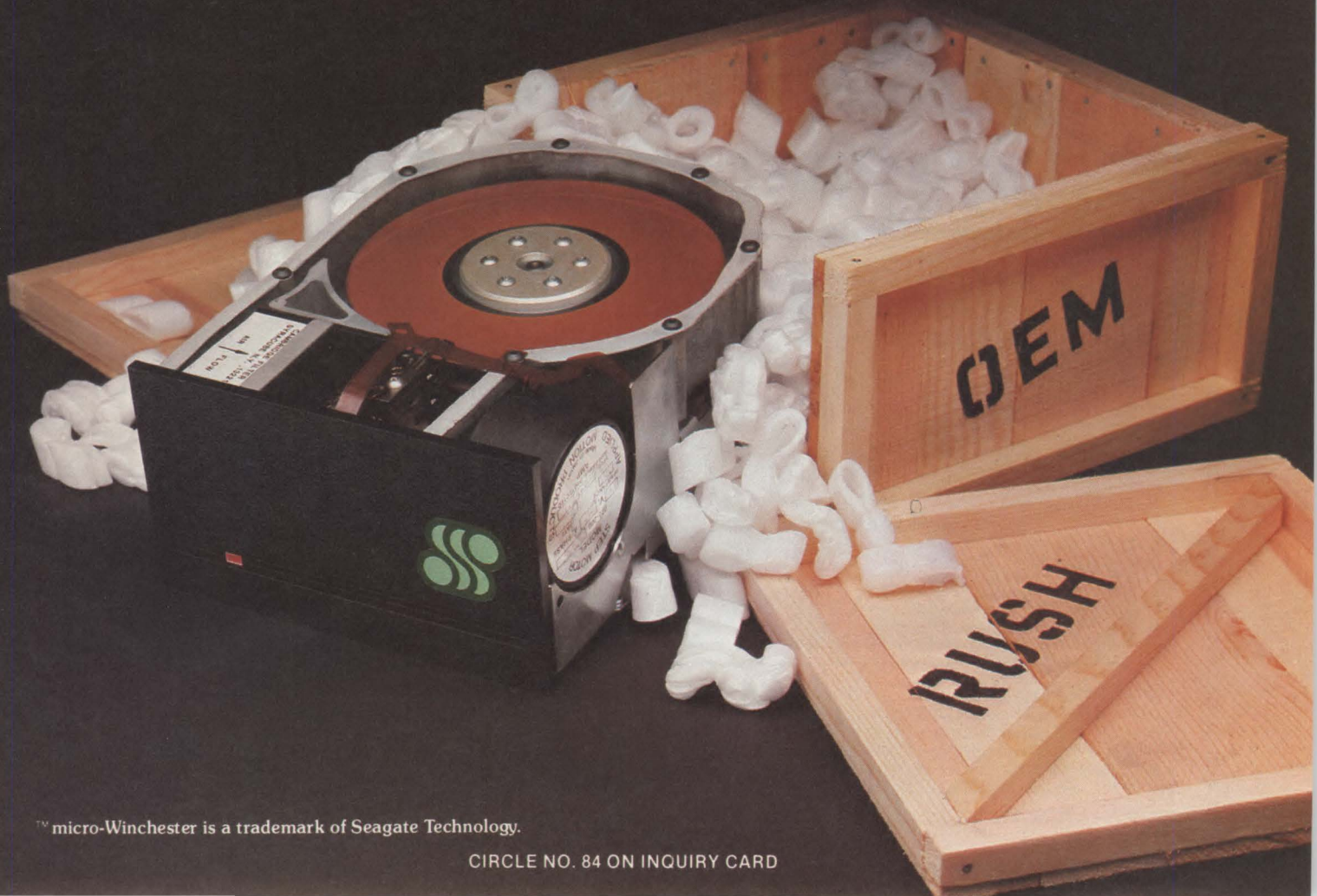

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Track-to-track and average figures are computed to account for all variables that affect access time, such as head-positioning time.

applications. Typical track-to-track access time for an IBM device is more than 200 msec., and average access time is almost 1.5 sec. By comparison, PerSci's models 277 and 299 exhibit 133-msec. track-to-track access and 163-msec. average access, both among the fastest in the industry.

These track-to-track and average figures are computed to account for all variables that affect access time: head-positioning time from track to track; head-settling time, allowing the head to stabilize after it moves; head-load time, bringing the head into contact with the surface of the diskette; and average latency time—the time for half a revolution of the diskette. Typical figures for a full-sized floppy are 3- to 8-msec.-per-track-positioning time; 10- to 15-msec. settling time; 35- to 40-msec. head-positioning time; and 83.3-msec. latency time.

The largest of these, the latency time, is computed with a drive-rotation rate of 360 rpm, or 6 rps, yielding 166.6 msec. per revolution, and 83.3 msec. per half revolution. In a junior-sized floppy, the rotation rate is 300 rpm, yielding a latency time of 100 msec.

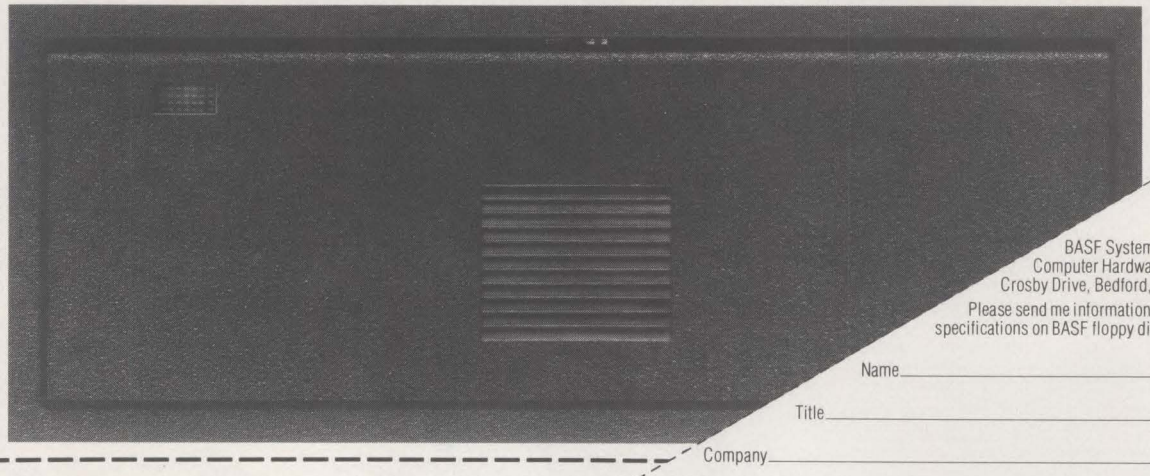
The track-to-track access time is the sum of the individual components. The average access time acounts for the time to move the head across one third of the tracks on a surface, as well as settling, loading and latency time.

For example, if a drive runs at 360 rpm, with 6-msec. track-to-track positioning time, 15-msec. settling time, and 35-msec. head-load time, the track-to-track access time will be 139.3 msec., with an average access time of 210.3 msec.

Shugart advises users of its minifloppy series to turn off the drive motor and unload the heads after 2 sec. with no drive activity. For the minifloppy user, this has a further impact on response time, because an additional 0.5-sec. delay is introduced each time the motor is truned back on. If the drive is heavily used, the heads remain loaded, and the head is repositioned while it contacts the media surface. This is the mode of operation for transfer of a file to a diskette. In such instances, head-load time need not be considered. ■

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

Only BASF can run a floppy drive ad this small.



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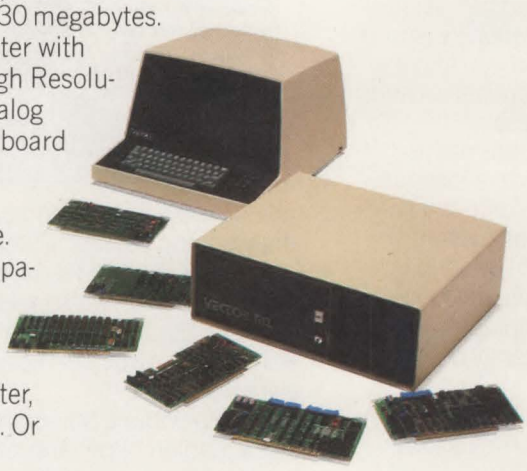

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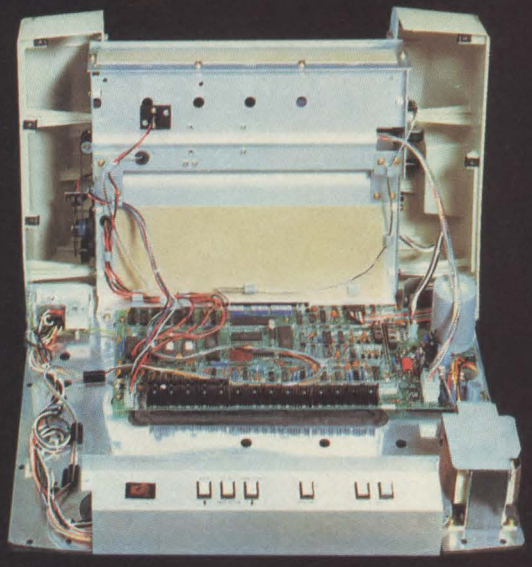

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SOFTWARE

An overview of the CP/M software market

LAURENCE PRESS, Small Systems Group

A look at what's available for this popular personal-computer operating system

The availability of CP/M on so many different manufacturers' systems has formed the backbone of the personal-computing software industry. More than 120 companies now offer CP/M systems and applications software. Not all of that software is very good, nor are all of the companies selling it reliable. Prospective buyers should be cautious in their dealings with vendors and should always get hands-on experience with a package before committing to it.

Small Systems Group and others are just beginning to work on the problems of CP/M software evaluation and comparison; much remains to be done. Meanwhile, we can share our survey information on what is available, including 304 packages from 101 companies.

An average CP/M-based software package uses 48K bytes of memory, a 24 × 80 dumb terminal, a 120-column printer and two 256K-byte single-density floppy-disk drives (Fig. 1). Most users are better off buying a somewhat larger system: the marginal cost of higher capacity (double-density) disks and additional memory is low, and a number of packages will support printer and terminal features that are not strictly required.

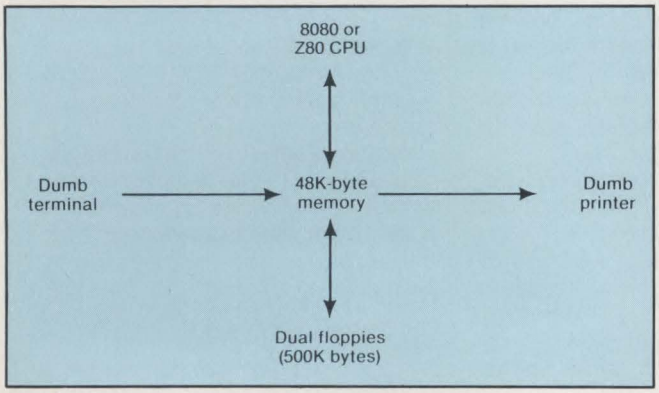

Fig. 1. Minimum hardware configuration *required to support an average CP/M-based software package. In practice, somewhat larger systems are often used.*

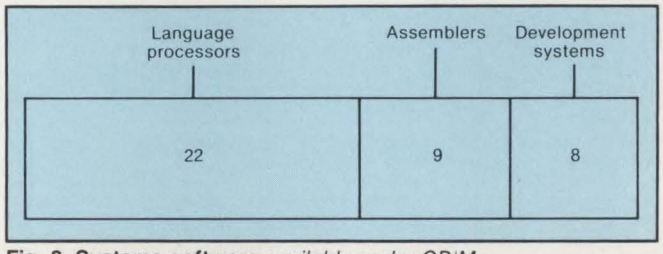

Fig. 2. Systems software *available under CP/M.*

For the purposes of the survey, programs were broken down into five categories: systems programs, accounting packages, word and text processors, utility programs and specialized commercial packages. Fig. 2 shows the number of systems programs represented. The development systems provide assemblers, loaders and debugging monitors. There are a number of macro assemblers and assemblers that generate relocatable code. The higher level languages are no longer restricted to BASIC, although it still dominates. Fig. 3 lists languages for which CP/M-based processors are commercially available.

Accounting packages were the next category covered (Fig. 4). Integrated packages are those that combine

Integrated accounting packages combine general ledger, payroll, payables and receivables. Many companies also offer independent accounting modules.

general ledger, payroll, payables and receivables. In addition, many companies offer independent accounting modules.This has been the most prolific area for applications software products, but the quality of some of these programs is not what it could be.

Word and text processing have also attracted a lot of attention from CP/M software vendors (Fig. 5). The first packages available were independent line editors and print formatters. The editors were primarily intended for writing programs, and the formatters came along so that people using the editors could produce documents as well. Since that time, however, a number of vendors have come out with fully integrated word-processing packages. A number of these are quite powerful, comparing favorably with commercial word-processing systems.

Fig. 6 describes utility programs available in the CP/M market. A typical sort package can sort a 500K-byte file in about 20 to 30 min. Some of the mailing-list packages provide crude facilities for editing letters, as well as maintaining name and address files, and can be used for mass mailings. Most of the data-management systems are simple screen editors

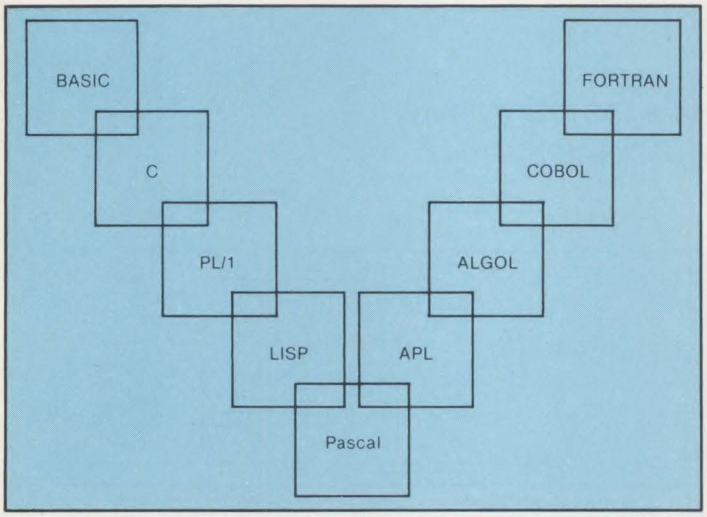

Fig. 3. High-level languages *commercially supported under CP/M.*

Program Type	Number of Packages
Integrated	10
General Ledger	20
Payroll	16
Accounts Receivable	23
Accounts Payable	15
Inventory	16

Fig. 4. Accounting packages *available under CP/M.*

Program Type	Number of Packages
Editors	9
Printer Formatters	8
Full Word Processors	16

Fig. 5. Word- and text-processing programs *available under CP/M.*

Program Type	Number of Packages
Sort	5
Mailing List	9
Data Management	14
Communications	6
IBM-CP/M	2

Fig. 6. Utility programs *available under CP/M.*

CP/M BACKGROUND AND HISTORY

Personal computing is not as new as Radio Shack and Apple would have one believe. In the old days (before OS), programmers often had dedicated use of even the largest machines. And in 1965, Fred Gruenberger of RAND Corp. wrote a paper entitled "Are small, free-standing computers here to stay?". His conclusion was that they were, and that they would double as time-sharing terminals.

In 1967, Tom Steel wrote a System Development Corp. internal note that not only predicted small computers were here to stay, but that they would soon become affordable to the average person. His prediction was for a $25,000 personal computer with the power of a 7090 by the mid-1970s and a market size of 5 million to 20 million units.

In 1975, the personal computer moved toward practical reality when MITS, a small company in Albuquerque, N.M., announced a bare-bones computer called the Altair. Soon a number of companies were formed to make accessory boards for the Altair, and not long after, many companies were producing complete personal computer systems.

Low-cost personal-computing hardware had become available, but there was hardly any software. The early personal computers had small memories and used audio cassettes or paper tape for auxiliary storage. The only significant software packages at that time were BASIC interpreters.

In late 1975, a small company called Digital Systems (now Digital Microsystems) exhibited a wire-wrapped prototype of a floppy-disk drive controller for the Altair at a Los Angeles computer club meeting. Not only did this controller work (unusual in those days), but it was supported by a rudimentary disk operating system called CP/M (control program/micro).

CP/M was developed by Gary Kildall to support the PL/M compiler he had written for Intel. He later wrote an editor, assembler and debugger to run under CP/M, and formed Digital Research to market the package. Digital Microsystems was the first OEM to license CP/M, but certainly not the last. More than 200 OEMs are now using CP/M, and it has been included on the Datapro Honor Roll.

Shugart has two right ways to backup its Winchester.

When Shugart Associates designed the SA1400 controller for their Winchester drive they included in its backup capabilities a 10 and 20 MByte ¼" Streaming Cartridge Tape Drive, as well as their own Floppy Disk Drives. They found that in many applications their customers required increased capacity and the choice was best left to the system designer.

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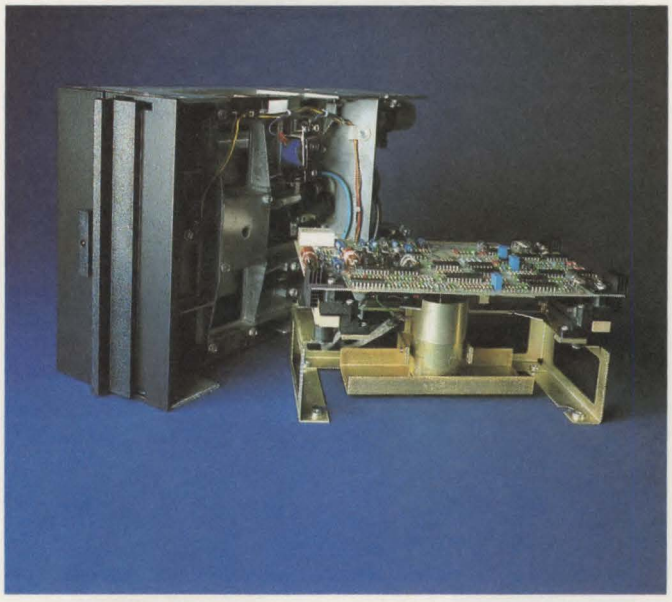

On top of capacity and data reliability matching the Winchester, our drives offer other advantages. Transfer rate is 5 MBytes per minute. Power consumption and heat dissipation are low. The unique two track bi-directional head with digital positioner provides low cost 4-track operation.

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Editors were originally intended for writing programs, and formatters came along so people using editors could also produce documents. Since then, a number of vendors have come out with fully integrated word-processing packages that are quite powerful.

Medical	Legal	Dental
Construction	Property Management	Membership Billing
Utility Billing	Golf Club	Insurance Agency
Lumber	Accounting	Professional Office
Medical or Dental	School Administration	Engineering
Bowling Alley		

Fig. 7. Specialized commercial software *available under CP/M.*

and report generators, reminiscent of FARGO from the days of the 1401; however, two of them implement more flexible, hierarchical data bases. The communications utilities enable a personal computer to emulate a terminal or remote job-entry station. Finally, the IBM-CP/M utilities are for floppy-disk conversion between IBM systems and personal computers.

Specialized commercial packages make up the final type of software identified in this market. Our survey turned up 38 programs for 15 applications ranging from bowling alleys to doctors' offices (Fig. 7). ■

Laurence Press, who holds a Ph.D. from UCLA, is president of Small Systems Group, a software house based in Santa Monica Calif.

NEXT MONTH IN MMS

March is data communications month for Mini-Micro Systems, with feature surveys of packet-switching network processors and concentrators, and of limited-distance network products. Also scheduled:

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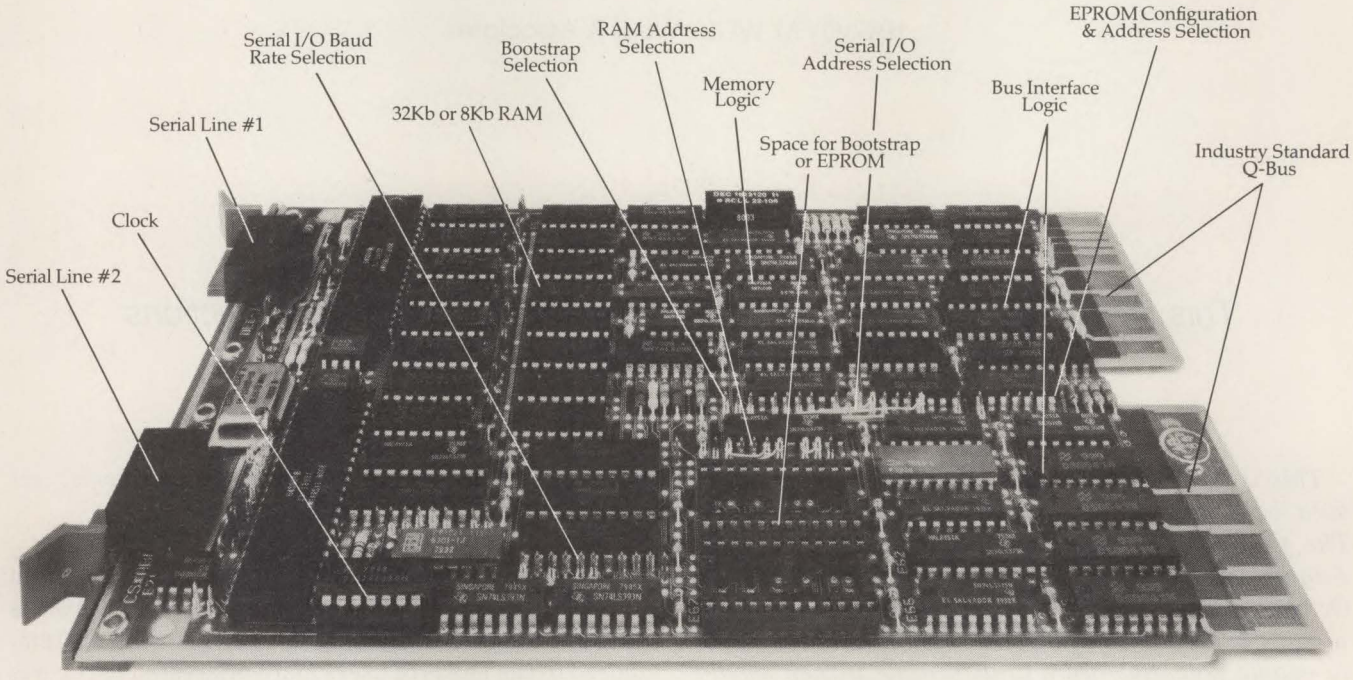

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QDMS brings data management to the masses

HARVEY M. WEISS, Weiss & Associates

This inexpensive system performs some data-management functions as well as larger and more costly systems

This is the third in a series of evaluative reports on data base management systems for minicomputers. The first, on the ORACLE system, appeared in the August, 1980, issue, and the second, which ran in October, reviewed SEED. These reports are intended to provide sufficient information about the subject DBMS to enable potential users to determine if they should consider installing the system. Each article surveys the features of a single DBMS and evaluates it against a standard set of criteria. If there is a particular system you would like to see reviewed, please send its name and supplier to: Editor, Mini-Micro Systems, 221 Columbus Ave., Boston, Mass. 02116.

Designed to run under the RSTS/E operating system on DEC PDP-11 minicomputers, Quodata Corp's QDMS is a data (rather than data-base) management system, tailored to the needs of users more interested in reports processing than in data-entity control. Out of a possible 400 points, QDMS scored 258 (see "The Evaluation Matrix," p. 181).

The system requires less technical sophistication

EXPLAINING THE EVALUATION MATRIX

The evaluation matrix is the chief tool used in evaluating QDMS. In a competitive evaluation, the matrix would list the criteria used, the vendors being considered and the ratings each vendor received. (Not all criteria are used each time.) The first step is to establish an importance weight factor for each criteria. This factor establishes the relative importance, on a scale of 1 to 10, of a feature or capability of the DBMS in meeting system requirements. The vendor's software is then rated, again on a scale of 1 to 10, according to its ability to meet that specific 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 an offering, its ability to meet this criterion might be rated as 1. The resulting effective score for this criterion for this vendor would be 10 ($1 \times 10 = 10$). However, vendor 2 might provide such a product, receiving a rating of 10. That vendor's effective score would then be 100 ($10 \times 10 = 100$).

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

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

The evaluation matrix is used here only to establish a rating for QDMS and its ability to meet all the criteria as if all had an importance weight of 10. If a criteria receives a score greater than 7, it indicates that QDMS 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.

from a user than a typical DBMS. Report design and preparation is simple, requiring minimal attention to physical file structures, keys or other traditional systems programming concerns. Although some understanding of RSTS/E is required, installation and maintenance are also relatively painless, and vendor support seems to be excellent.

The system's main shortcomings lie in the relative difficulty and inflexibility encountered in defining files and views of files, the lack of any automatic error or recovery processing, lack of true independence from RSTS/E, limited record design and handling flexibility and poor utilities. But for many users with small- to medium-sized file structures, QDMS's query and report-writer facilities, which are as good as those of many much larger and more complex systems, and its low $8000 price will make it an attractive alternative to more comprehensive and expensive systems.

System overview

QDMS requires 64K words of main memory and 1.2M bytes of disk storage. It supports only one language—BASIC-plus—and it supports data communications in a single-thread environment under RSTS/E. The package relies on user-initiated file dumps to ensure crash recovery: there is no automatic recovery process.

Like traditional file-management systems, QDMS adds data to its files in sequential fixed-length records, recording each entry in an index table. Because this table does not change as data is deleted or altered, file space can be reclaimed only on system reorganization.

Data retrieval is accomplished by relating the index and pointers to the data and the retrieval algorithm. If the file is not in the required sequence, a "tag sort" can be used to reorganize the pointers to minimize access time. The user can specify as many as 15 levels of retrieval criteria, each containing as many as 15 levels of "and" criteria. (Ad hoc and heuristic searches can be performed to the same extent.) A set of special "linked-file" commands controls multiple file accesses, and data from one file in one format can be inserted in another format (say, from binary to ASCII).

QDMS lacks a data dictionary in the classic sense, instead providing security (to the file or field level) and data integrity via the file descriptor records created when files are defined to the system. One of QDMS's weaknesses is that control over access to the files themselves is left to the facilities of RSTS/E.

Structurally, QDMS consists of one major component and two subsystems (Fig. 1). The managerial, or

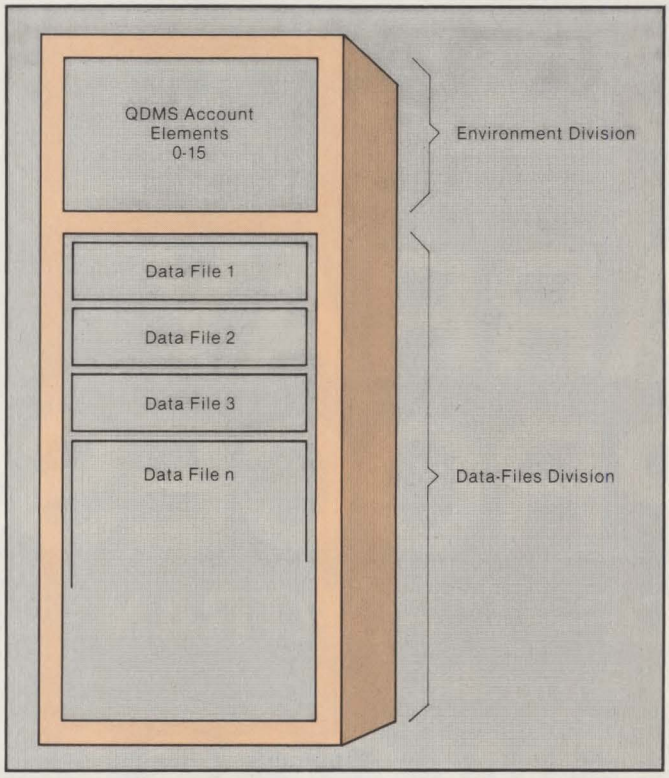


Fig. 2. A pictorial representation *of the logical relationships established as file structures are defined to QDMS.*

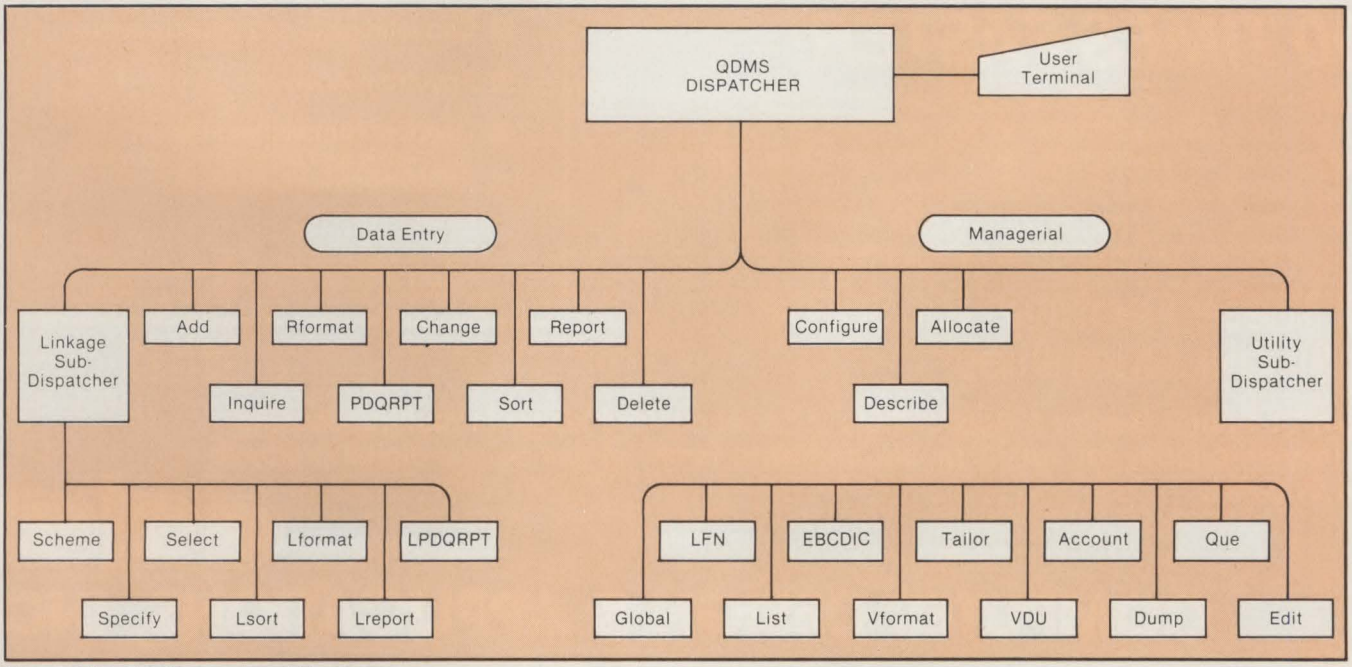
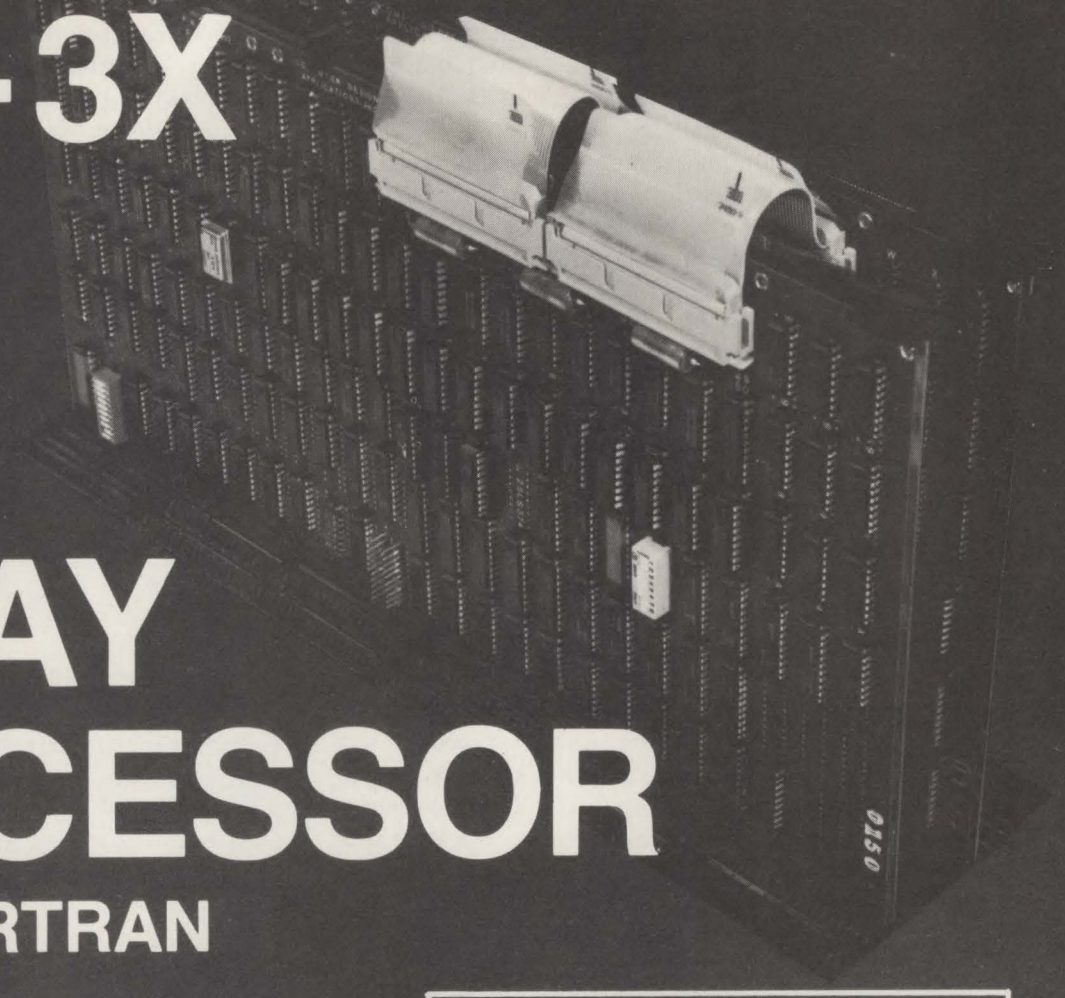


Fig. 1. The QDMS *command hierarchy.*

introducing the
MSP-3X



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CIRCLE NO. 94 ON INQUIRY CARD

Instead of designing a schema and describing it in a data-definition language, a QDMS user must define his files and their contents via configure, describe and allocate commands in the managerial subsystem.

account-configuration, subsystem comprises the commands that establish and maintain the QDMS system. An account (user ID) is configured to run QDMS when it has a configuration file, which describes to QDMS the environment in which the account is running. QDMS uses the file to find required QDMS components for the account and to provide security. These relationships are established via commands in the account-configuration subsystem. This subsystem is also used to develop the file descriptions and space-allocation parameters of the QDMS files being created. An account can have only one view of a particular QDMS file, although the same file can be viewed differently by different accounts.

The data-entry subsystem contains commands to enter data into previously configured files and to add, reformat, change, inquire, sort, delete or report that data. These commands can be executed in either batch or on-line mode, but not both simultaneously. When altering the files, additional indexes and pointers can be developed, but QDMS does not automatically keep them updated. The user must do that manually with another command.

The two subsystems are tied together by the QDMS dispatcher, which acts as an interface between RSTS/E, the physical file-management system and the user. It is this component that enables users without technical knowledge of RSTS/E to use QDMS.

Instead of designing a schema and describing it in a data-definition language, as would a DBMS user, a QDMS user describes his files and their contents via the configure, describe and allocate commands. Fig. 2 shows the logical relationships established as file structures are defined to QDMS. Once the structures are defined, user commands can be invoked to load the files. As the files are loaded, the system creates indexes, which enable the files to be accessed for data processing.

If the data is volatile, files, indexes and pointers will

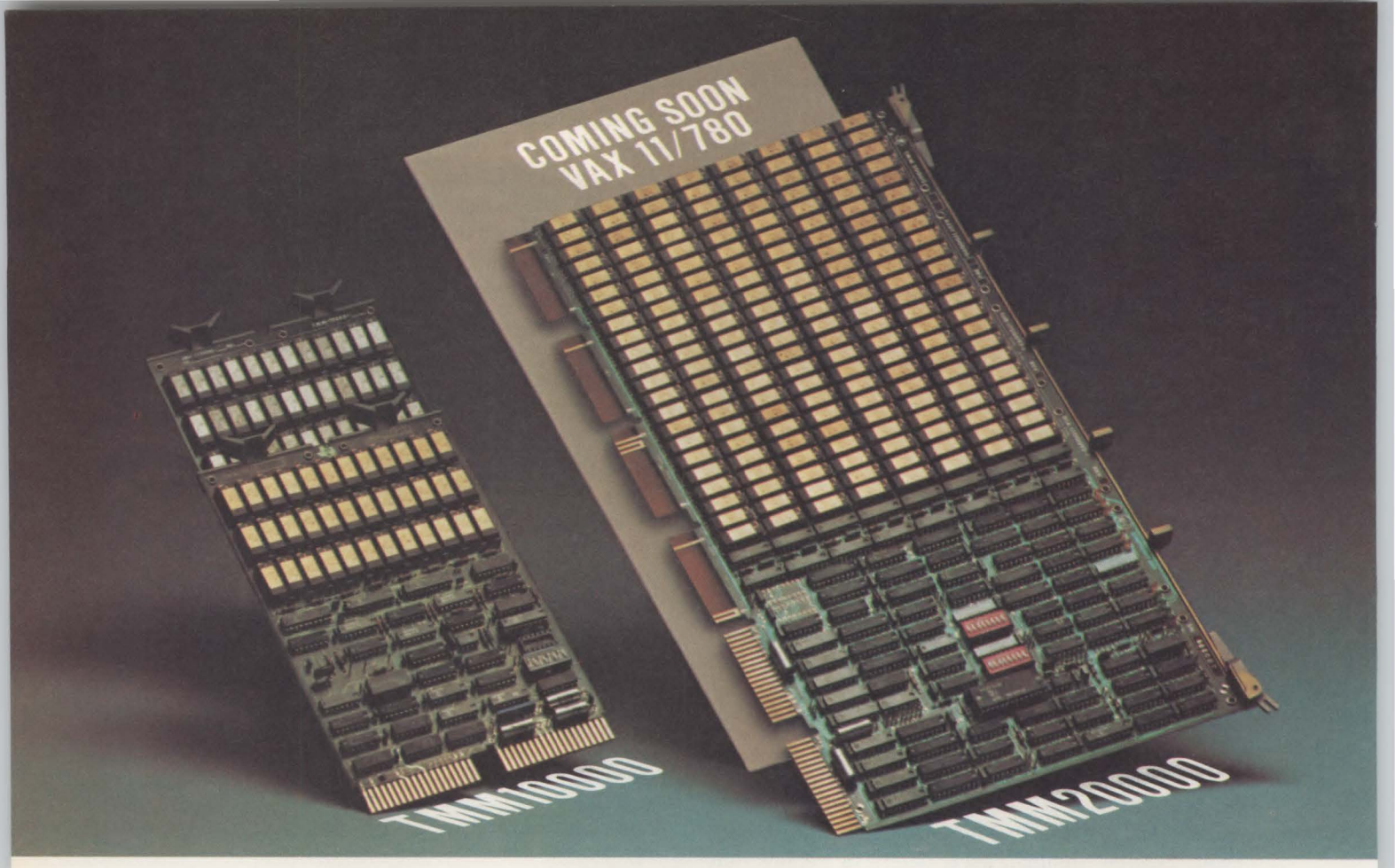
COMPANY PROFILE: QUODATA CORP.

Formed in 1971 to develop and market software for Digital Equipment Corp. hardware, Quodata Corp., Hartford, Conn., made its first QDMS installation in 1977. At this writing, 40 customers have the system installed or on order. Each QDMS purchase includes system upgrades and support service for one year, as well as two days of on-site installation support (travel and room and board at the customer's expense). Quodata also provides a hot line for customer problems and will accept help calls at employees' homes when necessary.

EVALUATION MATRIX VENDOR RATING: QDMS

SELECTION CRITERIA	VENDOR SCORE
1. Data-manipulation capabilities	
1.1 Data-manipulation processes	6
1.2 Privacy, security techniques	6
1.3 Error-recover procedures	1
1.4 Data-integrity controls	5
1.5 Format-modification ability	6
1.6 Redundancy consolidation controls	6
1.7 File growth	6
Possible: 70	36
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	6
3.3 Subsystem view development	8
3.4 Data base schema description process	6
3.5 Programmer skill required	6
Possible: 50	36
4. Physical file design:	
4.1 Physical file organization(s)	6
4.2 Record types supported	6
4.3 Record change capability	5
4.4 Ability to combine records	8
4.5 File-space management method	5
4.6 Indexing methods	6
4.7 Logical record-definition process	5
4.8 Logical structures	5
Possible: 80	46

SELECTION CRITIERIA	VENDOR SCORE
5. Datacomm interface capability:	4
Possible: 10	4
6. System installation:	
6.1 Physical file distributing control	10
6.2 Data-base loading facility	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	3
7.3 Simulation facility	1
7.4 Data dictionary facility	1
Possible: 40	7
8. Secondary features:	
8.1 System performance	8
8.2 DBMS maintenance policy	7
8.3 Systems design and development time	8
8.4 System designer training time	8
8.5 Ease of installation	9
8.6 Documentation	7
8.7 Vendor support	8
8.8 Vendor responsiveness to hardware/software changes	6
8.9 Customer experience	8
Possible: 90	69
Total Possible: 400	QDMS: 258



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CIRCLE NO. 95 ON INQUIRY CARD

QDMS lacks a data dictionary in the classic sense, instead providing security and data integrity via the file descriptor records created when files are defined to the system.

require frequent reorganization, and if data integrity is a concern, regular file dumps will be necessary to ensure economical crash recovery.

The major concern in acquiring a data-management system is its report-processing capability. In QDMS a user must ensure that the necessary data is in a file, that the indexes and pointers are in place and that the report format is also in place. Fig. 3 shows part of a format-definition session, in which each line of a report is defined and the parameters stored in a report file. When the report is requested, QDMS reads the data from its file and prints it according to the parameters in the reports file. If the data file is not in the proper sequence, a separate step is required to create with the sort command the needed indexes and pointers.

1. REPORT CONTROL FILENAME?		Definition of output format
2. FILE TPYE?		
3. QDMS FILENAME?		
4. REPORT NAME?		
5. REPORT FORMS?		
6. FORM WIDTH?		
7. "N" UP FACTOR?		
8. MAX LINES PRINTED PER PAGE?		
9. DISPOSITION OF REPORT?		
10. # LINES PER PHYSICAL PAGE?		
1. FIELDNAME?	Asked only if question #2 is answered YES	Definition of each field to appear on report
2. TEXT SUBSTITUTION?		
3. LOW VALUE?	Definition of each table entry per field	
4 HIGH VALUE?		
5. TEXT?		
6. ANOTHER RANGE OR VALUE?		
1. LINE NAME?		Definition of each line on report
2. LINE TYPE?		
3. SPACING BEFORE PRINTING?		
4. SPACING AFTER PRINTING?		
5. BREAK FIELD?		
6. COMPRESS LINE?		
7. STARTING POSITION IN LINE?	Definition of each field on the line	
8. FIELD OR TEXT FOR PRINTING?		
9. AUTO TOTAL ON THIS FIELD?		
10. PRINT MASK?		

Fig. 3a. Report format *(RFORMAT) input mask.*

RFORMAT Command — Online Mode
Sample Run

```
      QDMS              DISPATCHER PROGRAM J3.001
                              25-May-79      10:48

?RFORMAT
      QDMS          BUILD REPORT CONTROL FILE V3.001
                              25-May-70      10:48

BATCH OR ONLINE? ONLINE
  1. REPORT CONTROL FILENAME? QDMS:MAIL.RCF
  2. FILE NAME? QDMS
  3. QDMS FILENAME? CUSTMR.DTA
  4. REPORT NAME? MAIL LABELS & ACCTING STUB
  5. REPORT FORMS? LABL-STB-03
  6. FORM WIDTH? 80
  7. "N" UP FACTOR? $01
  8. MAX LINES PRINTED PER PAGE? 63
  9. DISPOSITION OF REPORT? ACCTS RECEIVABLE
 10. # LINES PER PHYSICAL PAGE? $066
      QDMS      RESOLVE QDMS REPORT FIELDS V2.002
                              09-MAR-78      10:50

  1. FIELDNAME? ID.NO
  2. TEST SUBSTITUTION? $NO
  1. FIELDNAME? L.NAME
  2. TEST SUBSTITUTION? $N
  1. FIELDNAME? F.NAME
```

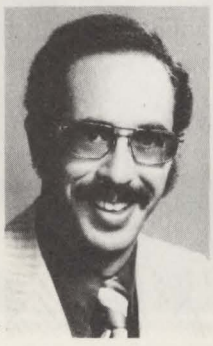
Fig. 3b. Part of *a typical report-format definition session.*

Customer reviews

As expected, a survey of six QDMS users, whose names were supplied by Quodata, showed them to be organizations with relatively small data files (e.g., a 1200-person payroll file, a 1000-person student file) and a need for multiple views of the information in those files. Their comments are summarized here:

- "QDMS offers our organization an inexpensive way of providing several departments with information they need quickly without requiring a great deal of technical know-how."
- "We were able to design and implement our financial system in one month."
- "Quodata's personnel have been available to us day and night to help us solve our system problems."
- "Although the user commands are relatively easy, we require one systems person to manage the facility."
- "QDMS was our choice because we could implement the package without building a large technical staff."
- "For a relatively insignificant price, we were able to go on-line quickly and easily."
- "We selected QDMS for its ability to produce reports and its low price. Company support was outstanding."

These remarks tend to reinforce the evaluation-matrix scores for ease of installation and use and vendor support. The matrix also indicates, however, that users with more extensive, complex or volatile file structures may find QDMS's file design, data-manipulation features and recovery procedures too primitive for their needs. Prospective buyers should also heed the rudimentary character of the system's QDMS's evaluation matrix scores do not indicate the success a user might expect to have with the system; they are subjective evaluations based on QDMS's ability to satisfy all system requirements, which will vary in importance from user to user. ■



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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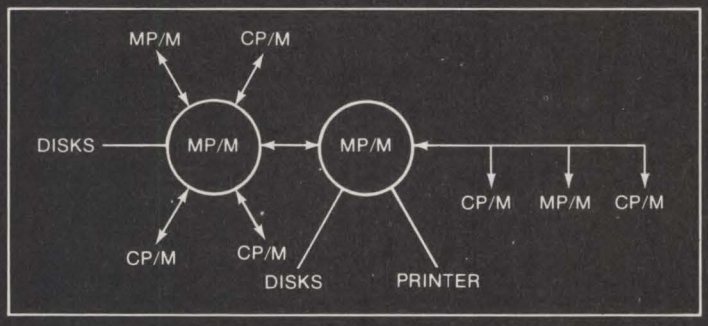

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80 character by 24 line format, plus a 25th line for operator messages and prompts.

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For under $1000,* the Zenith Z19 smart terminal is a very smart buy. It can be utilized with almost all commonly available computer systems and provides the most advantageous features for data entry, editing, inquiry, and transaction processing—wherever you need a top-of-the-line, general-purpose terminal.

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CIRCLE NO. 97 ON INQUIRY CARD

Lear Siegler's ADM-5: a human-engineered terminal

The password at Anaheim, Calif.-based Lear Siegler, Inc., these days is "ergonomics," or human engineering—the study of people and their working environment (MMS, November, 1980, p. 119). Human engineering was carefully considered by designers of the Data Products Division's new low-cost, VDT, designated the ADM-5 dumb terminal introduced at the recent Comdex '80 show in Las Vegas.

The ADM-5, which is hardware- and software-compatible with all popular ASCII computers, provides visual attributes such as reverse video, reduced intensity, limited editing capabilities (erase to end of line and/or page) and a gated extension port for selective transmission of data from the terminal to any RS232C peripheral device.

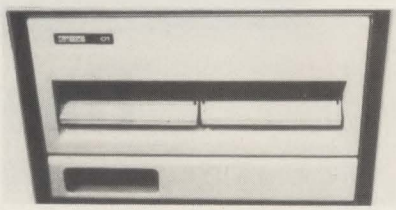
"Visual attributes," says John M. Ludutsky, marketing director, "significantly enhance the operator's ability to manage data on the CRT screen by adding more selectivity to what is displayed or by highlighting important elements." Other ergonomic features include a 12-in. diagonal display screen that displays characters as a 5 × 9 dot matrix or 7 × 10 dot-matrix field, and which allows for sharpness and easy reading. As many as 1920 characters can be displayed in an 80-character-per-line × 24-line format.

Lear Siegler's ADM-5 dumb terminal *is hardware- and software-compatible with all popular ASCII computers.*

The terminal operates asynchronously in half- or full-duplex modes at any of 11 data rates from 75 to 19.2K bits per sec., and as many as 32 control characters can be transmitted to the computer and/or entered on the screen. Available formats include standard 7- or 8-bit words; odd, even or no parity; or one- or two-stop bits. Switch-selectable 20-mA current loop and EIA standard RS232C interfaces are optional.

Lear Siegler recently announced another ergonomic terminal, the ADM-42, at the Interface West Computer Conference. The terminal has a tiltable 15-in. non-glare screen and a high-resolution monitor. Separate controls enable an operator to adjust contrast and brightness.

Price of the ADM-5 is $995; the ADM-42 is $2195. **Lear Siegler, Inc.,** Anaheim, Calif. **Circle No 181**



Winchester disk emulates DEC RL01

The model 11L plug-compatible 20M-byte Winchester-disk system for the LSI-11 μC directly emulates four Digital Equipment Corp. RL01 disk drives. A 10M-byte version replaces two RL01 drives. Rack-mounted or tabletop configurations are available. Backup is provided by video cassettes at 1M byte per min. with a 120M-byte capacity. The 11L sells for less than $5000 in quantities of 10 to 24. **Corvus Systems,** San Jose, Calif.

Circle No 182

Multi-user Z80 μC has Winchester, tape

The C8001MU, a five-user, Z80-based μc system, combines an 8-in. Winchester-disk drive and a tape-cartridge drive in a desk-top enclosure. The unit is compatible with all application programs currently running on its predecessor, the C8001, as well as MOASIS with multi-user BASIC and COBOL. The C8001MU has five serial ports, one parallel port and a disk-expansion port. **Onyx Systems, Inc.**, San Jose, Calif.

Circle No 183

Fairchild introduces VLSI tester

The model 120 VLSI test system tests devices with as many as 120 pins at rates as high as 20 MHz. The system also can handle static RAMs, bit-slice μps and microprogrammable controllers that run faster than 20 MHz by multiplexing pins. The system uses FST-2 CPU and a 24-bit-wide data bus. Memory capacity is 196 24-bit words. A 20-MHz sequence processor has 16 I/O registers, 16 mask registers and 16 functional invert registers. **Fairchild Camera and Instrument Corp.**, San Jose, Calif.

Circle No 184

Small business system uses two 16-bit μps

The model T.I. 32 small business system incorporates two Texas Instruments 9900 16-bit μps. A ROM-based operating system supports as many as 18 work stations. The system uses floppy-disk drives, cartridge tape or 8- or 14-in. Winchesters. Memory is expandable to as much as 192K bytes. Prices range from $8999 to $19,999. **Technico, Inc.**, Columbia, Md.

Circle No 185

LSI-11/23-based system has 256K-byte RAM

The model 401, an LSI-11/23-based, 16-bit system, consists of a multi-user CPU and system control, front-end processing and file operations subsystems. Each subsystem has a dedicated processor and operates independently of the CPU. The CPU has as much as 256K bytes of RAM, memory map and floating-point arithmetic. Prices start at $16,500. **Dicom Industries, Inc.**, Sunnyvale, Calif.

Circle No 186

LSI-11 SYSTEMS FROM ANDROMEDA

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For example, the 11/M1 system shown on the right weighs only 14 pounds yet contains 102kb of mini disk storage (expandable to 389kb), 64kb of RAM, space for up to 16kb of EPROM, 4 serial ports, and the LSI-11/2 CPU. All of this for less than $4000. While the 11/M1 will run the RT-11 operating system, it is best suited for dedicated applications where its small size but large processing power are needed.

Near the other end of the scale is the 11/H23-DDF system shown at the left. The mobile enclosure includes the LSI-11/23 processor, 256kb main memory, 10mb of storage on the double density RK-05 cartridge disk and 1.2mb on the double density floppy disks. This system also has 4 serial ports and 7 empty dual width slots for additional interfaces. The $22,500 price includes the video terminal shown, a 150 CPS matrix printer, and the RT-11 operating system.

These are just two examples of the many LSI-11 based systems available from Andromeda. And the standard systems are just starting points; we will provide any combination of package, processor, memory, interfaces, and peripherals to meet your requirements. In addition to general purpose systems, we also have turnkey packages for word processing, time-sharing, data acquisition, and graphics.

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New Systems

Disk initializer includes LSI-4/10

The System 800 automatic diskette initializer consists of an LSI-4/10 computer, a 1920-character CRT, a floppy-disk drive and an automatic media loader. A dedicated floppy-disk intelligent controller enables as many as eight initialization stations to be operated concurrently and independently. Disks can be loaded, initialized and sorted at a maximum rate of 80 per hr., per station, for 8-in. single-sided disks, and 45 for 8-in. double-sided. **Media Systems Technology, Inc.,** Santa Ana, Calif.

Circle No 187

Z80A-based systems include 64K-byte RAM

The MCZ-2/19 Z80A-based μc system has 64K bytes of RAM, a power supply that accommodates as many as four boards, and 2.4M bytes of floppy-disk storage. The MCZ 2/49-1 includes the MCZ 2/19, a CRT terminal, the RIO Version 3 operating system and COBOL. In 50-unit quantities, the MCZ 2/19 is priced at $5270, the MCZ 2/49-1 at $5890. **Zilog Corp.,** Cupertino, Calif. **Circle No 188**

Typesetting system supports six work stations

The Q300 series for use in typesetting supports as many as six work stations and has a 56K-byte main memory. The systems can serve as satellite systems, either on the same site or at remote locations. Options includes telecommunications interfaces, printers and word-processing software. **Quadex Corp.,** Wilmington, Mass.

Circle No 189

Centurion system has 64K-byte memory

The model 6500 includes 64K to 256K bytes of memory, a fixed/removable disk drive, a 1920-character CRT and a 150-cps printer. The system supports a second disk drive and as many as eight CRTs. **Centurion Computer Corp.,** Richardson, Texas. **Circle No 190**

Pertec announces multitasking system

The model 3600 multitasking distributed data entry/clustered processing system includes multiport communications, as much as 320M bytes of Winchester-disk storage and 512K bytes of memory. The system also includes 3270 emulation. **Pertec Computer Corp.,** Los Angeles, Calif.

Circle No 191

Delta System 700 includes floppy disks

The System 700 intelligent terminal system includes a double-sided floppy disk; a printer; and a data-entry, text-manipulation or small-business terminal. The system enables keyboard entry and the execution of BASIC programs with communications or print operations. The system processing unit controls the keyboard, display and printer. The auxiliary processing unit operates floppy-disk storage and BASIC. A typical System 700 is priced at $11,950. **Delta Data Systems Corp.,** Cornwells Heights, Pa. **Circle No 192**

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Linda Snyder,
Word Processing Supervisor
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Same Disk Drive as DEC RM02-03, RP06 and RM04-05
We use the same disk manufacturers as does DEC. The RM02-03 is the 9762 CDC 80MB and the new RM04-05 300MB is the CDC 9766. Only the LOGO is different.

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DRJM04 300MB + Controller	DTU125
DRWM05 300MB + Controller	Line Printers
RJM07 600MB + Controller	Memories
RWM07 600MB + Controller	11/34 → 11/70, VAX
RM07 600MB Slave	Systems

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CIRCLE NO. 102 ON INQUIRY CARD

New Products

printers

Thermal lines printer prints 96 ASCII set

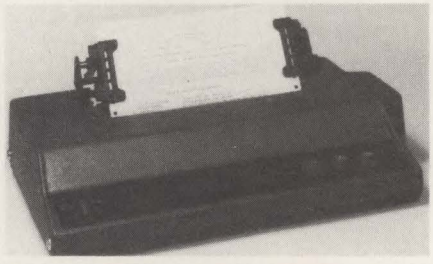
The PL-80E prints a 96 ASCII character set in a 7 × 11 dot matrix in a 9 × 16 field at speeds as high as 120 cps. Output is 80-column, or 132-column with compressed printing. The PL-80E includes serial and parallel TTL, IEEE 488, RS232C and 20-mA current-loop interfaces. Printing is at rates as high as 9600 bps at densities of 10 cpi and 6 lpi. OEM price is $672 in single-unit quantities, $545 in quantities of 100. **Telpar, Inc.**, Addison, Texas.

Circle No 193

B-900 band printer has 1100-lpm speed

The B-900 band printer, which prints at 1100 lpm using a 48-character set, at 900 lpm with a 64-character set or at 700 lpm with 96 characters, has a fully enclosed cabinet that provides 60-dBA operation. The μp-based B-900 incorporates a diagnostic and display feature to monitor machine status. OEM single-unit price is $9800, with quantity discounts available. **Dataproducts Corp.**, Woodland Hills, Calif.

Circle No 194



Data impact printer has six character sizes

The model 85 data impact printer includes a 7 × 7 or 14 × 7 dot matrix, six character sizes, 100-cps bidirectional print speed, selectable tractor or friction paper feed and "finger-clean" ribbon cartridge loading. The model 85 is priced at $625 in 100-unit quantities. **DIP, Inc.**, Boston, Mass.

Circle No 195

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CIRCLE NO. 105 ON INQUIRY CARD

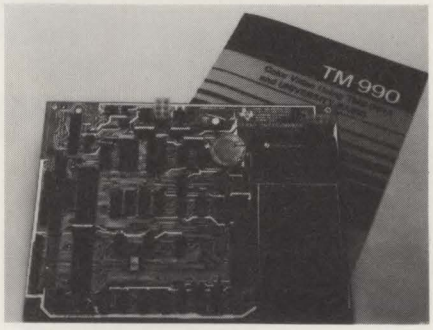
New Products

micros

Z80 CPU board fits S-100 systems

The 2810 Z80 CPU board for S-100 systems is fully compatible with Altair and Imsai computers. Features include a jumpered 2K ROM containing monitor firmware, with auto-baud select that enables users to configure the serial port to match speeds from 2K to 56K bps. The board also has a switch-selectable clock rate of 2 or 4 MHz. Prices start at $300. **California Computer Systems,** Sunnyvale, Calif.

Circle No 196



TI module supports University BASIC

The TM990/189-1 single-user, single-board μc can be used as an aid in learning high-level languages and 16-bit μp fundamentals and interfacing techniques. It comes with the University BASIC ROM kit, an asynchronous communication port, an on-board relay for audio cassette interfaces and off-board CPU expansion. The packaged board sells for $399. **Texas Instruments Inc.,** Dallas, Texas.

Circle No 197

CPU board is compatible with S-100

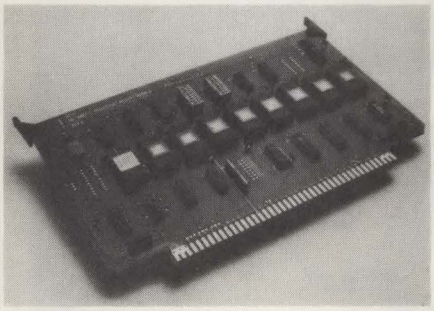
The Z80-based model CPD-280 CPU board provides 4-MHz operation and eight vectored priority interrupts, which eliminate the need for polling. Two serial and two parallel ports use DMA. Hardware interfaces can

be customized through external personality boards. Price for the CPD-280 is $750 in single-unit quantities, with quantity discounts available. **Measurement Systems & Controls,** Orange, Calif.

Circle No 198

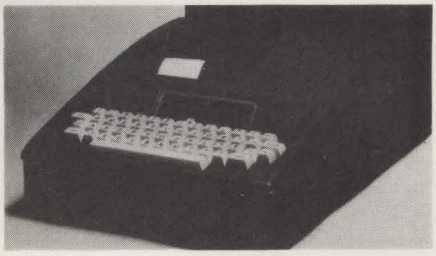
Counter-timer card has three channels

The 7308 STD BUS card provides three 16-bit counter/timer channels with six operating modes each. The card includes a crystal oscillator; a tapped clock divider; an eight-input multiplexer for each channel; and programmable logic states at each clock, gate and output signal. It is compatible with Z80, 8085, 6800 and other μps. The 7308 is priced between $195 and $145, depending on quantity. **Pro-Log Corp.,** Monterey, Calif. **Circle No 199**



Single-board μc includes 2K EPROM

The 9609 single-board μc module includes a 2K EPROM programmed with a resident monitor, 1K byte of static RAM, one RS232C I/O channel and two parallel I/O channels. Other features include a priority interrupt vector generator, optional battery backup circuits and a power failure protect/restart. The 9609 sells for $595 in single-unit quantities. **Creative Micro Systems,** Garden Grove, Calif. **Circle No 201**



μc preserves system's memory

The MMC-65 μc preserves memory contents after power loss for at least one month. The unit includes a keyboard, a 20-character display, a thermal printer and extensive I/O capability. The system can store as much as 56K bytes of RAM or ROM. A power-fail monitor permits 1000 bytes of program execution before the system ceases operation. The unit is priced at $2950, with quantity discounts available. **Dutec Inc.,** Jackson, Mich. **Circle No 202**

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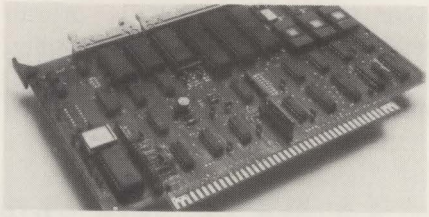
CIRCLE NO. 107 ON INQUIRY CARD

New Products

micros

DG announces single-board computers

The MBC/2 and MBC/3 single-board μcs, based on the vendor's MN602 CPU, are compatible with othe board-level products in the microNova line. Both μcs offer serial and parallel I/O circuits and sockets for as much as 1K byte of PROM. The MBC/2 handles 8K bytes of RAM, and the MBC/3 handles 32K bytes. The single-board MBC/SDX device functions as a debugging aid and I/O interface for other MBC boards. Prices start at $1200 for the MBC/2, $1700 for the MBC/3 and $600 for the MBC/SDX. **Data General,** Westboro, Mass. **Circle No 203**



CMS announces arithmetic processor

The single-board 9611 arithmetic processor/memory module provides a dedicated binary fixed-/floating-point arithmetic processor and 16K bytes of memory. The module uses the AM9511A arithmetic processor to perform 43 operations in 16- or 32-bit precision. Single-unit price is $495, without EPROM and RAM. **Creative Micro Systems,** Garden Grove, Calif. **Circle No 204**

ICB-85 has 48 I/O lines

The ICB-85 single-board computer uses the 8085A processor with as much as 16K bytes of ROM and 512 bytes of CMOS RAM. It is electrically compatible with STD bus specifications and can accommodate 2708, 2758, 2716, 2732 and 2516 PROMs. Two 8255As provide 48 parallel I/O lines. Price in 100-unit quantities is $290. **Trebor Industries, Inc.** Gaithersburg, Md. **Circle No 205**

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.

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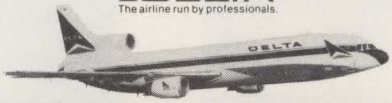


DELTA IS READY WHEN YOU ARE®

New Products

graphics

Digitizer has interface card for Apple II

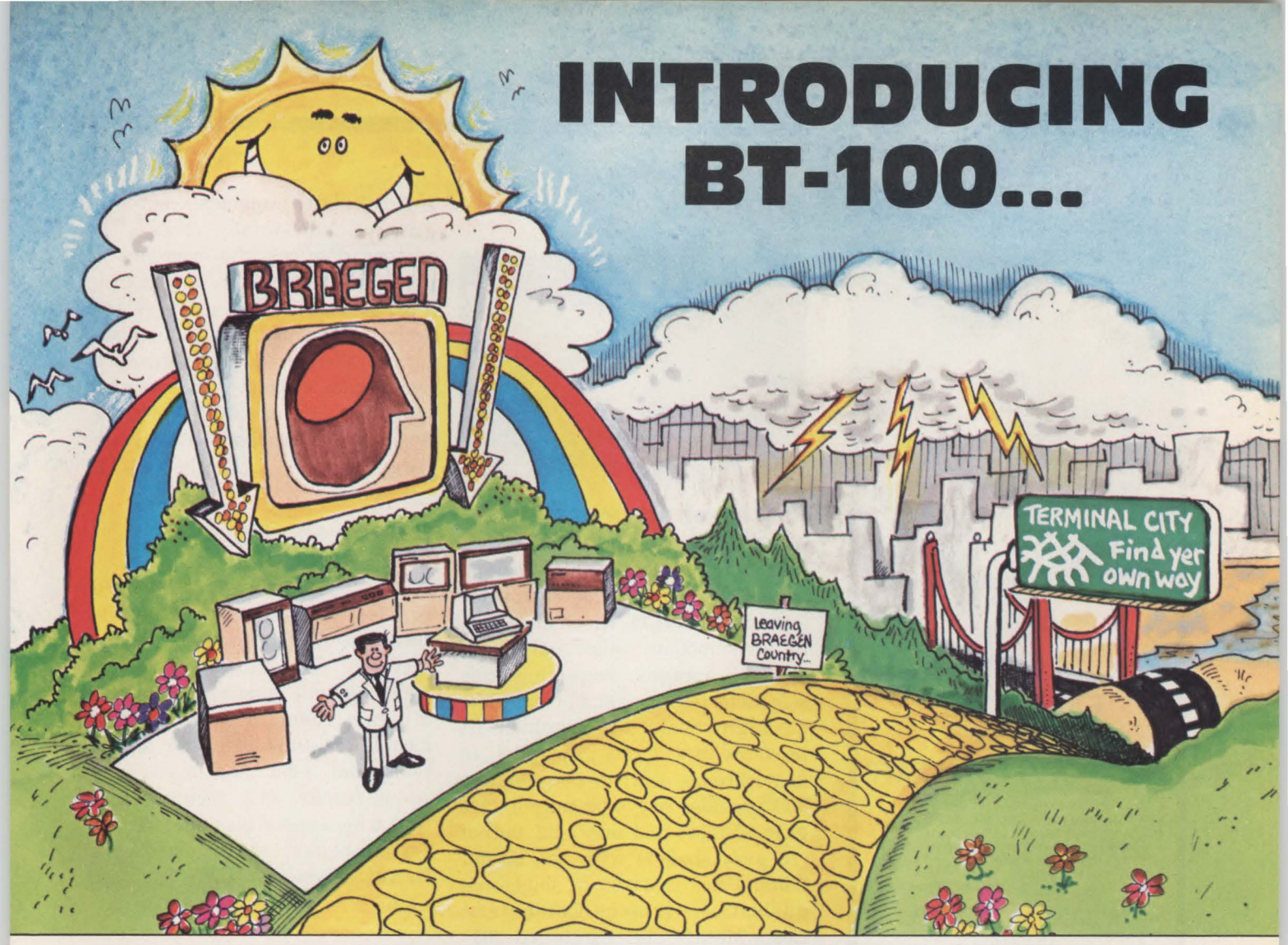
The DT-11A version of the HI PAD digitizer comes with a slot interface card for the Apple II μc, a floppy-based software package, a plastic menu overlay and a stylus. Functions include draw, line, area, background, pen color, separate, catalog, save, load, shape and others. Other features include slot independence, BASIC and Pascal compatibility, assembler driver code, user controls and an optional cursor. Price is $795. **Houston Instrument,** Austin, Texas. **Circle No 206**

Graphics terminal aimed at education

The GIGI general imaging generator and interpreter, a portable μp-based graphics terminal package, can be used with color or monochrome video monitors. Aimed at educational applications, GIGI has multiple character sets, local intelligence, eight-level color and shading support and a set of educationally oriented application software packages. It has provisions for interfacing either a graphics tablet or a graphics printer. **Digital Equipment Corp.,** Maynard, Mass. **Circle No 207**

Converted DEC VT100 has graphics capabilities

The Retro-Graphics VT1000 converted DEC VT100 video display terminal has graphics and alphanumerics capabilities. Graphics upgrade features include multiple character sizes, dot-dash lines, point plotting, vector drawing and selective erase. Graphics are displayed in green on a 12-in. diagonal screen at 640 × 480 resolution. Price is $3400. **Digital Engineering,** Sacramento, Calif. **Circle No 208**



The latest addition to our line of DEC®-compatible peripherals.

Locating the right VT-100® -type Video Display terminal can be a stormy proposition. BRAEGEN's new BT-100 is the ray of sunshine you've been looking for.

The first in a family of VT-100® - compatible terminals, the BRAEGEN BT-100 comes loaded with outstanding features that are only available as costly extras on other terminals in its class. For example: the BT-100 provides an advanced video package with four alternate character attributes: Bold, Underline, Reverse, and Blink, all of which can be selected in any combination on a character- by-character basis. Then there's an active or passive 20MA current loop and an RS-232 interface...all standard.

The BT-100's unique character spacing is designed to reduce eye fatigue and the standard typewriter style keyboard simplifies operator training. The list of features goes on and on. And, like all BRAEGEN peripherals, the BT-100 is backed by a one year warranty and a nationwide network of service centers.

Before you get lost in terminal city, contact your nearest BRAEGEN office and get the complete BT-100 Story. For applications not requiring the sophistication of the BT-100, ask about our Models BT-2A, BT-5A, and the BT-314.

OEM quantity discounts available

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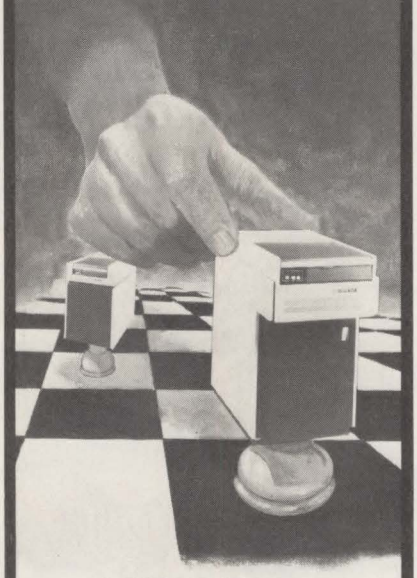
PDP/11* Peripherals



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DM-77	(125IPS)	$ 9,995
DM-45	(75IPS)	$ 8,995
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RWP06	(200MB)	$44,000
RJM02	(80MB)	$24,000
RWM03	(80MB)	$25,000
RP06	(200MB)	$34,000
RM02	(80MB)	$18,000
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Our systems are expanded or media compatible versions of standard DEC RP06/RM02 disc subsystems and TU77/TU45 magnetic tape subsystems. These subsystems are 100% compatible with all DEC software, diagnostics, and drivers.

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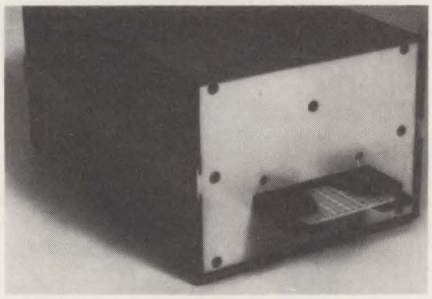
New Products

graphics



Processor accommodates color and monochrome

The GCT-3032-8 graphics-imaging processor includes a 256 × 13 video lookup table (VLT), which enables it to accommodate color and monochrome images requiring 256 selections per pixel and/or multilevel, high-resolution graphics. It provides 13 VLT bits in parallel. In monochrome, it drives two monitors and provides one 8-bit output (256 gray shades) and one 4-bit output (16 gray shades) with one bit for blink. Price is $4700 in single-unit quantities. **Genisco Computers,** Costa Mesa, Calif. **Circle No 209**

Electronic camera has high resolution

The Series 300 universal 35-mm. electronic camera system includes a solid-state camera and an image-processing unit that converts the camera's output to high-resolution digital data. The unit can read an 8½- × 11-in. document with a 40,000-point-per-sq.-in. resolution. Prices for the Series 300, including camera, image processing and compensation electronics, range from $7000 to $20,000 in single-unit quantities, with OEM discounts available. **Datacopy Corp.,** Palo Alto, Calif. **Circle No 210**

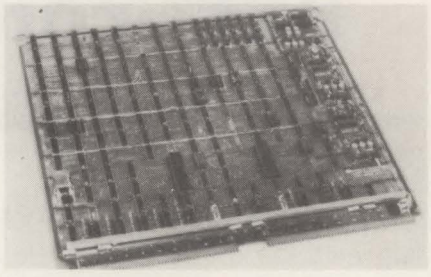
3D digitizer calculates volumes

The model GP-6-3D three-dimensional sonic digitizing system enables users to program the rotation of a digitized object for viewing from any angle on a CRT, and calculates volumes, center of gravity and surface areas. The system digitizes the contours of objects and imaginary, 3D shapes in a 30- × 30- × 70-in. active volume defined by a four-microphone sensor set. It also provides 2D measurement and calculates areas, line lengths and variable scaling. **Science Accessories Corp.,** Southport, Conn. **Circle No 211**

DeAnza announces array processor

The IP8500 array processor for remote sensing, nondestructive testing and 3D computer graphics includes four output channels, which provide independent pan or integer zoom. Other features include real-time histogram calculations and 8-bit multipliers with 16-bit results, fast vector generation, a high-speed disk interface and second-order wrap hardware. **DeAnza Systems, Inc.,** San Jose, Calif. **Circle No 212**

card equipment



Card-reader terminal has RS232C interface

The HT-100 manual card or badge reader, designed for industrial applications such as factory data-collection systems and warehousing, includes a power supply and an RS232C interface. The μp-based device converts Hollerith card data to seven-level ASCII, to which it adds start, stop and parity bits. Data is transmitted asynchronously at rates ranging from 150 to 9600 baud. **Taurus Corp.,** Lambertville, N.J. **Circle No 213**

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MST's rugged Time Machine is built to survive in a 21 hour-a-day copy production environment.

And you can configure MST's Time Machine to copy 8" and 5¼" disks simultaneously while verifying both copied formats and data.

The Time Machine allows you to download all your format and data information onto an 8" Winchester-type hard disk.

Best of all, it's easily upgradable to handle increased copy requirements.

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The success of the Cheyenne is really an inside story.

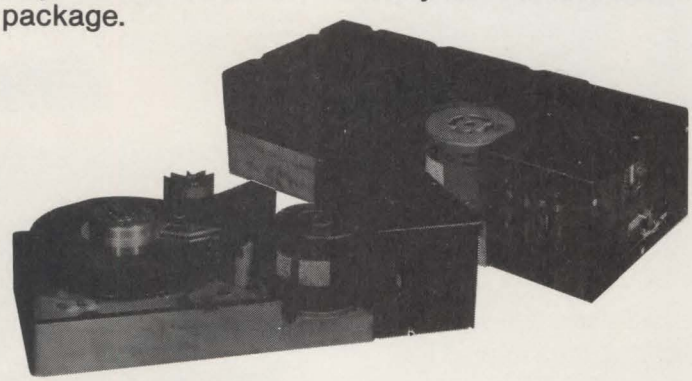
From the outside, the Cheyenne sealed disc memory tells the story of its rugged reliability. But *inside,* you can see the result of more than 15 years experience building rotating memories.

The Cheyenne features SLI's unique rotary positioner and closed-loop dedicated servo track system. Capacity is up to *51.4 megabytes,* unformatted, on 4 discs, with 7.3, 22 and 36.7 MBytes available.

Other Cheyenne features include microprocessor-based drive electronics, with built-in diagnostics; SMD interface (others available); 478 TPI and 6500 BPI.

The A/C spindle motor is standard, as is 50/60 HZ with no hardware change required.

There's more... inside the Cheyenne. Write or call Ray Kristiansen for the full story and our literature package.



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CIRCLE NO. 114 ON INQUIRY CARD

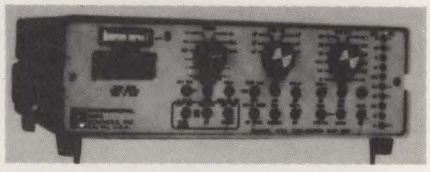
New Products

services

Software exchange aids PDP-11 users

This free software exchange service for PDP-11 users enables subscribers to submit their software for credits. These credits can be used to obtain other software listed in a monthly software-exchange bulletin published by General Systems, Inc. **PDP-11 Software Exchange,** Norcross, Ga.
Circle No 214

test equipment



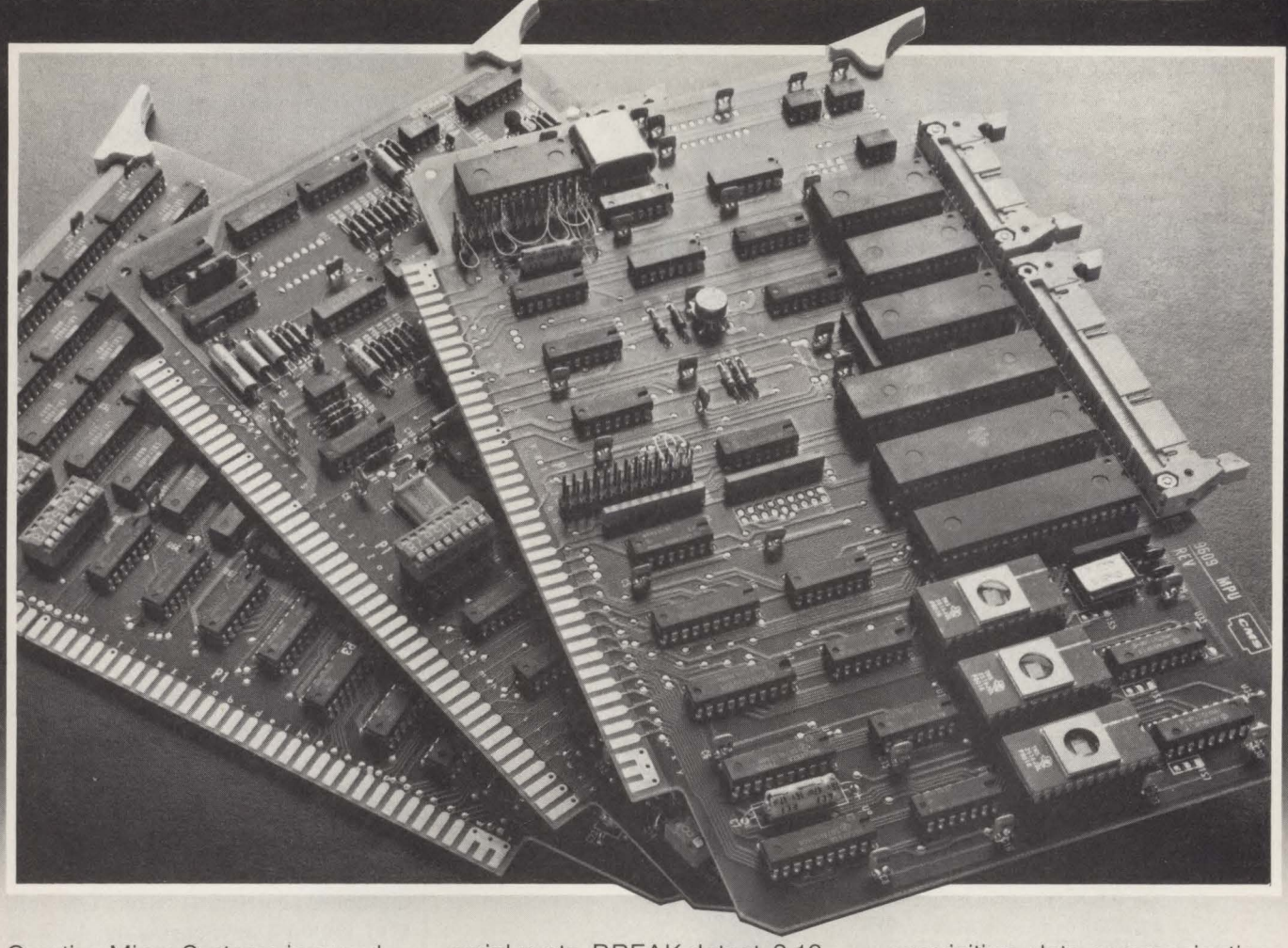
IDS unit tests bit-error rate

The model 1320 portable data test set for analyzing the error rate of any digital transmission network tests synchronous, asynchronous or start/stop character-oriented systems. The unit tests bit, character and block error rates by transmitting pseudo-random test patterns over a communications channel. The model 1320 sells for $3950. **International Data Sciences, Inc.,** Lincoln, R.I. **Circle No 215**

Control center does interactive diagnostics

The Tech Control Center, based on the vendor's Hawk 4000 Datatrap, performs interactive diagnostics and passive monitoring of data appearing at RS232 interfaces. Minitech 8900 control modules provide patching, switching and monitoring for reconfiguring backup systems and testing data networks. Prices start at $8000 for the Hawk 4000 and $6310 for the Minitech modules. **International Data Sciences, Inc.,** Lincoln, R.I.
Circle No 216

COMPARE THE CMS 6809 ADVANTAGE



Creative Micro Systems is proud of its line of general purpose microprocessor support modules. These M6800/M6809 based modules are pin and outline compatible with the industry standard EXORciser* and Micromodule* bus.

COMPARE THE CHOICE

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Each module in our product line is designed to respond to the needs of a major computer system function. Our 9609 module, featured above, is a complete microcomputer on a single board. It features the MC6809 processor, 6K of EPROM, 1K of RAM, 40 parallel I/O lines, 2 RS-232C serial ports, BREAK detect, 3 16-bit programmable timers, priority interrupt vector generator and a power failure protect/restart circuit.

For more extensive system requirements, the 9609 is supported by a variety of Memory, I/O, and Data Acquisition modules, and a broad line of card cages, power supplies, mother boards, prototype boards and accessories.

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Try to find another set of microprocessor modules in the same price and quality range with all the positive features Creative Micro Systems has to offer.

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Find us in the 1980 IC Master Catalog on pages 2608-2609.

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CIRCLE NO. 116 ON INQUIRY CARD

New Products

datacomm

Network concentrator controls large networks

The Supermux 790 intelligent concentrator provides multitrunk statistical multiplexing, alternate routing, host-computer selection and control of all resources in multinode networks. The unit accommodates any combination of 448 synchronous and asynchronous, dial-up and dedicated inputs at speeds as high as 9600 bps and concentrates them for transmission to as many as eight remote nodal locations at speeds as high as 72K bps. **Infotron Systems Corp.,** Cherry Hill, N.J. **Circle No 218**

Intertel announces limited-distance modem

The SLD1920 limited-distance modem for point-to-point and multipoint environments provides synchronous communications at speeds from 2400 to 19,200 bps over distances as great as 18 mi. The unit also handles asynchronous devices and incorporates digital loopback diagnostics. Price is $895 for a stand-alone version or $725 for a rack-mounted version. **Intertel, Inc.,** Andover, Mass.

Circle No 219

Xycom announces fiber-optic adapter

This fiber-optic communications adapter module, intended for use as a receiver and transmitter in industrial data-communications links, transmits asynchronously at DC to 5 MHz or synchronously at speeds as high as 1.544M bps. The module can operate as a computer interface or a repeater. Electrical inputs and outputs are TTL-compatible. A GaA1As infrared LED provides as much as 1000 mW of optical power output. **Xycom, Inc.,** Saline, Mich. **Circle No 220**

Seagate and Arrow

turning the tide in fixed disc technology

Seagate and Arrow's commitment to Winchester disc drive technology insures volume delivery and reliability—now and in the future.

Seagate's micro-Winchester 5¼-inch drive offers a low cost data storage alternative with higher performance, increased storage capacity and better reliability. Available in the same size as an industry standard minifloppy, the micro-Winchester stores thirty times as much data, cuts access time in half, and increases data transfer rates up to twenty times. The micro-Winchester's sealed media and components are safeguarded from external contamination, eliminating interchangeability and misalignment problems that can cause mistracking or data checks.

Seagate and Arrow are in front. Seagate designed, manufactured and marketed the first micro-Winchester disc drives, and Arrow is now Seagate's first and only nationwide distributor. Arrow's on-line real time computer inventory network provides immediate access to our in-stock product availability and is supported by a team of systems professionals and technicians who are ready to serve you today.

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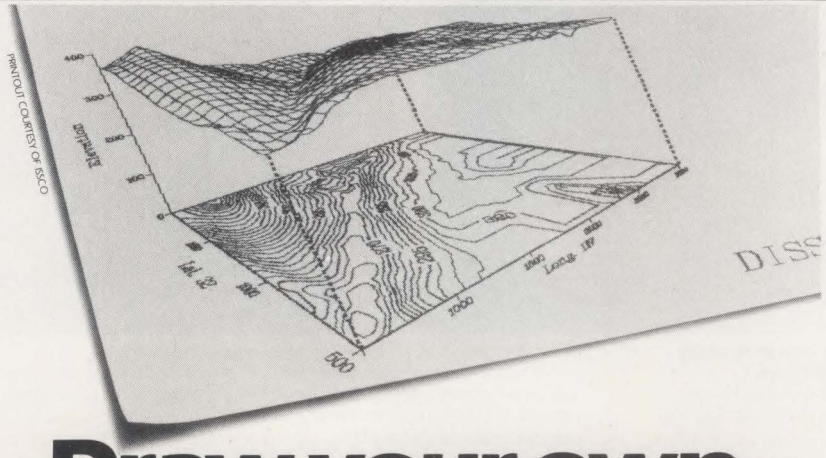

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CIRCLE NO. 119 ON INQUIRY CARD

New Products

datacomm

Statistical multiplexer handles error detection

The SM/2A statistical multiplexer enables two asynchronous terminals to communicate simultaneously over a single telephone line. The unit provides error detection and retransmission, compression of embedded blank spaces, independent buffering of each device and independent baud-rate selection to speeds as high as 4800 baud. The SM/2A sells for $825, with OEM and quantity discounts available. **Technical Analysis Corp.**, Atlanta, Ga.

Circle No 221

Processor handles advanced datacomm

The model 6050 statistical multiplexer and communications processor provides adaptive routing, user-destination routing, an intervention capability and adaptive data compression. It supports any mixture of asynchronous, bisynchronous and HDLC protocols and is transparent to network operation. Prices range from $40,000 to $80,000, depending on configuration. **Codex Corp.**, Mansfield, Mass.

Circle No 222

accessories and supplies

Antistatic mats reduce malfunctions

These antistatic mats prevent static-related equipment malfunctions, such as memory loss and alterations, video wipeout, word-processing carriage-return errors and unwanted start-ups and shutdowns. The grounded mats reduce charges in less than 1 sec. and work at any humidity level. Prices for a 5- × 4-ft. chair mat start at $123.50. **Uarco Computer Supplies**, DeKalb, Ill.

Circle No 223

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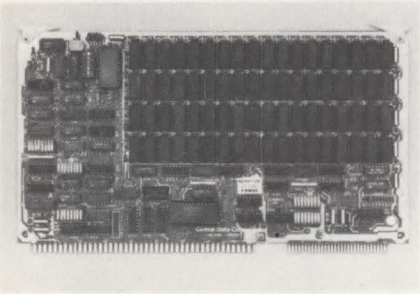
memories



Dynamic RAM board has 300-nsec. access time

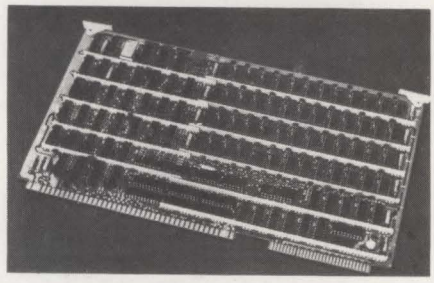
This Multibus-compatible board allows a user to add 32K to 128K bytes of dynamic RAM to an existing system. Parity checking generates an interrupt if any single-bit memory error occurs. The board has a 300-nsec. access time with a 16M-byte address capacity. Prices range from $700 for a 32K-byte board to $1775 for a 128K-byte version in quantities of 10 to 24. **Central Data Corp.**, Champaign, Ill. **Circle No 224**

CMOS RAM board supports 26-bit addressing

The BP-0220 CMOS RAM board features a 17K-byte read/write memory, eight sockets for 2716 or 2732 EPROMs, EPROM address decoding via bipolar fusible link PROMs and support for 16- and 20-bit addressing. It also provides A/C low-line input and 5V power fail detection. **NEC Microcomputers, Inc.**, Wellesley, Mass. **Circle No 225**

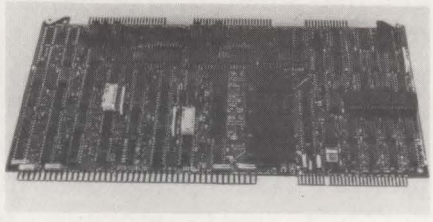
MOS memory for LSI-11 has 450-nsec. cycle time

This MOS memory board for LSI-11 μcs features on-board refresh, parity and battery backup. It provides as much as 128K bytes of storage on a dual-height card. Read and write access times are 140 and 100 nsec., respectively, and cycle time is 450 nsec. Price is $1300, with OEM discounts available. **Cambex Corp.**, Waltham, Mass. **Circle No 226**



RAM expansion boards offer error correction

The BLC-8064 family of RAM expansion boards is available with parity-error detection or ECC, which can correct 1-bit errors and detect 2-bit errors. The boards have 16K to 64K bytes of RAM in 16K-byte increments. The BLC-8064 family sells for $1033 to $2496 in 100-unit quantities. **National Semiconductor**, Santa Clara, Calif. **Circle No 227**



Memory and I/O board increases program storage

The iSBC 108A and 116A combination memory and I/O expansion boards contain 8K bytes and 16K bytes of RAM, respectively, sockets for as much as 32K bytes of EPROM, 48 programmable I/O lines, a programmable I/O port with RS232C drivers and receivers, eight interrupt-request lines and a 1-msec. real-time clock. In single-unit quantities, the iSBC 108A and 116A sell for $980 and $1185, respectively. **Intel Corp.**, Hillsboro, Ore. **Circle No 228**

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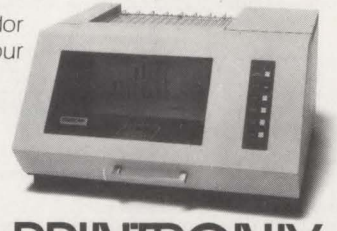

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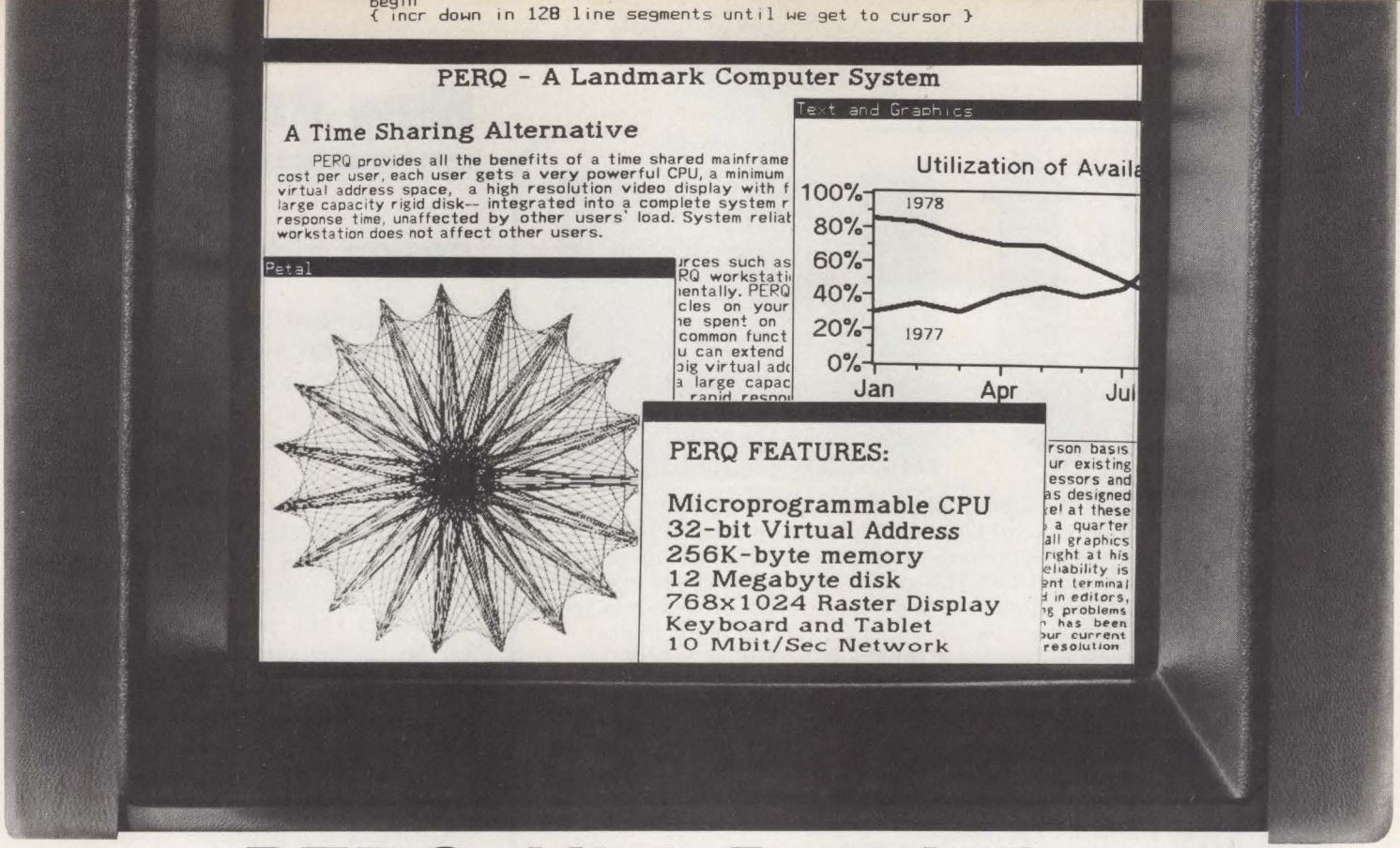

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PERQ is all the power you need.

PERQ provides you with a complete single-user system — all the processor, display, disk and memory one person needs, sitting right at his desk. And because PERQ workstations provide complete computing resources on a per-person basis, installations can be expanded incrementally. PERQ's Packet Stream Local Network interconnects PERQ systems in a distributed processing environment, allowing processor-to-processor communication at 10 megabits per second over a single coaxial cable.

PERQ is more powerful than any current microprocessor-based system

PERQ's CPU is a Three Rivers-designed, sophisticated, microprogrammed minicomputer which directly executes Pascal P-Code at up to 1 million P-Codes per second. A 32-bit virtual address means that very large programs can execute with ease. Even PERQ's operating system is written in Pascal, the front-runner in high-level languages for structured programming.

PERQ is leading the revolution against the mainframe.

Across America, PERQ is revolutionizing the way work gets done — because it provides all the benefits of a time-shared mainframe without any of the drawbacks.

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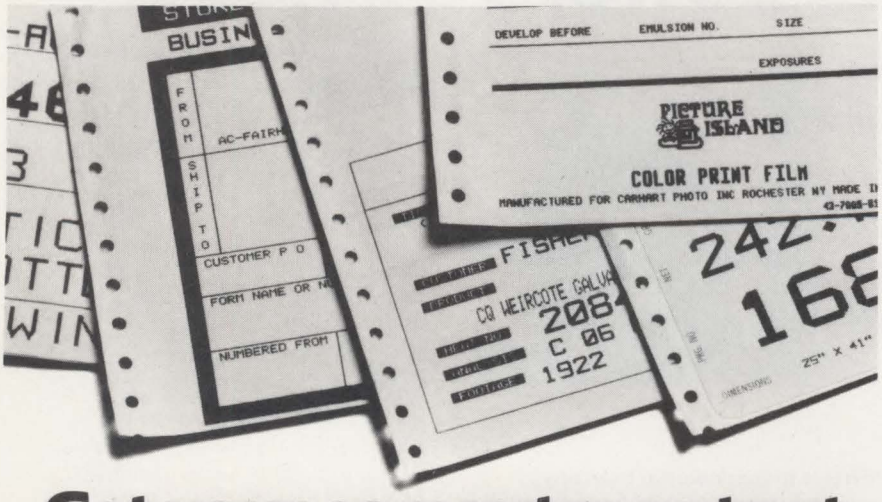

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Printronix printers not only print, they prepare forms for everything from invoices to labels.

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CIRCLE NO. 125 ON INQUIRY CARD

New Products

design aids

Development board fits into one slot

The STD Proto/System development board contains the STD bus decode logic, data I/O buffer logic and space for six 14-pin and 18 16-pin (or equivalent mix) low-profile IC sockets. The wire-wrap posts are located on the component side of the board. The board requires a ½-in. card-file space and can be inserted directly into the STD bus system. The device sells for $85.20. **Drum Systems,** Monterey, Calif. **Circle No 273**

Motorola introduces CMOS μp development system

The MEX146805 μp development system adapts existing EXORciser and EXORterm equipment to systems based on the vendor's CMOS MC146805E2 μp. The system gives real-time emulation of the MC146805E2 and enables a user to run multiple processors in the target system, with the debug function limited to one processor at a time. Price, in quantities of one to five, is $3000. **Motorola Semiconductor Products, Inc.,** Phoenix, Ariz. **Circle No 274**

AMI introduces PROM programmer

The Ariel universal PROM programmer and ROM simulator programs any 256- to 128K-bit MOS EPROM. The unit includes RS232C and TTY interfaces, a hexidecimal keypad and push buttons to control resetting, loading RAM from a master EPROM, verifying RAM contents against a master and programming a copy EPROM or verifying its contents. The Ariel sells for $2195 in single-unit quantities. **American Microsystems, Inc.,** Santa Clara, Calif. **Circle No 275**

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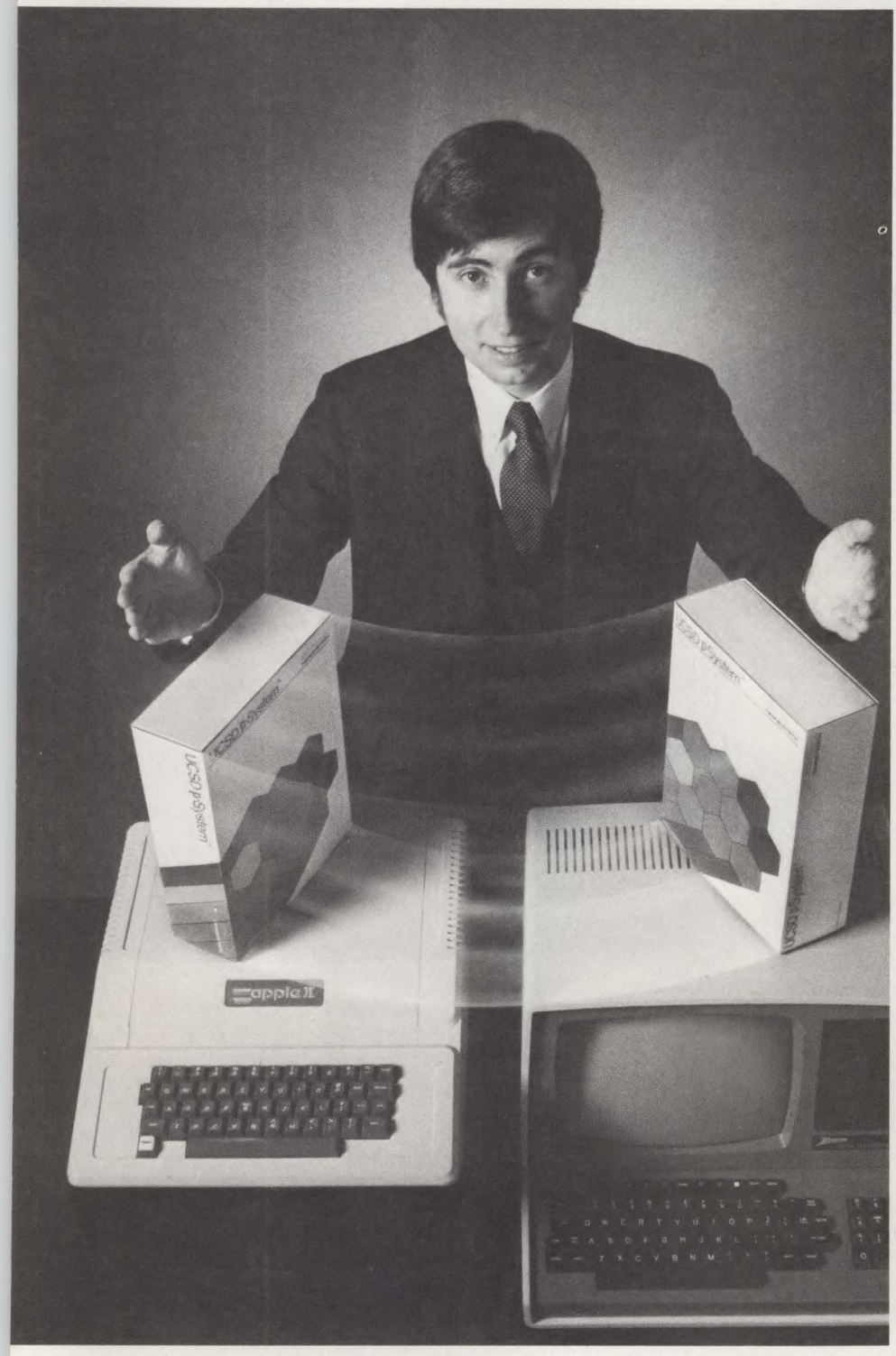

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CIRCLE NO. 126 ON INQUIRY CARD

New, from the makers of DMAX/16™

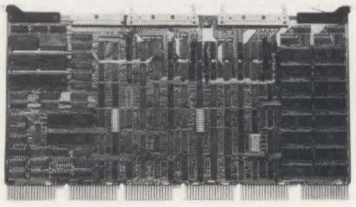
Super Max

The single-board, 16-line ABLE DH/DM™ that enhances any UNIBUS system with DH-performance at DZ-prices.

Two years ago, we broke new ground with our DMAX/16™, the original alternative to the DEC DH11. DMAX cut the space requirements from nine slots to three and became an immediate worldwide success. Now we've come up with something even better. This time it's ABLE DH/DM™, an alternative that achieves the optimum cluster size – 16 lines with modem control on a *single* board. You can compare price, or you can compare throughput. Either way, ABLE DH/DM™ beats everything in its class. No one else comes close.

The ABLE DH/DM™ is today's answer to VAX system needs for DMA communications multiplexing and serves all standard UNIBUS systems equally well. Each 16-line ABLE DH/DM™ installs in any standard hex-width slot at only one unit bus load and is DH11 compatible to the diagnostic level. Just plug it in and see it run – up to 19.2K baud using only half the UNIBUS bandwidth of a DEC DH11.

Key ABLE DH/DM™ features include on-board diagnostics with LED display, modem control on all lines, improved on-board silo depth and variable PROM set for proprietary OEM applications.



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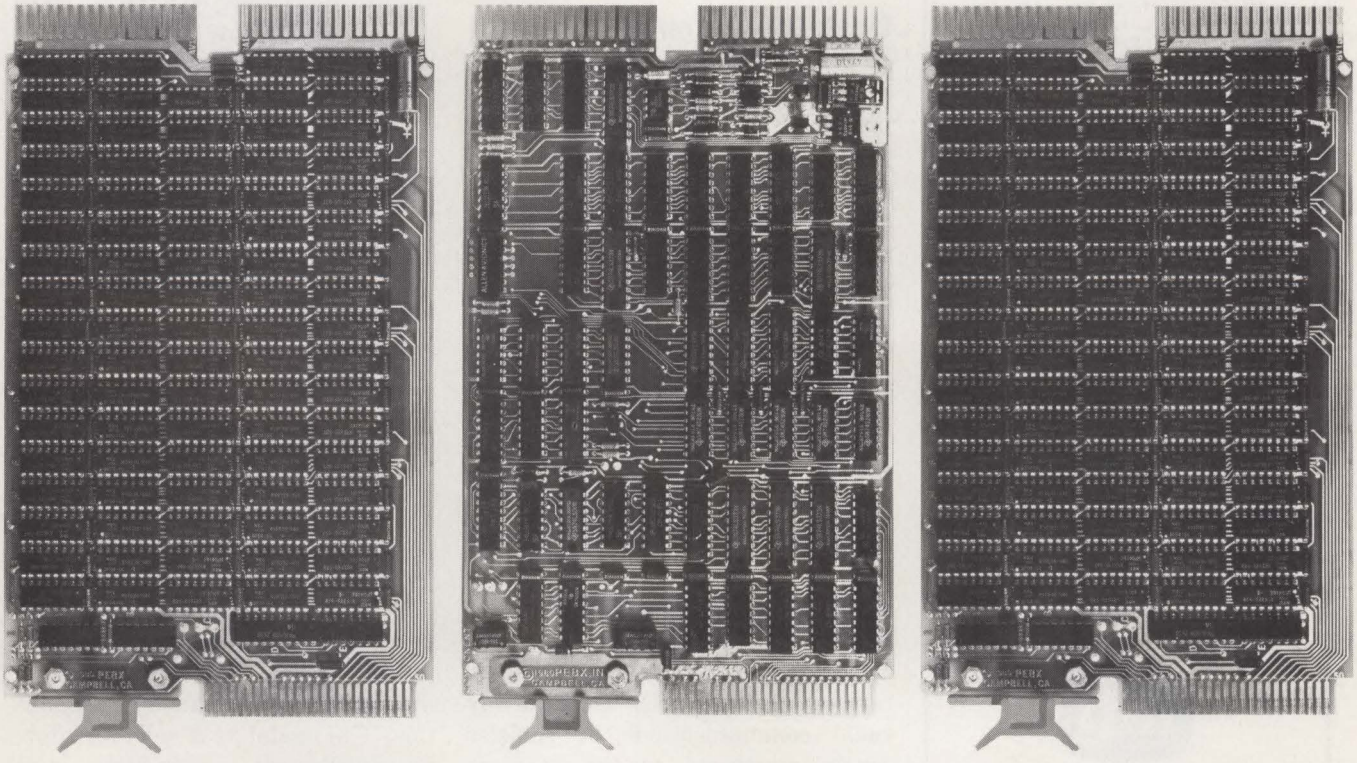

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	MTI price	Lease Price 12 mo.	24 mo.	36 mo.
VIDEO TERMINALS				
VT100	$ 1695	$ 92	$ 90	$ 85
VT132	2295	110	105	100
ADM-3A	*	55	45	40
ADM-3A+	*	65	60	55
ADM-31	*	75	70	65
ADM-42	*	100	90	85
1410 (Hazeltine)	825	50	45	40
1420	895	60	55	50
1421	895	60	55	50
1500	1045	70	65	60
1510	1145	75	70	65
1520	1395	90	85	80
1552	1350	85	80	75
300 BAUD TELEPRINTERS				
LA34-DA	1045	55	50	45
LA34-AA	1295	66	61	55
LA36	N.A.	95	90	85
Teletype 4310	1085	60	55	50
Teletype 4320	1225	65	60	52
Diablo 1640RO	3085	145	135	125
Diablo 1640KSR	3285	160	150	135
Diablo 1650RO	3185	150	140	130
Diablo 1650KSR	3385	185	175	165
Diablo 630RO	2295	125	120	115
TI 743	1190	65	60	55
TI 745	1585	78	73	68
TI 763	2690	115	110	105
TI 765	2895	130	125	120
(600 baud)				
TI 825RO	1565	75	70	65
TI 825KSR	1645	85	80	75
TI 825RO Pkg.	1750	85	80	75
TI 825KSR Pkg.	1895	98	95	85
1200 BAUD TELEPRINTERS				
LA120-AA	2410	135	125	110
LA180	2195	115	110	99
TI 783	1745	95	90	85
TI 785	2395	130	125	120
TI 787	2845	155	145	135
TI 810RO	1800	105	90	85
TI 810RO Pkg.	2047	115	110	105
TI 820KSR	1895	95	90	85
TI 820RO	1895	90	85	80
TI 820KSR Pkg.	1995	105	100	95
TI 820RO Pkg.	2047	95	90	85
(2400 baud)				
Dataprod. M200	2595	150	135	125
DATAPRODUCTS LINE PRINTERS				
B300 (300LPM)	5535	322	317	312
B600 (600LPM)	6861	393	388	383
2230 (300LPM)	7723	*	*	*
2260 (600LPM)	9614	*	*	*
2290 (900LPM)	12655	*	*	*
ACOUSTIC COUPLERS				
A/J A242-A	242	15	13	12
A/J 247	315	15	14	13
A/J AD342	395	20	18	16
A/J 1234 (Vadic)	895	50	45	40
A/J 1245	695	45	40	35
MODEMS				
GDC 103A3	395	25	24	23
GDC 202S/T	565	42	41	40
GDC 212-A	850	50	45	40
A/J 1256 (Vadic)	825	50	45	40
CASSETTE STORAGE SYSTEMS				
Techtran 816	1050	70	65	60
Techtran 817	1295	80	75	70
Techtran 818	1795	105	95	85
Techtran 822	2295	140	130	120
MFE 5000	1495	100	95	90
FLOPPY DISK SYSTEMS				
Techtran 950	1395	100	90	85
Techtran 951	1995	125	115	105

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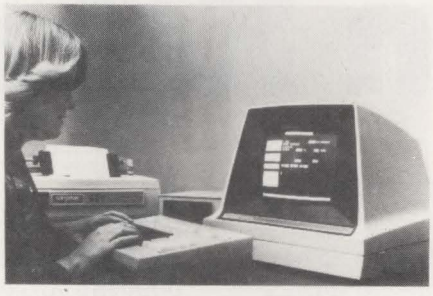
CIRCLE NO. 129 ON INQUIRY CARD

New Products

interactive terminals



Computek introduces intelligent terminal

The Z80A-based Display 8 user-programmable intelligent terminal includes as much as 16K bytes of EPROM or ROM, a 1K-byte static RAM scratchpad and 64K bytes of dynamic RAM. Other features include a 12-in., 25-line × 80-character CRT, two serial I/O ports and an S100 bus adapter. Single-unit prices range from $2700 to $3900, depending on configuration. **Computek, Inc.**, Burlington, Mass.

Circle No 232

Desk-top terminal is NCR compatible

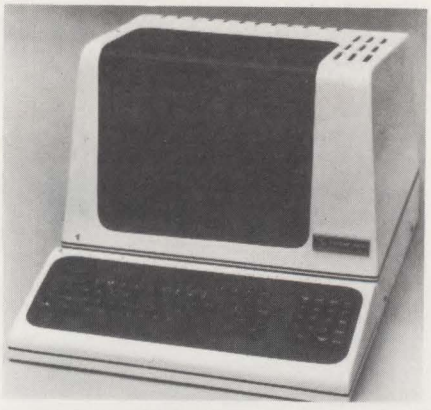
The model 304 N CRT terminal, a plug-compatible replacement for NCR 796-301 and 796-101 units, comes in two configurations: the D304-N desk-top model with a standard keyboard and the 1304-N executive version with the keyboard in a pull-out drawer. The unit, which operates at data transmission rates as high as 19,200 baud, includes a communications-testing mode. The 304-N sells for $2600, with quantity discounts available. **Informer, Inc.**, Los Angeles, Calif. **Circle No 233**

Mobile terminal sends two-way messages

The KDT-240 keyboard display terminal for use with FM two-way radio communications in vehicles sends messages to or accesses remote computers. Push-button status and message transmissions eliminate routine voice messages. A visual alphanumeric keyboard transmits text that appears on a shielded display. Automatic channel sensing reduces the number of garbled messages caused by two or more simultaneous message transmissions. **Motorola, Inc.**, Schaumburg, Ill. **Circle No 234**

Z80-based terminal has sealed keyboard

This Z80-based desk-top terminal for industrial or general-purpose use has a sealed keyboard that prevents entry of airborne and liquid contaminants. The terminal is tested under water pressure and can withstand ambient temperatures as low as 50°C. The unit has 96K bytes of RAM, 8K bytes of EPROM, four serial ports and two parallel ports. **Xycom, Inc.**, Saline, Mich. **Circle No 235**



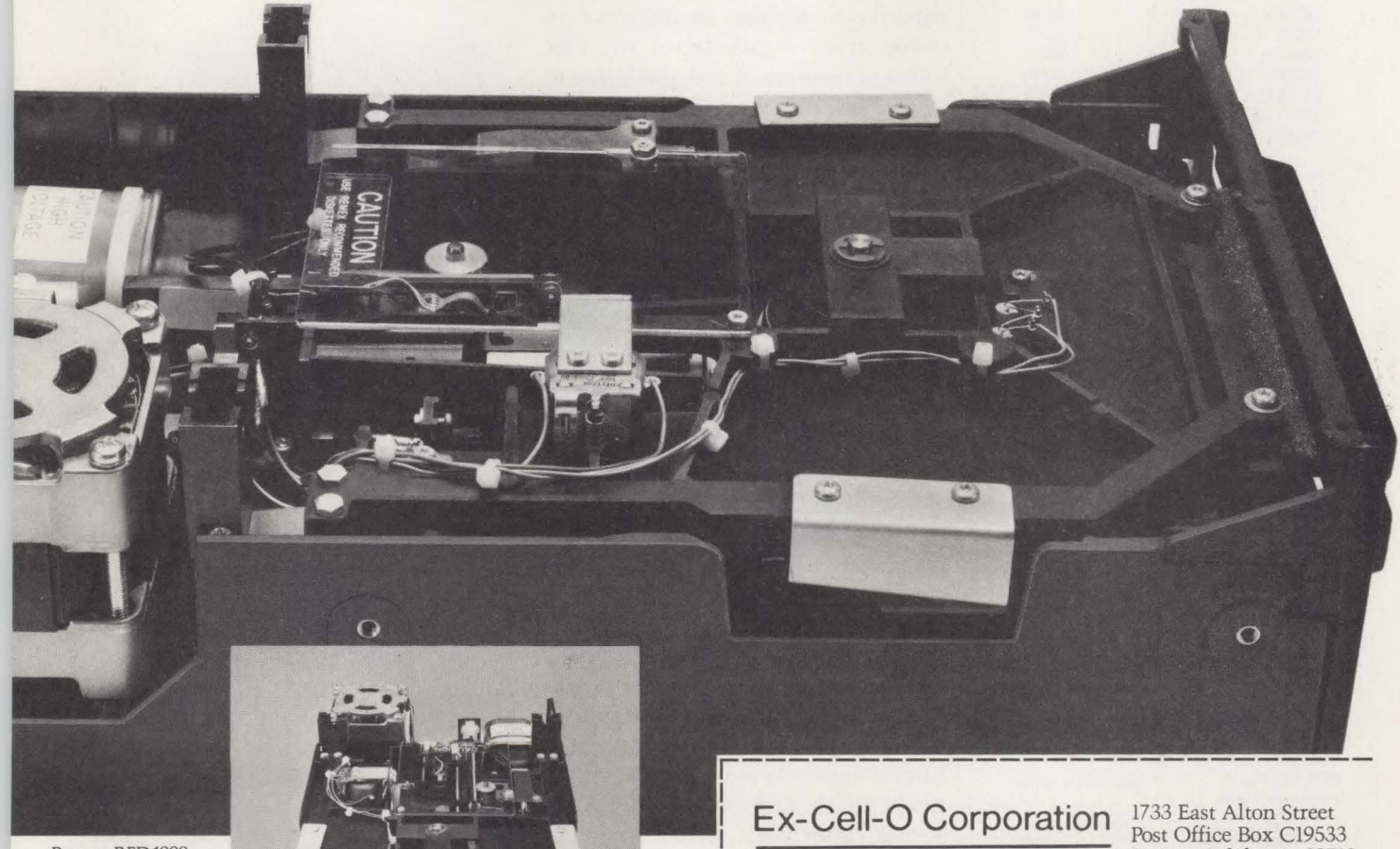
Video terminal emulates DEC machines

Compatible with Digital Equipment Corp.'s VT132, VT100 and VT52 terminals, the model 3132 video terminal incorporates a nonglare screen; numeric/special function keypad; reverse video, blinking, bold enhancement and underlining attributes; and text-editing by character or line, protected data fields and block or interactive data-transfer capabilities. The model 3132 sells for $1995 in single-unit quantities, with volume discounts available. **Cobar, Inc.** Fullerton, Calif.

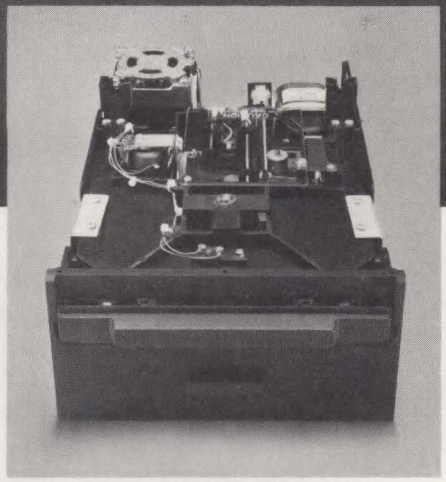
Circle No 236

Remex Dual Head Floppy Disk Drives.

No Extravagant Claims. Just Performance.



Remex RFD4000 Dual Head Flexible Disk Drive



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WDS821	20MB	8"	$2895
WDS831	30MB	8"	$3195
WDS841	40MB	8"	$3495
WDS1429	29MB	14"	$3395
WDS1458	58MB	14"	$3995

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CDS114	10MB	5440 T.L.	$5995

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CIRCLE NO. 132 ON INQUIRY CARD

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New Products

interactive terminals

Ramtek announces color graphics terminal

The RM-6212 color graphics terminal for business graphics, management information systems, CAD/CAM and educational applications connects to any host computer using an RS232C interface. The unit has 640- × 480-pixel resolution, capacity to display as many as 16 colors from a palette of 64, 32K bytes of ROM/PROM and 16K bytes of RAM. The RM-6212 sells for $16,000. **Ramtek Corp.**, Santa Clara, Calif.

Circle No 237

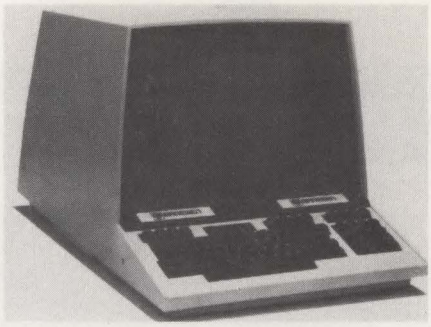
Hand-held terminal communicates over phones

This hand-held, portable data terminal, based on the vendor's LK-3000 personal computer, uses interchangeable modules to communicate with any computer via an RS232 interface. Other modules transform the unit into a language translator, filing system, calculator or programmable electronic note pad. The LK-3000 with communications module and acoustic coupler sells for $525. **Nixdorf Computer Personal Systems, Inc.**, Burlington, Mass. **Circle No 238**

Intermediate terminal has ergonomic design

The μp-based ADM-32 terminal has an ergonomically designed housing, including a detachable keyboard and a tilted screen. Other features include two 1920-character pages of memory; function keys; editing capabilities; block mode transmission; reduced intensity, blinking, blanking, reverse video and underlining; business graphics; a numeric keypad; full- or half-duplex conversation modes; self-test; and typewriter tab stops. **Lear Siegler, Inc.**, Anaheim, Calif.

Circle No 239



Braegen terminal emulates VT100

The BT-100 video display terminal provides DEC VT100 emulation, double-sized and reverse-video characters, 80 or 132 characters per line, split-screen and smooth-scrolling capabilities, blinking, underline and dual-intensity characters, transmission speeds as high as 19,200 baud and a full-duplex, asynchronous communications line. The BT-100 sells for $1995, in single-unit quantities, with volume discounts available. **Braegen Corp.**, Anaheim, Calif. **Circle No 240**

Video display terminal has non-glare display

The Dialogue 80 buffered CRT terminal includes a non-glare 128-character display. The unit also incorporates an RS232C asynchronous interface, a serial interface and 20 user-programmable functions, including consonants, screen formats or command sequences. The Dialogue 80 is priced at $1149 in single-unit quantities. **Ampex Corp.**, El Segundo, Calif.

Circle No 241

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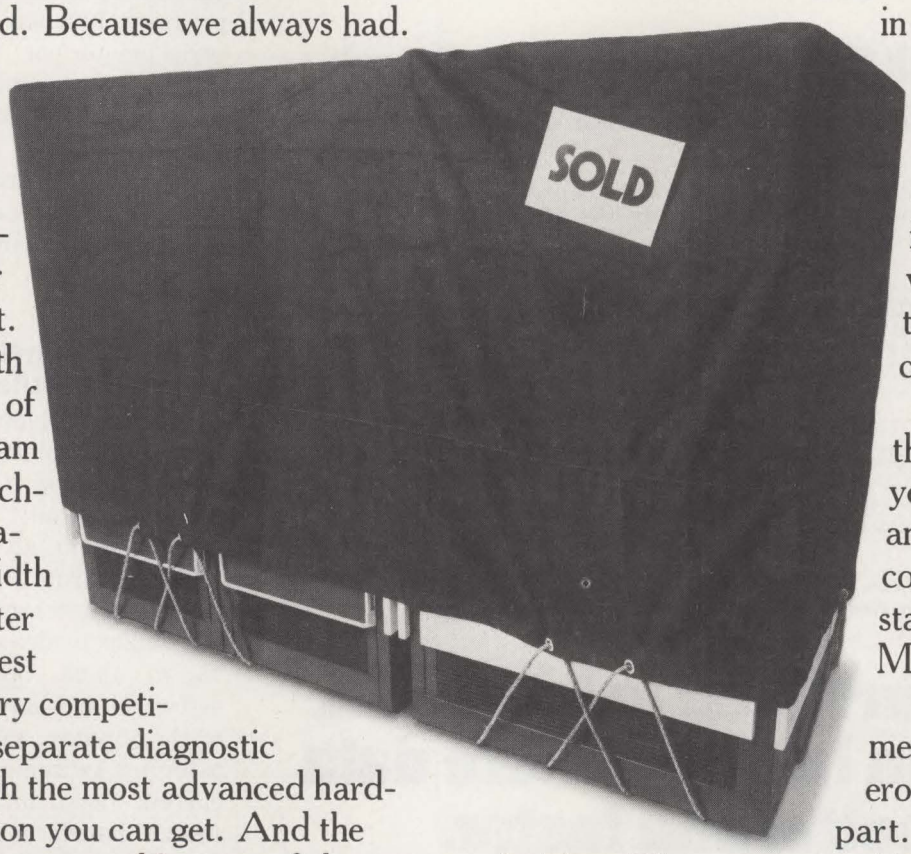
In this case we told them we'd deliver a 32-bit system unlike any other on the market.



One with the reliability of VLSI program array logic technology. A machine bandwidth 2-4 times faster than the nearest virtual memory competition. And a separate diagnostic processor with the most advanced hardware protection you can get. And the hardware features on this state-of-the-art-system supported by software. On the day of delivery. (Something some computer companies never get done.)

Which was precisely what they needed to work with the ECLIPSE® systems supporting development of the flight control/avionic systems for their new 757 and 767 airplanes. The first integrated avionic systems built around digital technology for commercial applications.

As it turned out, their MV/8000 system arrived ahead of schedule. Got up and running ahead of schedule. And from day one, has lived up to their expectations.

We tell you this story to point out that in an industry noted for abandoning its customers with every advance in technology, we have continued to take care of our own.

So much so that you can run your NOVA® and ECLIPSE code on our latest, state-of-the-art MV/8000 system.

This is not meaningless generosity on our part. It is a business decision. The one upon which this company was founded.

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And should that information tempt you to buy an MV/8000 system, there is one more thing we would like to point out.

You will not be the first.

Data General

We take care of our own.

CIRCLE NO. 135 ON INQUIRY CARD

interactive terminals

Teleray model 100 is VT100 emulator

The model 100 terminal, which is code- and performance-compatible with Digital Equipment Corp.'s VT100, features nonvolatile, programmable function memory, an RS232 peripheral port with programmable data rates, two programmable smooth scroll rates, four character widths and line-monitoring. The model 100 sells for $1790, with quantity discounts available. **Teleray,** Minneapolis, Minn. **Circle No 242**

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675 Mbyte Disc	Yes	No
Drives:	8/Per	4/Per
Buffering:	Full FIFO	No
Mix/Match Disc Drives:	Yes	No
Data-Lates:	No	Must Start Over
CPU Space:	One B or E Selch	Two I/O's
Construction:	Multiwire	PC

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CIRCLE NO. 136 ON INQUIRY CARD

Perkin-Elmer terminal has three modes

The μp-based model 550S block mode/editing video display terminal has three modes for conversational timesharing, transaction processing and text manipulation or software development. The unit features an 83-key keyboard with multifunction numeric pad and four to eight program function keys, an ASCII serial printer port, "XON/XOFF" host control over terminal block transmissions and field attributes for half intensity, blink, non-display and protected. The terminal is priced at $1189, with quantity discounts available. **Perkin-Elmer Corp.,** Flanders, N.J. **Circle No 243**

Dumb terminal provides visual attributes

The ADM-5 dumb terminal console provides visual attributes, editing capabilities and a gated extension port. The unit displays 1920 characters in an 80-character × 24-line format. The terminal operates asynchronously in half- or full-duplex modes at data rates from 75 to 19.2K bps. The unit is software- and hardware-compatible with popular ASCII computers, offering switch-selectable 20-mA current loop and EIA standard RS232C interfaces. The ADM-5 sells for $995. **Lear Siegler, Inc.,** Anaheim, Calif. **Circle No 244**

Model 4420 terminal has three-screen memory

The model 4420 buffered keyboard display terminal provides character or block transmission, speeds as high as 9600 bps, a three-screen memory, a buffered printer port, full editing and formatting capabilities, keyboard-selectable options, cursor XY addressing and readout, programmable PF keys, destructive scrolling and built-in diagnostics. The 4420 sells for $3824. **Teletype Corp.,** Skokie, Ill. **Circle No 245**

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Just when you thought you were totally confused by all the "smart" computer terminals on the market, Lear Siegler eliminates the confusion by bringing you exactly what you need.

IT™—the Intermediate Terminal™ video display from Lear Siegler.

IT compresses the broad spectrum of "smart" terminals into ITself. Now, when you're looking for a terminal that isn't too smart but isn't too dumb either, IT is perfect for the job.

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With IT you get two pages of memory (a total of 48 display lines). A complete range of visual attributes. Blinking. Blanking. Reverse video. Reduced intensity with protected fields. And underlining.

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CIRCLE NO. 137 ON INQUIRY CARD

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But if your system is ready for the 2½ Mbyte floppy *today* not next year—and, if you need access speeds at least three times faster than you have today—and, if you want data integrity that will make you forget every bad thought you ever had about double sided heads—then there is only one choice. You need the PerSci 299B, the IBM compatible, microprocessor-controlled flexible disk drive with hard disk performance.

Four Heads and Fast Positioning Look at PerSci's gutsy design. Four heads reading both sides of two diskettes in a chassis the size of a standard drive. That gives you two drives in one (at only $725 a spindle) for a total of 2½ Mbytes of formatted and removable data storage. And using high accuracy, "big disk" voice coil positioning, the 299B seeks data at a rate of 76 tracks in only 100 ms (including settle) with virtually no media wear. It's the worlds fastest floppy.

Microprocessor Controlled and Autoloading PerSci's superior patented read/write electronics allow the 299B to read all double density codes without (as well as with) write precompensation. Only PerSci and IBM can do it—so 2D interchange is assured. Diskette autoload on the 299B eliminates destructive media "hubbing," simplifies operation and, allows for complete computer control. And microprocessor controlled self diagnostics make drive maintenance easy.

And You Can Get It Maybe best of all, the PerSci 299B is not pie-in-the-sky. It's a quality-manufactured, dynamically tested reality with more than 12,000 operating spindles in the field. There's also a single sided version and a line of controllers to back it up.

Somebody once said you get what you pay for. He probably owned a PerSci. Now, we'd like to talk to you. PerSci, Inc., 12210 Nebraska Avenue, W. Los Angeles, California 90025. (213) 820-7613.

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LSI-11 MAGNETIC TAPE CONTROLLER, Model DQ 120, interfaces 4 industry standard reel-to-reel drives • emulates TM11* • handles 7 and/or 9 track NRZI drives to 112.5 ips • selectable DEC or IBM byte order formatting • data error checking • RT-11/RSX-11* compatible • extended addressing to 128K words.

LSI-11 MAGNETIC TAPE COUPLER, Model DQ 130, interfaces dual density (NRZI/PE) formatted drives • emulates TM11 • handles up to eight 9 track 800/1600 bpi industry standard drives at speeds from 12.5 to 125 ips • "streamer" mode capability • software or switch selectable density • RT-11/RSX-11 software compatibility.

LSI-11 MASS STORAGE DISC CONTROLLER, Model DQ 200, interfaces any two SMD flat cable interface compatible hard disc drives for up to 500 MB on-line storage • mix or match compatible Winchester, SMD or CMD • variable sector size • automatic media flaw compensation with bad sector flagging • optimized logical to physical unit mapping • implements Winchester fixed head option.

LSI-11 SHUGART SA4000 WINCHESTER DISC CONTROLLER, Model DQ 201, emulates DEC RK* • runs drivers under RT-11 and RSX-11M* systems • compatible with 14.5 MB SA4004 or 29 MB SA4008 drives • automatic media flaw compensation.

LSI-11 DISC CONTROLLER, Model DQ 100, interfaces 2.5, 5, 10 or 20 MB cartridge and fixed platter drives in combinations to 80 MB • RKV-11/RKO5* emulator • handles front load (2315) and/or top load (5440) drives • automatic power fail/power down media protection • RT-11/RSX-11 compatible.

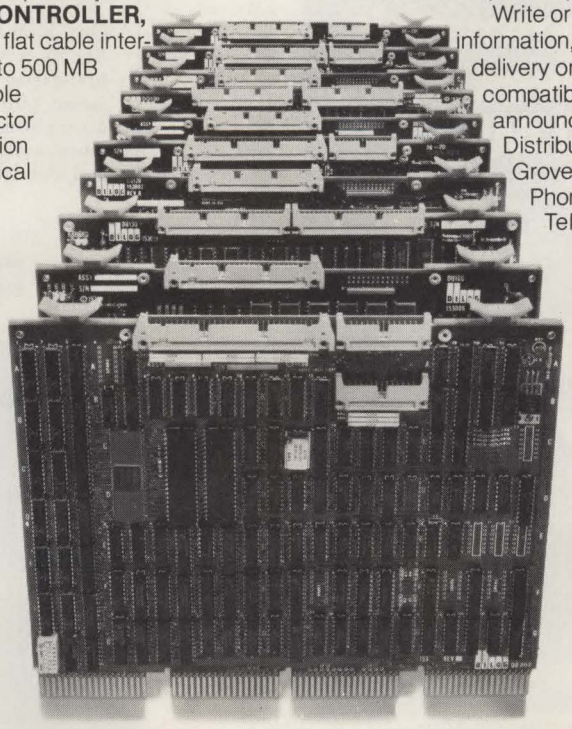
LSI-11 EMULATING MASS STORAGE CONTROLLER, Model DQ 202. Cost effective interface of two 8 and/or 14-inch Winchesters, SMD or CMD hard disc drives without changing controller . . . 8 to 300 MB capacity • RP emulator • automatic media flaw compensation.

PDP-11 MAGNETIC TAPE CONTROLLER, Model DU 120, emulates TM-11 and has same features as Model DQ 120 (LSI unit) • software compatible with RT-11, RSX-11, RSTS, IAS and MUMPS.

PDP-11 MAGNETIC TAPE COUPLER, Model DU 130, offers features of Model DQ 130 (LSI unit) • RT-11, RSX-11, RSTS, IAS and MUMPS software compatible.

PDP-11 DISC CONTROLLER, Model DU 100 includes features of Model DQ 100 (LSI unit) • RT-11, RSX-11, RSTS, IAS and MUMPS compatible • emulates RK-11.

PDP-11 EMULATING MASS STORAGE CONTROLLER, Model DU 202, offers same features as Model DQ 202 (LSI unit).



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All DILOG μP Products are Low Power, Quad Size

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CIRCLE NO. 139 ON INQUIRY CARD

disk/tape

Floppy-disk system reads RX01 and RX02

The RX03 floppy-disk system, which reads and writes Digital Equipment Corp. RX01 and RX02 formatted floppy disks, has a storage capacity of 1M byte per drive. The RX03 is available in a package containing two drives, a controller, 64K bytes of RAM, a DLV11 RS232 port, hardware bootstrap and an LSI-11/2 CPU. The package sells for $6555 in 50-unit quantities. **General Robotics Corp.**, Hartford, Wis.

Circle No 246

5¼-in. floppy stores 437K bytes

The CDC 9409 double-sided 5¼-in. floppy-disk drive for word-processing, small-business and personal computer systems provides storage capacities of 218K bytes (single density) or 437K bytes (double density). A band stepper mechanism provides head positioning. As many as four drives can be configured with one controller. Prices start at $225 in large quantities. **Control Data Corp.**, Minneapolis, Minn. **Circle No 247**

Portable recorder has 14 channels

The Sabre 80 portable magnetic recorder has a coaxial reel drive transport and eight bidirectional tape speeds from 120 to 15/16 ips. The unit also includes a choice of plug-in power supplies and direct bandwidth to 2 MHz or FM bandwidth from DC to 500 kHz. Prices start at $18,500 for a ½-in., seven-channel I-band direct version, and $33,800 for a 1-in., 14-channel wideband FM model. **Sangamo Data Recorders,** Sarasota, Fla.

Circle No 248

Subsystem combines tape, Winchester, floppy

The ASC8000-6S-MTU combines an 8-in. 1M- or 2M-byte floppy-disk drive, a 14.5M- to 58M-byte Winchester-disk drive and a 17M-byte, ¼-in. tape-cartridge drive. Other features of the Z80-based subsystem include tape initialization and disk-to-tape back-up. A single-user version of the subsystem sells for $12,650 in single-unit quantities, with OEM discounts available. **Altos Computer Systems,** San Jose, Calif.

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CIRCLE NO. 142 ON INQUIRY CARD

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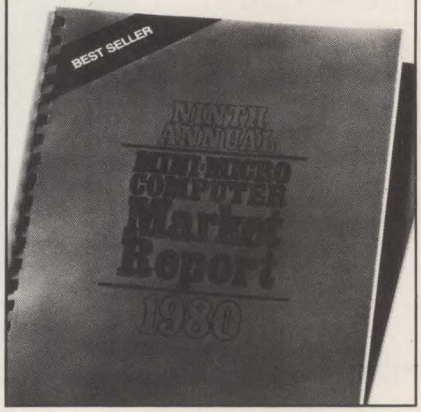

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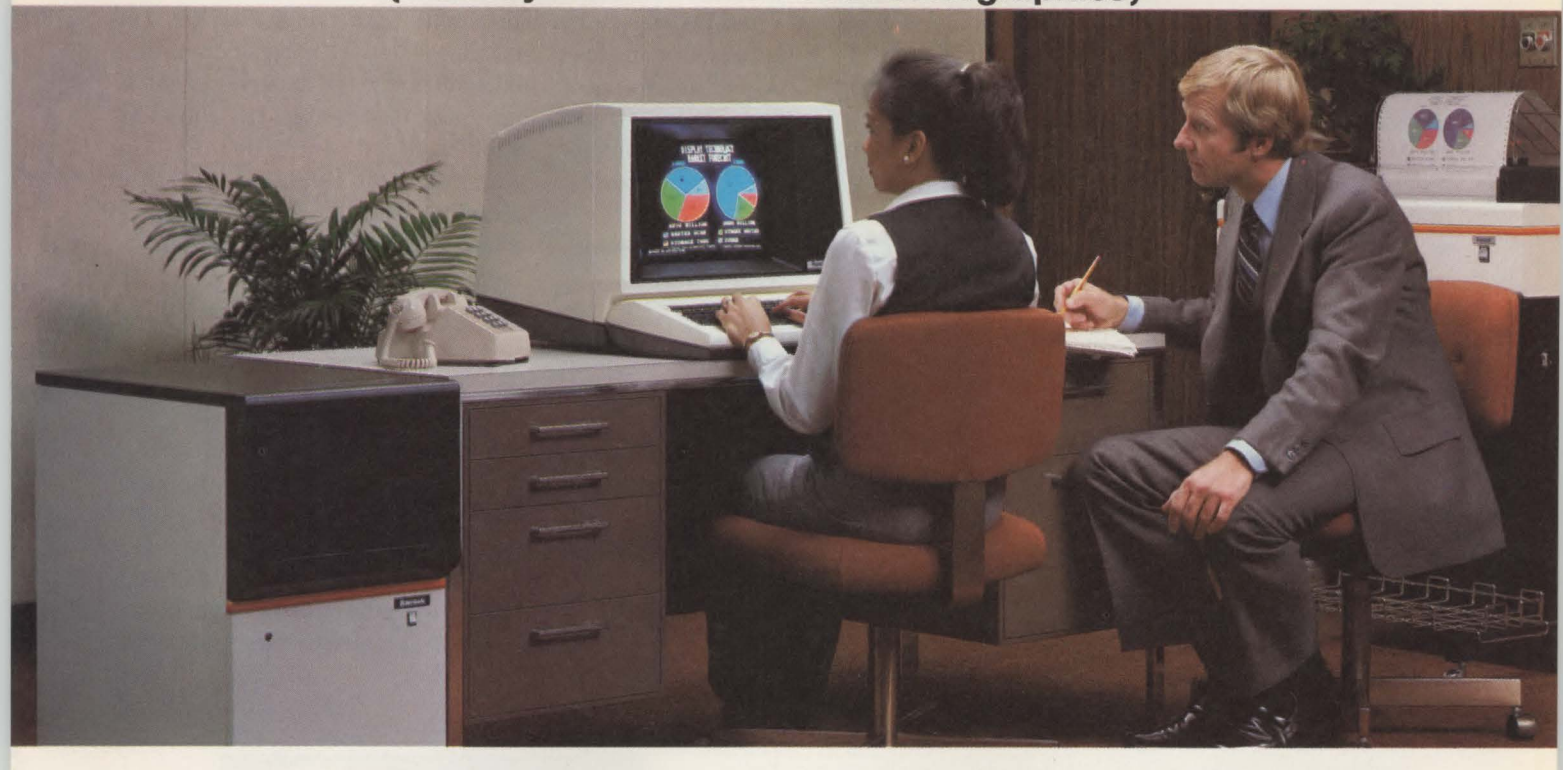

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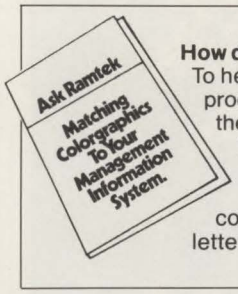

How do colorgraphics fit into your MIS picture? To help you evaluate the business graphics products on the market, Ramtek has prepared the booklet, "Matching colorgraphics to your Management Information System." It's Issue Number 5 of Ramtek's Use Our Experience Series. To get your free copy, write to Ramtek on your company's letterhead.

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CIRCLE NO. 143 ON INQUIRY CARD

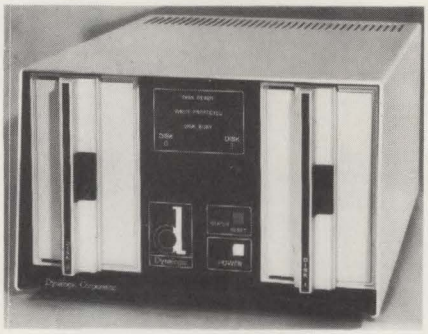
disk/tape

Militarized tape system stores 23M bits

The SETS-1 tape system for severe-environment industrial, military and aerospace applications meets MIL-E-16400, 5400 and 4158 standards. The unit, which uses sealed, removable tape modules, can store 23M bits at 1600 bpi on 300 ft. of ¼-in. magnetic tape. It can read and write bidirectionally with a 192K-bps transfer rate. Prices start at $7200. **EMM Sesco,** Chatsworth, Calif. **Circle No 250**

Cartridge tape backs Winchester

The TIP (tape-interchange package), an S-100-compatible cartridge-tape subsystem and software utility, transfers programs and data files from a Winchester disk to a 13.4M-byte, ¼-in. tape cartridge. The subsystem consists of a DS-100 controller, a 6400-bpi cartridge-tape drive and a rack- or table-mountable power supply. A rack-mounted version sells for $2100 in lots of 25. **Alloy Engineering Co.,** Framingham, Mass. **Circle No 251**



Floppy subsystems are RS232C-compatible

The models 7111 and 7112 single- and dual-floppy-disk subsystems are plug-compatible with all asynchronous RS232C equipment. The units can read, write and initialize IBM 3740 series-compatible disks and transfer data at speeds as high as 19,200 baud. The unit records data in EBCDIC; the communication code is ASCII. The model 7111 sells for $3295, the model 7112 FOR $3995. **Dynalogic Corp.,** Ottawa, Canada.

Circle No 252

SEL introduces magnetic tape system

This magnetic tape subsystem supports 125-ips tri-density magnetic tape drives with 800-, 1600- and 6250-bpi recording in NRZI, PE and GCR formats. Price is $14,500, with OEM discounts available. **Systems Engineering Laboratories,** Fort Lauderdale, Fla.

Circle No 253

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According to a leading financial journal, two major areas holding back the economic recovery of the United States are: the high cost of oil; and good software. There's not too much POINT 4 can do about the first, but when it comes to good software ... that's another story.

For example, our IRIS Operating System, with over 7000 successful installations, has become the world's leading independently-supplied Interactive Multi-User Operating System for POINT 4 and NOVA*-type minicomputers. IRIS supports multiple languages, including Business BASIC. It is a multi-tasking system that supports time sharing and batch processing tasks.

POINT 4 Data specializes in providing System Builders with fully integrated application software packages which can be easily adapted to customer requirements. MACS, our interactive, fully integrated Management, Accounting, and Control System is written in Business BASIC and designed to operate under IRIS.

For Word Processing applications, POINT 4 Data offers STYLUS, an easy, cost-efficient way to add multi-user, multi-terminals, shared-logic word processing to POINT 4 or NOVA-type computers using IRIS.

The READINET Project Control System was designed for utilization in complex projects typical of the Construction, Aerospace, Government, and R&D industries. It combines interactive computing techniques with PERT/CPM time, cost, and resource allocation analysis. READINET allows the project manager to plan the project, optimize the critical parameters within a set of constraints, and then monitor performance until the project is successfully completed.

But perhaps most valuable of all ... POINT 4 Data offers FORCE, an applications program generator that allows the system designer to specify screen layouts, file formats, data elements, etc. Fully coded, commented and documented programs are then automatically generated by the computer itself ... sometimes in 1/100th the time needed for manual programming.

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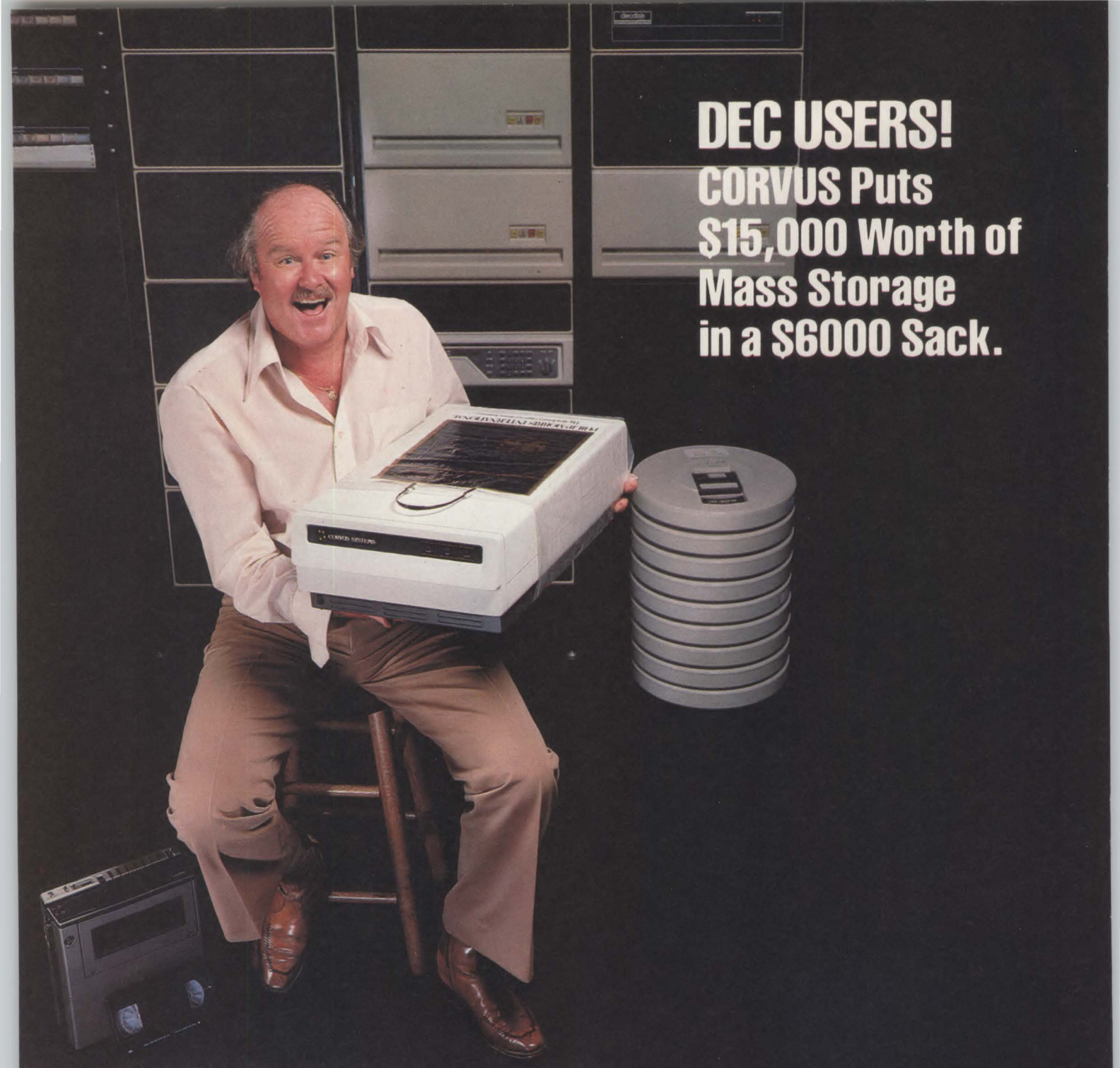

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CORVUS has a proven track record as the largest supplier of eight-inch Winchester disk systems to the microcomputer market. We back up our products too, with worldwide parts and service.

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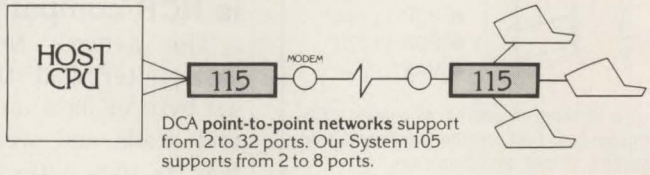
FROM STATISTICAL MULTIPLEXORS TO COMPLETE DATACOMM NETWORKS, EVERY DCA COMPONENT IS ENGINEERED TO EXPAND

DCA protects your initial investment in statistical multiplexors with the lowest-cost network growth in the industry. So you can start with a small datacomm network today, and expand or modify it to meet your needs tomorrow.

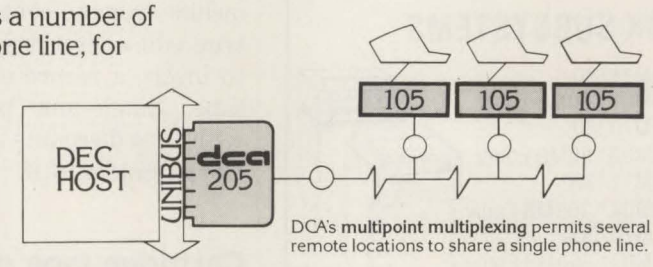
Our System 115 statistical multiplexor can be used in point-to-point networks to support from 2 to 32 asynchronous terminals at a remote site. DCA's statistical multiplexing assures excellent response time, character transparency and error-free transmission.



DCA **point-to-point networks** support from 2 to 32 ports. Our System 105 supports from 2 to 8 ports.

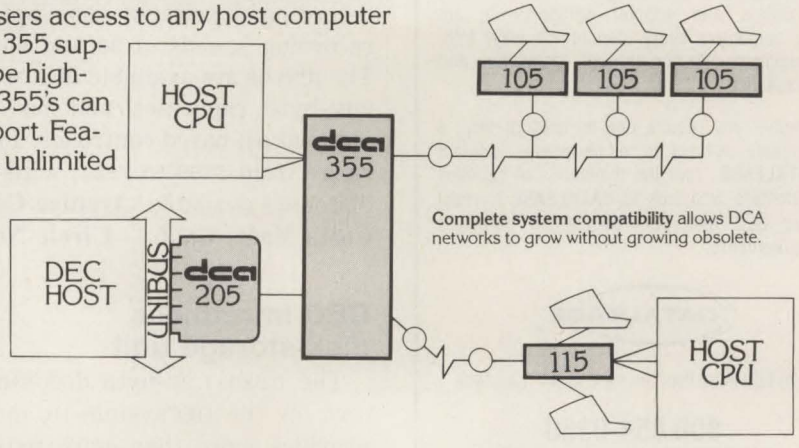
DCA's multipoint multiplexing configuration serves a number of remote terminal locations with just a single telephone line, for substantial savings in phone-line and hardware costs. DCA users have benefited from multipoint multiplexing since January 1979.

DCA's System 205 is a statistical multiplexor designed for DEC UNIBUS*-based computers. The 205 requires only one UNIBUS slot to emulate up to 16 DEC DZ11 modules and a 128-port stat mux. This greatly lowers hardware costs and improves response time as well.



DCA's **multipoint multiplexing** permits several remote locations to share a single phone line.

Because of DCA's unique modular design, all of the above networks could easily expand into larger, more powerful networks. As the master network processor, System 355 gives terminal users access to any host computer anywhere in the network. In addition, the 355 supports up to 126 ports, 62 of which can be high-speed synchronous trunk links. Several 355's can be combined to greatly expand this support. Features include port contention, switching, unlimited routing, X.25 support and a wide array of network management tools.



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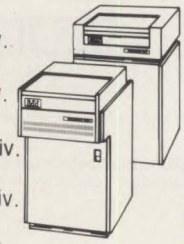

- DM11/80 RM02* 80MB Equiv.
- DM70/80 RM02* 80MB Equiv.
- DM11/300 RM04 * 300MB Equiv.
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CIRCLE NO. 149 ON INQUIRY CARD

New Products

disk/tape

8-in. floppy is TRS-80 compatible

The Maxi-Disk 8-in. floppy-disk drives are compatible with the TRS-80 model II and functionally identical to Radio Shack expansion drives. The drives are self-contained and can be inserted and removed without disturbing other drives. Three drives take up half the space of Radio Shack's three-drive box. The drives sell for $845. A three-drive cable is $60. **Parasitic Engineering Inc.**, Oakland, Calif. **Circle No 254**

Read/write cassette terminal is NCR-compatible

The 5450XL NCR-compatible cassette terminal stores as much as 1M byte of data on a 450-ft. tape, and reads and writes records as long as 1024 bytes. Other features include remote-control binary and true edit operations and the ability to insert a record-end message on tape. Single-unit price is $2245, with OEM discounts available. **MFE Corp.**, Salem, N.H. **Circle No 255**

Cartridge tape drives provide Winchester backup

The "Sidewinder" series of ¼-in. streaming cartridge-tape drives for Winchester-disk drive backup has a recording density of 8000 bpi and recording speeds of 30 and 90 ips. The drives are available in 10M- and 20M-byte capacities and have an optional μp-based controller. Prices range from $469 to $954, with OEM discounts available. **Archive Corp.**, Costa Mesa, Calif. **Circle No 256**

DEC introduces disk-storage unit

The RP20 1.2G-byte disk-storage unit for the DECsystem-10 and -20 provides more than 469M bytes of formatted storage. As many as four RP20 disk units can be attached to an RPT20 subsystem. The RPT20 subsystem with one RP20 disk unit is priced at $140,000. Additional RP20 disk units are priced at $49,000. **Digital Equipment Corp.**, Maynard, Mass. **Circle No 257**

Fixed module drive stores 675M bytes

The CDC 9775 675M-byte fixed module drive, which is interface-compatible with storage module drives, operates at a 1.2M-byte-per-sec. transfer rate. The drive operates at densities of 6495 bpi and 662 tpi. Average data access time is 25 msec. The CDC 9775 is priced at $15,155 in OEM quantities. **Control Data Corp.**, Minneapolis, Minn. **Circle No 258**

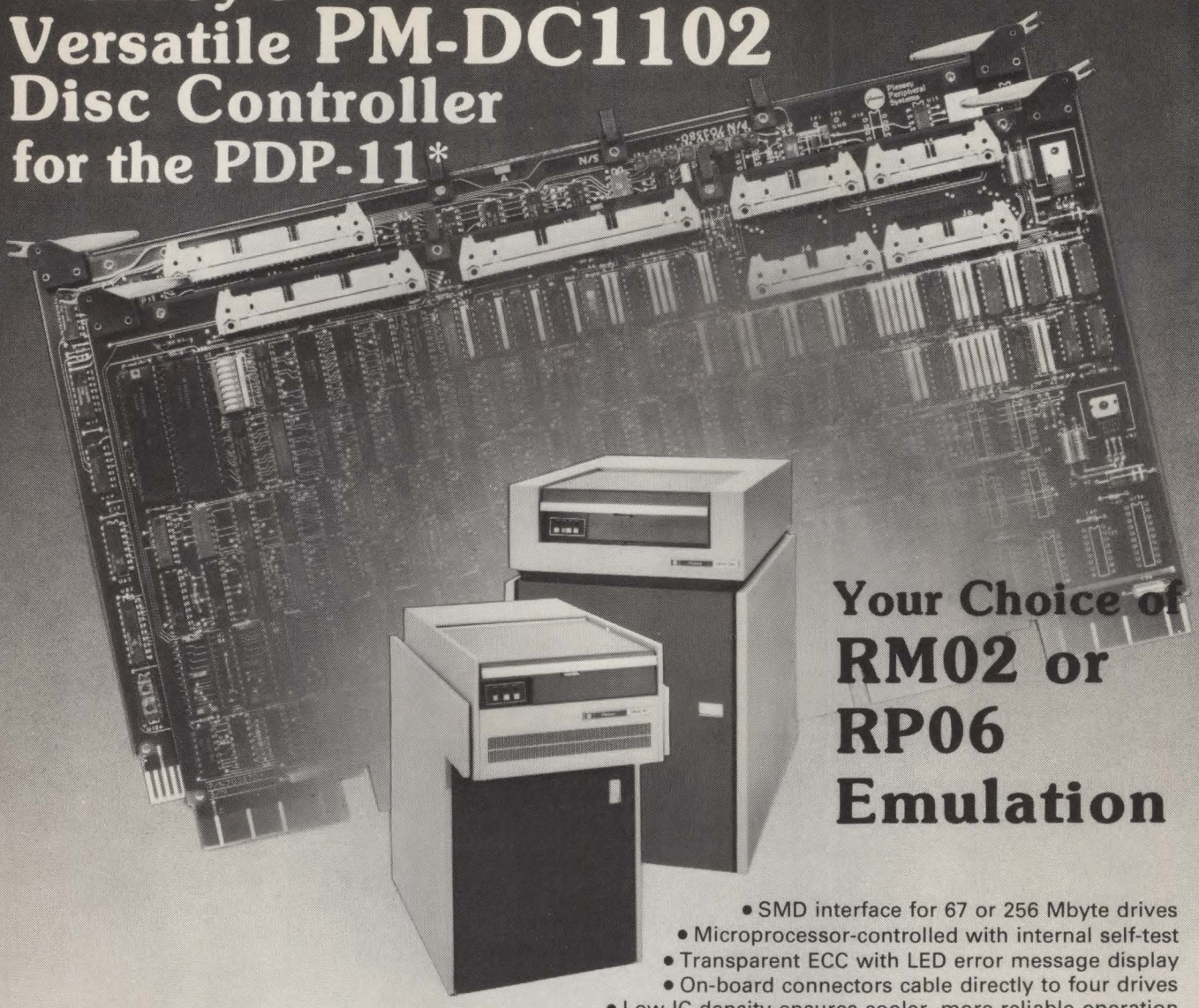
Hard-disk units are 1-, 2- or 3-platter

The 1250 and 1260 series 8-in. hard-disk subsystems are available in one-, two- or three-platter configurations with unformatted storage of as much as 8.91M, 26.73M and 44.56M bytes, respectively. Power supply options include 50-, or 60-Hz AC at 115, 215 or 230V. In 100-unit OEM quantities, the 1250 models sell for $2675, $2810 and $3125, and the 1260 series sell for $2954, $3089 and $3404. **Micropolis Corp.**, Canoga, Calif. **Circle No 259**

Disk drive replaces CDC9766

The DM-9300AQ disk drive uses Control Data Corp. 9883-91 type 20 surface disk packs and is plug-compatible with computers and controllers using a CDC model 9766. Data can be written by either the Ampex disk drive or a CDC drive and be read by the other unit. Features include an SMD-compatible interface and a single-port, daisy-chain interface. The DM-9300AQ is priced at $10,000 in small OEM quantities. **Ampex Corp.**, El Segundo, Calif. **Circle No 260**

Plessey's Versatile PM-DC1102 Disc Controller for the PDP-11*



Your Choice of RM02 or RP06 Emulation

- SMD interface for 67 or 256 Mbyte drives
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- Cost savings of 50% compared to RM02 or RP06 when configured into disc subsystem

PM-DS02D (RM02 emulation)

Plessey's PM-DS02D disc subsystem consists of the PM-DC1102 controller and one 67 Mbyte PM-DD11/80 SMD drive that has a proven history of reliability and data integrity. The PM-DS02D subsystem provides complete software and media compatibility with DEC's RH11/RM02 subsystem. The PM-DC1102, in this configuration, can directly support four 67 Mbyte disc drives for a total system capacity of 268 Mbytes. Disc pack files created on either the PM-DS02D or the DEC RM02 can be used interchangeably.

PM-DS06E (RP06 emulation)

The PM-DS06E consists of the PM-DC1102 disc controller and one 256 Mbyte PM-DD11/300 SMD disc pack drive with cables. The PM-DS06E provides for expanded capacity RP06 emulation (256 instead of 176 Mbytes) and, by use of minor software patches, is compatible with RSTS*/RSX11M* system software and diagnostics for DEC's RP06 disc subsystem. Up to four 256 Mbyte PM-DD11/300 disc drives may be cabled directly to the controller for a maximum system capacity in excess of 1000 Mbytes.

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With the "Independent Seek" option, unique to the Ampex drive system, throughput is further improved by allowing the head positioners to seek different cylinders simultaneously. The result: A cost-effective solution for optimizing subsystem performance.

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For the whole incredible story, call Gary Owen at 213/640-0150. Or write to him at Ampex Memory Products, 200 N. Nash Street, El Segundo, CA 90245.

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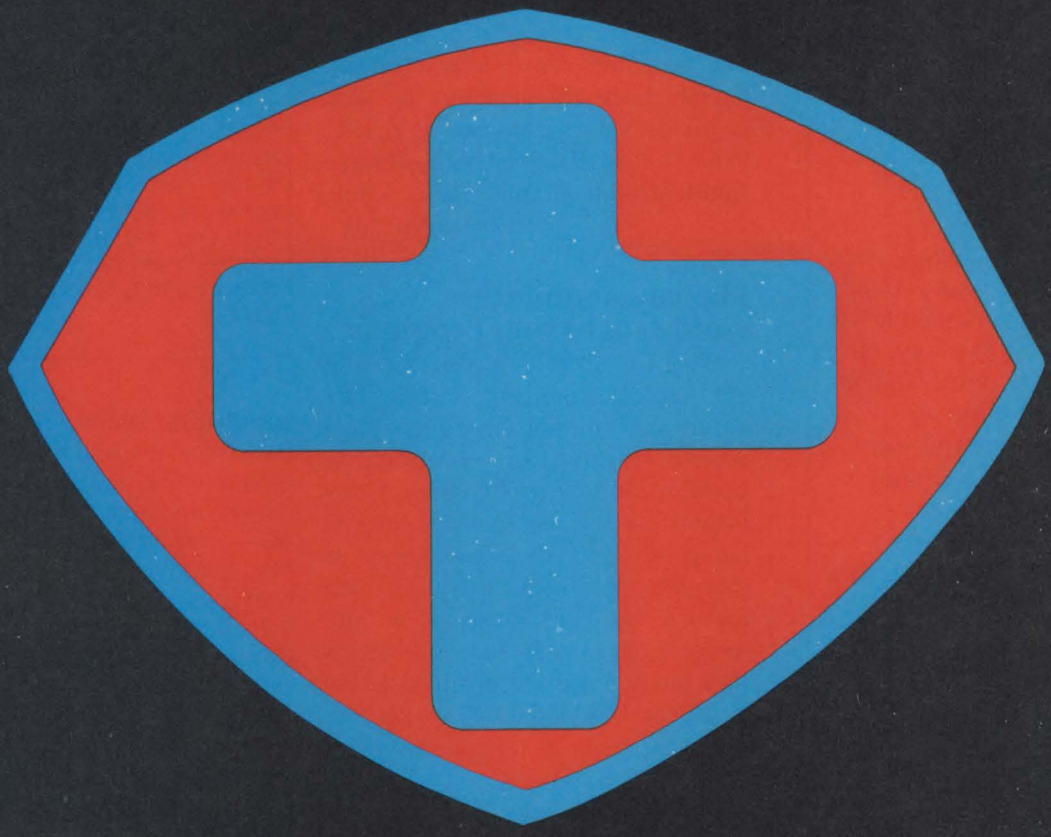

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random access intl.

Focuses on Winchester Disks, Floppy Disks and Tape Drives: Published by Roman Associates International.

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New Software

ISA program verifies spelling

Spellguard checks spelling in documents prepared with word processors and text editors; a 10,000-word document (20 pages) can be checked in less than 1 min. The package is supplied with a user-expandable dictionary containing 20,000 common English words. The program runs on computers using the CP/M operating system. The program can create multiple, personalized dictionaries in any language using a Roman alphabet. Price is $295. **Innovative Software Applications,** Menlo Park, Calif. **Circle No 261**

Plessey announces word-processing program

With the PWS-1 word-processing system, formatting commands determine spacing, margins, page length, tabulation, indentation, justification and hyphenation. Copy format can be changed as copy is being entered or after entry is complete. Using a list-processing feature, the program can sort and merge a list of names and addresses into the appropriate business letter to create individualized correspondence for mailings. Single-unit price is approximately $2300. **Plessey Peripheral Systems,** Irvine, Calif. **Circle No 262**

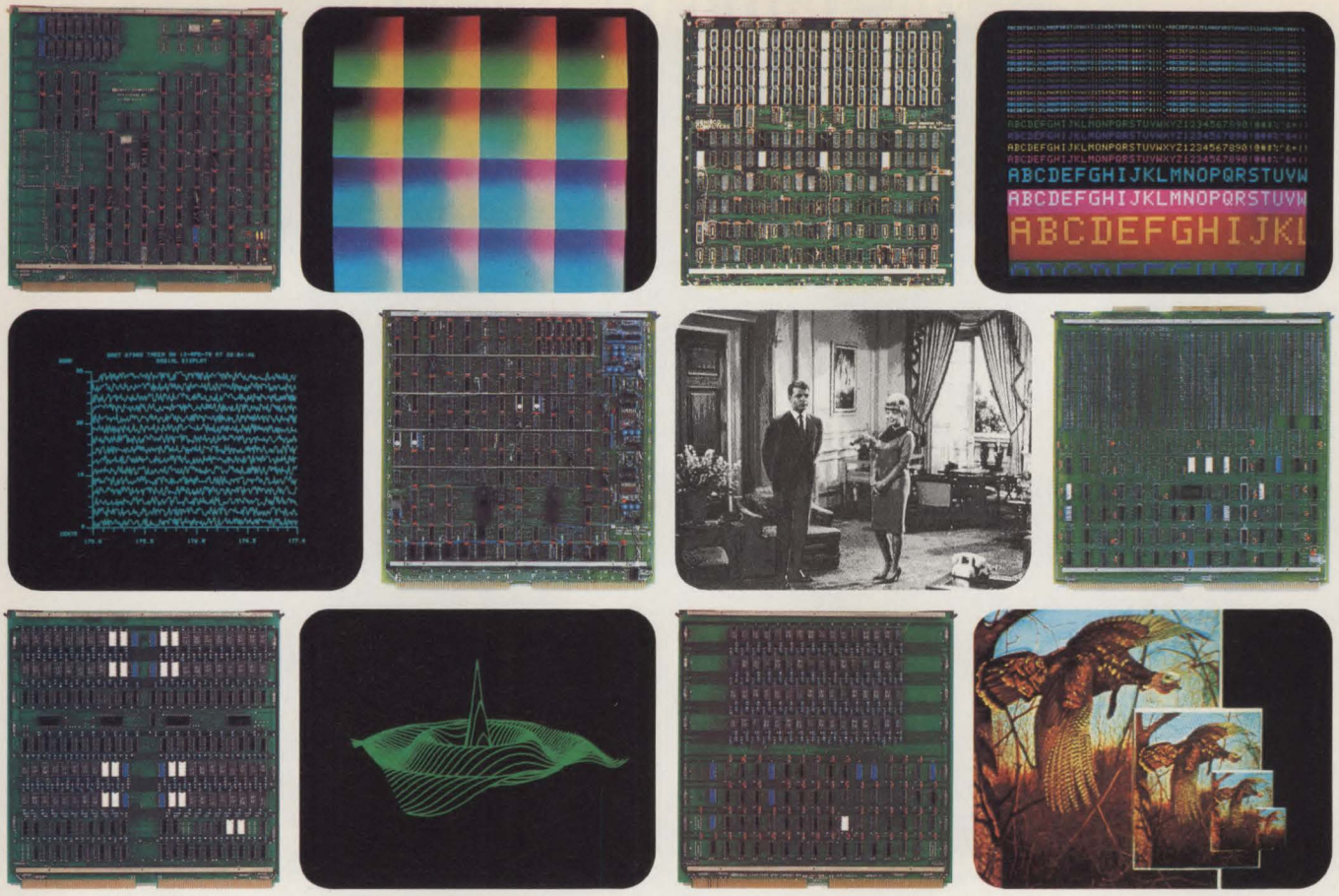
Cross-assembler accepts Motorola mnemonics

The XASM6800 MACRO cross-assembler implements algebraic notation, block-structured code, IF-THEN-ELSE, support for modular construction of programs, 255-character names and assembly-time relocation. The package accepts standard Motorola mnemonics executes on 8080 or Z80 CP/M systems and generates code for the 6800 and 6801 families. The $150 package includes a license, a manual, XASM6800 cross-assembler, MACRO source code, a utility program and a sample memory diagnostic program in XASM6800 source code. **Succinct Systems,** Santa Cruz, Calif. **Circle No 263**

SOFTWARE BRIEFS

Mini-Micro Systems receives dozens of news releases each week about new software products that may not warrant the detail included in the foregoing New Software section. Nevertheless, we don't want to deny readers the opportunity to get more information about the latest software developments. Toward that end, we offer the following brief entries, compiled and edited by Malcolm L. Stiefel, contributing editor.

GRAPHICS. Vector Automation, Inc., Baltimore, Md., announces a graphics programming system for its Graphícus-80 intelligent terminal. **Circle No 362** . . . **Harris Corp.,** Fort Lauderdale, Fla., introduces a finite-element-analysis package for its line of superminicomputers. **Circle No 363** . . . **Hewlett Packard,** Palo Alto, Calif., unveils a graphics-enhanced version of the Visicalc program, for manipulating numbers in tables, for its HP-85 personal computer, **Circle No 362,** and a graphics application package for analyzing mass spectrometer data that runs on its HP-2648 terminal, **Circle No 365** . . . **Andromeda Systems Inc.,** Canoga Park, Calif., offers graphics hard-copy routines for the DEC LSI-11 and PDP-11 computers, with output on the vendor's DP9500 and 9501 printers. **Circle No 366** . . . **Science Accessories Corp.,** Southport, Conn., releases PROM-resident data-transformation programs for its GP-Series 6 digitizers. **Circle No 367** . . . **Interactive Microwave, Inc.,** State Collage, Pa., provides curve-fitting routines, **Circle No 368,** and plotting routines, **Circle No 369,** both for the Apple II computer . . . **Compact Engineering, Inc.,** Palo Alto, Calif., brings out a package for computer-aided design of microwave circuits, for in-house or time-sharing use. **Circle No 370**



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Booklet details LSI-11 μc

Digital Equipment Corp.'s LSI-11 μcs are detailed in a catalog. The 36-page, illustrated booklet also covers DEC-compatible hardware and systems. The publication discusses word processing, time sharing, COBOL, Pascal, DBL and financial and integration services. **CompuMart Corp.**, Cambridge, Mass. **Circle No 264**

Pamphlet details strip chart recorders

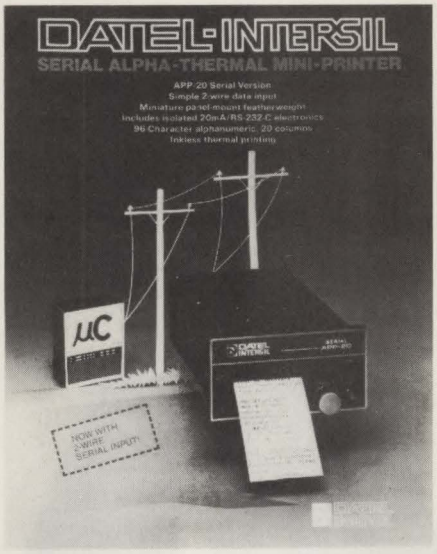
The 790 series miniature potentiometric recorders are detailed in a pamphlet. The four-page, illustrated publication describes the systems' plug-in range cards, overlapping channels, 100-mm. calibrated scales and 12 selectable chart speeds. The bulletin also lists applications, option information and specifications. **International Products & Technologies,** Willow Grove, Pa. **Circle No 265**

Data sheet features PDP-11 tape controller

The TC-131 single-board, dual-density magnetic-tape controller, intended for use with PDP-11 computers, is detailed in a data sheet. The illustrated bulletin describes the system's 33-word data buffer and command set. The catalog also covers options and ordering information. **Western Peripherals,** Tustin, Calif. **Circle No 266**

Booklet describes PROM programmer

The M980 universal PROM programmer is described in a brochure. The 32-page publication covers more than 500 MOS, bipolar, FPLAs, PALs and other programmable devices. The booklet, which contains diagrams and charts, details the systems' buffer memory, format variety and interface selection. The brochure also lists applications, warranty information and prices. **Pro-Log Corp.**, Monterey, Calif. **Circle No 267**



Pamphlet features serial printer

The APP-20 serial alpha-thermal printer is described in a brochure. The seven-page publication details electrical and mechanical parameters, two-wire interfacing and timing, I/O connections and input data coding. The brochure also includes block diagrams and technical notes and lists applications, options and sales offices. **Datel-Intersil,** Mansfield, Mass. **Circle No 268**

Catalog lists equipment for rent

A line of data-processing peripherals, desk-top computers and telecommunications equipment for rent is described in a catalog. The illustrated publication covers acoustic couplers, modems and accessories, graphic and interactive CRTs, multiplexers, data concentrators, printers and store-and-forward devices. The catalog also lists computer response time/use monitors, data-test monitors and protocol monitors. **Leasametric, Inc.**, Foster City, Calif. **Circle No 269**

Thin-film resistors featured in catalog

A line of thin-flim resistor networks is described in a catalog. The bulletin discusses the 694 mini-DIP for use with analog circuits and the 698 16-pin DIP and 699 14-pin DIP for high-speed converter products. The catalog details environmental, mechanical and electrical specifications, critical parameters of ratio matching, tempco tracking and absolute resistance accuracies. **Beckman Instruments, Inc.**, Fullerton, Calif. **Circle No 270**

Bulletin explains resistor network

A line of hermetically sealed SIP precision thin-film resistor networks is detailed in a data sheet. The bulletin describes the network's standard absolute and ratio tolerances, multilevel detector and bilateral current source. The data sheet also includes an outline drawing, time/stability graphs and circuit diagrams. **Electro Films Inc.**, Warwick, R.I. **Circle No 271**

Pamphlet examines voltage regulators

The series 710, 810 and 820 voltage regulators are detailed in a brochure. The pamphlet describes the systems' proprietary electronic control and sensing package. The booklet also explains the theory of operation, terminology and single- and three-phase applications. The brochure includes ordering information, diagrams, charts and photos. **Staco Energy Products Co.**, Dayton, Ohio. **Circle No 272**

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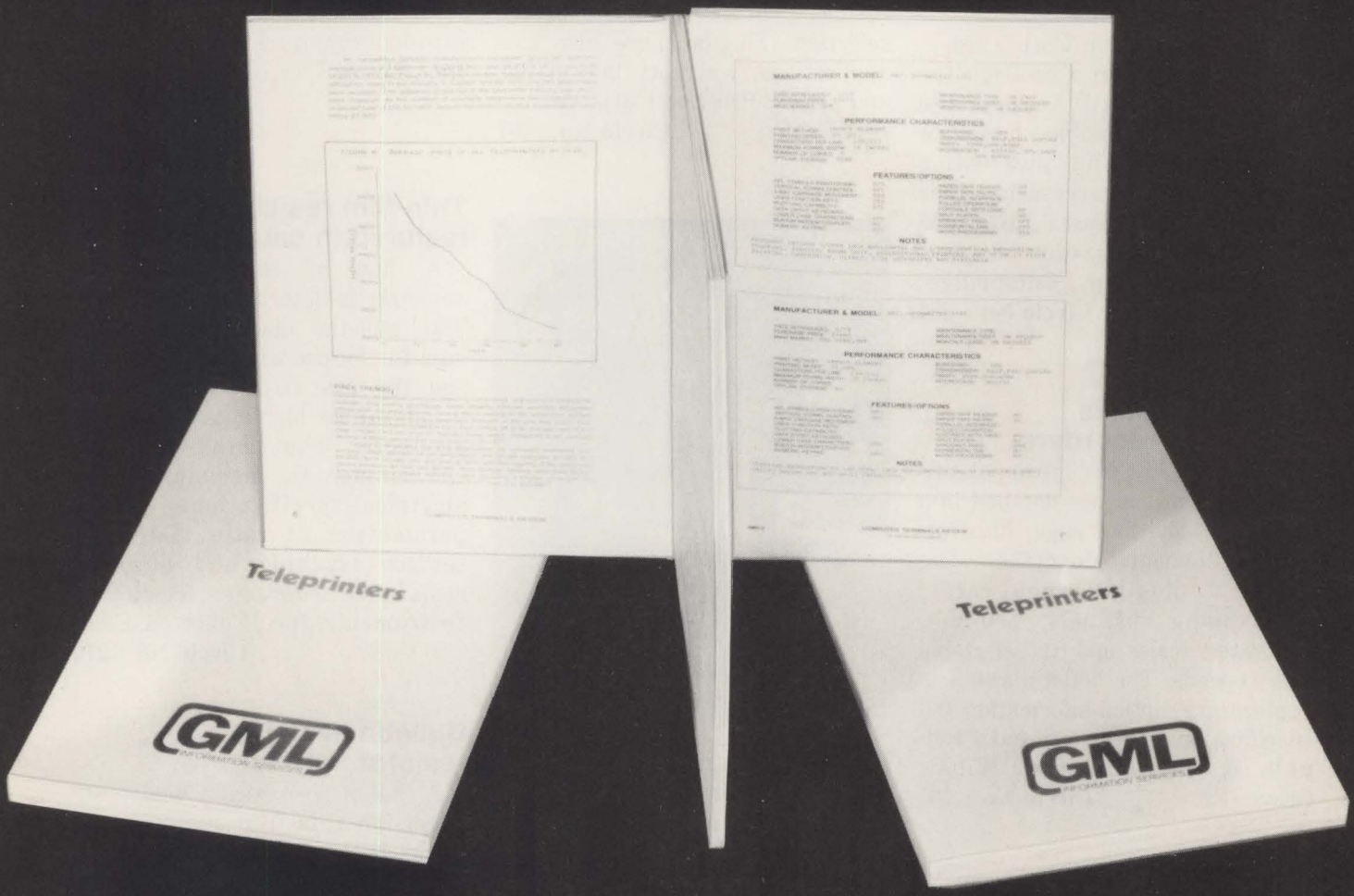

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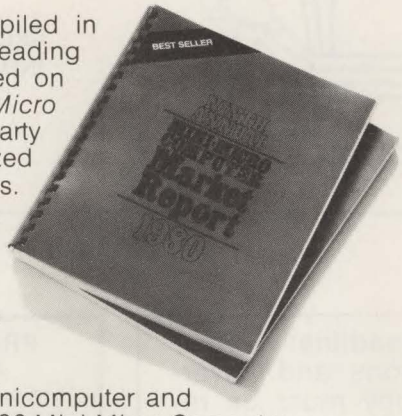

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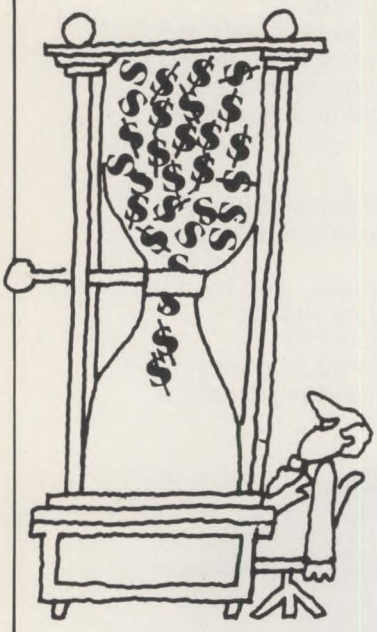

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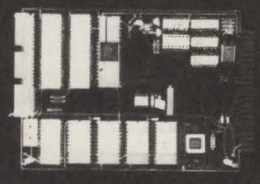

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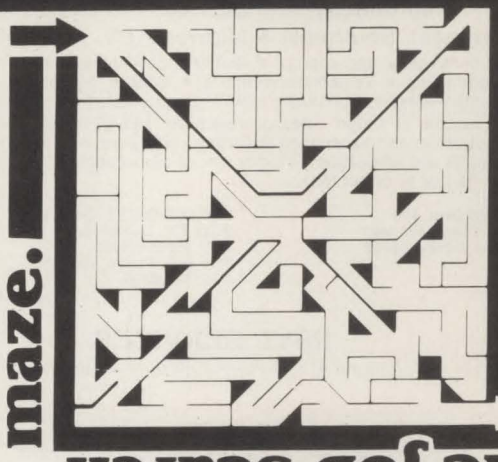

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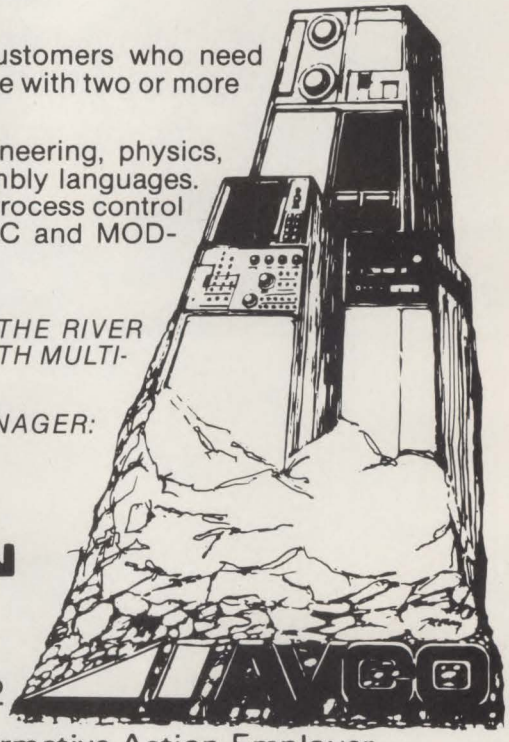

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EXTRA. EXTRA.

Now you get more extras when you pick the new dot matrix printers by C. Itoh. Choose the Comet 80-column printer and get the extra benefits of four character sizes and paper-saving print compression. Choose the Comet II 136-column printer and receive the added extra of a full-width computer size printer that accommodates paper widths to 381 mm (15").

Both the Comet and Comet II also offer the rare combination of low cost and high performance. Both models operate at an efficient 125 cps bidirectional print speed and in a 9 x 7 dot matrix.

C. Itoh's Comet series has the extra advantage of a unique multilingual capability with a selection of four different alphabets: English, German, Japanese and Swedish. Other special characteristics include a programmable VFU (Vertical Format Unit) plus self-test diagnostics. For your operator's convenience, there's easy bottom or back paper loading, and both Comets use a standard low-cost nylon ribbon. Plus our printers already meet 1981 Class A FCC, UL, and fire safety requirements.

If all that wasn't enough, Comet and Comet II are plug-compatible with all major printers in the industry, meeting standard parallel serial interface specifications. Our printers are backed by C. Itoh's warranty and a nationwide field service organization.

And as a final, all important extra, when you choose either printer from C. Itoh you get immediate off-the-shelf delivery.

So if you want the highest quality at the best price, look into the extras the C. Itoh Comet and Comet II printers offer. You'll get a lot more than you bargained for. For more information, contact C. Itoh Electronics, Inc., 5301 Beethoven Street, Los Angeles, CA 90066; Tel. (213) 390-7778. Chicago Office: 240 E. Lake Street, Suite 301-A, Addison, IL 60101; Tel. (312) 941-1310. New York Office: 666 Third Ave., NY, NY 10017; Tel. (212) 682-0420. Dallas Office: 17060 Dallas Pkwy., No. 108, TX 75248; Tel. (214) 931-0177 C. Itoh represented in Canada by Canadian General Electric.

C. ITOH ELECTRONICS, INC.

One World of Quality

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Do you have many asynchronous terminals? Do you have more than one computer?

Yes? Then, you should know about MICOM's Micro600 Port Selector. The Micro600 can lower your overall communication costs by maximizing computer port and terminal utilization in interactive computer systems, especially where minicomputers are involved.

For example...

If you have a growing terminal population and the cost of computer ports is getting out of hand, the Micro600 can act as a **super-contender**, allowing terminals to compete for the available ports on a first-come-first-served basis.

Or maybe you have more than one computer, or more than one group of ports on a large, multiprogrammed computer? For you the Micro600 can act as a **smart-switch**, directing terminal users to the computer or application program of their choice.

Or perhaps you are moving away from the dial network to multiplexed leased lines and dedicated terminal connections, in order to escape the rising costs of dial-up calls and benefit from increased terminal speed? The Micro600 can serve as your **access-controller**, replacing the contention function provided by the telephone rotary.

Or, if you have a backup computer standing by in the event of failure of your on-line system, the Micro600 can serve as an automatic **fall-back switch**, providing immediate switchover to the standby system.

Until recently, the Micro600 has been difficult to get, but our new manufacturing facility is now operating and delivery times have improved dramatically.

More than one hundred Micro600's are now installed in configurations supporting several hundred terminals as well as small systems supporting less than twenty. Send for complete details today, or ask for a free copy of our tutorial booklet, *The Value of Access Management*. We think you'll find it interesting.

MICOM™ MicroComputers for DataCommunications™

MICOM SYSTEMS, INC.: 9551 Irondale Ave. • Chatsworth, CA 91311 • Telephone (213) 882-6890 • TWX 910/494-4910
Regional Sales and Service: King of Prussia Business Center • 1004 W. 8th Ave. • King of Prussia, PA 19406 • (215) 337-4855
Regional Offices: Atlanta (404) 452-1600 • Boston (617) 235-8870 • Chicago (312) 823-9330 • Dallas (214) 258-0774
MICOM-BORER LTD.: Bel Court • 15 Cradock Road • Reading, Berkshire RG20JT, England • (0734) 866801 • Telex 847135

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