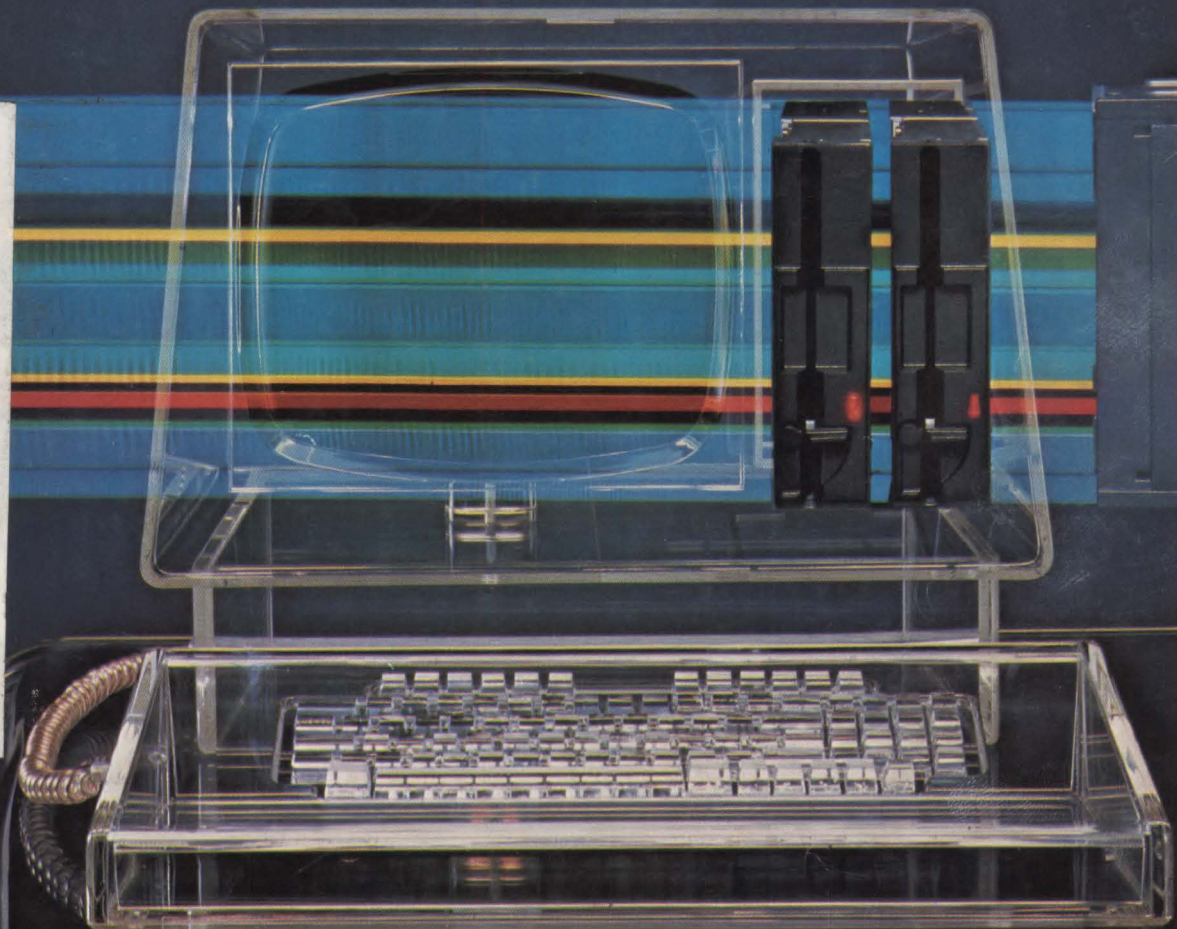


# Mini-Micro Systems

A CAHNERS PUBLICATION

FEBRUARY 1982

**Half-height floppies boost design flexibility**

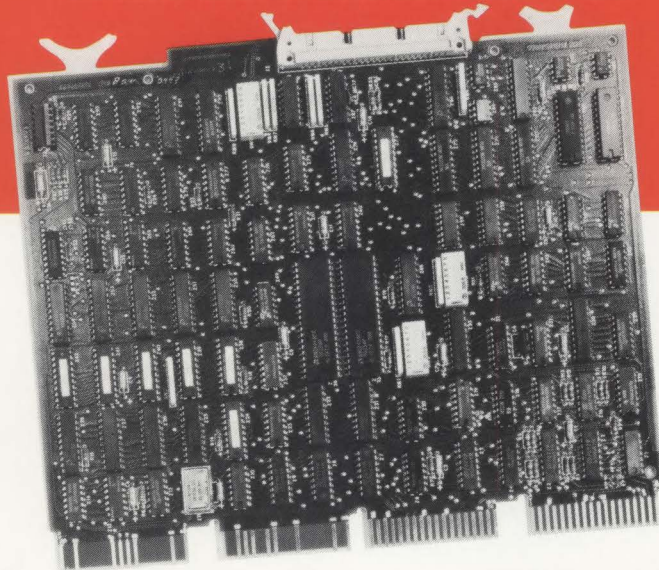


## **SPECIAL REPORT: DISK DRIVES**

- **Winchesters find rapid acceptance**
- **Floppies reach for multimegabytes**



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Dataram Corporation offers the industry's widest range of DEC-compatible peripheral controllers — from comparatively simple NRZI tape controllers to complex 300 MB storage module drive (SMD) controllers.

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CORPORATION**

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

CONTROLLER	DESCRIPTION	COMPATIBILITY
C03	Cartridge disk controller	RK05
C33	Cartridge disk controller	RK05
T03	NRZI mag tape controller	TM11/TU10
T04/N	NRZI mag tape controller	TM11/TU10
T04/D	Dual density mag tape controller	TM11/TU10
T34/N	NRZI mag tape controller	TM11/TU10
T34/D	Dual density mag tape controller	TM11/TU10
T36	Dual density mag tape controller	TM11/TU10
S03/A	80 MB/300 MB SMD controller	RM02/RM05
S03/A1	80 MB/160 MB SMD controller	RM02
S03/B	80 MB/300 MB SMD controller	RK07
S03/C	200 MB/300 MB SMD controller	RP06
S03/D	96 MB CMD controller	RK06
S33/A	80 MB/300 MB SMD controller	RM02/RM05
S33/A1	80 MB/160 MB SMD controller	RM02
S33/B	80 MB/300 MB SMD controller	RK07
S33/C	200 MB/300 MB SMD controller	RP06
S33/D	96 MB CMD controller	RK06

Products printed in red are LSI-11 Bus compatible.

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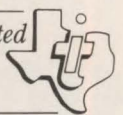
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CIRCLE NO. 2 ON INQUIRY CARD





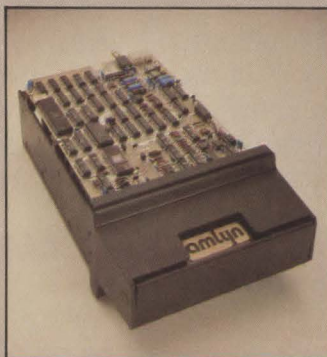
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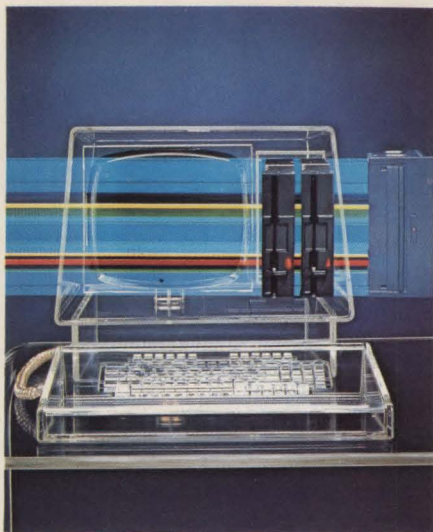
So, if you want relief, give us a call. Or write. All you have to lose are The Frazzles.



# Mini-Micro Systems

A Cahners Publication

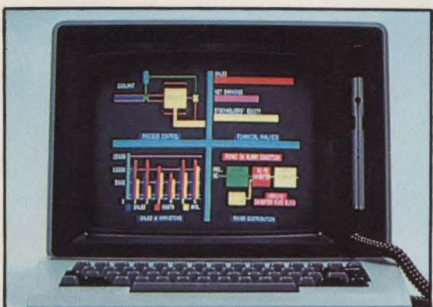
Vol. XV No. 2 February 1982



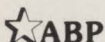
Shugart Associates' half-height 8-in. floppies boost reliability and design flexibility (see p. 185). Cover design by Gail Tavares, Blankenship-Tavares, Inc.; photo by Sollecito Photography; CRT terminal model by Iceberg Associates, courtesy of Shugart.



Page 67 . . . . . Sorbus expands service



Page 109 . . . . . Graphics hit price lows



MINI-MICRO SYSTEMS (ISSN 0364-9342) is published monthly by Cahners Publishing Company, Division of Reed Holdings, Inc., 221 Columbus Avenue, Boston, MA 02116. Norman L. Cahners, Chairman; Saul Goldweitz, President; William M. Platt, President, Boston Division. Circulation records are maintained at Cahners Publishing Co., 270 St. Paul St., Denver, CO 80206. Second class postage paid at Denver, CO 80202 and additional mailing offices. Postmaster: Send Form 3579 to MINI-MICRO SYSTEMS, 270 St. Paul St., Denver, CO 80206. MINI-MICRO SYSTEMS is circulated without charge by name and title to U.S. and Western Europe based corporate and technical management, systems engineers, and other personnel who meet qualification procedures. Available to others at the rate of \$35.00 per year in the U.S.; \$40.00 in Canada and Mexico; \$65.00 in all other countries (12 issues). Single issues \$4.00 in the U.S.; \$5.00 in Canada and Mexico; \$6.00 in all other countries.

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## **MARKET CENTERS OPENING IN DALLAS, BOSTON, CHICAGO**

Market centers aimed at attracting volume buyers of computers and related equipment are appearing around the U.S., with the first three centers in Dallas, Boston and Chicago. The Dallas center is perhaps the most ambitious. There, plans for the International Information Processing Market Center (Infomart) will be unveiled this month. Infomart will house companies and services in a 1-million-sq.-ft., 26-story building in the Dallas Market Center Complex. Tenants also will have access to a 202,000-sq.-ft. exhibit center. Infomart is backed by Trammell Crow, one of the largest real-estate brokers in the U.S.

Targeted for completion in fall of 1983, the center is touted as a cost alternative to trade shows and as a location for regional headquarters. Tenants will include major suppliers of information-processing systems, subsystems, software, peripherals and accessories, as well as independent sales organizations and consultants. Tenants will offer products ranging from  $\mu$ cs to mainframes. The complex will also handle user-group and educational seminars. Infomart's managers plan to sponsor quarterly vertical market trade shows, all geared to luring qualified leads at minimal cost. Infomart backers are still negotiating contracts to attract tenants.

## **PERKIN-ELMER UNVEILS HIGH-END CPU, POWERFUL FORTRAN**

This month, Perkin-Elmer Corp., Oceanport, N.J., will add a high-end processor to its line of 32-bit computers and introduce a new implementation of FORTRAN, which the company claims is a major step beyond globally optimized FORTRAN. Code-named "Clipper" and designated the model 3250, the processor will be less expensive than P-E's top-of-the-line model 3240, says a company source. Like the 3240, the 3250 supports 16M bytes of directly addressable memory, but the 3250's memory is packaged more densely than is the 3240's. The company claims that the FORTRAN implementation offers performance factor improvements four or five times over the performance available from globally optimized FORTRAN. Next month, the company reportedly will announce a software-based networking product, and during the next several months will add a high-end processor above the 3250.

## **DEC SAID TO BE LATE FLESHING OUT VAX LINE**

A source close to Digital Equipment Corp. says the company is late with several superminicomputer expansions to its VAX line. Most notable is Venus, a 3-million-instruction-per-sec. version of VAX targeted for introduction next month. The source says the project has been delayed into next year, and is being guided by C. Gordon Bell, vice president of DEC's Office of Development/Engineering. DEC's single-station VAX is also late, reportedly because of the state of the U.S. economy and because it will impact PDP-11/34 sales. It is expected to carry a \$25,000 price tag. The system can use a single disk drive. A company spokesman declines comment about the unannounced products.

## **REAL-TIME OS-ON-A-CHIP FOR 8086, 68000**

Hunter & Ready, Inc., Palo Alto, Calif., will introduce two new versions of its VRTX real-time operating system-on-silicon, one coming this month for Intel's 8086 and 8088, and the other in April for Motorola's 68000. The software, a multitasking, interrupt-driven system, is a 4K-byte nucleus supplied in two PROMs. The two-year-old company has been delivering a VRTX for Zilog's Z8002 for several months. Plans call for a version aimed at National Semiconductor's yet-to-be-delivered NS16000. Prices for the new OS-on-silicon will probably parallel those of the firm's Z8002 software: about \$2000 each; \$200 each in quantities of 100.

## **APOLLO WILL ENHANCE DOMAIN LOCAL-NETWORK SYSTEM**

Apollo Computer, Inc., Chelmsford, Mass., is enhancing its Domain (Distributed Operating



# Breakpoints

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Multi-Access Interactive Network) system by boosting main memory and mass storage, easing interaction with the display and speeding performance. Last month, the company introduced the second version of Domain, which incorporates an enhanced display manager, a black-and-white screen and a touch pad in the keyboard. Through the display manager, the touch pad can position the cursor in any of 15 variable-sized on-screen windows, enabling the cursor to be used as a selection device for applications software and other functions. The system, including 0.5M bytes of memory, is priced at \$30,500. The second version's CPU operates at 10 MHz, rather than 8 MHz, as on the lower end model. The company recently added a 66M-byte Winchester-disk drive to its offerings. This month, Apollo will increase internal memory capability from 1M byte to 3.5M bytes.

Next month, the company will announce a high-performance version of Domain. It will include a performance enhancement board with a 4K cache memory buffer and floating-point functions implemented in hardware. The board sells for about \$4000, and can be used on the two previous versions.

## **DEVICE WILL TIE MINIS TO SNA ENVIRONMENT**

A network processor due during the second quarter of this year will implement the transport facilities of IBM's System Network Architecture (SNA) and will allow various minicomputers to operate within the SNA environment. Being tested by the manufacturer, Marcol Computer Systems Ltd., Cambridge, Mass., the Marcnet 1801A also handles network monitoring and control. Richard Rosmarin, vice president of engineering at Marcol, says the stand-alone 1801A provides advantages over networking software offered by some minicomputer vendors, because the Marcol unit doesn't use valuable minicomputer memory and processing power. Also, he points out, simple protocol converters don't offer the network monitoring and control features available from the Marcnet 1801A.

Each 1801A will support several computer architectures and software protocols simultaneously. However, Rosmarin says, the number of minicomputers each box will support won't be known until the product has been more thoroughly tested. On the low end, the 1801A handles such standard protocols as bisync, async and ASCII.

## **TWO PI FOUNDER ANDERSON ENTERS CAD BUSINESS**

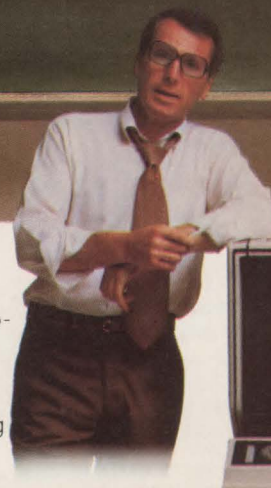
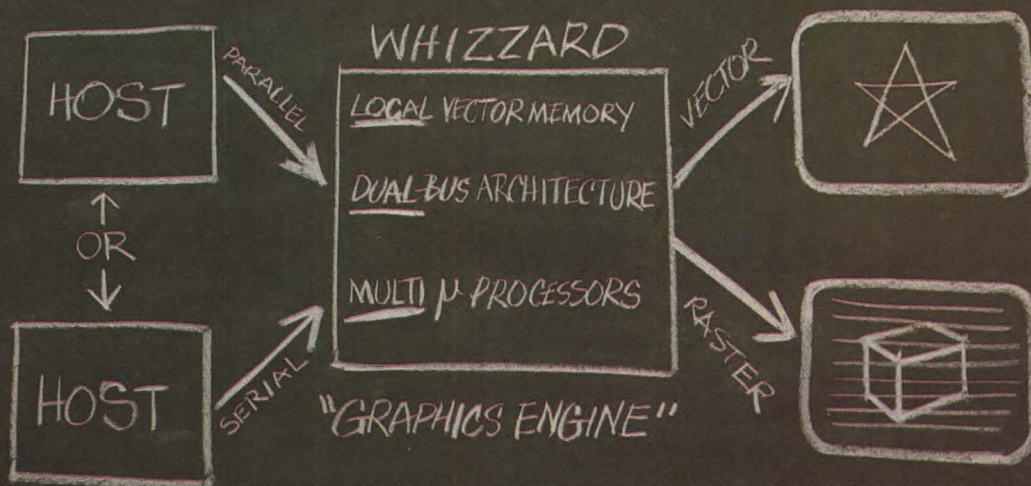
Jerry Anderson, founder and president of IBM-compatible minicomputer maker Two Pi Corp., has surfaced again as founder and president of Valid Logic Systems, Inc., Santa Clara, Calif. Details of the company's hardware are sketchy, but Anderson says his firm is in the CAD-systems business, and that products will be aimed at the "general electronics-design" market. Valid will probably unveil its first hardware this spring, Anderson adds. Two Pi was acquired in 1980 by distributed systems maker Four-Phase Systems, Inc., which was purchased by Motorola, Inc., in December, 1981.

## **AMDAHL READIES NEW LINE OF DATA-COMMUNICATIONS SYSTEMS**

Tran Telecommunications, acquired by Amdahl Corp. in early 1981, is resurfacing as that company's Communications Systems Division. The new division's first product, the Amdahl 3400 distributed-network system, aimed at Fortune 100 companies, uses a Computer Automation minicomputer at each regional switching node. The system's  $\mu$ p-based network concentrators, which are local to a user or remotely accessed, condense traffic to a trunk line at data-transmission rates as high as 230K bps. The system is data transparent and features internal network diagnostics and automatic transmission rerouting in case of node failures. Amdahl claims the system is unmatched in terms of being user friendly, citing its mnemonic naming of system resources and an automatic queue system that dials a user back when a busy resource becomes free. A source at Amdahl says the system can be installed as soon as 90 days after an



# THE MEGATEK DIFFERENCE: OFFLOADING THE HOST



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And all of this is totally "transparent" to the host. Display outputs can be either vector refresh (4096<sup>2</sup>) or raster scan (512<sup>2</sup> or 1024<sup>2</sup>, monochrome or color). Or both. High-speed hardware also generates up to eight character sizes — and allows individual segments to be moved from one point on the screen to another without changing the stored data. And in the case of Whizzard 7200 systems, optional 2D and 3D hardware clip, rotate, scale and translate modules reduce complex transformations to a single real-time operation.

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order is placed, depending on the configuration. The 3400 is the first of a line of Amdahl data-communications systems; a major product announcement is expected at East and West Coast press conferences scheduled for this month.

## **NATIONAL READIES SPEECH-DEVELOPMENT SYSTEM**

National Semiconductor Corp., Santa Clara, Calif., expects to have a speech-development system for low-volume users by May. The Z80-based MSC-6605 word-editing system hardware uses the company's Digitalker time domain speech-synthesis device and allows words to be extracted from a diskette and down-loaded to RAM for compilation into a custom vocabulary. The system diskette includes about 1000 words spoken in a male voice, the company says. The MSC-6605 will be priced at less than \$10,000.

## **OLIVETTI OPE MOVES INTO RETAIL MARKET**

Olivetti OPE, Tarrytown, N.Y., has entered the retail market with a \$1-million contract for its DY-211 low-cost daisy-wheel printers and sheet feeders. The agreement is with CPU Computer Corp., Charlestown, Mass. The products will be sold through CPU Wholesale, a CPU Computer division that acts as a domestic and international wholesaler to computer dealers. There are no plans for other Olivetti peripherals to be marketed through the agreement.

## **PANASONIC PLANS VOICE I/O FOR PERSONAL COMPUTER**

Panasonic plans to begin shipping a 6800-based personal computer called the JR-100 in July. A unit with typewriter-style keyboard, 16K bytes of RAM, a BASIC interpreter and an RS232C port will retail for \$200; a similar unit capable of color graphics will retail for \$300. Both units output their video signal to a home TV. Panasonic also plans an optional VLSI voice I/O chip for the JR-100. A prototype of the chip was demonstrated as part of a voice-driven desk-top calculator at the January Consumer Electronics Show in Las Vegas, but Panasonic won't say when it would go into production. Panasonic says 60 software packages, including word processing and business graphics, will be initially available. Options include 32K-byte RAM expansion, a floppy-disk drive, an 80-column dot-matrix printer and a joystick.

## **FIRST VALIDATED ADA COMPILER EXPECTED IN SPRING**

Intermetrics, Inc., Cambridge, Mass., expects its full-set Ada compiler to be the first to pass the Department of Defense-sponsored suite of Ada validation tests. Completed under Defense Advanced Research Projects Agency order, the compiler runs on a DECSystem 20 under the TOPS-20 operating system. Primarily a teaching or illustrative compiler handling the full Ada syntax, the program has passed 70 percent of the tests applied to it. The company expects full validation sometime this spring.

## **APPLE TO DISTRIBUTE MICROSOFT SOFTCARD FOR APPLE III**

Microsoft will release a softcard for the Apple III in early March, says a company source. The Bellevue, Wash., company's softcard for the earlier Apple II makes that hardware CP/M-compatible and is responsible for nearly 20 percent of all Apple II sales. Unlike its predecessor, the Apple III softcard will be distributed by Apple rather than Microsoft. An Apple source says the card is scheduled for availability during the first quarter. Price has not been set.



# Breakpoints

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## SOFTWARE MODULE SUPPORTS CP/M-86, MS-DOS

An as-yet-unnamed software module from Lifeboat Associates, New York, will allow programs that run under the control of Digital Research's CP/M-86 operating system to also work with Microsoft's MS-DOS 16-bit operating system (used on the IBM personal computer and the soon-to-be-announced Zenith Z-100). It will require no special patching to MS-DOS; it can simply be added to a system, eliminating the need for extra software. The module is priced at less than \$200.

## ZGRASS UPGRADE TURNS GAME INTO BUSINESS GRAPHICS $\mu$ C

Astrovision, Inc., the Ohio-based company that took over Bally's share of the video-game market, has announced an upgrade to its Astro Professional Arcade that allows the Z80-based video-game unit to be used to create complex, animated graphics. The add-on unit, called the ZGRASS-32, includes a typewriter-style keyboard, a Votrax speech synthesizer and a 32K ROM ZGRASS interpreter. ZGRASS developer Tom DeFanti says ZGRASS is the only  $\mu$ c language designed specifically for graphics. Astrovision expects the ZGRASS-32 to be used for business applications, user-developed animated games and video art. The unit attaches to the Astro Professional Arcade that retails for \$299 and will be available in April for \$599. The add-on unit can be expanded to run CP/M and has two RS232C ports and interfaces for a light pen, a graphics tablet, disk drives and joysticks.

## RANDOM DISK FILES

**Applied Magnetics Corp.**, which late last year announced that it intended to abandon a year-old plan to liquidate the company, is getting set to mass-produce 3370-compatible thin-film read/write heads—initially for the plug-compatible disk-drive market, with hardware aimed at OEM drive vendors to follow. Also under development at the Goleta, Calif., company is a 3375-compatible head that will be the same as the 3370 version with the exception of track width, company sources report. Both heads could appear in volume by mid-year, with OEM 3370 heads available during the fourth quarter. Also planned for fourth-quarter introduction is a plug-compatible 3380 thin-film head.

Saratoga, Calif., start-up **Cartrex Corp.** plans to unveil a high-capacity  $\frac{1}{4}$ -in. tape cartridge this year. Designed around a patent held by **Newell Research Corp.**, the cartridge will be offered in a four-track serpentine version that will store 30M bytes of data on 900 ft. of tape in a package compatible with cartridges manufactured by 3M Co. Sources close to the company say multi-channel in-line versions will follow. These versions will handle as many as 16 data tracks and bit densities in the 10,000-bpi range for storage capacities around 300M bytes. The new medium, called the NC-250, is designed for 90-in.-per-record backup of Winchester-disk drives. Also due from Cartrex this year is a high-capacity DC-100-compatible 0.15-in. cartridge designated the NC-150. Prices have not been set for either cartridge.

The first combination of **Amlyn's** five-platter, 5M-byte,  $5\frac{1}{4}$ -in. floppy-disk drive and **Seagate Technology's** 6M-byte,  $5\frac{1}{4}$ -in. ST-506 Winchester-disk drive may appear this quarter in a Z80A-based desk-top computer system from **Colon Systems, Inc.**, San Jose, Calif. Colon's unnamed and unpriced hardware will run CP/M and MP/M, as well as a proprietary operating system based on the FORTH programming language. Production versions of the system will be available for commercial applications this quarter through retail outlets, while FORTH-based systems will be targeted at OEMs selling into scientific applications. Colon reportedly is funded in part by **Dysan Corp.**, a Santa Clara, Calif., media house that has also participated in the funding of Amlyn and Seagate.

**Control Data Corp.** will phase itself out of the business of refurbishing disk packs and disk cartridges and shift this work to **Magnetic Data Storage, Inc.**, a Minneapolis start-up CDC plans to fund.

The new company plans to open for business this month. Disk refurbishing entails cleaning a disk's surface, examining a medium for cuts or scratches, replacing disks as required and realigning the pack and/or rewriting servo data if necessary.



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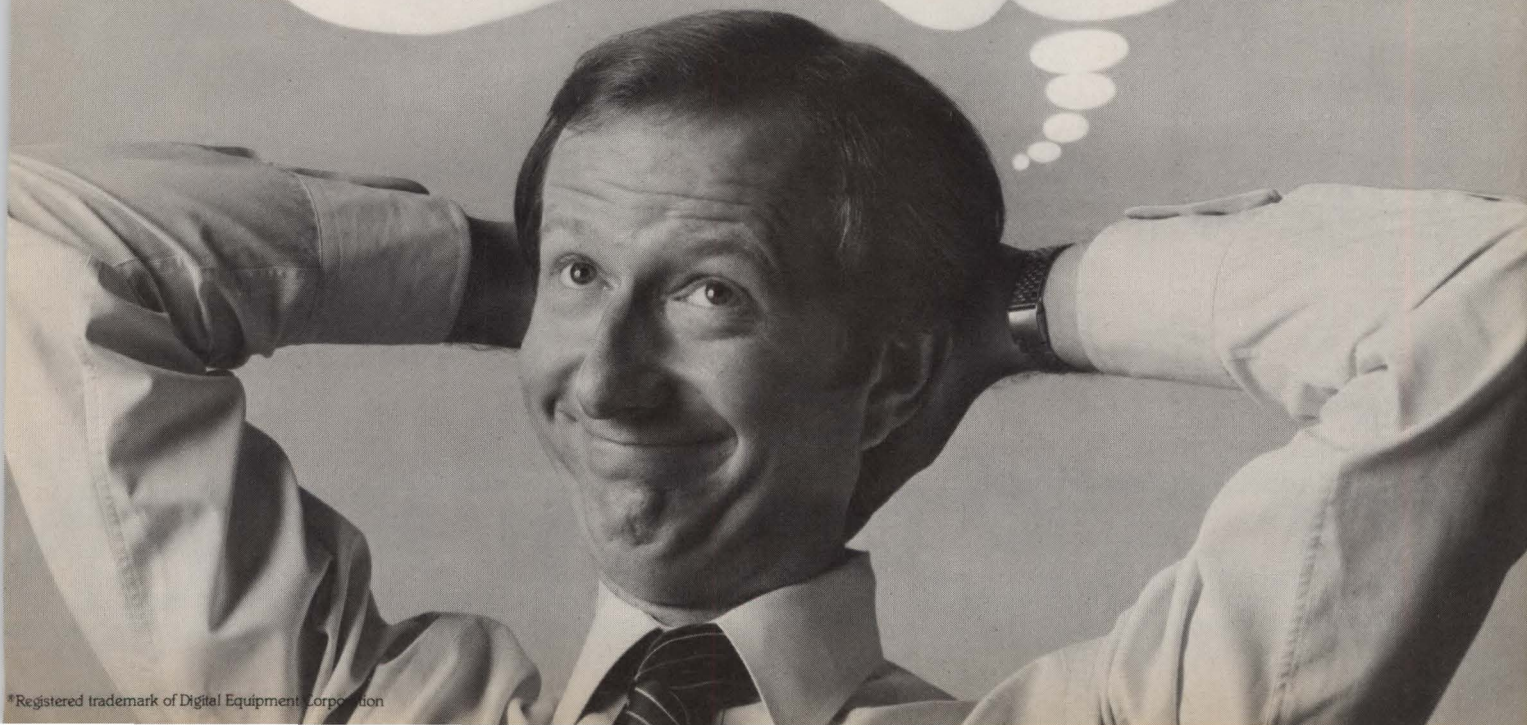
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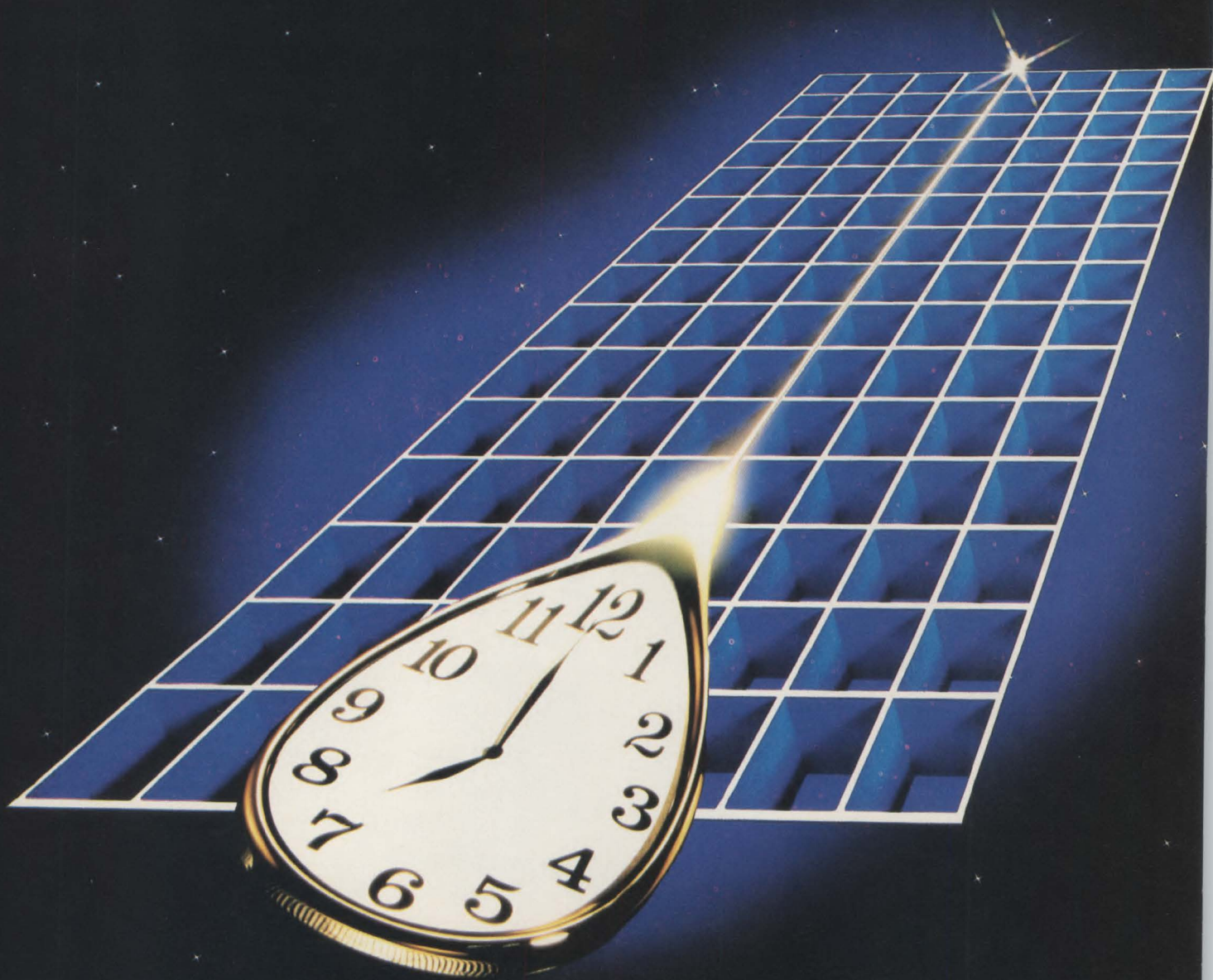


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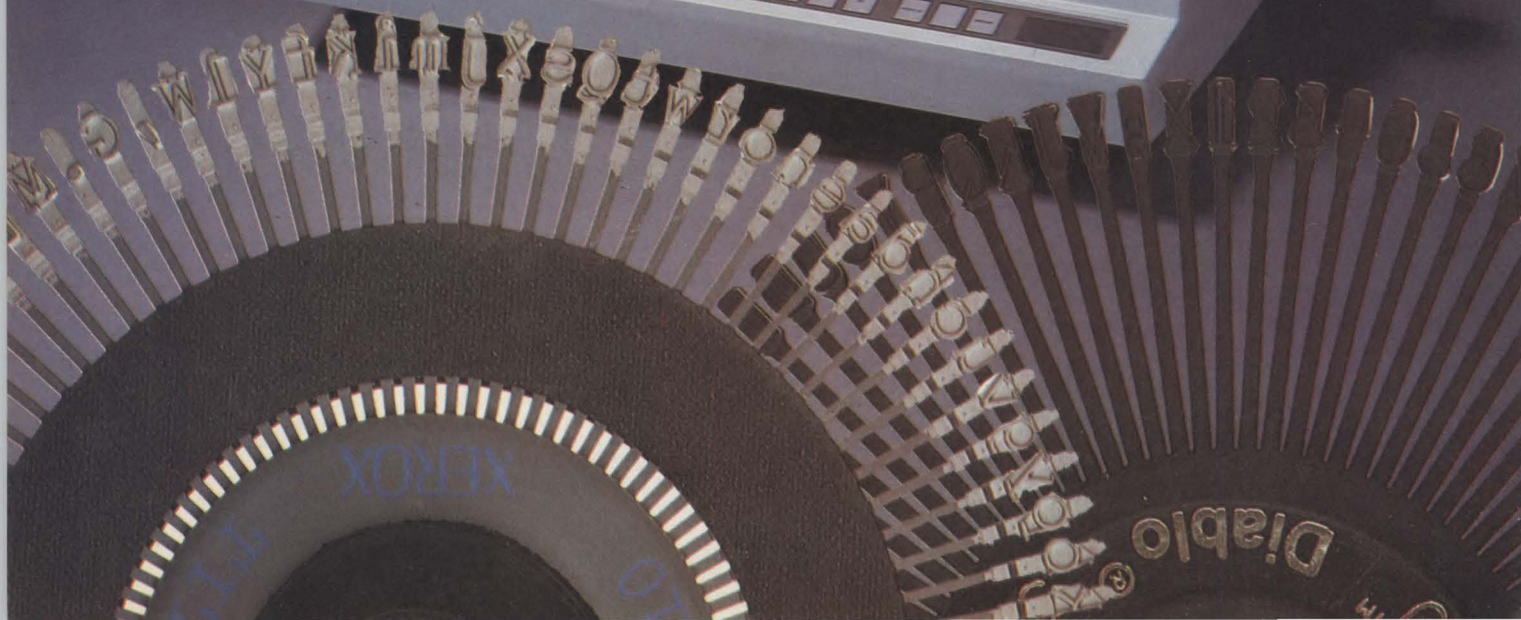
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## Xerox moves to bolster embattled Ethernet

For Xerox Corp.'s Office Products Division, 1981 was not an easy year. The struggling division reportedly continued to lose vast sums of money, and technical problems forced the delay of its 8000 series products, including the Star work station. But most frustrating for the OPD were growing attacks against its Ethernet local-area-networking (LAN) standard, culminating in a Strategic, Inc., study that claims Ethernet will fail within two years, taking much of OPD's office-automation strategy with it. Another blow occurred when Hewlett-Packard Co. dropped its support of Ethernet in favor of the slightly different IEEE 802 proposed LAN standard.

Now, after keeping a low profile during its Ethernet travails, Xerox has come out swinging. At a press conference introducing the company's higher level networking protocols (see "Xerox publishes high-level networking standards," page 18), David Liddle, vice president and general manager of the OPD, defended the single-channel, baseband approach used by Ethernet against multi-channel, broadband LAN methods. He also took issue with the critical Strategic, Inc., report, entitled "Xerox—The Key Issues."

"Out of about 100 pages," Liddle said, "only about two and one-half pages deal with Ethernet. Most of the remainder consists of historical data, untrue information and gossip. The Ethernet material that does exist is incorrect."

Michael Killen, president of the San Jose, Calif.-based Strategic, Inc., counters by claiming the technical aspects of Ethernet have already received enough coverage in the trade press, "and we believe the

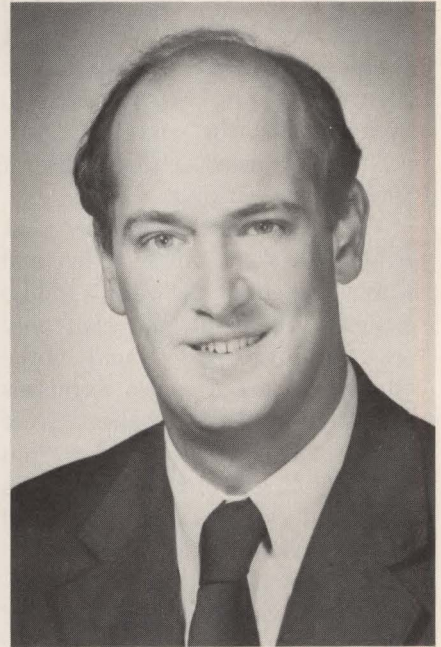
key issue is the very weak position of the Xerox OPD."

Killen maintains that Ethernet has already failed, in a sense, by not becoming the de facto baseband LAN standard, and he expects Xerox to fold the entire Ethernet project within two years. "I think one of the best kept secrets at Xerox is how badly the entire OPD is doing," he says. "There is already plenty of opposition to Ethernet within Xerox, and when the ink continues to stay red, and gets deeper and deeper, somebody upstairs is going to say, 'We blew it. Let's see how to get out of this thing as gracefully as possible.'"

Killen also charges that Xerox's sales force is "inept at selling an information system like Ethernet." The company planned 300 Ethernet system installations by year-end, 1981, he says, and got only 12 in place. OPD's Liddle disputes this number, saying that more than 45 Ethernets were installed at year-end. He also denies Killen's other claims.

While he admits the number of installed Ethernets, even at 45, is behind schedule, Liddle says the problem has nothing to do with Ethernet's technical aspects or with an inept sales force. "We slowed down the rate at which we launched the whole family of 8000 series products," he notes, "and you don't really install Ethernets unless you install Stars."

The Star work-station delay resulted in Xerox's placing Ethernets in just 16 cities by year-end, rather than in the planned 64 locations, Liddle says. The delay also caused Xerox to postpone training most of its 600-person sales force until last month. Before January, only about 30 of the sales



**David Liddle, vice president and general manager of Xerox's OPD, says support for Ethernet remains strong within the company.**

people had been trained to sell Ethernet, Liddle says.

As for internal dissension, Liddle says, "There is no opposition inside Xerox to Ethernet." And OPD's shaky financial situation will turn around this year. "I expect OPD to grow at 50 percent over this year. We are directed toward short-term profitability," he says.

Liddle regrets that the proposed IEEE 802 standard is "slightly, annoyingly different from Ethernet," and he says H-P's switch from Ethernet to the 802 version occurred primarily because H-P didn't want to appear to endorse a competitor's product. "H-P still wants the functionality of Ethernet," Liddle says. "They would just prefer the 802 name."

Putting the standards and OPD-solvency issues aside, Killen and others charge that Ethernet is simply inferior to broadband networking techniques. "Users have to look at their needs now and several years from now," Killen says. He believes users who are concerned primarily with word and data



communications will increasingly want to integrate voice and video over one local network. "They won't be able to do that if they put an Ethernet cable in," he says. He also maintains that the costs of broadband will drop faster than those of baseband networking.

"There is zero evidence that people will want voice, video and data over a single network," Liddle responds. He points out that only PBX vendors offer local voice communications. He also dismisses the oft-cited video application of security surveillance, saying, "You can't do that sort of video in a single broadband cable because you need too many channels."

Liddle claims assertions of broadband cost advantages are "rubbish." Although many broadband components are the same type of units used for CATV transmissions, and are, therefore, produced in quantity

at low costs, the broadband transmitters are relatively expensive and difficult to maintain on a one-per-work-station basis, Liddle says. Broadband systems also require a separate modem and controller for each terminal at each node, while Ethernet requires only one controller per node.

Broadband also suffers in comparison to baseband during the planning stage, Liddle says. "You need a galactic plan to implement a broadband network because you must ensure system balance, since a strong signal can overpower a weak one." Drop cables to terminals must also be of the same length, he says.

If users could plan several years in advance, as Killen suggests, broadband might be feasible, Liddle says. "But people can't anticipate their office-automation needs that far down the road." Given the difficulty in long-range planning,

Liddle maintains that Ethernet, which can be expanded and altered without concern for system balance, represents the best LAN available.

While the Ethernet-versus-broadband debate is sometimes argued as an either/or problem, many observers believe a combination of both approaches would work well. One analyst, John W. King, president of K/3 Group, Monterey, Calif., says Ethernet is alive and well and has "excellent" prospects through the 1980s. King sees Ethernet and broadband networks working together. "In large buildings, such as skyscrapers," he says, "it makes sense to use fiber cables or broadband coax to go up the building, with gateways to Ethernet systems, which will operate on each floor. Broadband is too expensive to install at every office throughout a large building," he says.

—Dwight B. Davis

## XEROX PUBLISHES HIGH-LEVEL NETWORKING PROTOCOLS

As predicted, Xerox published its high-level networking protocols late last year (MMS, November 1981, p. 35). Addressing levels three through six of the International Standards Organization's seven-layer networking model (see chart), Xerox's Network Systems (NS) protocols can be used with the firm's Ethernet local-area network, or with any communications network that addresses the lowest two levels of the ISO model.

Not a joint project, as is the Xerox, Corp., Digital Equipment Corp. and Intel Corp.-supported Ethernet, the high-level protocols represent the networking software Xerox developed for its own equipment. By publishing its protocol documents—"The Internet Transport Protocols" and "Courier: The Remote Procedure Call Protocol"—Xerox is making good on its promise to make its entire networking strategy open to all vendors and users, says David Liddle, vice president and general manager of the Office Products Division.

"The NS protocols give work-station vendors access to Xerox networking

services, and they give service vendors access to Xerox work stations," Liddle says. The protocols function in such a way that network users and application software require no knowledge of the location of data or resources. If the data and resources are remote, Liddle says, a local user would use the same procedure and routing calls normally employed.

Other NS-protocol functions include

establishing end-to-end connections, distributing routing information and changes throughout an entire network and multiplexing many connections over a single link. Like International Business Machines Corp.'s Systems Network Architecture (SNA) and DEC's DECNET, the Xerox high-level protocols theoretically operate over any communications link because physical connections are essentially hidden from the upper protocols.

ISO levels	Xerox protocols
Application	— Due in mid-1982
Presentation	— Courier remote procedure call protocol
Session	} Sequenced packet protocol
Transport	
Network	— Internet datagram and routing information protocols
Data link	} Ethernet protocols
Physical	



## AT&T, IBM SETTLEMENTS CAUSE CONCERN FOR COMPUTER INDUSTRY

Early speculation on the course of the communications and computer markets in the wake of the historic settlement of the AT&T and International Business Machines Corp. antitrust suits appears to be centering on what action—if any—will be taken by Congress to review and perhaps modify the Bell agreement. Observers are also predicting that the most significant antitrust action in decades will clear the way for Bell and IBM to become two giant competitors in the data-processing and communications markets.

In legal terms, the twin decisions appear to vindicate the views shared by many antitrust experts that the size of the corporation is not what counts. Rather, it is how the company throws weight around that matters.

In the IBM case, antitrust chief William Baxter said the government simply had insubstantial grounds to prove that the computer giant had misused its dominant market when the case was filed. "It may well be that IBM is a monopolist and controls some segment of the computer market," Baxter said in a memorandum to U.S. Attorney General William French Smith. "However, even if that were so, the government's case does not allege that IBM achieved that position illegally."

But the AT&T case is different. This time, Baxter and others close to the case believe that they had proved that the company used its dominant position in the communi-

cations market to illegally stifle competition. With the case in a Washington courtroom drawing closer to a verdict, company chairman Charles Brown and Bell lawyers decided to deal for the out-of-court settlement. They felt that, regardless of Judge Harold Green's decision, the case would become entangled in the very expensive appeals process for several more years.

The spinning off of Bell's 22 local operating companies is precisely the solution the Justice Department wanted. The creation of one or more new companies to manage the local subsidiaries will create a separation between AT&T, with its dominant intercity network, and the companies that own and operate nearly 90 percent of the local telephone loops. The Justice Department sought this kind of separation throughout the seven years of litigation.

But only sentimentalists or Bell old-timers will mourn the passing of local control from AT&T's hands. For while the local companies generate roughly 44 percent of total revenues, they account for 80 percent of its costs. In an age of satellite communications, fiber optics, coaxial cable and computer networks, twisted-pair technology is fast becoming aged, even obsolete.

Barring a refusal of the settlement by Judge Greene, which most observers feel is unlikely, the settlement will allow AT&T to enter virtually any market it chooses. While it will continue to be regulated on

long-distance rates, it can enter unregulated communications and computer markets, subsidizing its efforts with revenues generated by its rate-regulated services.

It is this part of the agreement that disturbs key computer concerns. In his statement on the settlement, Vico Henriques, president of the Computer and Business Equipment Manufacturers Association, said:

"In the past, CBEMA consistently has taken the position that AT&T should be allowed to compete in the unregulated telecommunications markets. But we also have said that this should be done through a fully separate entity to guarantee that revenues from the regulated monopoly are not used to cross-subsidize these competitive activities. We continue to endorse this basic premise."

After the settlement announcement, AT&T's Brown said the company does not intend to use rate-regulated revenues as a subsidy for other services. But Congressional leaders may not be comfortable with Brown's assurances. They will begin holding hearings this month on the Bell and IBM settlements to determine whether the government and the companies acted in the public interest. Congress may also decide in the coming weeks whether it should modify the Bell agreement to meet the concerns of AT&T's competitors.

—Arthur Hill

## Two new terminals are key to GTC's future

When General Terminal Corp. recently shipped its 10,000th GT-400 terminal to its largest customer, Cii-Honeywell Bull of France, GTC's vice president of sales and marketing, Bob Wolkowicz, called the event "an example of our commit-

ment to provide OEMs with reliable, customized products under long-term, high-quantity delivery schedules." But GTC's 1981 annual report reveals that sales of old products such as the GT-400 will not be enough to ensure continued delivery

on that commitment. The report also states that market acceptance of GTC's two new programmable terminals, the Avant 300 and the VT-100-emulating SW10, is key to GTC's future success.

The company recorded a net loss of \$1.4 million for fiscal year 1980, and went \$900,000 into the red in fiscal year 1981. Working capital, which stood at \$3.5 million at the end of fiscal year 1979, had



# Mini-Micro World



General Terminal Corp.'s vice president of marketing and sales Robert Wolkowicz believes that its two new terminals, the Avant 300 and the SW10, will help the company to thrive.

dwindled to \$580,000 by the end of fiscal year 1981. The annual report also notes that this shortage of working capital has forced GTC into extensive short-term borrowing at as much as five percent higher than the prime rate, making continued high interest rates especially damaging.

One reason leading to this financial predicament was the company's turnover of three presidents in two years. GTC's director of manufacturing, Rajan Munjal, says this management turmoil caused several expensive changes to plans for a new terminal then in R & D. That terminal never made it to market.

But the major drain on GTC's resources occurred in 1979 when the company, then headquartered in Burlington, Mass., and known as Infoton, opened a satellite manufacturing facility in Tustin, Calif. Despite denials that a corporate move was contemplated, Tustin also became the company's headquarters that year. The manufacturing

portion of the Tustin operation closed less than a year later, because it was less efficient than the Burlington plant, and there were insufficient orders to keep both it and the Burlington plant busy.

That weakness in GTC orders is attributable to downturns in the business of its primary customers. Paris-based Cii-Honeywell Bull, which took 35 percent of GTC's 1981 shipments, is ordering at reduced levels that reflect the impact of Europe's recession. GTC's 1981 annuals report also notes a suspension of orders from its largest domestic OEM, Sperry Univac, resulting from "their own business decline and a large inventory of (GTC's) terminals."

Wolkowicz says GTC is about to turn things around. He says the company's main problem, an inability to produce the right product at the right time, has been solved with the Avant 300 and the SW10. Munjal agrees, saying customer response to the VT-100-emulating SW10 is excellent. He does not find this

surprising in light of the product's \$995 single-unit price.

"The VT-100 market is glutted," explains New York consultant Joel Orr. "But it is the classic, mature market, in that price makes things move, and \$995 is the lowest price by about \$200 I've heard for full VT-100 emulation. Companies may react, which means essentially you've got the makings of a price war. But the best shot to fire in a price war is the first one," says Orr.

GTC has kept the SW10's price low by subcontracting production of the CRT terminals to a large TV manufacturer in South Korea, says Munjal, and by making easy assembly a primary design consideration. Munjal also closely monitors inventory, both to cut costs and because of short supply of operating capital.

"In my first year with GTC, we were slated to build 18,000 terminals, but orders didn't come anywhere close to that," says Munjal. "I had to cancel deals from vendors, which has strained relations with some of them. This time, I don't want to go through that kind of stuff." He says he is keeping tabs on the customer base and order backlog, and will build inventories and manpower only in response to firm orders. "I'm planning 300 terminals a month for four or five months. If the order rate improves, we can jack that up. We have the vendor base and capacity to push to 35,000 a year if the orders come in."

Only a few sizable orders have been received for the SW10. But an order from Travacom, a division of British airways, for the Avant 300 is worth \$1 million a year for five years, says Wolkowicz.

The Avant 300's design lends itself to Travacom's travel-agency application. Its monitor can be adjusted on three axes and rotated to show a customer on the other side of a counter. The device's 10K of down-loadable memory is also useful in such applications.



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- LSI-11 system boxes with 22-bit addressing and switching power supplies.

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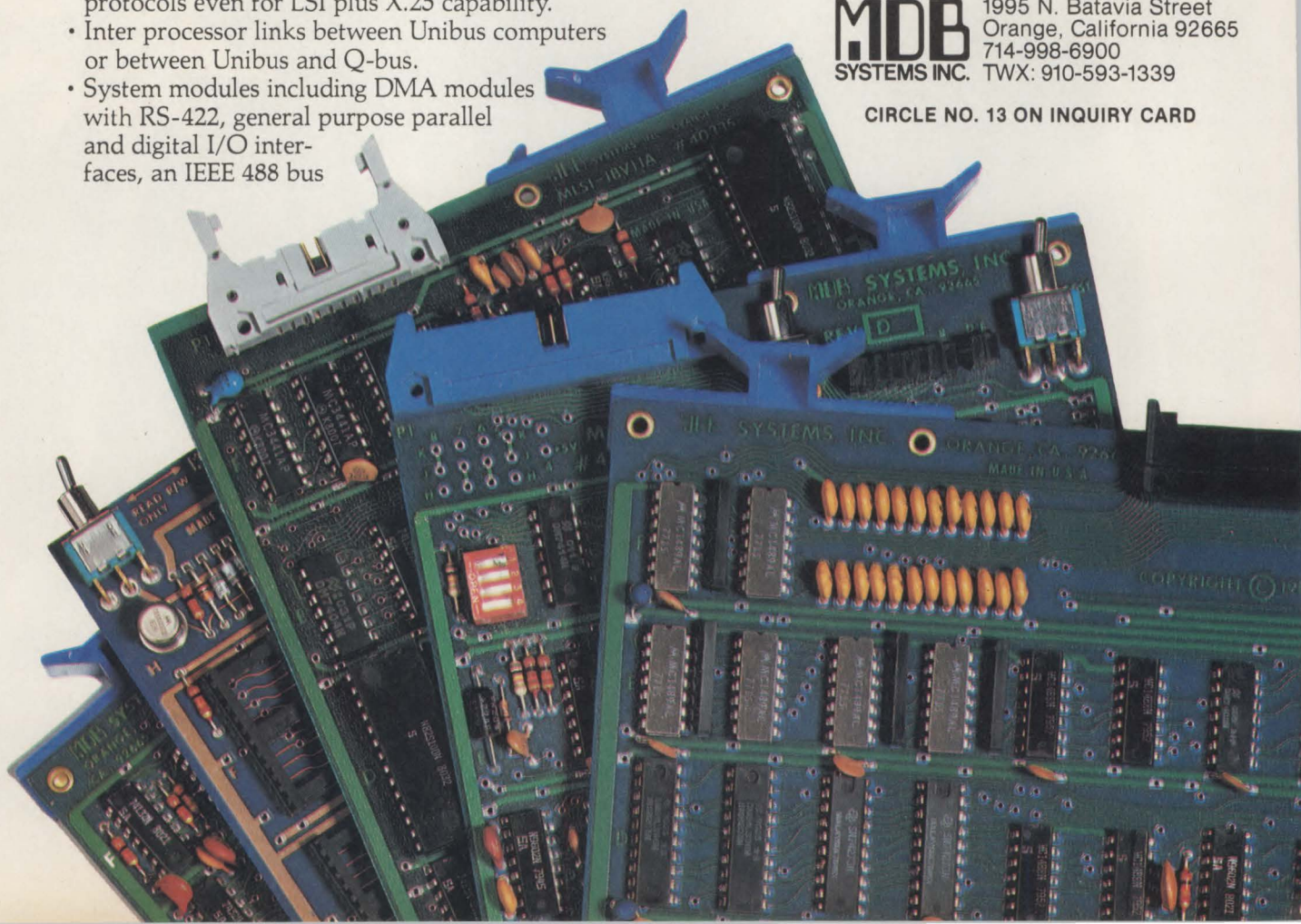
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"Down-loading capability is useful in editing for data entry," says Orr, "because you can off-load from the CPU and hook a relatively large number of terminals to a relatively small computer without straining the resources. People in that programmable market are also looking for specific qualities for a specific application," he says.

Wolkowicz recognizes the demand for such customization and hopes to tap it. "We're interested in doing specials for certain OEMs under the

right conditions," he says. Although GTC agreed to one deal with an English firm that wanted only part of the programmable capability of a GTC terminal if the price were reduced, Wolkowicz prefers adding value. The Avant 300 has an internal socket on which GTC can add an EPROM that automatically loads a custom program into the RAM on power-up, for example.

Wolkowicz is confident the company will thrive with its new terminals; he also feels its history of

problems won't be a hindrance. "We did a study," he says, "and found that most OEM buyers don't track their vendors the way a peer company would. They'll judge us by products GTC is making now, and not on last year's problems. "It looks good for us," Wolkowicz continues. "The first week we ran an ad for the SW10, we got 20 orders. I think the first quarter will tell, and I think it'll show us turning the tide."

—Kevin Strehlo

## Companies try to make the best of layoffs

While a tough economy and layoffs or shutdowns among electronics and computer companies may strain employees, some employers are making the best of a trying situation. That is the consensus drawn from a dozen companies surveyed by MMS.

Some of these companies tout furloughs as being convenient during the holidays when worker productivity is low and employees want to take days off. Other companies, which built staff and manufacturing plants during more profitable order periods, use layoffs and shutdowns as belt-tightening measures to bring company resources in line with market demand. Most claim there is no near-term harm to new-product planning or manufacturing as a result of idle periods. Additionally, while most companies are reluctant to discuss the slowdowns or shutdowns, they do not expect similar plant closings soon.

Texas Instruments Inc., which has used Christmas furloughs for the past two years as a cost-trimming measure, laid off 3 percent of its worldwide work force

last May because of a softening in semiconductor orders. During the holidays, employees must take paid vacation or time off without pay. "It's hard to keep some operations going anyway, with half the people gone," says a TI spokesperson.

General Automation, Lear Siegler, Dataproducts Corp. and Tektronix, Inc., are among the companies that pitch the furlough as a benefit. "We've been doing it for seven years, and everyone loves it," says a Tektronix spokesperson.

But all is not rosy. Other measures taken last year by Tektronix to bring production in line with market demand included two week-long shutdowns without pay, and a mandatory day off without pay every two weeks during most of the second quarter. The spokesperson says the shutdowns began to pinch employees so hard that top management eliminated some "unimportant" jobs and put 110 persons out of work.

For the first time in its history, General Automation had to extend its normal shutdown by one week. "The economy is in a position that orders are not flowing," says Larry

Kromlin, director of marketing at GA. "To economize and save an extra week's worth of employee pay, a decision was made to cut expenses by closing the factory down a week early.

Perhaps the most startling indication of order softening was the December shutdown of 13 of industry-barometer Digital Equipment Corp.'s 28 plants. The DEC shutdown occurred between last Christmas and New Year's, and employees were given the option of taking vacation days during that period.

Others affected include Honeywell, Inc., and Data General Corp. Additionally, Nixdorf Computer Corp. laid off 250 employees in mid-November and does not expect to rehire them. A Nixdorf spokesperson is concerned about DEC's move to slow manufacturing operations. "Many people use DEC as a standard for the health of the industry. (One must be concerned) when they show some type of problem," he says.

A DEC spokesperson says the company's four-day plant closings last December were a way of dealing with a slowdown in customer orders, but adds that he does not expect additional closings this year.

For its part, Honeywell cut 400 production workers from its payroll



by closing its Northboro, Mass., plant last November. Company spokespersons will not comment about rumors that the company plans to lay off additional marketing and support personnel this year, but says the 400 workers would be rehired.

DG halted work for three days at its Sunnyvale, Calif., wafer-fabrication facility during the holidays. A DG spokesperson does not foresee additional stoppages, but adds that there are no high hopes for a resurgence of orders in 1982. "The only reason a company would slow down or shut down operations is to bring inventories in line with demand," says the spokesperson. "Demand has been pretty soft in the industry for some time now, and we're not expecting a stellar year in '82." Only production workers at the Sunnyvale plant stayed home from work and were given the option of taking vacation days in 1981 or 1982.

Nixdorf was especially hard hit by order softening and a poor economy. "We had a lower than projected volume of business, which is attributed to the economy," says Robert Giroux, vice president of personnel at the company's Waltham, Mass., facility. The firm laid off 250 people company-wide in mid-November. Giroux says that managers, directors and vice president were told to streamline operations.

A Nixdorf spokesperson says the decision to cut staff was a U.S. problem and not one with its parent in West Germany. Nixdorf AG's U.S. operation was the only one affected. He adds that sales fell short, possibly because of unrealistic sales goals.

The spokesperson says that the company was overstaffed for its level of business over the past two years. Nixdorf expects no similar layoffs. The company helps to place people who were laid off, allows

those employees to continue receiving benefits for 39 weeks following dismissal and pays them through the first day of this month, plus vacation time.

The company is also attempting to realign corporate objectives in terms of markets. While Nixdorf will continue focusing on four market areas—data entry, distributed data processing, compatible mainframe systems and integrated office systems—the company will not take on any new markets in the short term. Nixdorf's move to retrench, build offerings and not pursue secondary markets may be a wise decision until the economy improves. Nixdorf also will continue its emphasis on software operations. "We will concentrate resources to improve offerings in the four markets, and bring better products out," says Giroux.

Most companies say that their rate of R & D will continue and that product plans and manufacturing abilities will not be affected.

"R & D is the lifeblood of DG, and we will continue to keep up our pace in that area," says a DG spokesperson. "We wouldn't be in any position to take advantage of an upturn in the economy, if and when it happens, if we didn't."

H-P, one company that didn't have furloughs or layoffs, has some firm objectives in mind. "We'd rather work overtime during our peak periods so we don't have a hire/layoff situation," says L.H. Fulgham, personnel manager for H-P's computer group. The philosophy is part of H-P's written corporate objectives, which are circulated to all company employees: "The objective of job security is illustrated by our policy of avoiding large ups and downs in our production, which would require hiring people for short periods of time and laying them off later."

—Reported by Frank Catalano, Nancy Love, Kevin Strehlo, Lori Valigra; compiled by Lori Valigra

## MINIBITS

### DG LOSES MORE MANAGERS

The shake-ups of Data General Corp.'s massive corporate reorganization last year are still occurring. Last December, Barry J. Fidelman became the last of at least five vice president to leave the company in 1981. Fidelman, former vice president of DG's information systems division, joined Apollo Computer, Inc., Chelmsford, Mass., as vice president of marketing and customer services and as a member of the board of directors. Frank P. Silkman and Dr. Michael Schneider, senior vice president of DG's business divisions and vice president and general manager of the technical products division, respectively, are temporarily assuming Fidelman's duties. Donald L. McDougall, director of marketing in Schneider's division, becomes acting general manager of that division.

Additionally, S. Ralph Wertheimer, general manager of DG's general-distribution division, resigned after seven months at that post. Wertheimer was preceded by William Jobe, who also resigned last year. A successor has not been named.

In other divisional-manager developments, John H. Crawford has replaced Lawrence Seligman as vice president and general manager of DG's small business systems division. Seligman resigned last August to pursue outside business interests. Crawford formerly served in posts at Mohawk Data Sciences, Modcomp Business Systems and ADL Systems. Two of DG's three business divisions formed last year have acquired new heads.

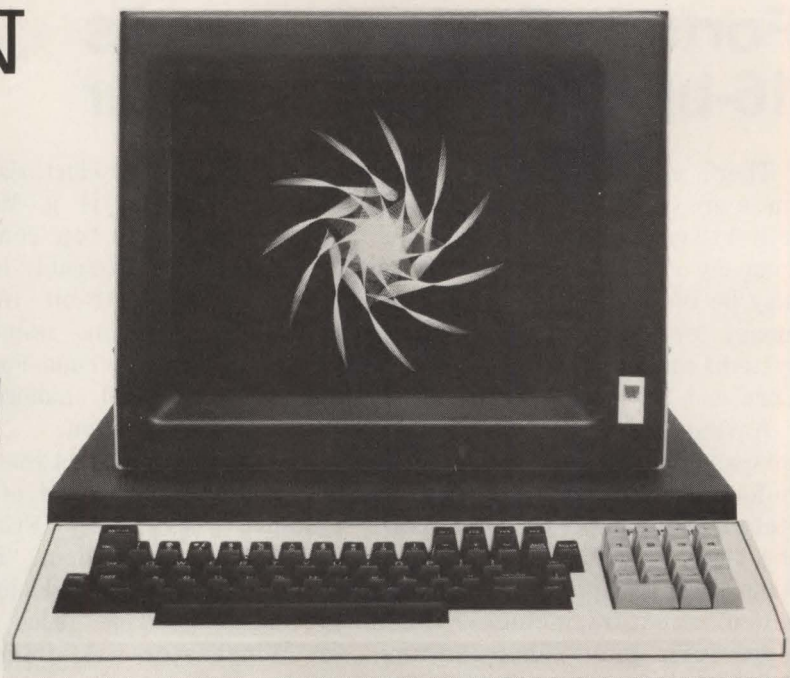
One new position was also announced. M. Tracey Zellman has become director of advanced manufacturing, engineering and technology. Zellman most recently was a senior engineer in advanced manufacturing systems at International Business Machines Corp.'s Boca Raton, Fla., facility, where he was responsible for developing advanced robotic systems.



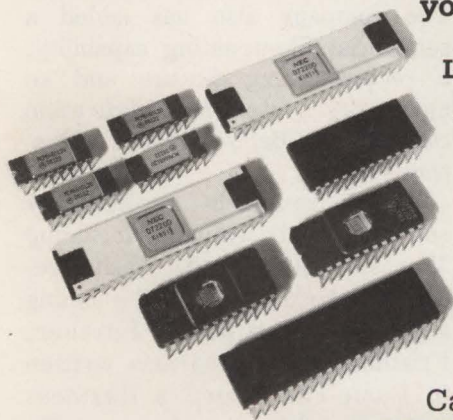
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## Fortune Systems unveils 16-bit desk-top computer

There are start-ups, and then there are Start-ups. With its roots in Intel Corp., the glamour computer company of the 1970s, and with what may be the largest sum of venture money ever raised for a small-systems company, Fortune Systems Corp. is a Start-up.

Among the San Carlos, Calif., company's founders are an Intel co-founder, the past president of Intel's business systems division and the director of marketing for that same Intel group. The company's seven investors include French electronics giant Thomson-CFS, Greyhound Computer Corp., First National Bank of Chicago, Banque de Paris des Pays-Bas, Walter E. Heller & Co. and two venture-capital groups, Brentwood Associates and Asset Management Co. The total first-round capital raised is \$8.5 million.

The firm's first product, slated for March deliveries, is a Motorola 68000-based desk-top computer called the 32:16 ostensibly because of the 68000's 32-bit internal architecture and its 16-bit data paths. The system runs Fortune's adaptation of Bell Laboratories' UNIX operating system.

"We wanted a product that would be on the leading edge of 16-bit systems," says Gary Friedman, co-founder and president. "But we wanted to reduce the risks by using proven technologies," such as 5¼-in. Winchester-disk drives and UNIX.

The single-user version of the 32:16 carries a \$4995 price tag. It includes a 1M-byte floppy-disk drive, 128K bytes of RAM, a keyboard and a 12-in. display.

Unlike other desk-top systems, the 32:16 has parity checking and

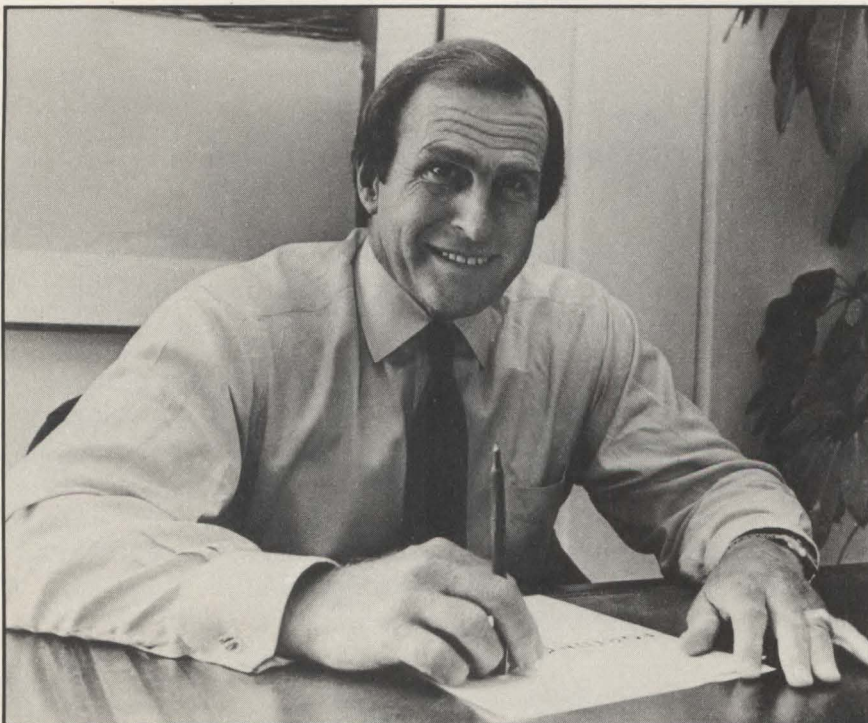
error-correcting capabilities, Friedman says. Memory is expandable to 1M byte with boards using 64K-bit RAMs. The company plans Winchester-disk storage and is evaluating drives from Seagate Technology Corp., Shugart Associates and Tandon Corp.

The single-user 32:16 is expandable to a multi-user system. For such systems, Fortune sells the slave terminals, possibly ones of its own design, Friedman says. Besides the additional memory, proposed options include color graphics, asynchronous and bisynchronous communications and an Ethernet interface. Friedman says that a freeze-frame video capability also may be in the 32:16's future.

Fortune is aiming the 32:16 at the business market. Although UNIX is not known for its applicability to the business environment, Fortune's version has overcome that limitation, Friedman says. Besides shrinking standard UNIX to a diskette-based single-user system, Fortune has added a "menu shell" to UNIX's user interface. The menu shell keeps UNIX transparent to the user while listing all the applications programs available on the system. The company also has added a sequential file-updating capability, a record-locking feature and an automatic system-reconfiguration capability to Bell's standard operating system.

A full range of applications software will be available, including Microsoft's (Kirkland, Wash.) recently introduced financial planning package, Multiplan. Further, Friedman says, programs written in Basic-Four Corp.'s Business BASIC III will run on the 32:16. He says the company also plans to offer CP/M emulation soon.

Though no benchmarks have been run pitting the 32:16 against competitors, Friedman is confident of the system's capabilities. He says the hardware "can compete favor-



**Gary Friedman, Fortune's president and co-founder:** "We wanted a product that would be on the leading edge of 16-bit systems, but we wanted to reduce the risks by using proven technologies."





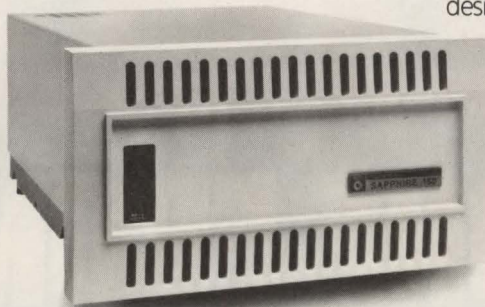
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The ANSI interface is microprocessor-based, and works efficiently at high data rates. The result: 3M drives are easy on customers' equipment overhead.

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three disks, with track density increased to 693 TPI. Modularly expandable, the drives offer you and your customers cost-effective increases in capacity from 10 to 240 megabytes.

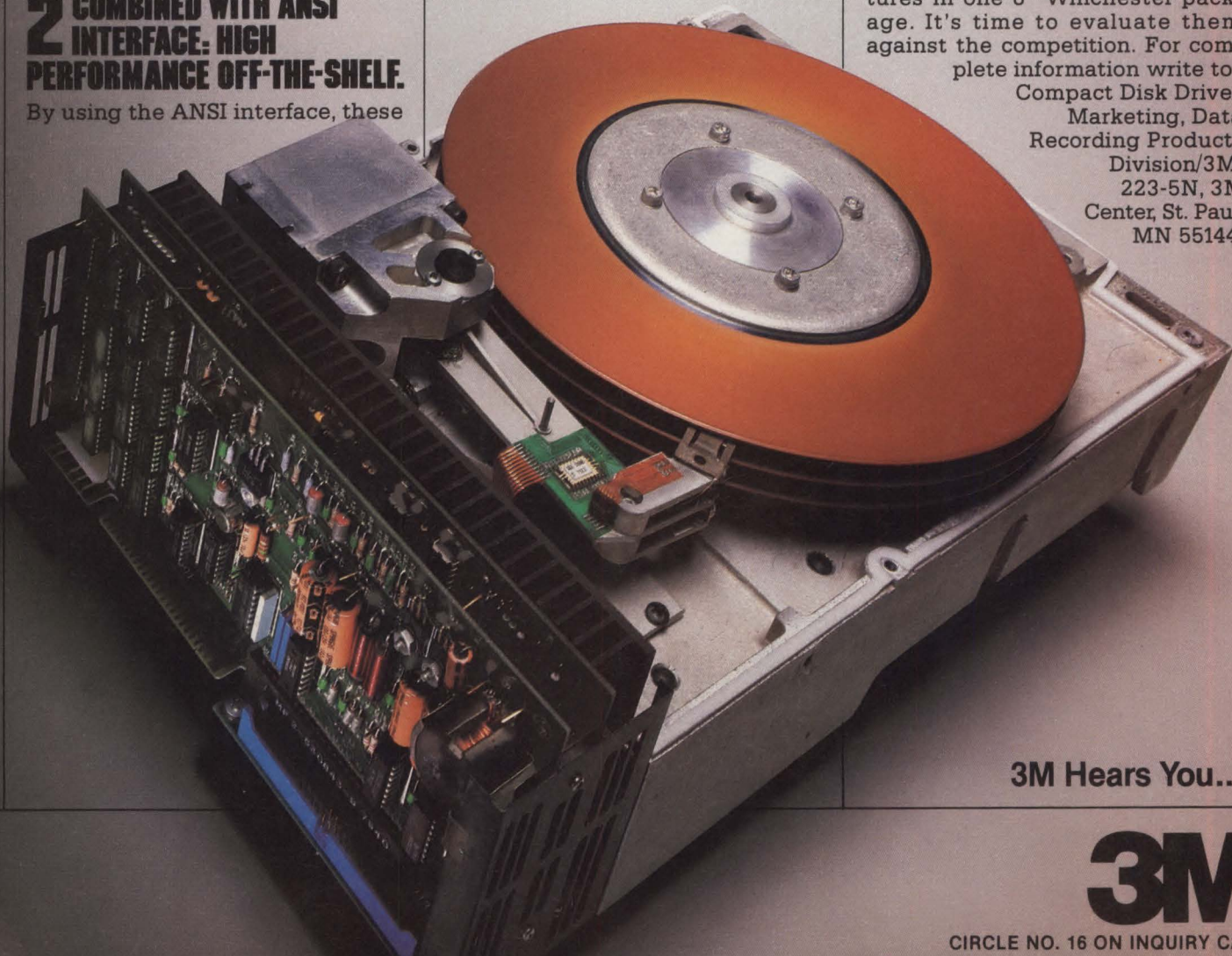
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#### Performance Plus

The full standard ASCII 96 character set, with descenders and underlining of all upper and lower case letters, is printed bi-directionally, with up to 5 crisp copies, at speeds up to 200 CPS. Models DP-9500 and DP-9501 offer 132/158/176 and 132/165/198/220 columns respectively. Print densities are switch- or data-source selectable from 10 to 16.7 characters/inch. All characters can be printed double-width under communications command.

#### Interface Plus

Standard in all models are the three ASCII compatible interfaces (Parallel, RS-232-C, and Current Loop). Also standard is a sophisticated communications interface to control Vertical Spacing, Form Length and Width, Skip-Over Perforation, Auto Line Feed, X-On/Off, and full point-to-point communications.

#### Features Plus

As standard, each model features forms width adjustment from 1.75 to 15.6 inches, shortest-distance sensing, full self-test, 700 character FIFO buffer (with an additional 2048 characters, optional), and a quick-change, 6 million character life ribbon.

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ably with any machine out there [selling for] as much as \$25,000."

Key to the system's anticipated success is its manufacturability, Friedman says. An automated assembly line that Friedman hopes to have running full tilt by the summer is already in the works. He has hired Johan Willems, ex-International Business Machines Corp., ex-Memorex Corp. manufacturing guru, to build the system. Willems, who claims responsibility for launching Storage Technology Corp.'s disk-drive manufacturing, says that by mid-1983, Fortune will be turning out 400 to 500 systems a day.

Fortune will sell the 32:16 through retailers, and has already signed up Computerland and Datel, a New York-based store. Datel president William Barton served as a consultant during Fortune's hardware development, Friedman says.

The firm also plans to sell to traditional system OEMs, about 25 of which are interested in the system, Friedman says. He expects other sales to be made to firms that will add their logos to the Fortune hardware.

To one industry consultant, however, Fortune's expectations are out of proportion to the company's ability to deliver the 32:16 on schedule. The announcement of the system is premature, says one source, who believes the company's investors are pursuing Fortune to prove the system will work before they provide additional funds. "The company has been pretty cagey about letting people look at the machine," the source says, and much of the product is still in the breadboard stage. Fortune hasn't chosen a keyboard, for example. The source admits that the 32:16 is a prototype for a new breed of desk-top systems, but says it's too early to judge if the system is everything its publicity says it is.

"Fortune has been called the



The 32:16 Motorola 68000-based desk-top computer runs Fortune's adaptation of Bell Laboratories' UNIX operating system and sells for \$4995.

Apple of the 16-bit generation," says Jean Yates, senior analyst at Gnostic Concepts, Menlo Park, Calif., "but it could be the Imsai." Although she agrees that it's too soon to evaluate the system, she says the firm is in a high-risk business, and it's moving a level of technology further than its competitors. The publicity it has received could hurt, however. "Fortune has a chance of selling tons of systems," Yates says, "but if the product turns out to be less than it appears, it could get just as much bad press."

A partner at one San Francisco Bay Area Computerland outlet, however, thinks the 32:16 will live up to its pre-delivery specifications. He believes Fortune will be able to deliver the hardware it specifies with the software it promises.

Computerland will be a beta site for the system, the source says, and he believes that store will get a machine on schedule in March.

Fortune's vice president of planning, Homer Dunn, says the company is a month ahead of the schedule given to its investors. He says the firm does not plan to seek additional financing.

Price for a single-user 32:16 with UNIX is \$4995. A UNIX software package, which gives full software support for two users via two diskettes, is priced at \$500. A typical three- to four-user, hard-disk-based system will sell for less than \$10,000, the company says. A separate Winchester drive with controller is expected to sell for about \$3400.

—Larry Lettieri



## Semi broker's software cuts custom chip costs

Designing and building a VLSI circuit probably remains a black art to most system houses. However, there are times when a unique device is needed. In those cases, system designers rely on semiconductor houses whose speciality is the custom design and fabrication of circuits. The high volumes and high costs associated with these so-called silicon foundries often discourage the system house that may want only a few chips to test its design.

But 14-month-old SynMos, Palo Alto, Calif., claims to offer an alternative to the high-volume commitments offered by more traditional custom semiconductor makers. SynMos president and co-founder Larry Matheny says his company uses a proprietary software package to spread the costs of

custom chip development among several designers.

Called shared silicon technology (SST), SymMos's proprietary software handles an average of 50 different designs at once, Matheny explains. The typical chip size is 150 sq. mils. Based on the exact die size, the software determines the probability of an error occurring during fabrication. From those statistics, Matheny says, the program decides the number of chips of each design that must be made to ensure that at least one will work. SynMos guarantees its customers one working device, he says.

Traditional semiconductor manufacturing techniques put only one circuit design on a 4-in. silicon wafer. Matheny says costs can run as high as \$15,000 for a custom

circuit made with these masking and fabrication processes. In contrast, SynMos reduces these costs by merging several designs onto one wafer.

For \$3500, Matheny's company gives a customer a 10-week course in VLSI design, during which the custom circuit is developed. At the end of the course, Matheny's students receive their circuits mounted in chip carriers ready for testing. Matheny's service also extends to customers whose circuits are already designed and who need only a prototype device built. In such cases, the prices depend on the die size, and average \$3000 for a 150-mil device, says Matheny. So far, SynMos has shipped more than 600 custom devices, Matheny says.

The company teaches the Mead-Conway approach to VLSI design, says Matheny. Other custom houses teach and use Mead-Conway design rules—which specify 5 $\mu$ , N-channel silicon-gate technology—but none is using the merge software (see “Mead-Conway aids in chip design,” left).

SynMos does not have its own wafer-masking and fabrication facilities. Therefore, Matheny acts as a broker for his customers' work. He is dealing with three masking houses and six fabrication facilities processing NMOS and CMOS circuits. SynMos farms out chip burn-in and testing. Matheny says, “Whoever gives us the fastest turnaround gets the business.” SynMos also acts as a broker for production runs of circuits developed and tested under the company's program.

—Larry Lettieri

### MEAD-CONWAY AIDS IN CHIP DESIGN

The Mead-Conway design method evolved out of a joint effort between the California Institute of Technology and the Xerox Palo Alto Research Center to simplify the design of integrated circuits so that integrated system design could be learned quickly and be practiced more widely by system designers. The design philosophy resulted in the textbook *Introduction to VLSI Systems* by Carver Mead of Caltech and Lynn Conway of Xerox PARC.

Mead-Conway directs the designers to concentrate on functional chip design and not on the actual implementation process. The method is composed of structured design techniques, scalable design rules and standards for layout descriptions. The design techniques aim to efficiently break a system down into functional blocks and then to implement those blocks using the smallest number of

different types of cells, resulting in a highly “regular” design. Scalable design rules are used for ease of implementation and for compatibility with different process geometries.

Additionally, Mead-Conway advocates hierarchical ordering of the cells in a layout for “bottom-up” implementation. The multi-project chip (MPC) was developed as a low-cost means of prototyping chip designs by university students. The MPC technique is used to place several circuits on one die. After fabrication, each die is placed in a package and the appropriate circuit is bonded out.

SynMos Corp. is taking the Mead-Conway method to the commercial arena. SynMos teaches courses in VLSI design, provides a prototyping service and provides production services including design assistance and design tools.

### NEXT MONTH IN MMS

March is data communications month in Mini-Micro Systems, with feature surveys of modems and teleprinters, including comprehensive product listings.



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- 4. Responsive service.** We have service centers both in the U.S. and Europe. We offer 4-hour response to any call within a 50-mile radius of major U.S. cities. And 24 hours/day, 7 days/week service contracts for all key metropolitan areas.
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**Europe:** System Industries (Europe), System House, Guildford Road, Woking, Surrey, GU22 7QQ, England, (44) 4862 5077, Telex 859124.  
**California** (714) 851-6289, (213) 822-3161; **Colorado** (303) 986-1591; **Georgia** (404) 955-2252; **Illinois** (312) 948-9330; **Massachusetts** (617) 695-4022; **Michigan** (313) 663-4925;  
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CIRCLE NO. 19 ON INQUIRY CARD

## Calendar

### SHOWS & CONFERENCES

#### FEBRUARY

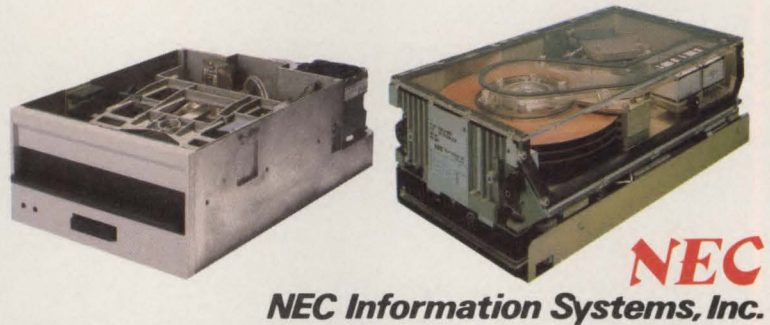
- 21-23 Non-Impact Printing Technologies DataBase Access Meeting**, San Francisco, sponsored by Advanced Technology Resources Corp. Contact: Linda M. Tempero, ATR Corp., 6256 Pleasant Valley Rd., El Dorado, Calif. 95623, (916) 626-4140.
- 22-24 Federal DP Expo**, Washington, presented by The Interface Group. Contact: The Interface Group, 160 Speen St., Framingham, Mass. 01701, (800) 225-4620 or (617) 879-4502.
- 22-24 Fourth International Learning Technology Congress and Exposition**, Orlando, Fla., sponsored by the Society for Applied Learning Technology. Contact: Raymond G. Fox, President, Society for Applied Learning Technology, 50 Culpeper St., Warrenton, Va. 22186, (703) 347-0055.
- 23-24 OEM Conference on International Export & Sales**, Paradise Island, the Bahamas, sponsored by the Caribbean Association of Industry and Commerce. Contact: Van Ferguson, Executive Producer, Ormand Vee Co., 8852 Leslie Ln., Des Plaines, Ill. 60016.
- 26-28 Computer Expo '82**, Orlando, Fla. Contact: Tom E. Blayney, Executive Director, Adventure International, P.O. Box 185, 377 E. Highway 434, Longwood, Fla. 32750, (305) 399-1731.

#### MARCH

- 1-3 National Conference on Publishing and Printing: Technology and Management**, Washington, sponsored by the American University Center for Technology and Training. Contact: Program Professor Lowell H. Hattery, Center for Technology & Administration, American University, Washington, D.C. (202) 686-2513.
- 3-7 Third Annual Microcomputer Week Conference**, Jersey City, N.J., sponsored by Catalyst. Contact: Mitchell E. Batoff, Jersey City State College, Jersey City, N.J., (201) 434-2154 or 547-3094 or 3098.
- 6 Fourth Annual Delaware Computer Faire**, Dover, Del., sponsored by the Delaware Council of Teachers of Mathematics, the Delaware Teachers of Science and the State Department Council on Computer Education. Contact: William J. Geppert, State Supervisor, Mathematics, or John C. Cairns, State Supervisor, Science/Environmental Education, Department of Public Instruction, Townsend Building, P.O. Box 1402, Dover, Del. 19901, (302) 736-4885.
- 7-10 TI-MIX (Texas Instruments Minicomputer-Information Exchange Conference)**, Las Vegas, Nev., sponsored by Texas Instruments Users Group. Contact: TI-MIX, 2200, P.O. Box 2909, Austin, Texas 78769, (512) 250-7151.
- 8-12 DIDACTA '82, World Fair for School, Education and Training**, Hanover, West Germany, sponsored by Hanover Fairs. Contact: Hanover Fairs Information Center, P.O. Box 338, Whitehouse, N.J. 08888, (201) 534-9044.



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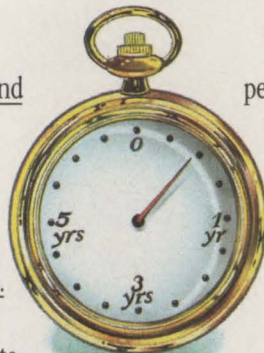
They're less expensive going in, and that's only the beginning.

Our disks also give you extra margins which no competitive products can touch. Here's how.

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```
! LARGE DATA ARRAYS DECLARED
SUBROUTINE PROCS(RDATA,ADATA,INDX)
COMMON /XXX/RDATA(30000,500),ADATA(500,500),BDATA(500)

DO II = 1,500
DO JJ = 1,500
ADATA(II,JJ) = RDATA(INDX+II,JJ)
ENDDO
ENDDO

! INCREMENT TIME INDEX
! INCREMENT MEASUREMENT INDEX
! LOAD DATA ELEMENT
! END INNER LOOP
! END OUTER LOOP

CALL ANALYZ(ADATA,BDATA)
! COMPUTATION

CALL DISPL(BDATA)
! DISPLAY RESULTS

RETURN
END
```

hp 2626A  
HP MODEL 2626A

f2

f3

f4

23

1

f5

\*

1



# 1000 Model 65: sitting at a mainframe.

Now you can tackle your large applications without breaking your budget. That's because our new HP 1000 Model 65—with a powerful real-time operating system and advanced memory management scheme—can handle jobs that previously required a mainframe computer. And do it at a minicomputer price.

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## Getting a head start on development.

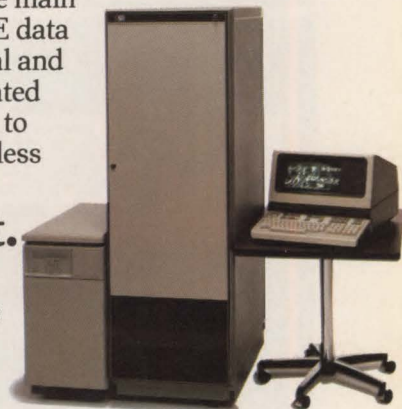
A Model 65 development system gives you maximum HP 1000 power in one fully-configured package. You start with RTE-6/VM, floating point hardware and one megabyte of high-performance main memory. You also get our award-winning IMAGE data base management system; FORTRAN 77, Pascal and Macroassembler; a 16 Mb fixed disc with integrated tape cartridge; and a powerful graphics terminal to use with our Graphics/1000-II software. All for less than \$65,000.

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*A one megabyte Model 65 development system is priced at under \$65,000.*

*When performance must be measured by results.*



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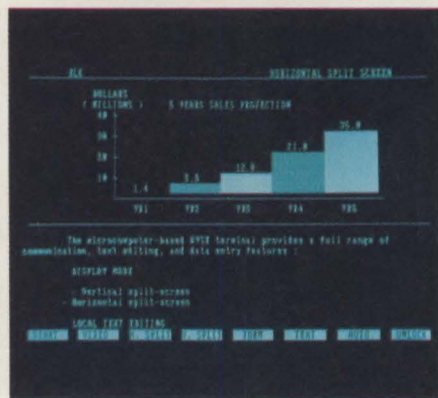
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HPTC-70



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# Calendar

- 9-11 Federal Office Systems Exposition**, Washington, D.C., sponsored by National Trade Productions, Inc. Contact: Joseph P. Rubel, National Trade Productions, Inc., 9418 Annapolis Rd., Suite 206, Lanham, Md. 20706, (301) 459-1815.
- 10-12 Fourth International Conference on Thermoelectric Energy Conversion**, Arlington, Texas, sponsored by the Graduate School and the Electrical Engineering Department of the University of Texas at Arlington and Fort Worth Section and Region of the IEEE. Contact: K.R. Rao, Professor of Electrical Engineering, P.O. Box 19016, University of Texas at Arlington, Arlington, Texas 76019, (817) 273-2671.
- 11-12 Fourth Annual Minnesota Joint Computer Conference**, Bloomington, Minn., sponsored by the Association for Computing Machinery, the Association for Systems Management and the Data Processing Management Association. Contact: Susan Rohrman, Northwest Computer Services, Northwestern Operations Center-SAC4, 255 Second Ave. S., Minneapolis, Minn. 55479, (612) 372-9584.
- 16-18 SOFTWARE/Expo-West**, Anaheim, Calif., sponsored by Professional Exposition Management Company. Contact: SOFTWARE/expo-West, Suite 400 222 W. Adams St., Chicago, Ill. 60606 (312) 263-3131.
- 17-19 Executive Forum on Decision Support Systems**, Washington, D.C., sponsored by the School of Government and Business Administration of George Washington University. Contact: GWU Executive Forum Manager, U.S. Professional Development Institute, 12611 Davan Dr., Silver Spring, Md. 20904, (301) 622-0066.
- 22-24 Information Systems Education Conference**, Chicago, sponsored by Data Processing Management Association Education Foundation. Contact: Dr. Stephen B. Weiner, Program Coordinator, 12611 Davan Dr., Silver Spring, Md. 20904, (301) 622-0066.
- 22-25 The Second Middle East Business Equipment Show**, Manama, Bahrain, organized by Arabian Exhibition Management WII. Contact: Rosemary Phillips, Arabian Exhibition Management WII, Windsor House, 4950 Calthorpe Rd., Edgbaston, Birmingham B15 1TH U.K., (021) 454-4461 or Stefan Kembell, Arabian Exhibition Management WII, P.O. Box 20200 Manama, Bahrain, (Telephone) 250033.
- 22-25 Interface '82**, Dallas, sponsored by *Business Week* and *Data Communications* magazines. Contact: Peter B. Young, The Interface Group, P.O. Box 927, 160 Speen St., Framingham, Mass. 01701, (800) 225-4620.
- 22-26 WCGA '82 "Computer Graphics for Design and Construction Productivity" Conference**, Washington, D.C., sponsored by World Computer Graphics Association Inc., The Building Research Advisory Board of the National Academy of Sciences in cooperation with the International Planning Committee and others. Contact: Exhibit Coordinator, WCGA, 2033 M St., N.W., Suite 250, Washington, D.C. 20036, (202) 755-9556.

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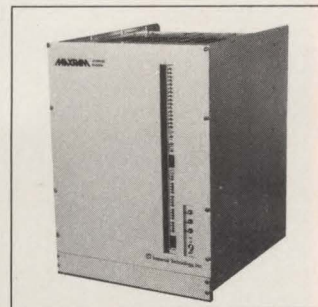
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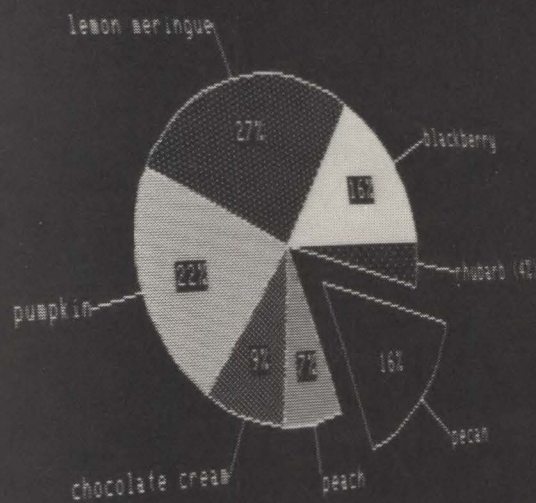
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# incredible Advantage<sup>TM</sup> over IBM and Apple.

The ADVANTAGE<sup>TM</sup> desktop computer from North Star is better in every category than either the IBM Personal Computer or the Apple III. Compare for yourself!

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The ADVANTAGE from North Star offers you the best in price/performance. You get more data storage per dollar invested, more applications programs, more available languages, and more graphics capabilities. At an incredible list price of \$3999.

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THE INCREDIBLE ADVANTAGE COMPUTER COMPARISON CHART\*

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

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

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

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\*LSI-11 and PDP-11 are trademarks of DEC.



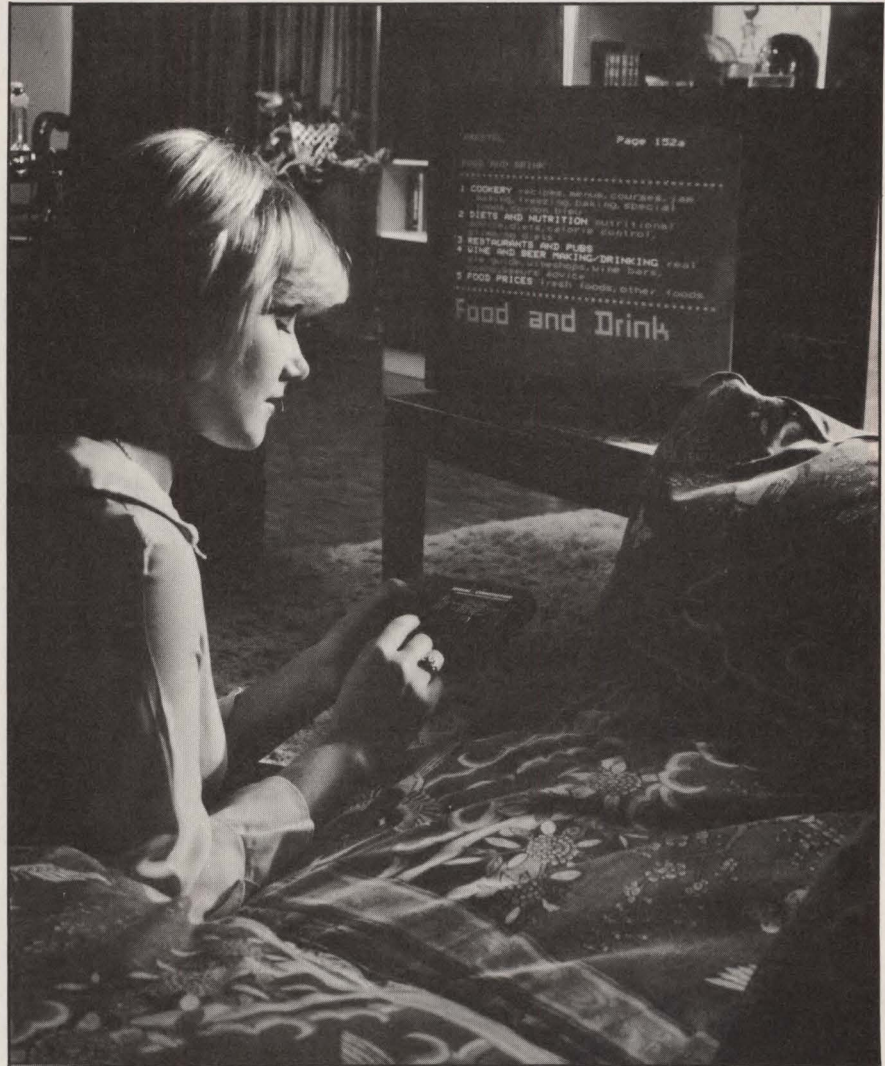
## IBM gets contract for West German videotex

It is a cliché of the computer industry that when International Business Machines Corp. enters a market, other suppliers cheer rather than groan because that market has, in effect, received the IBM "seal of approval."

In Europe, IBM has moved into the fledgling videotex market with a vengeance. The company has secured a contract worth roughly \$25 million to install a public videotex system covering West Germany on behalf of that country's government-owned common carrier, the Deutsche Bundespost. Moreover, the order is only an initial contract for completion within three years.

Suspensions of IBM's interest in the videotex market were aroused before the placement of the contract. The company's subsidiary in Britain, where videotex use is wider than anywhere else, made two announcements in 1981. In May, it announced software enabling users to link videotex terminals to application programs hosted on an IBM mainframe at the center of a network employing IBM's Systems Network Architecture. The second announcement, in October, introduced Series/1 Videotex System, a private videotex software for the IBM Series/1 minicomputer. SVS/1 runs as an applications program under EDX, the Series/1 operating system, and supports as many as 24 ports and 24 concurrent videotex terminals. SVS/1 manages a database with 5000 to 350,000 information pages, using as much as 512M bytes of disk storage. The SVS/1 package sells for £10,500 (about \$20,000).

Series/1 is also a key ingredient in the complex hardware/software mix supplied by IBM to the Deutsche Bundespost for Bildschirmtext, its



IBM's Series/1-based Bildschirmtext public videotex system for West Germany will be used in homes, much like the Prestel service is used in the U.K.

public videotex service. By the end of 1984, the service will include 12 regional centers, each equipped with eight Series/1s. Six of them, called Line Processors, will each provide 96 ports and hold 30,000 frequently used pages. The other two machines, dubbed Databank processors, will each store 60,000 additional pages. The database hierarchy will be completed by one IBM 4341 mainframe, probably at

Ulm, West Germany. That machine will act as an archive for hundreds of thousands of pages, any of which can be retrieved at the local centers.

Bildschirmtext project leader Erik Danke says the service's most important feature is its Gateway facilities, which will provide access for videotex terminals to systems operated by third parties such as banks and travel agencies. Access



# ALTOS PRODUCE

A woman with dark hair, wearing a white t-shirt with the Altos logo and blue jeans, sits at a desk. On the desk is a computer monitor displaying text and a keyboard. A green garden hose is coiled on the desk. Behind her, a wooden wall features a cowboy hat, a broom, and a clock. To her right, several wooden crates are stacked, each labeled with the Altos logo. In the foreground, two large wooden crates are filled with straw. Each crate contains an Altos computer system (a large black and silver unit) and a sign. The sign on the left crate reads "Winchester and Floppy from \$10,500\*". The sign on the right crate reads "Winchester and MagTape from \$12,990\*". The Altos logo on the crates includes the text "PROVEN VALUE", "COMPUTER SYSTEMS", and "PRODUCED IN THE HEART OF SILICON VALLEY, CALIFORNIA, U.S.A."

Packed with Fresh Ideas  
**ALTOS**  
COMPUTER SYSTEMS

Winchester and Floppy  
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# HIGHER YIELDS

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

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

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

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

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

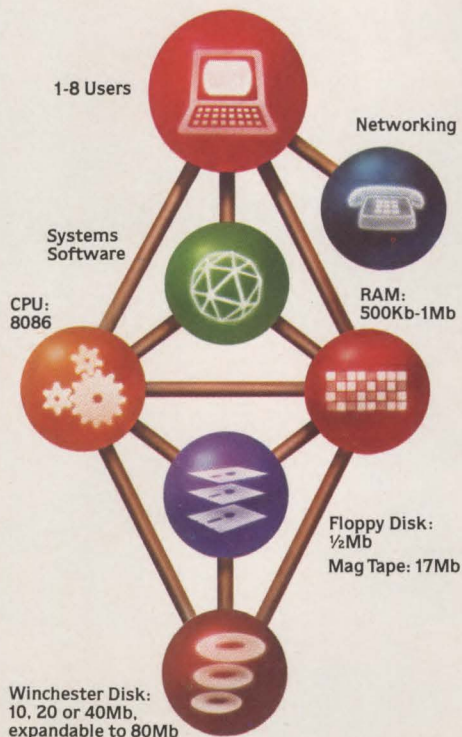
Take a closer look at these features. Multiple processors work together to share the workload for faster execution and response time. A unique memory management system subdivides up to one megabyte of memory, automatically giving each user the maximum available memory. Error detection and correction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

Integral data storage includes a choice of 8-inch floppy disks or magnetic tape backup option, plus a choice of Winchester hard disk capacities from 10, up to 80 MBytes. A Multibus™ expansion interface

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OASIS-16 is a product of Phase One Systems, Inc.  
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# SIEMENS

## The disks are flexible, our standards are not. Inflexible Standard No.1...Design Excellence

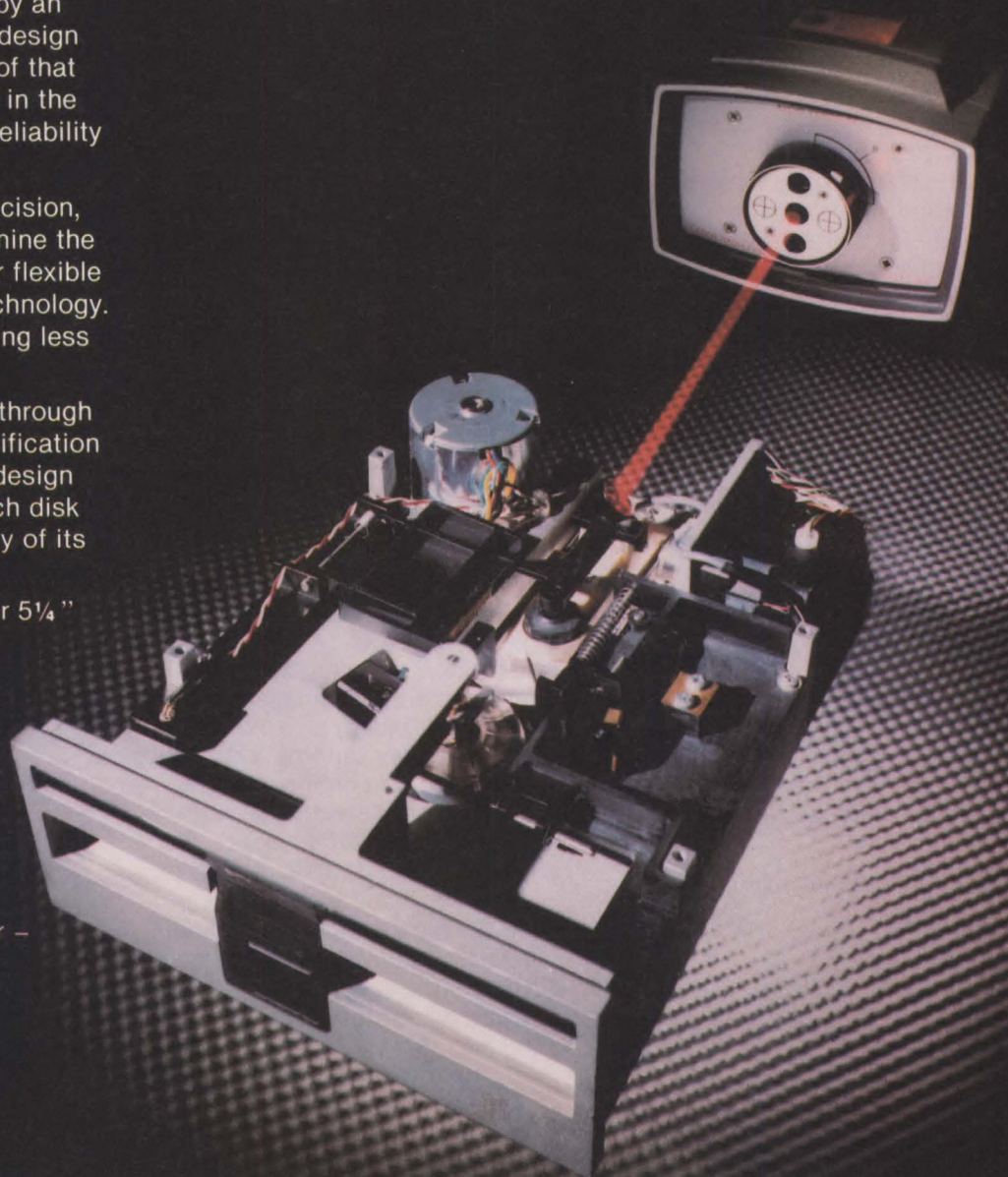
At Siemens, we're driven by an inflexible commitment to design excellence. The intensity of that commitment is evidenced in the proven performance and reliability of our disk drives.

With uncompromising precision, Siemens engineers determine the positional accuracy of our flexible disk drives using laser technology. Design excellence. Anything less would not be Siemens.

From design conception, through product certification, qualification and implementation, our design standards ensure that each disk drive we produce is worthy of its Siemens nameplate.

Further information on our 5¼" or 8" Flexible Disk Drives is available from Siemens Corporation, OEM Data Products Division, 240 E. Palais Road, Anaheim, CA 92805 (714) 991-9700 Telex 685695

Or contact our Distributor - Diplomat Electronics, 490 S. Riverview Drive, Totowa, NJ 07512 (201) 785-1830



### Siemens... Engineering Reliable Drives

CIRCLE NO. 28 ON INQUIRY CARD

CL/3010-003 510-966



will be provided Deutsche Bundespost's public packet-switched network, Datex-P. Each Series/1 Line Processor will handle Gateway and Bildschirmtext-database access. With Gateway, a videotex terminal user can update his bank account, order goods or plan a vacation from his home. About 2000 West German customers are using the trial Bildschirmtext service to gain access via Gateway to 18 third-party computers.

Bildschirmtext tests will continue until the IBM system goes public in the fall of 1983. The tests are based on the Prestel public videotex system developed by Britain's government-owned common carrier, British Telecom. The host computers, 4000 Series machines, are built by the British firm, GEC. There are about three GEC machines operating in West Berlin, West Germany, and another three in Düsseldorf, West Germany. GEC bid against IBM for the contract to equip the full Bildschirmtext network as part of an agreement with several other British organizations, including software house Systems Designers Ltd. and Aregon International, the British government-backed company to promote British technology overseas.

Danke is tight-lipped about why the Deutsche Bundespost chose IBM over the British group, but it is known that West Germany is IBM's largest market outside the U.S. In comparison, GEC Computers is minute, and its installed base of 4000 Series machines is small compared with Series/1. Moreover, the GEC machines host Prestel software, which is written in Babbage, a real-time language supported only on those machines. In addition, most third-party computers accessed by Gateway are IBM machines.

GEC's bid was further hampered by the need for a redesign of much Prestel software used in the tests.

The PTTs state-owned common carriers in Europe agreed late last year on a European Unified Standard technique for generating pages on a screen of a videotex terminal (MMS, August, 1981, p. 59). The standard is a compromise between the display techniques employed by Prestel and the French public videotex system, Teletel. Terminals built for Prestel can receive and display a page formatted to the new standard, but they cannot use several extra features incorporated into the new standard. For example, the new standard enables more characters to be displayed on a page. Characters can be underlined, double width or double sized, and character sets can be dynamically redefined. Moreover, the new standard eliminates the on-screen blank spaces that Prestel control characters generate and enables character attributes to be changed more than once per line.

IBM will handle most software development for the Series/1 machines in the Bildschirmtext network. The coding for the Gateway facility must handle the X25 protocol used on Datex-P and other European packet-switched networks.

The main difference between the European Unified Standard and the AT & T standard announced in 1981 is that the European standard is based on alpha-mosaic page-display techniques, while AT & T's is based on alpha geometrics. Alpha geometrics involves graphics generated from graphical primitives stored in a terminal, while alpha mosaics employs a building-block method. IBM's system in Germany will transmit page information for terminals incorporating alpha geometrics only if the terminals are members of a closed user group having exclusive access to a library of pages. Alpha geometrics will, therefore, play a secondary role in the German network. It remains to be seen whether the experience accumulated by IBM in developing the West Germany system will lead ultimately to a clash with AT & T in the U.S., with IBM backing the European standard. But, in the world of public videotex networks, common carriers call the tune, so a compromise by AT & T is more likely to be forced on the U.S. carrier by the combined forces of Europe's PTTs than by IBM. —Keith Jones

## European software houses address U.S. DEC market

Digital Equipment Corp. has derived about 30 percent of its worldwide sales from Western Europe for more than 10 years, and has been active in some parts of that market since the early '60s. As a result, many software houses in Europe focus their attention on DEC machines as closely as do U.S.-based software developers.

European software houses addressing the DEC market in the U.S.

include Systime, Leeds, England. Its Systel teleprocessing monitor is sold out of its Washington, D.C. offices. Time Utilising Business Systems, Leicester, England, promotes its Cupid system-development software through Consultech Marketing International, San Carlos, Calif. Three London-based software houses also sell DEC versions of portable products in the U.S. They include the Rapport



# Mini-Micro World



December's Software Info International was held at the Wembley Conference Centre in London.

relational database system from Logica, New York, the ANSI '74-standard CIS COBOL compiler from MicroFocus, Santa Clara, Calif., and the MicroCOBOL family of portable application packages from Palo Alto, Calif.-based Microcobol Products Inc., the U.S. arm of Micro Products Software Ltd.

Several other European software houses that want to exploit the enormous sales potential of the U.S. DEC market appeared at December's Software Info International, the European version of the U.S. Software Info show, at the Wembley Conference Centre in London.

Martin Marietta Data Systems, Greenbelt, Md., is promoting the MAS-M family of commercial application packages for DEC machines for the company's London-based sister company, the Hoskyns Group. Hoskyns's MAS modular applications systems products are available in versions for International Business Machines Corp. and Sperry Univac mainframes and Hewlett-Packard Co. HP 3000 systems. The MAS-M versions run on DEC Datasystem-500 machines based on PDP-11/34, 11/44 or 11/70 processors.

Hoskyns completed the "Americanization" of MAS-M late last year.

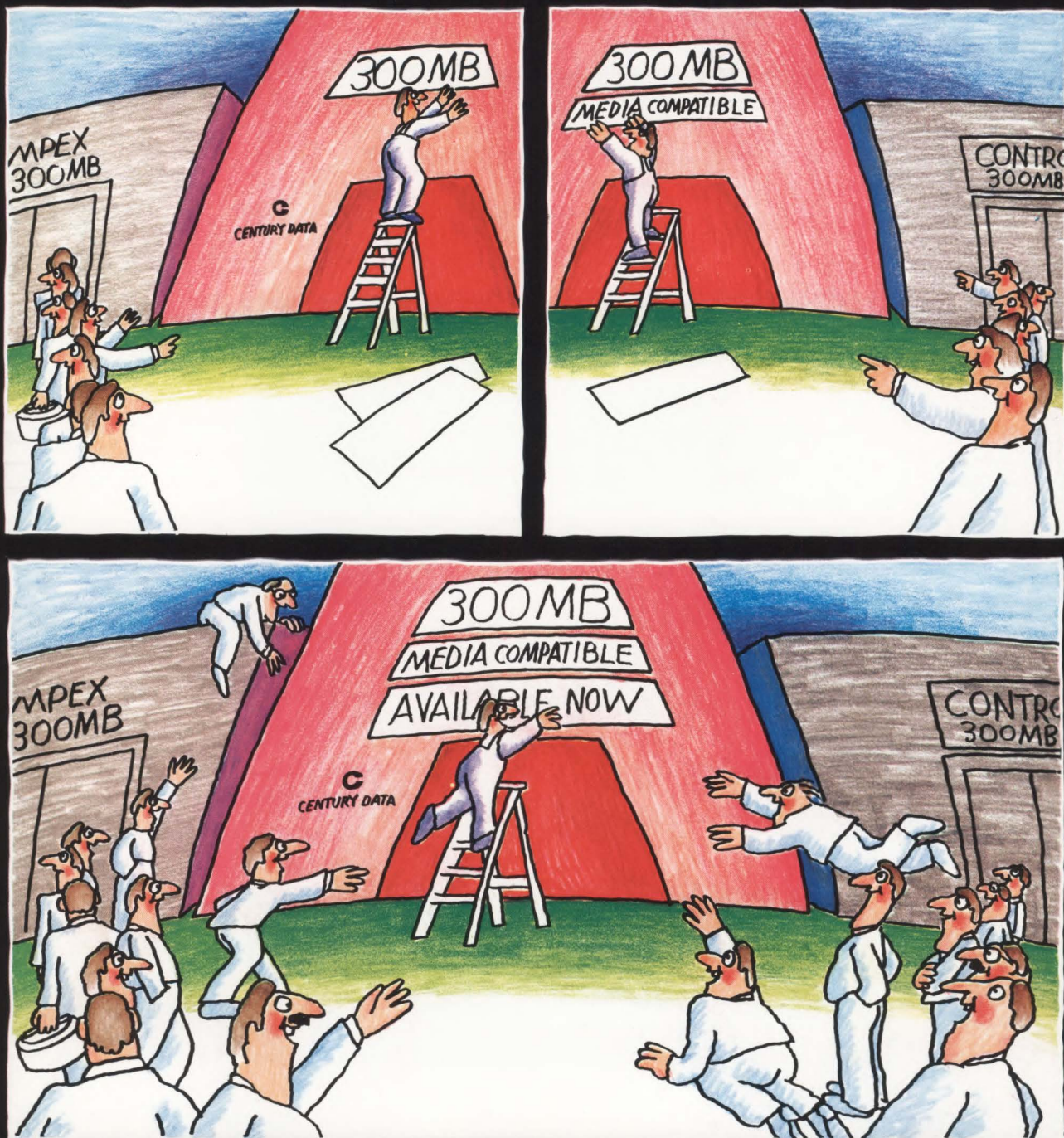
There are 40 MAS-M customers in the U.K., and about 200 elements have been sold at £4000 to £5000 each, including source code and documentation. Hoskyns says MAS-M products are developed around the company's teleprocessing monitor, which runs under RSTS and controls the data flow between the screen and the CPU. Elements are available for order processing, inventory control, purchasing, general ledger and payroll.

Another exhibitor at the Software Info show, Systems Designers Ltd., intends to enter the U.S. DEC market in mid-1982 through its subsidiary, Sysdes Inc., Alexandria, Va. Elwyn Wareham, the company's software technology marketing manager, is tight-lipped about these products, but they will probably be real-time systems for communications, industrial control and defense. Many of SDL's products are based on the real-time language CORAL, which was formerly a standard of the British Ministry of Defence. CORAL is popular in the U.K., but is not widely used elsewhere. SDL is seeking other real-time languages because nearly all CORAL programmers are U.K. based. However, SDL has developed one major software product for the U.S. market. That product is IVS-3, a private videotex system written in FORTRAN IV for PDP-11 machines, which is sold by Aregon Systems, Anaheim, Calif.

Wareham says about 50 of SDL's worldwide staff of more than 300 are working on software development, and the remainder is working on real-time system-implementation projects. System implementation will also be a major activity of Sysdes Inc.

DEC systems developed by ADOS Ltd., Ruislip, England, are being actively marketed in the U.S. by Telecom Computer Systems Inc., Portland, Ore. The company's main product is BACmac, described as the





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

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

Introducing the Trident T306—ready for shipment today and well worth the wait. Because it's more than a match for any

other removable-pack drive on the market.

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

*Continued on next page*



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

*Tom Amerson, President  
Consultant Field Engineering  
Mission, Kansas*

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

For instance, there's Tom

Amerson, president of Consultant Field Engineering, an independent service company that maintains over 200 brands of computer equipment.

Mr. Amerson is also chairman of the board of IASCO, the International Association of

Service Companies, a new organization that seeks to establish standards for the industry.

He has a lot to say about Tridents:

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

"That isn't really unusual for a Trident, though. In the last six years, I haven't seen more than one head crash in a Trident. Which is something I sure can't say about other manufacturers' drives. "Overall, Tridents are just amazingly reliable. In fact, we don't do much business writing service contracts on them. Most people would rather just call us once a year for maintenance. And really, that's about all the attention a Trident needs."

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



## T306 *Continued from first page*

a catamaran head shape significantly improves aerodynamic performance.

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

What's more, Trident T306 is quiet. Very quiet, in fact. Our design meets not only the NC55

quietizing standard for office environments, but even exceeds this standard.

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

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

In fact, new assembly and test facilities have significantly

increased our Trident production capacity.

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

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



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

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

And we manufacture them in an exacting way. In fact, every

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

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

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

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

Trident that leaves our facilities is virtually a Winchester. If you never remove the disk pack, it's a Class 100 clean room environment inside.

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

Most important: maximum up-time.

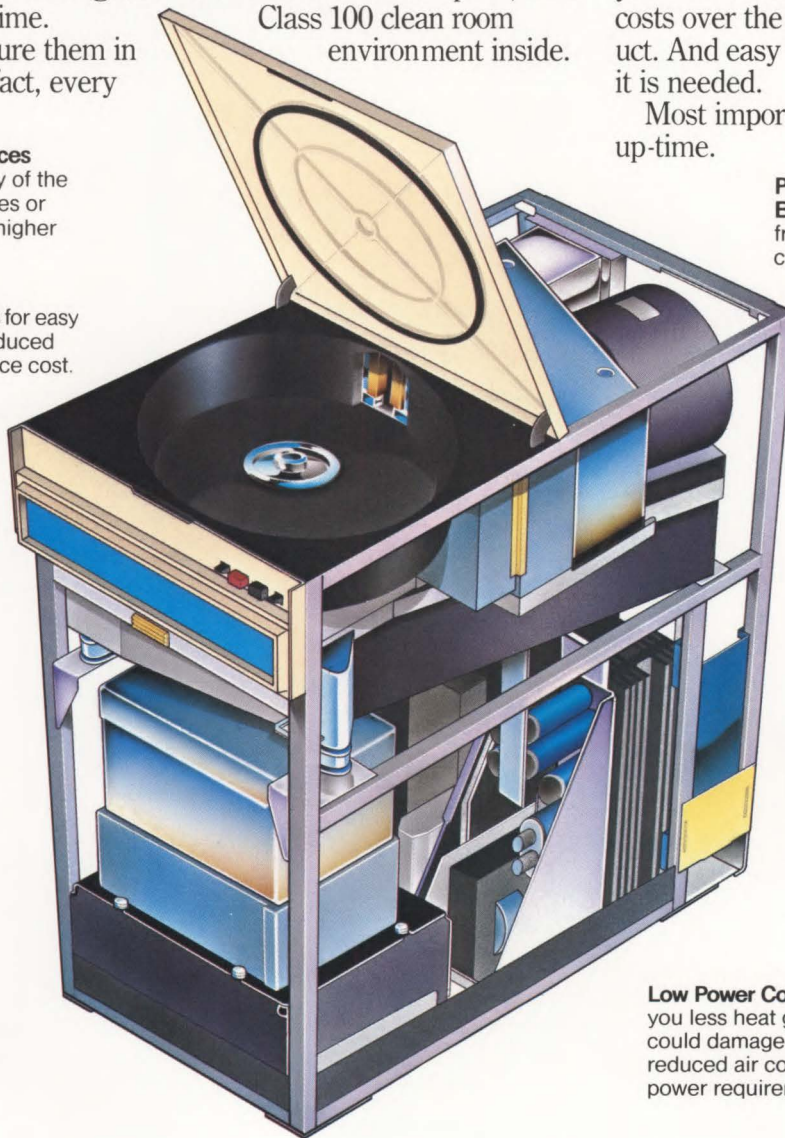
**Protected Carriage Bearings** are isolated from air movement that could dry out the lubricant.

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

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

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

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



## SMD-compatible 200 MB Tridents: Available now.

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

The result is a compact, low-maintenance 200 MB drive that

not only saves floor space, but also makes a perfect plug and media-compatible replacement.

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

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



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

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

These are the ideals that the Marksman T-Series is designed to meet—a complete mass storage system of Winchester drive, streaming 1/4" cartridge tape drive, intelligent and composite disk/tape formatter.

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

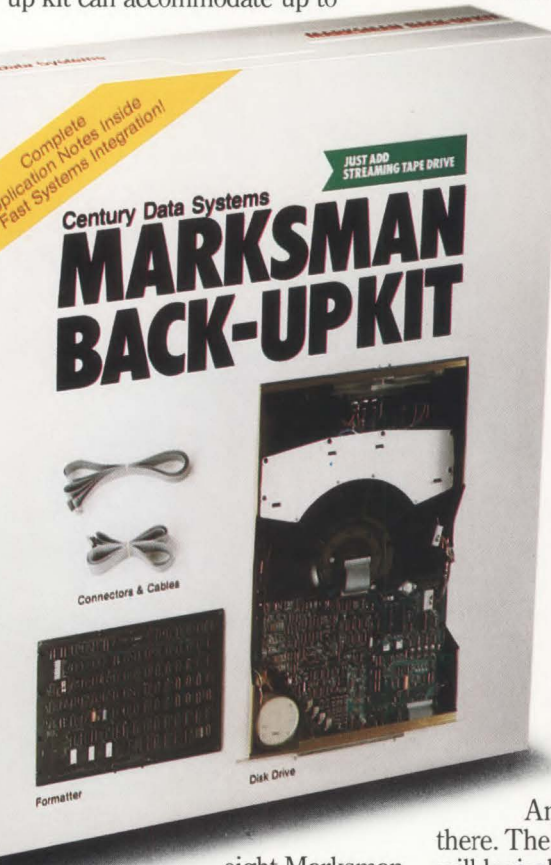
Plug our system into your system for mass storage that gives you extreme reliability, has the highest cost efficiency, and Winchester/tape file loading and unloading without downtime for the operator.

The secret is transparent, prioritized commands. While our new T-Series Marksman is fully or selectively backing up data onto 1/4" streaming tape, direct requests from the CPU for access to data files on the disk can be given higher priority. The user is unaware of any time lapse as the back-up function is interrupted, the user's data need is fulfilled, and the back-up function is resumed, without further host system intervention.

## Marksman Winchester.

The Century Data Systems back-up kit can accommodate up to

eight Marksman Winchester drives, giving you a storage capacity from 20 MB to 160 MB per drive, enabling a total capacity as high as 1280 MB.



eight Marksman Winchester drives, giving you a storage capacity from 20 MB to 160 MB per drive, enabling a total capacity as high as 1280 MB.

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

## 1/4" Streaming Tape.

The Marksman T-Series ties into what may be the ultimate Winches-

ter back-up device—1/4" streaming cartridge drives. They are fast becoming recognized as the ideal sequential-data drive available today. Because dump/restore and program entry could never be performed as inexpensively and quickly before.

No other back-up drive has the cost-efficiency, speed and large removable capacity of 1/4" streaming tape.

In fact, cost per megabyte never looked so good.

## Ultimate Marriage.

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

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

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

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

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| <input type="checkbox"/> All Trident Drives |   |

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RSTS/E Supercharger. ADOS director David Changer points out that more than 60 copies of BACmac have been shipped in a year, most of them to U.S. users, including the Ford Motor Co. and the U.S. Army.

Changer says BACmac provides five times better performance than BASIC-PLUS programs running under RSTS/E. This improvement is achieved mainly by making the run-time code sharable. An automatic BASIC-PLUS-to-MACRO converter/compiler, BACmac also generates code to run under RT-11, provided a program has no RSTS/E-specific features.

David Changer says ADOS is working on a BACmac facility that will convert BASIC PLUS RSTS source code to C. The C code can be linked with ADOS's RSTS features library and then with the Whitesmith's System Interface Library, enabling application migration to Whitesmith's IDRIS, a UNIX-like operating system that resides on several DEC and non-DEC computers. Changer says the most difficult part of the project has been adding the RSTS features library, but the new facility should be available this year.

Another European software house that exhibited at Software Info is BL Systems Ltd., Redditch, England. The company is aiming at the vertical-manufacturing and insurance markets. BL is the computer-services arm of automobile manufacturer BL Ltd. At the show, the company unveiled Famis, a comprehensive family of factory-management systems for DEC PDP-11 computers. BL Systems executives hope to contact U.S. software houses interested in handling the product. Autostore, a store-management system, ranges in price from £80,000 to £120,000 (more than \$200,000).

Logsys (U.S.A.) Inc., New York, a U.S. marketing operation established by Logsys Ltd., Crowthorne,

England, will begin promoting insurance systems for DEC machines this year. Logsys managing director Stuart Ashton says that the company's initial activities in the U.S. include placing British software-development personnel at U.S. sites. The company plans to introduce insurance packages aimed at the insurance business. Ashton says the requirements of U.S. users are virtually identical to those of the insurance industry in the U.K. He believes that his company's personnel and products will be well received in the U.S. because British programmers are better trained than their U.S. counterparts. He also believes that coding British software products is more efficient than coding U.S. ones because hardware is higher priced in Europe.

DECUS, the worldwide DEC user group, has access to European-developed software in the 1000 or so offerings in its software library, which is maintained by DEC at the group's U.S. headquarters. DECUS members can obtain any program for no more than the cost of the storage medium and distribution. But DEC admits that the library does not have many good application programs and that the

documentation is "less than perfect." Sources in the DECUS community contribute products to the library on an "as-is" basis. As a result, the DECUS library poses no serious threat to the sales prospects of products developed by software houses for commercial use.

Moreover, the prospects for the products of small European software houses in the U.S. may be significantly boosted by DEC's EASL external applications software library, introduced in mid-1981, which also includes system software. With EASL, DEC can sponsor an external product by paying a royalty to its developer for the rights to sell it.

DEC is also introducing an EASL-type service in Europe, and the company's software-products-promotion personnel are seeking software from European companies. That software could be added to EASL in the U.S. as well as to the European library. Thus, small software houses in Europe could gain access to the enormous DEC user base in the U.S. without the financial burden of setting up a direct-marketing operation or the headaches of finding competent, reliable distributors. —Keith Jones

## FOUR-PHASE TO MERGE WITH MOTOROLA

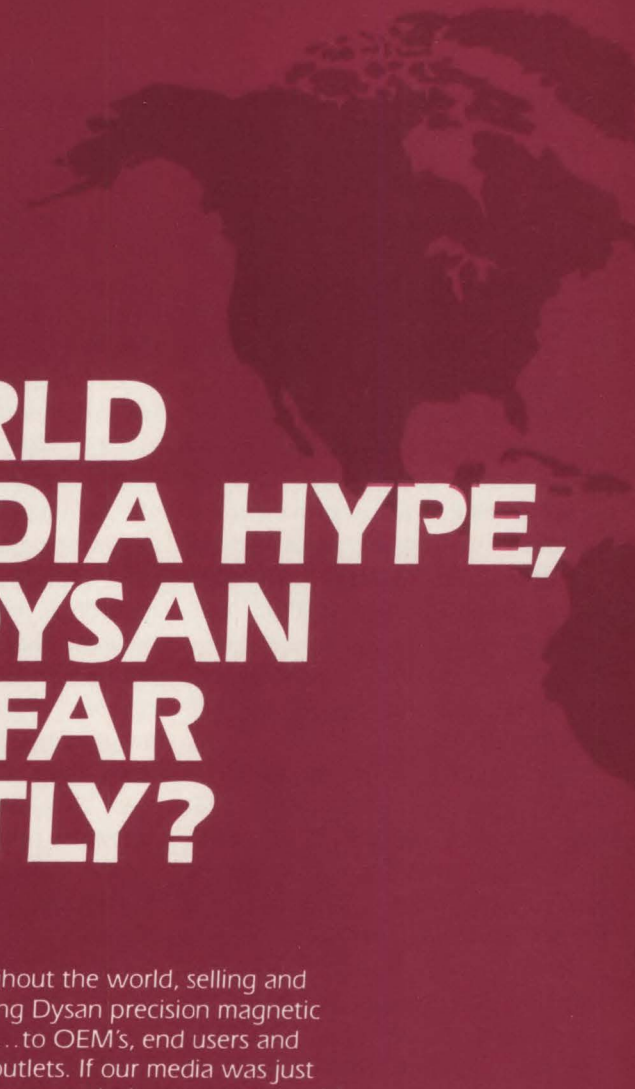
The boards of Four-Phase Systems, Cupertino, Calif., and Motorola, Inc., Phoenix, have approved an agreement in principle for the acquisition of Four-Phase by Motorola. The agreement—announced by Motorola chairman Robert Galvin and Four-Phase chairman Lee Boysel—will provide each Four-Phase shareholder with a value of \$45 per Four-Phase share in Motorola common stock.

The agreement also provides that Four-Phase's outstanding 9½-percent convertible subordinated debentures

will remain outstanding and will be convertible into Motorola shares at a price based on an equivalent adjustment.

Four-Phase officers and directors have agreed to vote the shares they own in favor of the transaction. In addition, Four-Phase has agreed to grant Motorola an option to purchase as many as 1 million shares of its common stock at \$45 per share. The transaction is designed to be tax free to Four-Phase shareholders and to be accounted for by Motorola as a pooling of interests.





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





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CIRCLE NO. 30 ON INQUIRY CARD



Universe 68 leapfrogs  
the 16-bit minis.

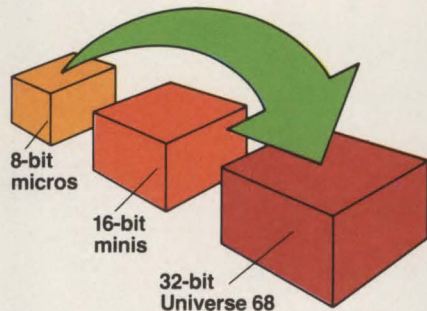


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## Introducing the first 32-bit supermicro for OEMs

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



## Jumping over outmoded 16-bit architecture

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

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



The Universe 68/10 computer system

## Outhopping supermini prices

The Universe 68 gives you 32-bit performance at micro prices -- while the big frogs in the minicomputer pond are still offering 32-bit technology only in expensive "superminis." A Universe 68/10 with 32-bit processor, 256 kbytes of memory, floppy disk,

and Winchester disk sells for under \$20,000. Order ten, and the unit price drops to \$16,860, including system software.

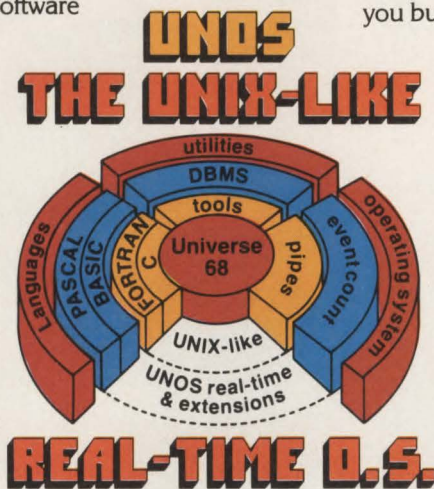
## Springing past conventional system software

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

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

## Croaking obsolete business practices

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



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

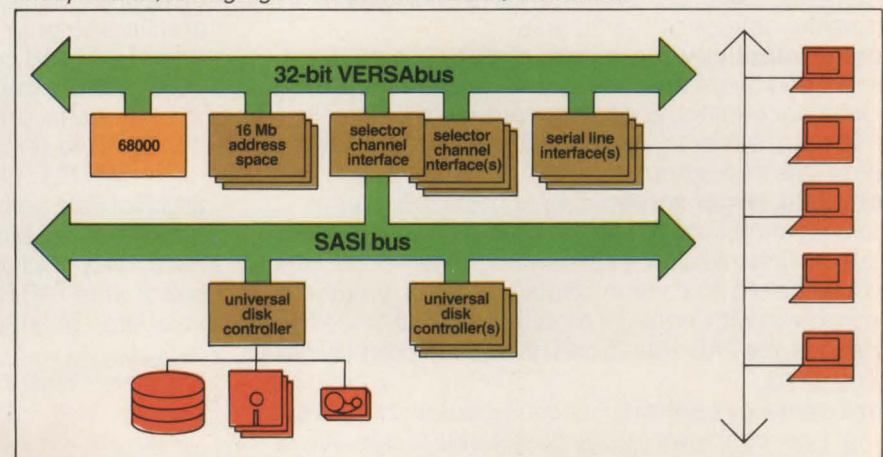
We've also introduced a more sensible approach to discounts. We give you discount credit for everything you buy. Our software discounts are based on how many licenses you buy, not in one year, but over *twenty* years. And they cut deep -- all the way to 98%. We think this honestly reflects our costs: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

## Swallowing up the competition

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

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

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



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



# Compare TAB's 132 column, 15 inch terminal with any other smart terminal.



TAB 132/15: The Difference is More Than Clear

## The difference is more than clear!

"Perhaps the finest quality 132 column display on the market today..." See for yourself. Send for your FREE unre-touched, actual size photo of the TAB 132/15. Place it by any other terminal. Compare the non-glare 15 inch screen, the crisp, clear 132 characters per line with the large 7" x 11" dot matrix resolution. Even with just a photograph, you'll see the difference... and more!

**More productivity, more throughput.** Give people a better tool and they'll produce more—whether they're the president, accountant, engineer or order entry clerk. An easier to read, easier to use terminal means more effective, error free throughput.

**More data, larger screen.** Display data in the same 132 column format you're used to seeing on your printer. Reduce or eliminate slow, expensive printed reports. Break away from the old 80 column display limitation. Whether you're involved with inquiry, interactive or word processing applications, the TAB 132/15 can give you the display flexibility you need.

**More operator comfort.** Recent European studies suggest that poor character quality contributes to operator fatigue. The TAB 132/15 has the largest, clearest character

display on the market plus a host of other ergonomic features. Given a choice, operators pick TAB every time.

**More than compatible.** ANSI and DEC<sup>1</sup> VT52<sup>1</sup>, VT100<sup>1</sup> and VT132<sup>1</sup> compatibility, plus a special TAB mode for even more capabilities. All standard. The TAB 132/15 also gives you four page memory, 14 function keys, status line and English prompts on the screen. With options like printer port and current loop.

**More capability with full graphics.** TAB's optional graphics package is full featured and emulates Tektronix 4010<sup>2</sup> terminals and is compatible with PLOT 10<sup>2</sup>, TELLAGRAF<sup>3</sup>, DISSPLA<sup>3</sup>, Template<sup>4</sup> and Plot Pak<sup>5</sup> software. Features include arc and vector drawing, point plotting, area fill, selective erase and more. For a free photo print or a demonstration of the TAB 132/15, call or write TAB Products Co., 1451 California Avenue, Palo Alto, CA 94304, (415) 858-2500.

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**TAB**  
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## Megatek's Shaw combines tenacity with expertise

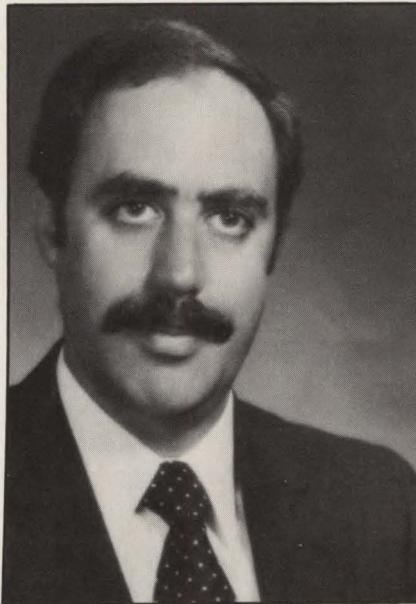
"I graduated in engineering because I was too damned stubborn to quit," says Peter J. Shaw. He credits that tenacity, which got him through a program from which only one of three engineering students graduated, with getting him where he is today: the recently appointed president and chief executive officer of San Diego, Calif.-based Megatek Corp., manufacturer of graphics work stations and software.

Shaw's engineering background has served him well, despite his avowed dislike of the field. While a student at New York City College, he invented a submersible footage-readout device for undersea exploration. That fact served as a useful icebreaker during interviews early in his career. Shaw joined Megatek in 1975 as director of marketing and was named a vice president in 1979.

Shaw says the highlight of his career is the marketing campaign starting in 1975 that he directed for Megatek. "We didn't have much in the way of product," Shaw says, "and we were a very small company, way undercapitalized. So we needed to put on a big show on a small budget." He received much exposure for little cash through public relations and promotion, particularly at trade shows. Customers' fascination for computer graphics made his job easier, Shaw says. "We had a lot of success at shows providing computer games for people to play."

United Telecom's acquisition of Megatek in August, 1981, finally ended Megatek's problem. "I see us taking a more aggressive company posture now because we have the resources. We can move a little faster and enter bigger arenas."

Shaw's main problem as chief



**Megatek's president and chief executive officer Peter J. Shaw:** "I see us taking a more aggressive posture now because we have the resources."

executive officer is common to any executive of a booming company: managing growth. Shaw sees the problem as one of balancing the need for structure with the need for a small-company spirit. He uses his experience in classic American management theory he learned at the University of Connecticut, and

elements of the Japanese-influenced "Theory Z," which was popularized in William Ouchi's best seller on how U.S. business meets the Japanese challenge. Shaw spends much time getting input from the company's vice presidents and lower level management. He also spends time walking through the plant, where he is on a first-name basis with many employees.

"Although the Japanese sometimes lose sight of the profit motive, they do a lot of things right in terms of their treatment of people," says Shaw. "Until I became president, I didn't understand that. But now, I feel a real responsibility for our people. If I screw up, they might be out of a job."

Given Shaw's excellent track record, Megatek's growth from a \$100,000 graphics base in 1975 to nearly \$15 million in 1981 sales and the promising outlook for CAD/CAM graphics systems, Shaw's worry seems unfounded.

Before joining Megatek, he headed both national and international sales for Talos Systems in Scottsdale, Ariz. He also worked for three years as a systems engineer with the Optical Technology Division of Perkin-Elmer Corp. and was a design engineer with the Dorteek subsidiary of Dorr-Oliver, Inc.

—Kevin Strehlo

## Sorbus's Wallace makes work a people business

For Ronald A. Wallace, the recently appointed president of Management Assistance, Inc.'s Sorbus Service division, service is a people business. The company works with end users, and is very responsive to its own personnel. Wallace intends to keep Sorbus a people-oriented company, and con-

tinue with one-half the average yearly field-engineer attrition rate, or 10 percent.

"We offer good benefits and a good salary program, and treat our people the way we think they'd like to be treated," he says. "This is an individual's company," with good relations with management.





Sorbus president Ronald A. Wallace says that good benefits and salary and proper treatment of employees has given the company a field-engineer attrition rate of half the industry average, or 10 percent.

Additionally, service personnel can advance through training programs and by mastering more complex equipment. Sorbus handles some training in-house. Sorbus also uses 70 color-video playback units in the field. The units provide information on products, software updates and meetings Wallace holds. People orientation extends to the company's customers. Wallace says that local managers in the field sell most of Sorbus's maintenance business. "They are responsible to the customers directly, which improves accountability," he says.

Formerly senior vice president of operations at the company, Wallace succeeded Stephen J. Keane as president six months ago. Keane

moved to head MAI's Basic Four Information Systems Division in Tustin, Calif. Wallace also served in regional director positions in Sorbus since he joined the company in 1972. He also spent several years working for MAI's special service division.

Before entering MAI, he spent nine years as a field manager with International Business Machines Corp., and held customer engineering positions at Allied Computer and Potter Instrument Co.

His experience at IBM is key in his new role at Sorbus, and 50 percent of Sorbus's personnel consists of IBM veterans. "IBM set the standards, and to compete with IBM, your nucleus of people must be from IBM," he says.

—L. Valigra

## PEOPLE IN THE NEWS...

Honeywell Inc., Minneapolis, Minn., has restructured its information systems organization into a realigned headquarters organization and three operating groups: a new Systems Group, a U.S. Marketing and Services Group and an International Group.

**William R. Smart** continues as senior vice president, Information Systems, and **Richard R. Versoi**, formerly vice president, U.S. finance and administration in Waltham, Mass., was promoted to vice president of finance, in Minneapolis.

**James R. Berrett**, formerly vice president of corporate development, will head the Systems Group as vice president. The Systems Group comprises the existing large information systems division in Phoenix, Ariz., the small systems and terminals division in Billerica, Mass., and a new networking management systems division.

**Michael J. Keliher**, has been promoted from vice president of the U.S. Marketing and Services Division to head of the U.S. Marketing and Services Group, which includes

national industry operations, field-marketing operations (formerly data-processing operations), distribution-sales operations and the page-printing systems organization.

**Richard R. Douglas**, formerly vice president of large information systems division, will now head the International Group as vice president.

**John J. Dougherty** has been appointed president and chief executive officer at Molecular Computer, Cupertino, Calif. He replaces co-founder **Rockland Awalt**, who continues to head Molecular's engineering activities.

Telex Corp. has appointed **George L. Bragg** president and chief executive officer of the company's subsidiary, Telex Computer Products, Inc., Tulsa, Okla. He was also named a group vice president of the parent company.

**A. Graner Thorne** has joined Siemens Corp., Iselin, N.J., as vice president and general manager of the OEM data products division. He

was previously general manager at Ampex Memory Products.

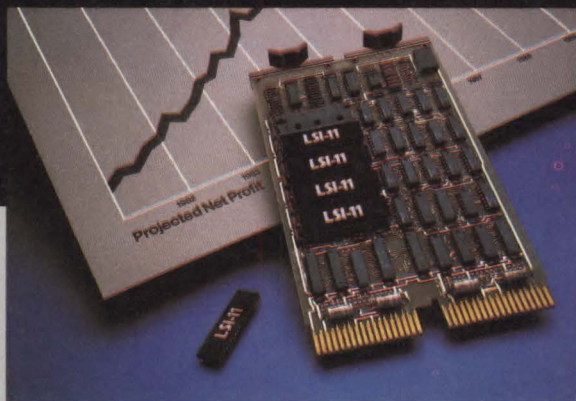
**Edwin J. Turney** has been named executive vice president, Micro Z Corp., Los Angeles, Calif. He was also elected to the company's board this year. His responsibilities include administration of sales and marketing.

**Robert J. Kelly** has been promoted to director of financial planning and analysis for the U.S. marketing and services division of Honeywell Information Systems, Waltham, Mass. He was formerly manager of business analysis at the same division.

**James A. Pitts** has been named corporate controller at Data General Corp., Westboro, Mass. He is responsible for the accounting and financial reporting, planning and control functions of the company. He was previously assistant corporate controller for Digital Equipment Corp.



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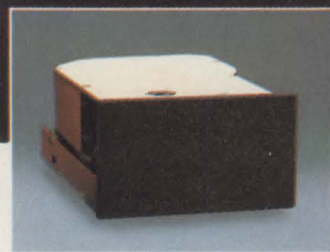
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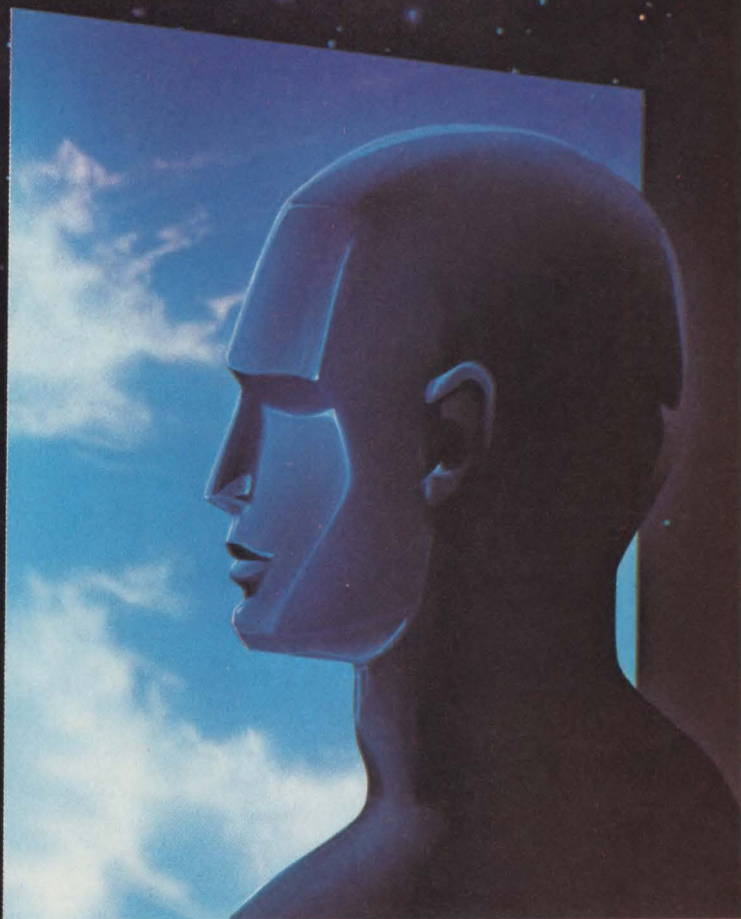
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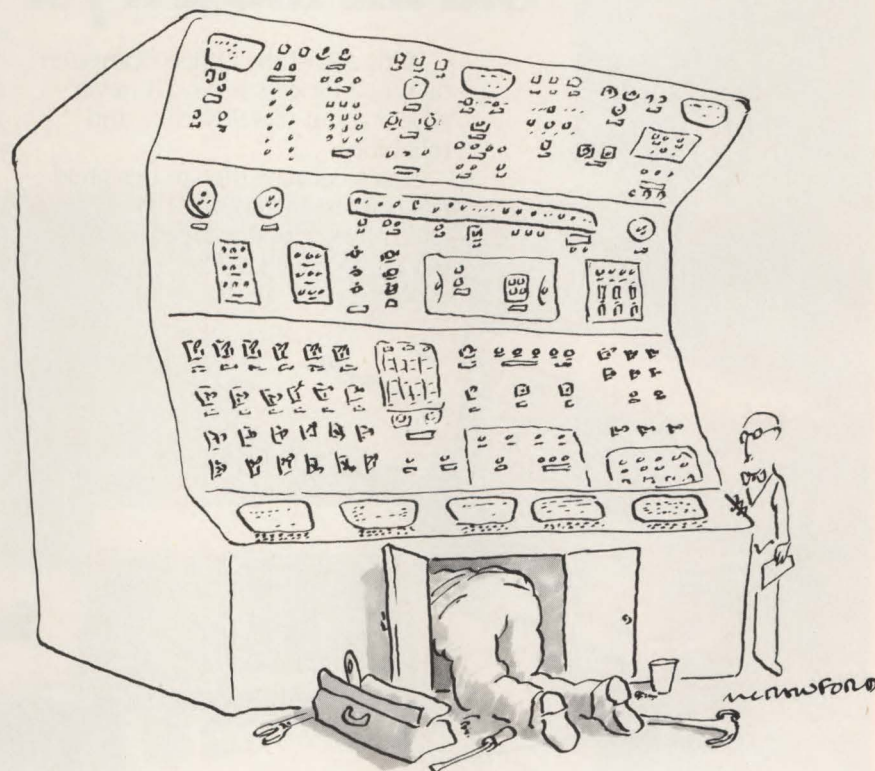
## Sorbus moves cautiously to expand service base

Conservative moves by the largest third-party maintenance organization in the U.S., Sorbus Service Division, into new markets seem puzzling, given the firm's extensive in-house resources and 10 years of experience as well as the expanding need for service. Instead of plunging into the carry-in repair business, Sorbus plans a steady yet cautious move into a market that could be as large as \$466 million this year and more than \$1 billion by 1985.

The deliberation by Management Assistance, Inc.'s, Frazer, Pa., service subsidiary can be viewed as too conservative or prudent. "People keep telling me about a \$500-million business out there that is ready to take," says Sorbus's recently appointed president Ronald A. Wallace. "(We'd) spend \$100 million to get that \$500-million business" (see "Sorbus's Wallace makes work a people business," p. 59).

Sorbus's experience in other markets and MAI's history may explain the relaxed effort into new markets. Sorbus's main business is on-site service contracts similar to those offered by International Business Machines Corp. About one-third of Sorbus's revenues are derived from on-site service of IBM equipment at prices about 20 percent lower than those of IBM. Another third is from service for MAI's Basic Four Information Systems division products. The remaining third is combined subscriber and carry-in service business, predominantly subscriber. Sorbus has 160 domestic service locations and more than 1000 technical-support personnel.

Half of the IBM equipment revenues are comprised of Unit



Record punch-card equipment. Oddly enough, Wallace claims there is still \$100-million worth of business for this equipment, which nearly put MAI out of business in the mid-1960s. MAI built its business in that decade by convincing lessors of the IBM Unit Record to buy the equipment at a depreciated price, resell it to MAI and then lease it back at fees as much as 20 percent lower than those of IBM. But that lustrous business died almost overnight when IBM introduced the model 360, leaving MAI with outmoded equipment. Yet, Sorbus acquired a business in which there still are enough Unit Record installations to yield a profit, and Sorbus can repair

them with inexpensive salvage parts.

In its businesses, Sorbus boasts of its experience as a service trend setter, offering technician training and documentation support as part of its service package. "We're more than a service company," claims Wallace. "When most people think of a service company, they picture someone in overalls who comes out of the back of a garage and jumps into a truck." Sorbus credits itself as a major factor in forcing large manufacturers to see service as a profit business rather than a cost center. Both Data General Corp. and Digital Equipment Corp., for example, have watched their serv-



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ice revenues climb to 20 percent of sales.

Having learned from the MAI ordeal, Sorbus has begun a planned progression into market opportunities.

Wallace questions whether carry-in centers meet businesses needs. He believes that a business person does not want to put a  $\mu$ c into a car and drive the machine to a repair shop. Wallace also expects some repair work to be handled on-site because Sorbus handles service for Fortune 1000 companies with 500 to 1000 units.

In both carry-in and on-site service, however, low hardware prices may enable a system swap. For example, Sorbus could swap functioning models for defective equipment until the defective units are repaired. Those plans are still formative, however.

The company has 15 district carry-in centers, and will have 50 by September. Wallace hopes to have hundreds of centers eventually. Each center has a bench technician. Customers or Sorbus van drivers bring products into the service center. Sorbus has more than 800 field stocking locations with spares and tracks more than 120,000 parts numbers.

Sorbus has agreements with manufacturers to service their equipment in this manner. The company does not repair systems now, but does service Qume Corp. and Diablo Systems, Inc., printers and Lear Siegler, Inc., Hazeltine Corp. and Wordstream terminals. Sorbus is slowly investing resources in personal-business computer repair. "Service is a low-margin business," says Wallace. "We'll gradually put money into the (new) business. In four to five years, carry-in could be as large as our on-site business."

Carry-in business is expected to be a prime boost to growth, Wallace adds. Sorbus has averaged about 20

percent in annual growth for the past few years. Wallace wants to increase that average to 25 to 30 percent. "But, you can shrink margins with carry-in business, so you must take it a step at a time," he cautions. This means making sure the business is available and getting high volumes.

Sorbus's revenues exceeded \$80 million last year, and with MAI's international service operation, those revenues accounted for 34 percent of MAI's \$332-million total revenues. About 64 percent of MAI's revenues came from worldwide sales of its Basic Four information-processing systems. Basic Four maintenance accounts for about one-third of Sorbus's revenues. Another third is from IBM equipment on-site maintenance.

Basic Four systems, which pioneered in the small-business market in the early 1970s, are being affected by high-end  $\mu$ cs. Despite a softening market for the Basic Four systems, its maintenance has not been affected, says Stephen T. McClellan, a Salomon Brothers analyst, New York. McClellan points out that the Basic Four computer base is large.

"There is no end to the demand for Sorbus service," he says. Sorbus could make a healthy business from small-computer companies that lack the resources for their own service organizations, McClellan says. If a small company goes out of business, Sorbus still will have more than enough business.

This small-company service, called subscriber business by Sorbus, involves an agreement with an equipment manufacturer, in which Sorbus services only the end user on-site. Subscribers include Qume, Diablo, Lear Siegler, Ampex Corp., North Star Computer and Pertec Computer Corp.

Contrary to McClellan's opinions, Sorbus has curtailed the subscriber business that it pushed in the 1970s.

Over the past three years, Wallace explains, more than 50 subscribers were reduced to 30 "producers." "It is not difficult to sign up manufacturers, especially small ones, but (some) did not produce much business, because the manufacturers failed to penetrate their market," says Wallace. The 20 customers were not neglected, however. Sorbus shifted them from national to local coverage. National contracts include the added benefit of attention from an administrative coordinator, a regional vice president and national technical support people.

Despite aiming more than two-thirds of the company's business at on-site service, Wallace recognizes the need for an alternative for owners of \$8000 to \$10,000 small-business systems. "You can't send someone out on a service call for \$20," he says. "That would not cover salary, labor and overhead. That's why service costs are high."

It costs a service company about \$40 to \$50 per hour to send a technician on-site. That cost includes salary, labor, parts and travel. Sorbus makes about a 10-percent pretax margin, so the cost to the customer is about \$55 to \$65 per hour.

Another factor that boosts maintenance costs is equipment failure rate. Wallace recommends that manufacturers commit to design systems with low failure rates and are easy to repair. "Failure rates come back to haunt the manufacturer and the user," he says.

For the short term, Wallace expects the big growth areas to be the IBM, subscriber and carry-in segments, despite a tough economy. "People are looking for a lower cost to save money on service," he says. And service is still essential. "People scream when their machine goes down," he says. —L. Valigra



## Datacomm distributors spell success for Micom

When Micom Systems, Inc., proposed to sell minicomputer-oriented communications products through distributors in 1978, not many people took the company seriously. Today, people pay a lot more attention to the Chatsworth, Calif.-based manufacturer of low-end data concentrators, port selectors, modems and other data-communications devices.

Micom, which made its first public offering last June, reported sales of more than \$23 million for the six-month period ending September 30, 1981, an 82-percent increase over 1980 sales during the same period. Six-month earnings and earnings per share increased 126 percent and 96 percent, respectively, over the corresponding period in 1980.

Micom has had the minicomputer link-oriented communications market to itself for several years. While most other communications vendors focused on direct sales of high-end, networking-oriented products to Fortune 1000-type firms, Micom quietly used its network of distributors to sell into the vast, mostly untapped minicomputer market. Encouraged by Micom's success, other vendors are now mimicking the company's distribution techniques.

Most noticeable of these new, low-end competitors is Timeplex, Inc., Rochelle Park, N.J. Last fall, Timeplex introduced its E-Series of low-end data concentrators (MMS, December, 1981, p. 155), and announced it would use distributors to market and service the new line.

"When Micom started using distributors, nobody thought they would be a viable sales channel for this type of product," admits Timeplex president Edward



**William Norred, Micom's president,** says the only growth-related problems for the company are spotting new markets and determining how to enter those markets.

Botwinick. "Micom made believers out of us." Botwinick estimates that Micom holds at least 95 percent of the low-end data-concentrator market, and he believes that the market's growth will permit Micom and other companies to prosper. "In the point-to-point market," he says, "there are far more customers who don't even know there's a solution to their application problem than there are customers who have already bought equipment."

Roger Evans, Micom's executive vice president, agrees that small- to mid-sized companies with minicomputers represent a large, untapped market. "Our market research of about a year ago indicated that, in the concentrator area alone, the market penetration was only at a 10-percent level," says Evans. Micom has placed more than 30,000 of its Micro800 data concentrator units, a product that was superseded last year by the company's new flagship product, the Micro800/2.

Data concentrators account for

about half of Micom's business, Evans says, but even with a growth rate approaching 50 percent, the concentrator portion of the business is no match for the firm's Micro600 port selector, which had a growth rate of about 75 percent over last year.

Essentially a data PBX, the Micro600 provides terminal-to-terminal and terminal-to-computer switching. The device represents Micom's closest attempt to offer a local-area networking product, Evans says. He predicts Micom will eventually become more active in LANS, but not until the market matures and a consensus is reached about which networking techniques will be most popular.

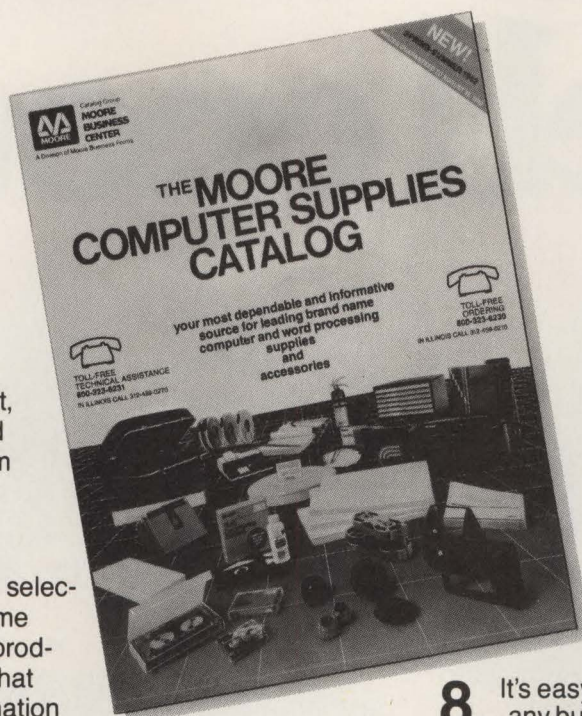
The "wait-and-see" stance is typical of Micom's approach to entering new markets, Evans explains. Although the company has a reputation as a high-tech innovator, he says, Micom is often part of the "second wave" that exploits technologies developed by the "first wave." For example, Micom let other companies do the initial experimenting with statistical-multiplexing techniques in concentrators, Evans says. "We pioneered the common-sense application of the technology."

Micom also plans to enter the X.25 packet-network market soon. "We believe X.25 has become a part of the real world in which we operate at the minicomputer end of the business," Evans says. The company's initial product in this area is essentially an enhancement to Micom's data-concentration product, he says.

Any new product that Micom offers must meet certain criteria, says Steven W. Frankel, vice president of marketing and development. "First, the products must be able to be sold through our distribution channels. Second, the products must have some cleverness and ingenuity, with the goal



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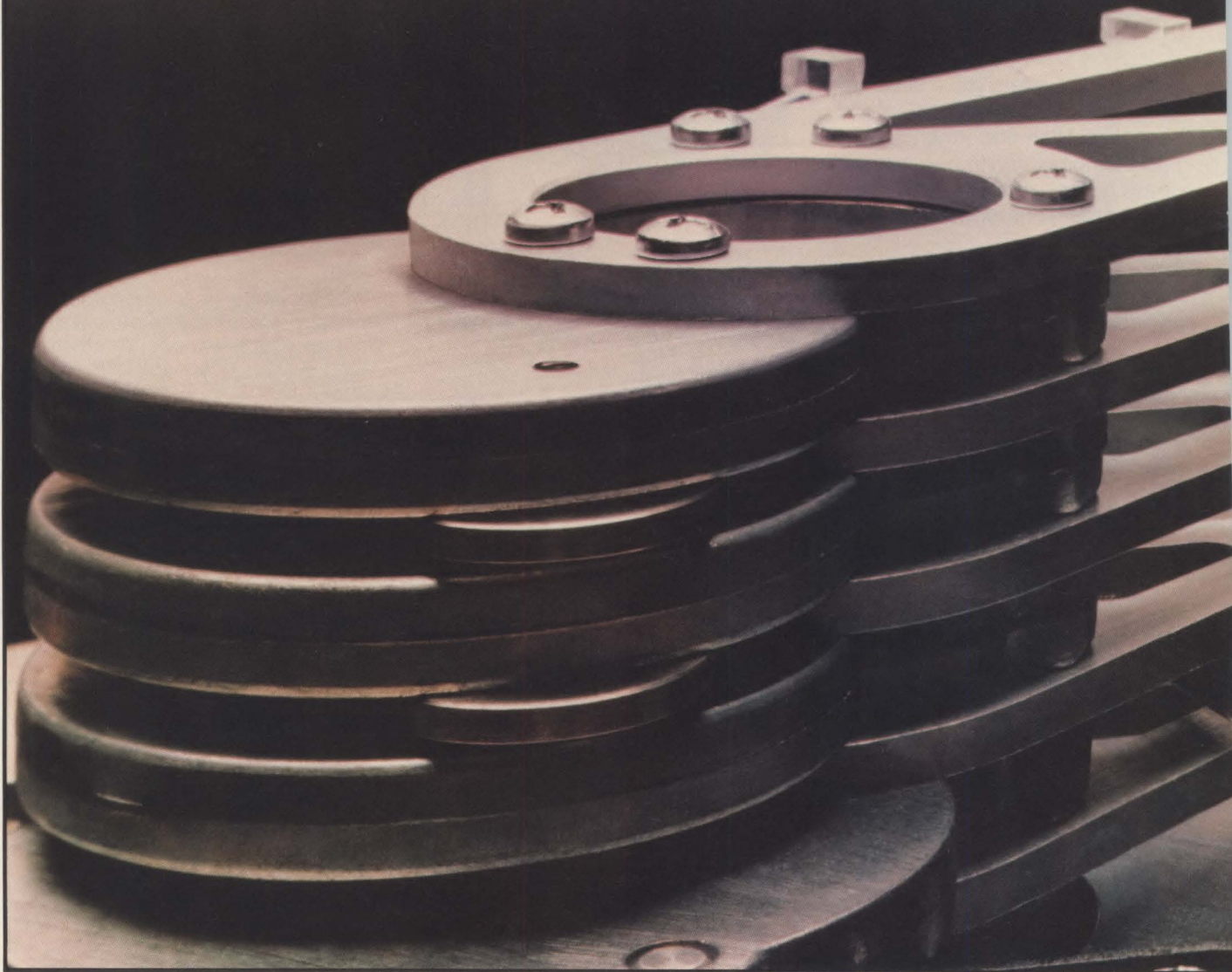
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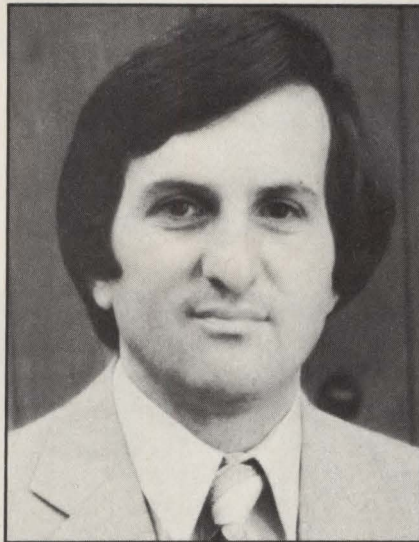


being to make the product very simple to install, support and maintain."

Micom's growth is tied as closely to its service and support methods as to its distribution methods, says company president William A. Norred. When the company addressed the low-end datacomm market, it signed up General Electric Co. to perform third-party maintenance. Micom also offered complete replacement units through Federal Express and telephone support to users experiencing problems with equipment. "As it turned out," Norred recalls, "the Federal Express approach was so well received by this market that I don't think GE did more than two or three service calls in six months." As a result, the third-party contract was canceled, and Micom has continued its phone and complete replacement support.

"We push the fact that the installation is done by the customer, and we push our support methods," Norred says. "It has proven very successful. We get some support from our distributors, but we knew we couldn't always count on that."

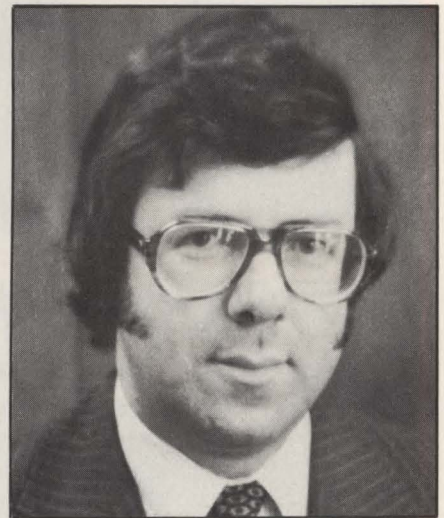
Norred says the company's growth, although rapid, is progress-



**Micom's shopping list for new products** covers any datacomm equipment that can be sold through the company's distributors, says Steven Frankel, vice president of marketing and development.

ing as planned. He worries that Micom may become less responsive to market opportunities as it gets larger, but he says no problems have yet caught the company off guard. And he expects Micom to continue the growth rate that has outpaced most other data-communications companies over the past year.

Executive vice president Evans explains that Micom's target market



**Roger Evans, executive vice president,** says Micom manages to place some of its equipment in large network environments by selling its products to such large OEMs as Codex Corp., Paradyne Corp. and General DataComm Industries, Inc.

has permitted it to sustain a higher growth rate than other datacomm companies. "We are not selling complete systems that typically involve capital-appropriations cycles and that are being seriously slowed by the recession in the U.S. Most of our customers, with purchases of \$5000 or \$10,000 here or there, can justify that the products will pay for themselves in a year or less." —Dwight B. Davis

## Okidata goes it alone, streamlines product line

Confidence creates a winning team, whether in sports or company management. Okidata Corp., Mount Laurel, N.J., is flaunting such a strength now, three years after pulling out of a joint venture and streamlining its product lines.

"It was our charter three years ago to make Okidata a large presence in the American market," reflects company president Bernard Herman. The first step was to change 10-year-old Okidata from an

equally owned joint venture of American entrepreneur Dave Nettleton and Tokyo, Japan-based Oki Electric Industry Company, Ltd., into full ownership by the \$1-billion Japanese parent. The second step was the October, 1980, sale of Okidata's Santa Barbara, Calif., disk-drive operation to Ohio Scientific, Inc., now a M/A-COM, Inc.-owned company.

Kenneth G. Bosomworth, president of International Resource

Development, Inc., Norwalk, Conn., lauds Okidata's decision to go it alone. "They got rid of relatively weak U.S. partners. There may be a trend developing with the Japanese shaking U.S. partnerships and going out alone on a well-financed basis," he says. He also commends the strength of NEC Information Systems, Inc., which traditionally has been strongly influenced by its Japanese parent.

A decade ago, Japanese companies sought American venture partners as their door into the U.S. market, Bosomworth explains. But those companies are reconsidering. He says much of the competition in



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**Okidata's Baffa credits the low-end Microline printers with boosting the company's business, and expects them to continue as bread-and-butter products.**

the printer market is Japanese, "so the Japanese feel secure; they know what they're up against."

Of the second major step, Herman says selling the disk-drive operation was a "fine move." That product line dipped considerably into Okidata's profits, while comprising 40 percent of the company's business and using valuable marketing talent. Herman admits that selling disk drives was not Okidata's forte. The company has also shied away from the small-systems mar-

ket. However, Oki Electric sells the IF800 small computer through the BMC trading company in America.

Herman prefers focusing Okidata's attention on printers. Although he won't give figures, he says that Okidata is profitable. The 10-year-old printer line began with the model CP110, an 80-column, 80-cps serial matrix printer. One version of this OEM product is sold as a bankbook printer. It contributes to about 15 percent of Okidata's revenues. The company also offers the Slimline series of five high-speed graphics printers and four Microline low-end printers.

A significant boost to the company's 80-column printer line occurred when the Microline 80 was introduced in 1979. That printer was intended to compete with Centronics Data Computer Corp.'s model 730 for the TRS-80 market. Herman says the company was too late to gain the Tandy Corp. contract, so Okidata went to distributors and OEMs. A little more than a year later, Epson America, Inc., entered the market, and both less-than-\$1000 printers faltered.

"The MX-80 had more capability than the Okidata printer," Herman says. "Epson had cut prices, and everyone followed suit." Herman says Okidata quickly learned to produce "cookie-cutter" printers in large volumes. Two problems remained: the use of seven-pin print heads and low speed.

The company introduced the seven-pin-head models 82 and 83 as stop-gap measures at increased speeds of 120 cps. Last August, the company announced the models 82A and 83A, which included nine-pin heads. The introductions are the major reason that Microline business in dollars quintupled last year, and accounted for 60 percent of Okidata's business, says Chet Baffa, Okidata's vice president, marketing and sales. Another reason is that the models 80, 83A and 84 will be

sold and serviced through Sears Business Systems Centers. Single-quantity prices for the 80, 82A and 83A are \$449, \$649 and \$995, respectively.

Baffa ranks Okidata behind Epson and ahead of Centronics as the top three 80-column-printer market contenders. He describes the Microlines as bread-and-butter products and predicts that business will continue its booming pace this year with the help of the models 84 and 2350, which are ready for shipment.

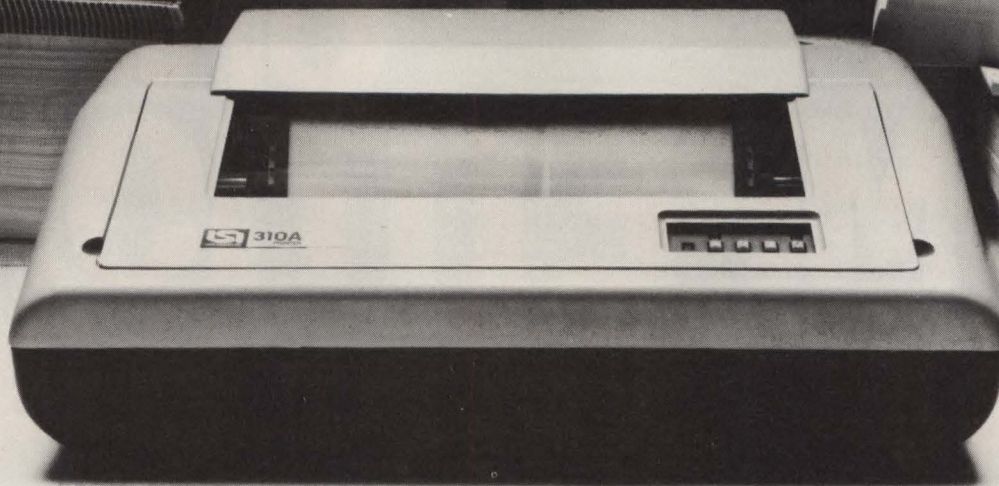
The high-end 200-cps Microline 84 produces graphics in three switch-selectable modes. The nine-pin unit produces draft-quality print in a single pass. Two passes increase dot density with a 40-in.-per-sec. slew rate. Near-letter-quality printing is done at half speed, or 100 cps, in two passes and with vertical paper movement, thus printing both full- and half-dot positions. The first two modes are available now, and the near-letter-quality mode will be available in May. Single-unit price for the initial model is \$1395.

The nine-pin model 2350, which will go into production in March, will have similar capabilities. It will be available in a multiple-pass configuration for high-quality printing in late spring. The product, which prints in red or black, is pegged as a high-end serial matrix printer that will also compete with low-end line printers. Single-unit price is \$2350, and OEM prices for quantities of 100 or more units are \$1500 to \$1600. Price for the multi-pass version will be slightly higher. More 2350s will be introduced this year.

Okidata's broad product line, focus on high-end printers and U.S. presence of both service areas and in-house engineering give the company a strong competitive edge, says Herman. "We'll exceed Epson in market position in two years," he predicts.

—L. Valigra





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MODEL	CPS	PGS/8 HR DAY (50 LINES/PG)		NOISE LEVEL dBA
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LSI 310A	180	960	811	56
DEC LA120	180	914	748	65
TI 810/820 RO	150	576	576	70
Centronics 704	150	582	582	65

But the Hummm Terminal isn't just quiet. It also gives you the fastest throughput around. In fact, it leaves the competition in the dust in typical applications, such as reports, tab runs, order entry, inventory, and other documentation.

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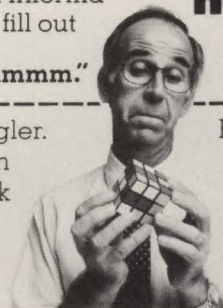
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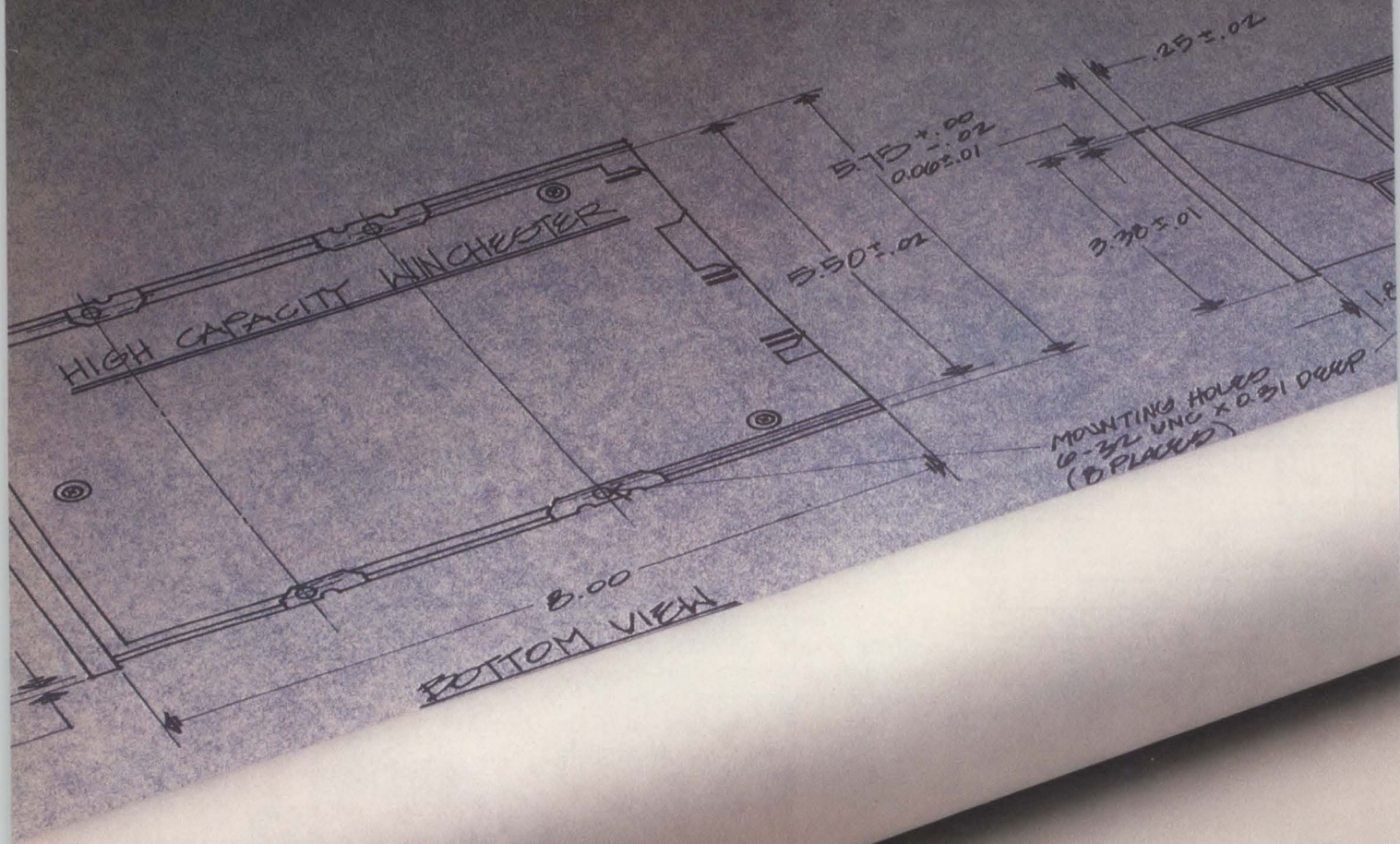
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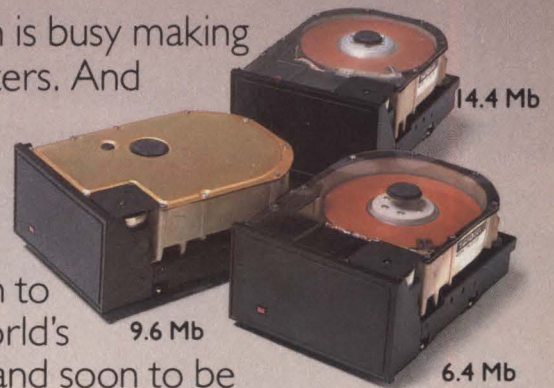
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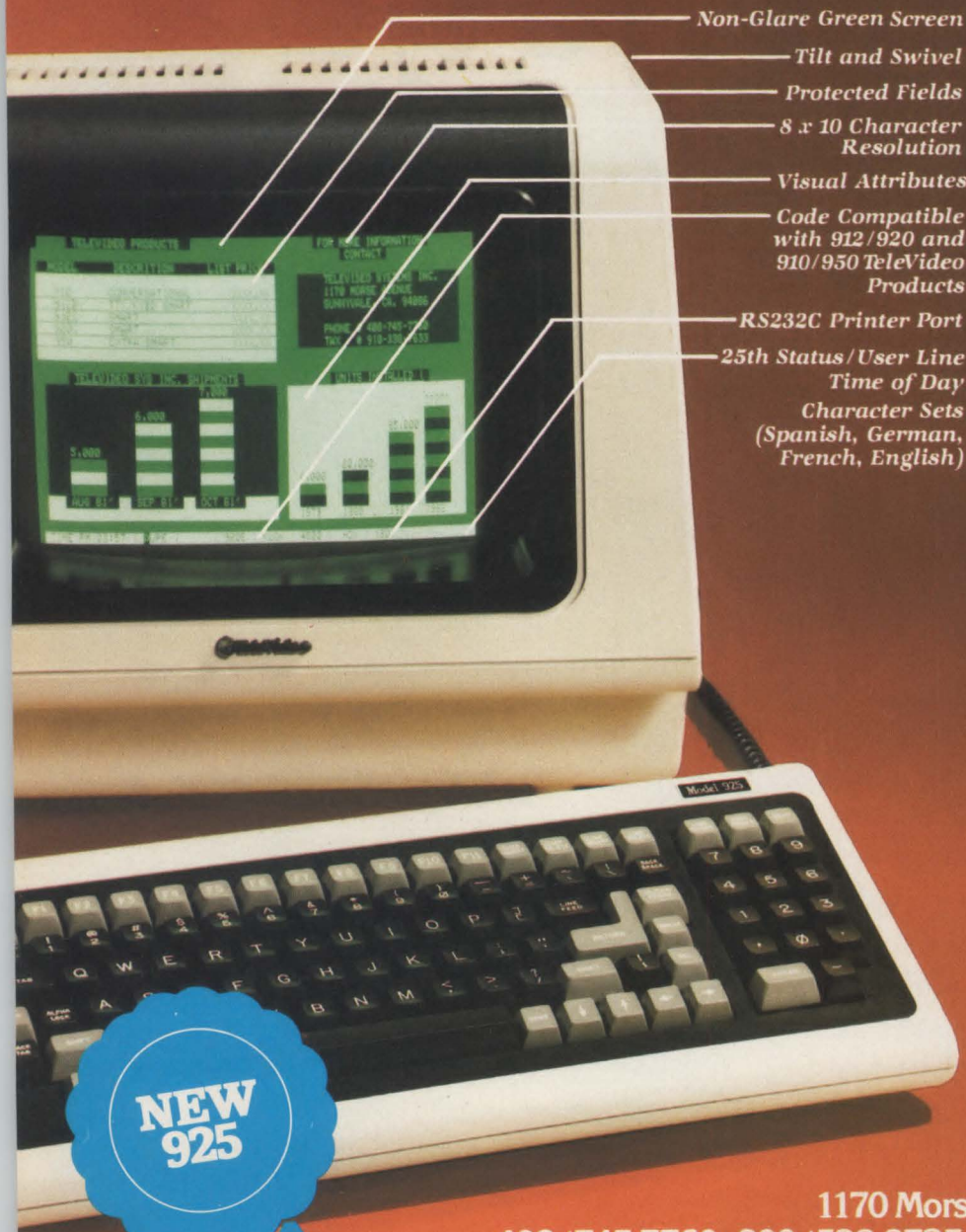
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CIRCLE NO. 44 ON INQUIRY CARD



## Entrepreneurs find new ways to sell software

What are the "software supermarket," the "un-hardware store" and the "software-of-the-month club"? They're innovative methods to sell software that are now being explored by entrepreneurs.

The software-supermarket idea is the brainchild of a former New York City Opera tenor, Richard Taylor, and a hairdressing-salon executive, Richard Stanley, who opened Programs Unlimited in Jericho, N.Y., in March, and in Westchester County, N.Y., in November. The two computer enthusiasts met through Micronet, a nationwide time-sharing service. Both were frustrated by two basic problems they had encountered when trying to buy software—a customer's inability to test programs before buying and the lack of a single source offering a wide choice of programs.

Aiming to solve those problems, they came up with a supermarket approach, a retail store devoted to software—making computers and programs available to the general consumer market and giving customers hands-on experience before buying. Taylor and Stanley, the company's president and chairman, respectively, envisioned a store in which "programs would be king," Stanley says.

This is similar to what Barry Passen, an ex-Digital Equipment Corp. employee, had in mind in November when he opened the Microcon Software Center, a software-only retail store in Watertown, Mass. Microcon will also offer a software-of-the-month club, which Passen claims is yet another way of catering to software customers.

"We differ from a computer store in that we focus on software rather than hardware," Passen explains. "We will be known as the un-

hardware store." Like Programs Unlimited, Microcon also offers the chance of "trying before buying," Passen says.

Programs Unlimited's Stanley says this is a better approach than buying through a mail-order house because mail-order houses, as well as computer stores, have only limited selections. And neither offers customers the ability to test programs on the type of equipment they might own because computer stores sell only their own equipment. "I wasted lots of money buying programs—through mail-order houses—that I had not tried and weren't what I needed," Stanley says.

The Programs Unlimited Store, in a Long Island shopping mall, is arranged in 15 circular work areas that contain different computer models on which customers can try software programs. Hardware includes TRS-80, Apple II, Commodore, NEC and Atari  $\mu$ cs. The staff is trained to "talk English—not computerese," Stanley claims, and to stress software rather than hardware. The store does sell hardware, including computers and printers, as well as disk drives and computer books. But, unlike a hardware store that pushes its own brands, Programs Unlimited does not make a hard sell on any type of hardware, Stanley says.

Microcon provides 12 working computer systems in its store, including ones from Apple Computer Inc., Radio Shack, Commodore Business Machines Corp., Xerox Corp., IBM Corp. and Vector Graphic Inc., Passen says the store's staff consists not of salespeople, but instead, of financial, accounting and management experts who can identify business

requirements and "objectively identify the top two or three packages for a customer to try." Using the store's demonstration systems, the staff also customizes complete hardware/software packages.

The store offers more than 1000 programs in the areas of business, education and entertainment and is segmented along those lines, with the business section resembling a consulting environment. Microcon offers off-the-shelf packages that include 30-day free telephone support and bundled packages that include various amounts of customer training, on-site support and telephone support. Business packages range in price from \$49.95 to \$5000, Passen says, and include real-estate management, accounting, time-management, billing and other programs. Games and educational programs sell for \$7.95 to \$99.95.

Another approach aimed at drawing and keeping customers, Passen says, is the software-of-the-month club. Customers who become members are given a 33-percent discount on the first product or products they buy. They are then required to purchase at least two more products over a six-month period. On those products, they receive 10- to 30-percent discounts.

Passen expects most revenues to come from the business segment, although games will probably lead in number of units sold.

At Programs Unlimited, most programs are gathered from large vendors and the "zillions of programs put out by the software cottage industry," Stanley says. The store carries about 600 programs, with prices ranging from \$10 to \$1000. It also sells its own programs, including games and learning utilities. One, called DIRINDEX, is an index of directories that allows users to make changes on a disk while the disk is still in the



# Mini-Micro World

machine. All programs carry a 15- or 30-day money-back guarantee.

Customers range from kids to sophisticated users, Stanley says, and include personal users and small businesses with six or fewer employees. The shopping-mall location attracts people who "just want to play," Stanley says, but, so far, that has caused no problems.

Stanley draws an analogy between Programs Unlimited and a record store of the 1950s, in which a customer could request that a selection be played before he decided to buy it. Stressing the importance of software, he adds, "Without records, there would be no need for audio equipment. Programs are the future of the industry."

"Large computer stores, such as Radio Shack," he adds, are unwilling to talk to small-computer users about software. They are interested primarily in selling hardware, while software takes a backseat."

John Shirley, Radio Shack's vice president of merchandising, computer products, says Radio Shack computer stores attract a variety of users. "It's impossible to sell hardware without software," he says, adding, "Radio Shack offers a complete package to users, and does not ignore software." Further, a large percentage of Radio Shack's brand-name software is written by outside contributors and fills wide-ranging applications.

Nevertheless, Taylor, Stanley and Passen see a need for their type of store. "There really isn't anywhere else in this area," Passen says, "where a person who feels comfortable with equipment but has no software expertise can go to try programs out. We focus on software; the computer is only a tool."

Passen plans to open another store in the Philadelphia area early next year and to open five more within an 18-month period, including ones in Chicago, Atlanta and

New York. He also plans to start franchising next spring.

Programs Unlimited's plans include more stores and franchises in

metropolitan areas, but locations have not yet been decided.

—Fran Granville

## BOX SCORE OF EARNINGS

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

Company	Period	Revenues	Earnings	EpS
AM International	year 7/31/81	652,712,000	(245,051,000)	(26.71)
	year 7/31/80	689,085,000	(5,800,000)	.69
Beehive International	year 9/30/81	39,893,508	4,121,789	1.48
	year 9/30/80	33,110,181	2,218,692	.88
Cambex	year 8/31/81	8,048,000	435,000	.24
	year 8/31/80	4,047,000	201,000	.11
Commodore International	3 mos 9/30/81	54,150,000	7,580,000	.74
	3 mos 9/30/80	35,212,000	4,517,000	.44
Gomsat	9 mos 9/30/81	244,440,000	32,635,000	2.61
	9 mos 9/30/80	217,756,000	28,573,000	3.57
Datapoint	3 mos 10/31/81	126,547,000	10,916,000	.54
	3 mos 10/31/80	98,685,000	10,284,000	.57
Data Terminal Systems	9 mos 11/1/81	89,006,000	(7,190,000)	(1.28)
	9 mos 11/2/80	98,034,000	4,303,000	.85
Emulex	3 mos 9/27/81	2,858,638	402,813	.18
	3 mos 9/28/80	2,039,912	248,935	.15
Floating Point Systems	year 10/31/81	57,890,000	6,350,000	.81
	year 10/31/80	42,405,000	3,765,000	.51
IT&T Corp.	9 mos 9/30/81	12,354,127,000	274,438,000	1.84
	9 mos 9/30/80	13,133,462,000	608,964,000	4.17
Interaction Systems	3 mos 9/30/81	412,000	(26,000)	(.02)
	3 mos 8/13/80	62,000	(5,000)	(.01)
Lundy Electronics & Systems	3 mos 9/30/81	6,082,901	108,513	.09
	3 mos 9/30/80	5,864,208	214,353	.24
M/A-COM	year 10/3/81	514,668,000	40,275,000	1.05
	year 10/3/80	341,456,000	26,669,000	.79
Management Assistance	year 9/30/81	332,186,000	9,415,000	1.16
	year 9/30/80	303,751,000	388,000	.05
Mohawk Data Sciences	6 mos 10/31/81	156,185,000	2,922,000	.22
	6 mos 10/31/80	156,367,000	9,111,000	.80
National Semiconductor	year 5/31/81	1,110,053,000	52,426,000	2.37
	year 5/31/80	910,113,000	45,043,000	2.22
Network Systems	9 mos 9/30/81	14,003,000	1,975,000	.20
	9 mos 9/30/80	8,285,000	986,000	.18
Perkin-Elmer	3 mos 10/31/81	251,040,000	14,222,000	.33
	3 mos 10/31/80	252,054,000	16,406,000	.38
Prime Computer	year 9/27/81	350,516,000	37,233,000	1.24
	year 9/28/80	230,424,000	26,314,000	.93
Ramtek	year 6/30/81	35,239,000	1,442,000	.52
	year 6/30/80	25,149,000	1,156,000	.57
Scientific Atlanta	3 mos 9/30/81	81,427,000	4,816,000	.23
	3 mos 9/30/80	55,832,000	3,646,000	.17
Tandon	year 9/25/81	54,200,000	4,500,000	.52
	year 9/26/80	22,761,000	1,507,000	.24
Unitrode	9 mos 10/31/81	84,817,856	8,399,583	1.45
	9 mos 11/1/80	76,998,116	7,811,856	1.23
Western Digital	3 mos 9/30/81	6,870,000	(667,000)	(.05)
	3 mos 9/30/80	6,617,000	166,000	.01



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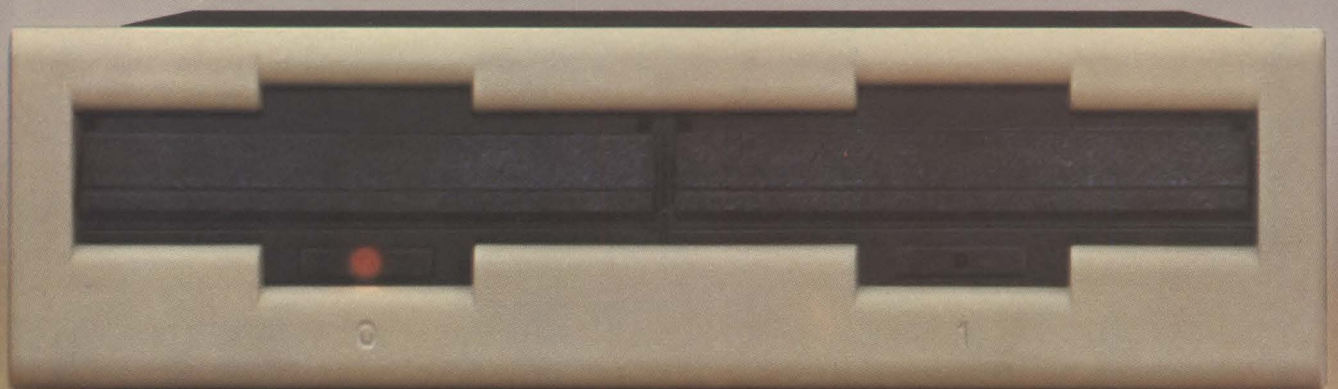
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## Britton-Lee aims database machine at small systems

Databases are fast becoming important tools to minicomputer and  $\mu$ c system users. But as databases grow, the ability of the host computers to handle them often shrinks. One solution to this problem has been the use of hardware dedicated to running database software, freeing the host to run basic application programs or process reports.

The latest hardware of this kind comes from Britton-Lee, Inc. Last month, the Los Gatos, Calif., company began delivering the IDM200, a relational-database machine aimed at systems ranging from Digital Equipment Corp. PDP-11/70s to multi-user  $\mu$ c-based systems such as Plexus's P/40 or Zilog's System/8000. Company officials say the IDM200 can serve as a stand-alone device supporting several intelligent terminals or as a centralized database resource for one or more CPUs.

Company president David Britton says the new hardware is essentially a stripped-down version of the firm's IDM500, a relational-database machine introduced a year ago but targeted at large minicomputers and mainframes in the DEC VAX and International Business Machines Corp. 4300 class. The entry-level IDM200, says Britton, has less memory and I/O than its sibling, but sells for half the price.

The \$35,000 end-user price buys an IDM200 with a Z8000-based database processor like that in the IDM500, 500K bytes of memory, two I/O ports and one SMD disk controller that handles as many as four drives. The system is packaged in a cabinet with a seven-slot chassis and power supply. The company plans to offer the hardware in a bare-bones configuration to allow OEMs to

embed the machine in their systems. OEM prices are expected to be less than \$20,000, says Britton.

Options include an additional 500K bytes of memory, a tape controller, an IEEE-488 parallel I/O channel and an eight-line RS232C channel.

The system supports as many as 16 host processors at speeds of 10 to 12 transactions per sec. The transaction rate, says product manager Mark Willner, depends on the application. With 1M byte of memory, the IDM200 handles 128 active users with 16 transactions running simultaneously, he says.

As for software, the IDM200 runs the same relational DBMS as the larger machine, says Britton. The DBMS provides full concurrency control, transaction management, security and database backup and recovery. The system also includes a completely integrated data dictionary. The software occupies about 300K bytes of memory.

Britton expects most OEMs to have little difficulty integrating the database machine into their systems. Britton-Lee has developed the query language for several processors, he says, including those from DEC, Data General Corp., Control Data Corp. and Perkin-Elmer, and for  $\mu$ ps such as the Z80, Z8000 and 8080. "An OEM is left with having only to link some query language to his application programs," Britton says, adding that screen and report generator software is also needed.

So far, the only competition the company sees for the IDM200 is database software running on a host computer. Such software sells for about \$30,000. A few firms put database software on general-purpose minicomputers or  $\mu$ cs and

dedicate the combination to the database chore, the company says.

One company taking a turnkey-systems approach is CSSN, Inc., Boston, which introduced a database processor, Dispatch, this fall (MMS, October, 1981, p. 15). The Z80-based hardware uses a version of Digital Research's CP/M operating system and includes 8- or 14-in. Winchester disk-drives, a controller that supports as many as four drives and a tape-cartridge drive. The system runs hierarchical database-management software. Three models are available, with OEM prices ranging from \$15,000 to \$22,000 and an end-user price of \$30,000.

Britton expects mainframe companies to be in the database-processor business within two or three years. But he sees the biggest threat to the IDM200 as Intel Corp., which, with its software subsidiary, MRI, Austin, Texas, has been developing an 8086-based database machine for some time. Britton says the Intel machine is the only other "database processor built from the ground up." He doesn't anticipate an introduction for at least a year, although one source thinks it could happen sooner. Intel has no comment.

Britton thinks the IDM200 can overcome the criticisms leveled at relational databases and database machines in general. A processor that specifically runs a relational database will quiet complaints about relational software's poor performance, he says.

Willner agrees: "People have argued that database machines are impossible. That's true for [machines running] other database models." The basic difference between a relational data model and its two rival models, networked and hierarchical, is that the former does not require definition of the links among data sets within the database, while the two latter models do. The links in those cases must be



defined at the start. The transaction-specific relational model, however, requires more processing power. As the database grows, the performance drops. For this reason, software-only versions of these databases have not been well accepted, Willner says.

He claims that the IDM200 overcomes the performance handicaps. "As a database machine, the

IDM200 is ideal," Willner says, adding that the hardware handles all disk reads and writes and performs simple computations besides running the database.

Britton says the time is ripe for database machines for small systems. "Small systems have existed largely because database hardware [for them] did not exist," he contends. There's nothing a mini-

computer or  $\mu$ c system can do that a database machine cannot do, he continues. Most small machines have been programmed to handle one function, he says. There's no reason why these functions can't be moved to a database machine to free the host for report generation, display-screen control and processing application programs, he says.

—Larry Lettieri

## Anadex's Mathews faces Japanese competition

Despite his belief that the U.S. cannot compete with Japanese imports in the low-end dot-matrix market, Anadex, Inc.'s vice president of marketing Ken Mathews is confident of his company's continued growth (MMS, May, 1981, p. 27). "The Japanese can succeed only in extremely high-volume markets, and only after a long R & D effort," says Mathews, citing the extensive development and tooling ramp-up behind the success of Epson's MX-80. He says his strategy is to introduce a new generation of a product before the Japanese bring their cost reduction to bear on the previous generation. That new generation is the WP-6000 dual-mode correspondence/data-processing dot-matrix serial printer and the DP-9600 and DP-9620 teleprinters.

The new printers represent a jump into a safe, mature market. Shakeouts in teleprinters decreased the number of entries from 300 to 180 last year, and orders are falling. Thus, the market is an unlikely target for a Japanese high-volume attack. Nevertheless, Mathews says Anadex plans to sell about 5000 DP-9620 Keyboard Send/Receive (KSR) teleprinters within a year, mainly on the strength of the



Anadex vice president of marketing Ken Mathews is confident his company will thrive despite tough competition from the Japanese.

product's 40-character fluorescent vacuum display and 220-character scrolling capability.

Mathews says the KSR is an editing keyboard. "We intend to take some of the market away from Digital Equipment Corp. with it and the 9600 RO (receive-only) terminal. The 9600 RO will be available immediately through our distributors." Volume production began last month.

Anadex pins high hopes on the WP-6000, which uses an 18-wire

print head, says Mathews. He feels its 150-character-per-sec. speed, lack of alignment problems and single-pass approach make it superior to some competing multiple-pass dot-matrix printers that achieve similar quality to that of the WP-6000 at about half the speed. In the data-processing mode, the WP-6000's throughput increases to as much as 500 cps.

The printer features three resident fonts, including a scientific face with Greek and mathematical symbols; other fonts can be down-loaded from a host processor's memory. Raster graphics capability is built in, providing a resolution of 144 dots per in. vertically and horizontally. In quantities of 1000 or more, the printer is priced at \$1679.

The market for high-resolution dot-matrix printers is growing at a 164-percent compound annual rate, according to a study done by Venture Development Corp., Wellesley, Mass., and Mathews's theory that U.S. companies cannot compete with the Japanese in high-volume, high-technology markets will soon be tested. The first wave of high-resolution, dual-mode dot-matrix printers, from Japanese companies such as Okidata Corp., is already arriving, Mathews admits, and the second wave cannot be far behind.

When that wave arrives, Anadex will soften the blow by increasing its emphasis on OEM customers.



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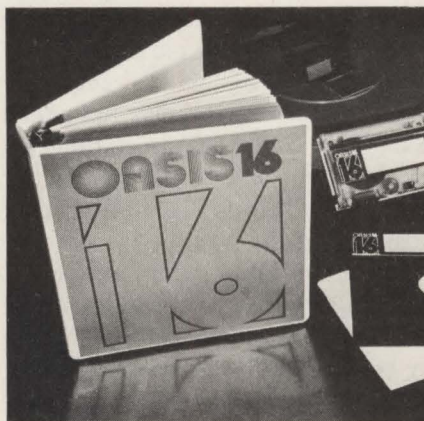
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# Mini-Micro World

Mathews says Anadex's distributor-to-OEM ratio is three to two. Mathews hopes that ratio will even out. "Being part of an OEM package tends to lengthen the life of a product," he says. "Distributors tend to buy whatever will move off their shelves the fastest, so they switch more quickly than the OEM to a new, lower cost product."

Despite Mathews's view of Japanese competition, Anadex plans to vacate its 82,000-sq.-ft. facilities to move into a 175,000-sq.-ft. facility in Camarillo, Calif., in March, 1983. If

Anadex keeps pace with the predicted growth rate for high-end dot-matrix market, revenues will grow from \$27 million during fiscal year 1981 to about \$70 million for fiscal year 1983.

How will Anadex achieve that growth if the company is excluded from markets just when the markets reach high volumes? "It all depends on whether we can keep ahead of the Japanese," says Mathews, "and you can bet I'm working on our next move."

—Kevin Strehlo

## Savin WP/DP systems use Convergent $\mu$ cs

Savin Corp. has joined such companies as NCR Corp. and Burroughs Corp. in announcing computer systems based on Convergent Technologies, Inc.'s AWS and IWS  $\mu$ c lines. Savin's series 1000 and 2000 Information Stations include an interchangeable touch panel of function keys, a sophisticated computer-aided instruction program and software that permits customers to tailor application programs to a user's requirements.

Based on the 8088 and 8086  $\mu$ ps, respectively, the series 1000 and 2000 run under Convergent Technologies' CTOS operating system.

The series 1000 consists of four models containing 128K to 256K of RAM and supporting mass storage of as much as 5.5M bytes on integral 5¼-in. floppy- and Winchester-disk drives. Also consisting of four models, the series 2000 ranges from 192K to 256K of RAM. Using a combination of 8-in. floppy- and Winchester-disk drives, the 2000 machines can expand to 20.5M bytes of storage in a standard configuration, or to 60.5M bytes (120.5M bytes by the end of this quarter) in

an optional Maxi-Cluster configuration.

Developed primarily within the Savin Information Systems group, Sunnyvale, Calif., the systems will be marketed through dealers and Savin's branch offices, which carry the company's copier products. The new systems will obsolete Savin's model 950 word processors, which are no longer manufactured but are sold from inventory.

A limited partnership called Savin Associates provided financing for the project. The partnership has supplied \$9 million to the new venture, and Savin Corp. has added \$1 million. Savin has also arranged a guaranteed loan of \$60 million for the project through banks and other institutions.

Although intended as integrated data- and word-processing systems, the Information Stations will initially be sold as word-processing units, says Harry M. Farnham, director, Savin Information Systems. "Our experience is in word processing, our sales force knows it, and we have an existing customer base. Data processing will be phased in

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# The Freedom



**Announcing the Freedom Generation of 5 $\frac{1}{4}$ " thin film drives from Seagate Technology. They will bring new freedom to the designer of small, powerful computer-based systems. Freedom ST538: 38 megabytes in a 5 $\frac{1}{4}$ " package.**

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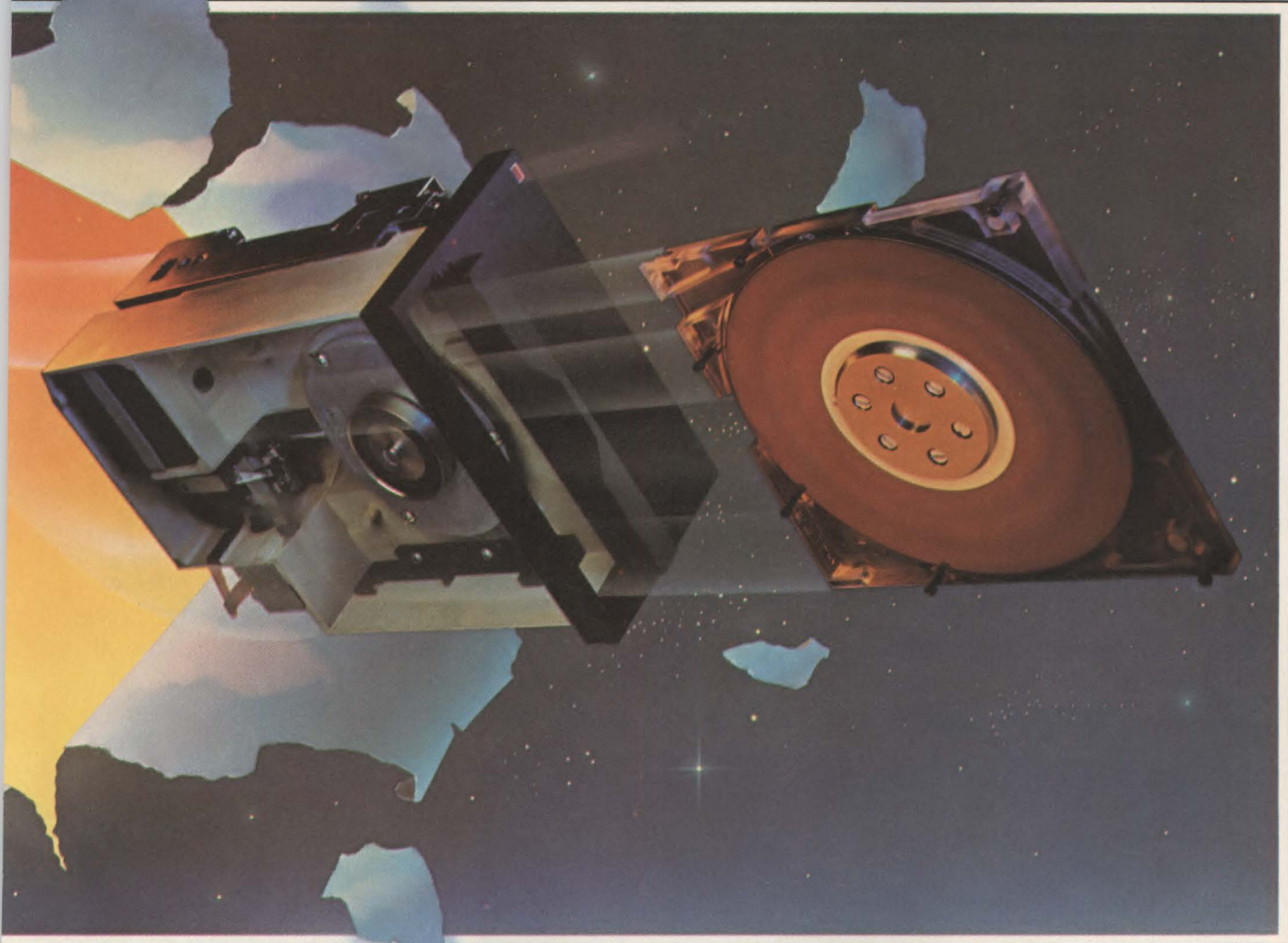
And don't forget to consider the simplicity of integration with the ST538 when you're thinking about a 16- or 32-bit system.

**Freedom ST706: the 6 megabyte MicroDisc cartridge drive.**

The ST706 MicroDisc cartridge drive combines Winchester reliability and data



# Generation!



access speed with the portability of a 5¼" removable disc cartridge.

It's the perfect I/O, program loading, and backup companion for the ST538 or the ST512, the first 5¼" to utilize thin film technology.

Six megabytes unformatted per ST706 MicroDisc cartridge give you more capacity than floppy or mini-floppy media.

Random access delivers faster backup than tape. Plus data integrity and system reliability are better than either floppy or tape.

#### **Free and Easy Integration.**

Each member of the Freedom Generation is designed for minimum impact on controller design, packaging, power supply requirements and software implementation.

And each is compatible with all existing products from Seagate.

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For Freedom Generation product literature, circle our readers' service number.

## Seagate Technology



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CIRCLE NO. 52 ON INQUIRY CARD

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Now, Complete 5 1/4" System  
5 Mbytes \$2,495

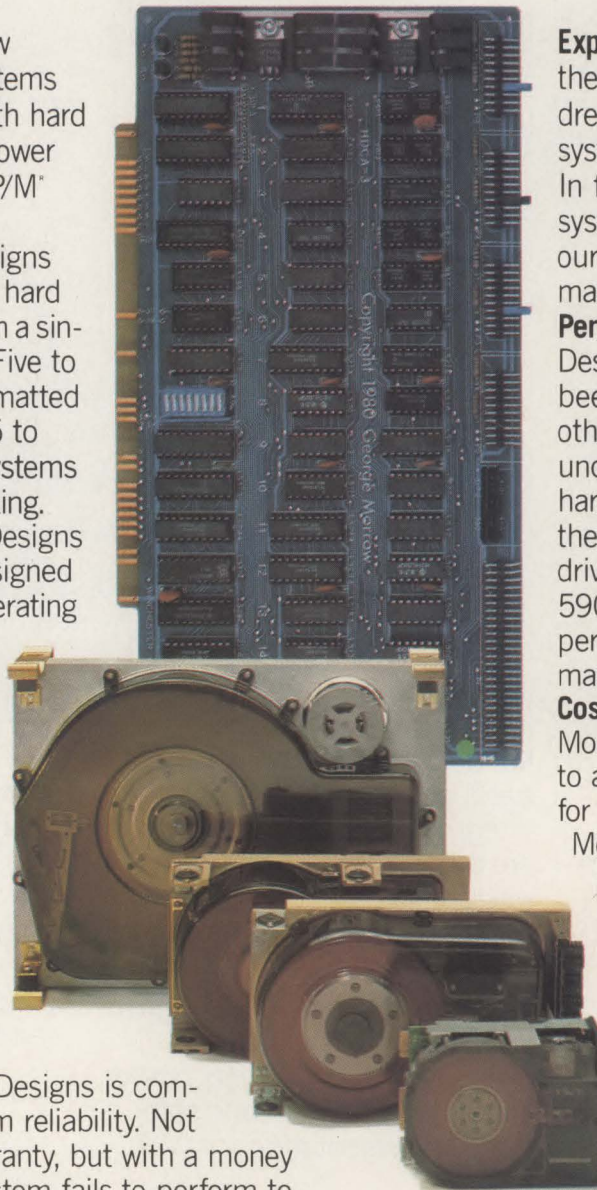
## Leading edge technology in hard disk systems.

Complete systems. Morrow Designs hard disk subsystems are delivered complete with hard disk, controller, cabinet, power supply, fan, cables and CP/M\* 2.2 operating system.

**Widest range.** Morrow Designs offers the widest range of hard disk systems available from a single supplier. 5 1/4," 8," 14." Five to over 100 megabytes of formatted hard disk storage. \$2,995 to \$17,980. Cost effective systems that work. And keep working.

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**Cost effective answers.** Compare Morrow prices and performance to anything presently available for S-100 systems. You'll find Morrow's price/megabyte/performance ratio to be unmatched. Leadership in disk systems technology earned us leadership in price/performance. And that may have earned us a call from you. Circle the Reader Service Number for our full line data sheets. Can't wait? Call us at (415)

524-2101. And yes, OEM quantity prices are available. **LOOK TO MORROW FOR ANSWERS.**

### MORROW DESIGNS

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\*CP/M is a trademark of Digital Research.  
\*\*Northstar is a trademark of North Star Computers, Inc.  
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\*\*\*\*Exidy is a trademark of Exidy Corporation.



gradually," he says.

For each application program Savin offers, the company will develop a touch panel of application-specific functions. The proprietary touch-panel overlay fits into a slot in the keyboard and displays as many as 32 functions in English. A HELP key on the touch panels provides an explanation of application functions.

Farnham believes the devices' ease of use and computer-aided instruction program are key selling points. Savin's Program-Assisted Learning (PAL) interacts with the application software and evaluates an operator's expertise. Instruction

rate is self-paced, depending on an operator's ability.

The systems can be completely upgraded, and application programs can run without modification on the 1000 or the 2000 machines. The Information Stations will initially be sold with Qume Corp.'s 45-cps Sprint 9 impact printer.

The low-end 1000 unit, essentially a terminal with no mass storage, sells for as little as \$4500, Farnham says. The series 1000 dual-floppy Information Station sells for \$7750, and the dual-floppy series 2000 unit sells for \$9450.

—Dwight B. Davis

using 4K-byte nonvolatile RAM modules that can be upgraded to 8K bytes. Six 8K modules can be attached simultaneously via an I/O adapter, which can also be used to attach peripherals.

A built-in 159 × 8-dot LCD displays 26 upper- and lower-case characters simultaneously. A built-in keyboard includes 65 keys in typewriter format, with two-key rollover. Rechargeable nickel-cadmium batteries power everything but the TV adapter, which is powered by an AC adapter/recharger. Using the SNAP operating system, a derivative of FORTH, the Panasonic and Quasar units will be available with a CP/M disk system by June, says Ron Gordon, president of Friends Amis, a San Francisco-based software house that designed Matsushita's hand-held computer.

More than 15 application packages are offered with the product, including programs for sales order-entry, portable word processing, point of sale, field diagnostics and timekeeping/cost accounting. William Kupp, a Panasonic marketing director, says that additional packages are being developed by third-party and independent software vendors, although no delivery schedules have been announced. Application programs are written in PROM and ROM and are stored on thumb-sized, snap-in capsules developed by Friends Amis. The capsules are available in 2K-, 4K-, 8K- and 16K-byte versions, and as many as three capsules can be plugged in at once.

Panasonic hopes to sell 200,000 hand-held units by next year through distributors such as David, Jameson Carlyle and dealers such as the Xerox Store. Kupp says Panasonic's industrial sales division is also contacting large OEMs, including Xerox, Honeywell Information Systems, Inc., and Wang Laboratories, Inc.

—Frank Catalano

## Panasonic, Quasar offer hand-held computers

A battery-powered, portable hand-held computer that can interact with personal and mainframe systems and perform data communications has been announced by Matsushita Electric Industrial Corp. subsidiaries Panasonic and Quasar. Aimed at middle managers for use as a second computer, the hand-held device sells for prices starting at \$500.

"People are becoming addicted to computing power," says Egil Juliussen, a partner with Future Computing, Inc., Richardson, Texas. "Now when people leave their offices and go home or on a trip, they want to take word- or data-processing and communications capabilities with them."

Because of the portability of the Panasonic and Quasar products, plus their ability to serve as data terminals to larger systems, Juliussen projects that the sales of such units will skyrocket in the 1980s.

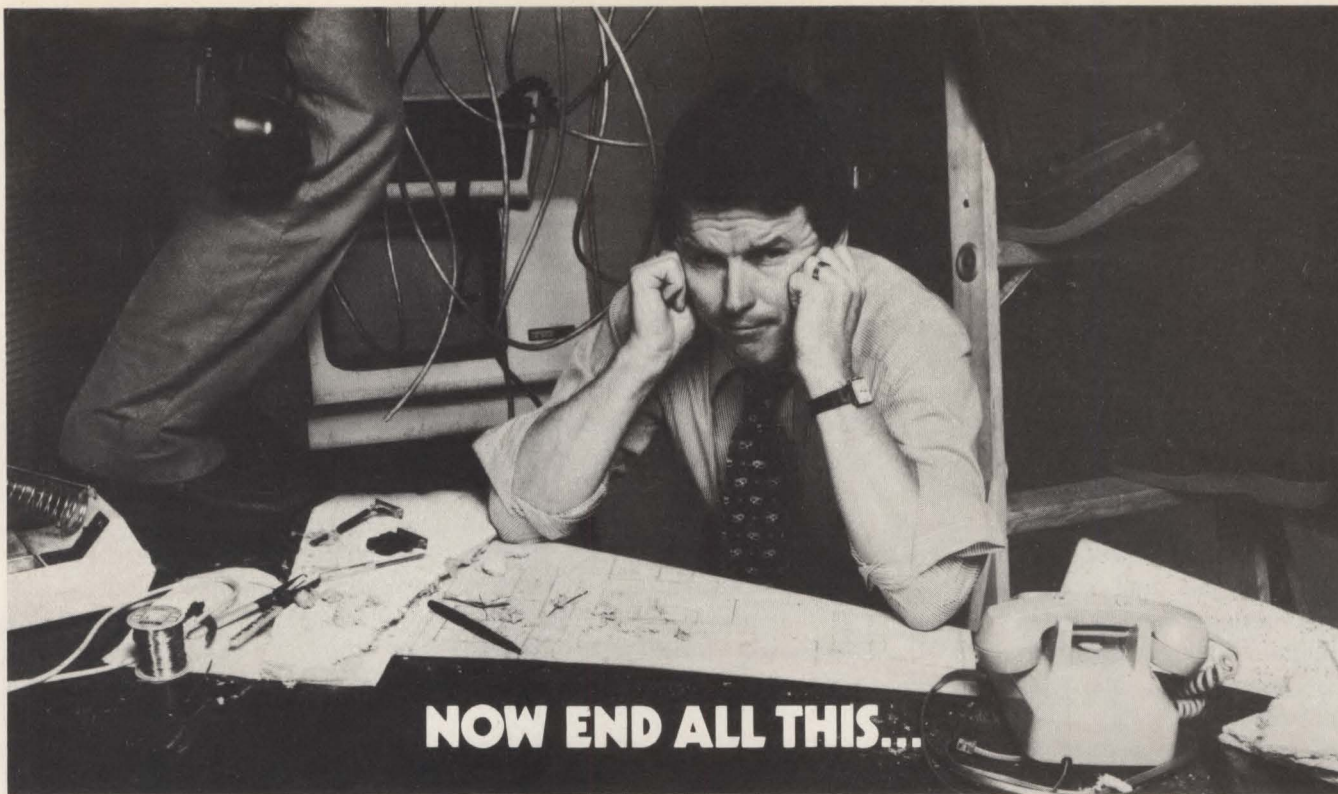
According to a study by Future Computing, only 15,000 hand-held

units were shipped in 1980 by manufacturers such as Sharp, Casio and Radio Shack. The study projects, however, that the market will grow over the next few years at a 78-percent annual rate and that more than 2.5 million units valued at \$750 million, will be sold by 1985.

The Panasonic and Quasar devices are priced about \$300 more than the Sharp, Casio and Radio Shack computers, which have been on the market for a year, but the latter units are stand-alone systems and cannot be expanded with peripherals. Unlike the others, the Panasonic and Quasar products can be connected to thermal printers, bus expanders, programmable memory extenders, modems and a color TV interface, all of which sell for \$158 to \$349 each.

Weighing less than 1 lb. and measuring about the size of a paperbook book, the Panasonic unit is available in a briefcase package. The 6502  $\mu$ p-based unit is available in 2K- and 4K-byte versions. Memory can be expanded externally





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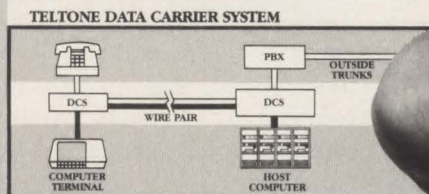
compared with other methods of data communication.

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# Let's tone down the network rhetoric

Despite the diversity of computer users' equipment and the variety of individual company requirements, many potential users have developed the conviction that a single type of local-area network (LAN) will satisfy virtually every conceivable communications need. Fueling this conviction are LAN vendors making sweeping product claims, industry consultants picking likely LAN winners and losers and the trade press dutifully reporting each volley of claims and counterclaims. An example of this cycle appears in an article on p. 12 ("Xerox moves to bolster Ethernet") detailing the ongoing Ethernet debate.

No doubt, certain LAN approaches will become more popular than others, but to expect a single networking technique, or even four or five techniques, to dominate the market seems farfetched, at least for the foreseeable future. And with only a handful of local networks installed, no one can claim to have much hard experience in evaluating or comparing LANs, especially with new products appearing every other week.

Given the LAN industry's youth and the widespread confusion surrounding local networks, we think it's time for everyone involved to tone down the rhetoric and concentrate on developing experience with actual installations. At times, it seems the main approach LAN companies use to sell their products is to warn that the purchase of a competitor's product will leave the customer out in the cold five or 10 years from now.

In fact, it's highly unlikely that a company installing any of the major LAN products offered will one day be estranged from the rest of the communicating world. Numerous customer needs will probably support numerous types of LANs, and some vendors will do quite well supplying gateway products that permit users of these different networks to communicate.

With all the activity surrounding local networks, it's easy to overlook an extremely important topic tied inextricably to LAN's success—higher level protocols. These protocols give life and meaning to the inert LAN media links, whatever they are. Xerox has taken the right approach in publishing its high-level protocols for use by any interested party. Other LAN vendors should follow suit.



*Dwight B. Davis*

Dwight B. Davis  
Associate Editor



# Letters

## DATABASE FOR MINIS

### To the editor:

The article entitled "CSSN plans to offer turnkey database  $\mu$ cs" (MMS, October, p. 15) described the introduction of a family of database machines using MDBS software. The Micro Data Base System (MDBS) was incorrectly classified as a hierarchical database-management system. MDBS is an extended-network database-management system. As such, it allows not only hierarchical structures, but CODASYL networks, shallow-networks and relations (flat-file) structures, as well. Beyond these older and

more limited data-structuring approaches, MDBS permits extended-network features, such as direct named many-to-many relationships and direct named recursive relationships. One of the user interfaces to an MDBS database is a non-navigational, English-like query language. This language is comparable to IBM Corp.'s SQL query language, except that MDBS does not force a user to specify inter-relation matchings based on common fields. In addition, MDBS has data-dictionary and report-writing facilities.

The article stated that MDBS

database software uses a minimum of 24K bytes of memory. We market two versions of MDBS. Version I uses a minimum of 18.5K bytes of memory on a Z80 CPU. Version III can be selectively linked to an application program, leaving even more room for the application program. This code size is extremely small compared to other database-management systems.

**Gary J. Koehler**  
President, CEO  
Micro Data Base Systems, Inc.  
Lafayette, Ind.

## ADD-IN OMMISSION

### To the editor:

Malcolm Stiefel's article "Add-in memory suppliers offer varied menu" (MMS, November, 1981, p. 141) was somewhat disturbing, in view of the fact that one of the original suppliers to this market, Monolithic Systems Corp., was not included.

NSC began operations based upon semiconductor technology more than 11 years ago and continues to be a major vendor of memory to the add-in market.

During the early 1970s, MSC designed and manufactured semiconductor memory for Digital Equipment Corp. computers—the first to do so—and has been supplying it ever since. MSC subsequently began supplying Multibus memory in the mid-'70s. It has shipped more than 500,000 memory boards, either directly or in our development systems, and continues to make state-of-the-art products available. The company prides itself on the fact that it can supply

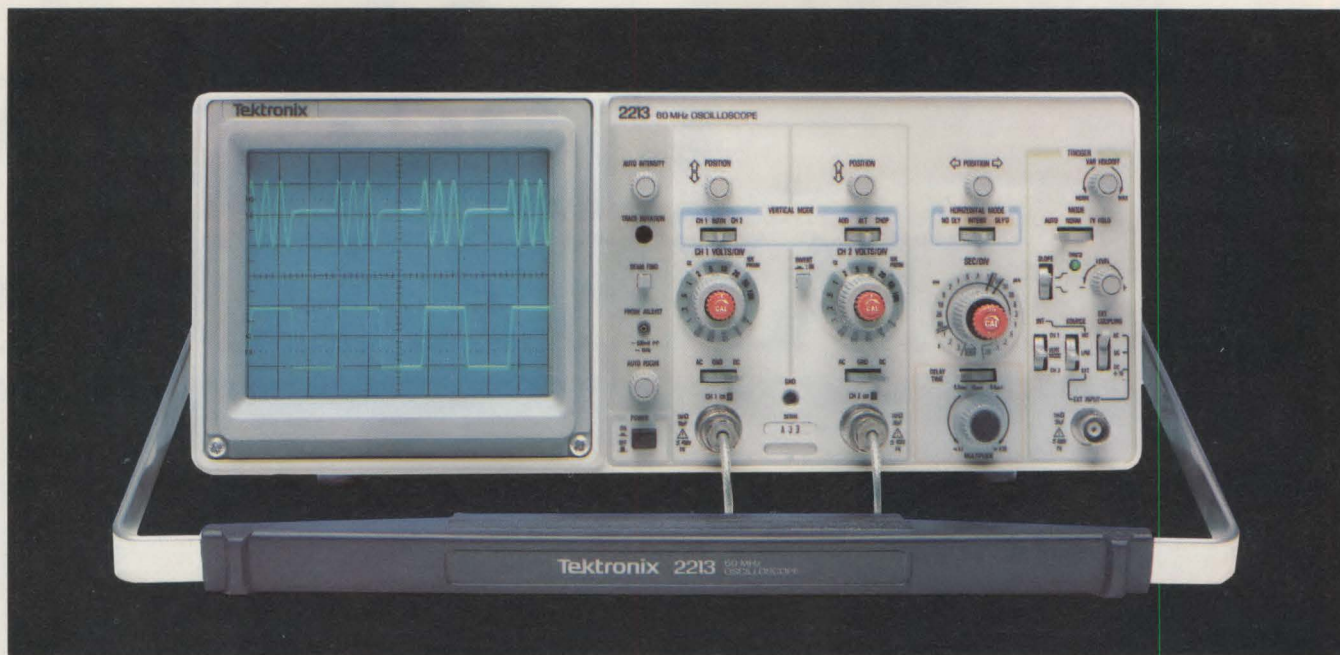
high-quality products quickly and can react to the ever-changing technology and customer demand for standard or custom products.

Below is a table reflecting the MSC products that should have been included in the article, arranged under the same headings as in the table.

**Dell D. Glover**  
Vice President, Marketing  
Monolithics Systems Corp.  
Englewood, Colo.

Monolithic Systems Corp.									
Type	Capacity	Segmentation	Typical current (mA)	Model #	Organization	Access time	Price qty. 1	Delivery time	Date first shipped
<b>Multibus</b>									
DRAM	16K;8/16	S(4K),E	2000	4602	16K $\times$ 1	350	\$695	2 to 4	12/78
DRAM	32K;8/16	S(4K),E	2000				\$742		
DRAM	48K;8/16	S(4K),E	2000				\$782		
DRAM	64K;8/16	S(4K),E	2000				\$824		
DRAM	128K;8/16	S(4K),B,E	4200	4805	64K $\times$ 1	450	\$2267	2 to 4	7/81
DRAM	256K;8/16	S(4K),B,E	4200				\$2829		
DRAM	384K;8/16	S(4K),B,E	4200				\$3427		
DRAM	512K;8/16 Plus 6ECC	S(4K),B,E	4200				\$3990		
<b>LSI-11</b>									
DRAM	32K;18	S(4K),B,E	1300	4604	16K $\times$ 1	240	\$437	2 to 4	4/79
DRAM	64K;18	S(4K),B,E	1300				\$487		
DRAM	128K;18	S(16K),B,E	2500	4804	64K $\times$ 1	240	\$896	2 to 4	6/80
DRAM	256K;18	S(16K),B,E	2500				\$1280		
<b>PDP-11</b>									
DRAM	128K;18	S(16K)	2500	3605	16K $\times$ 1	450	\$956	2 to 4	6/79
DRAM	256K;18	S(16K)	2500	3606	16K $\times$ 1	450	\$1281	2 to 4	6/79
<b>PDP-11/70 and VAX</b>									
DRAM	256K 32 + 7ECC	S(256K)	3000	3610	16K $\times$ 1	250	\$1046	2 to 4	6/80
DRAM	256K 32 + 7ECC	S(256K)	3500	3611	16K $\times$ 1	250	\$1112	2 to 4	3/81
DRAM	256K 32 + 7ECC	S(256K)	3500	3612	16K $\times$ 1	250	\$1112	2 to 4	3/81





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**Performance is pure Tektronix:** there's the

bandwidth for digital and high-speed analog circuits. The sensitivity for low signal measurements. The sweep speeds for fast logic families. A complete trigger system for digital, analog or video waveforms. And, with the 2215, you get fully calibrated delayed sweep for fast accurate timing measurements. New high-performance 10X Tektronix probes are included!

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**Sensitivity:** Scale factors from 100 V/div (10X probe)

to 2 mV/div (1X probe). Accurate to  $\pm 3\%$ . Ac or dc coupling.

**Delayed sweep measurements:** 2213: standard sweep, intensified after delay, and delayed. 2215: A only, B only, or A and B alternately with A intensified by B.

**Complete trigger system:** Modes include TV field, normal, vertical mode, and automatic; internal, external, and line sources; variable holdoff; separate B sweep trigger on 2215.

**Probes:** High performance, positive attachment, 10-14 pF and 60 MHz at the probe tip.

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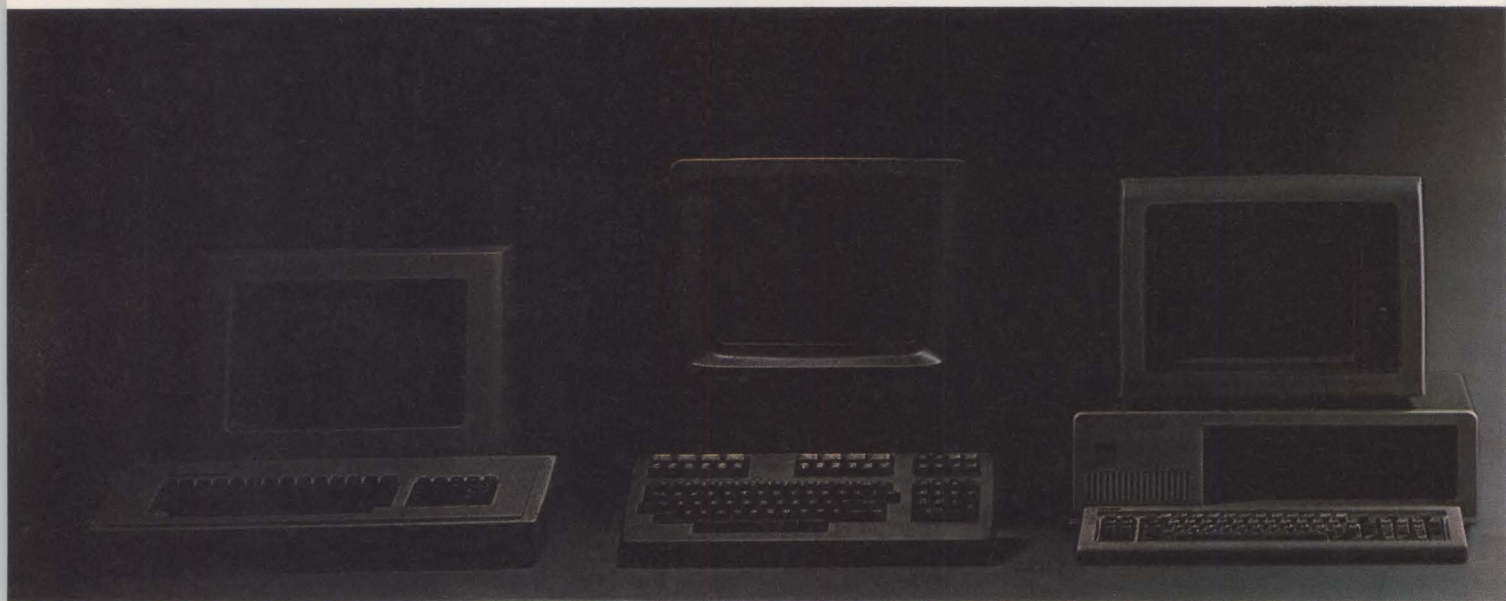
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\*Prices F.O.B. Beaverton, OR

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Because it's the only machine now using 64K RAM chips to keep 256K tidy on a single board.

And because it's the only machine that gives you the help of SOS.

## THE MOST SOPHISTICATED OS.

SOS is the Apple III's Sophisticated Operating System, an elegant software interface that frees you from most system control tasks. It features a hierarchical file system, device- and user-level interrupt capabilities, a device-independent file system and memory management capability.

Since all Apple III languages use SOS, they share a common disk format. So Apple III programs can merge and communicate—a Pascal application program can directly access a BASIC text file, for example.

Xerox 820	Hewlett-Packard 125—Model 10	IBM Personal Computer	Apple III
<i>Standard Memory</i>			
64K	64K	64K	128K
<i>Maximum Memory when fully configured*</i>			
64K	64K	192K	256K
<i>Expandability</i>			
No expansion slots	No expansion slots	No extra expansion slots in fully configured* 192K system	4 extra expansion slots in fully configured 256K system*
<i>Diskette Storage (per drive)</i>			
92K	256K	160K	140K
<i>Mass Storage (per drive)</i>			
—	1.16 megabyte Floppy Disk	—	5 megabyte Hard Disk
<i>Display Graphics Capability</i>			
High resolution B/W	High resolution B/W	High resolution B/W or 4-color (color requires additional card)	High resolution B/W or 16-color
<i>Software Available</i>			
Word Processing VisiCalc® — Communications — CP/M® library	Word Processing VisiCalc® 125 Business Graphics Communications — CP/M® library	Word Processing VisiCalc® — Communications — CP/M® 86 programs	Word Processing VisiCalc® III Business Graphics Communications Apple II software library CP/M® library (available Spring, 1982)

\*"Fully configured" means system includes, at minimum, monitor, printer, 2-disk drives and RS-232C communicator. NOTE: Chart based on manufacturer's information available as of December, 1981.



# WE'VE SEEN THEIR GENERATION AT OUR THIRD.



SOS allocates system resources to make the most of dynamic memory, simplifies programming with standard device and file interfaces for all languages, and speeds software development by reducing program size and complexity.

## OUR NEW PROFILE.

ProFile™ is Apple's new personal mass storage system—a quick, quiet 5MB hard disk ideal for software development or any mass storage application. Shown above twixt monitor and console, it comes with everything you need to get up and running, including interface card and driver software.

The III's standard built-in drive is a 140-K floppy that can be daisy-chained with three additional drives through a back panel connector. Which leaves you plenty of expansion slots for things like our new Universal Parallel Interface Card or our OEM Prototyping Card.

## CHANGE KEYS.

The 128-character ASCII-encoded keyboard happens to be fully-programmable. So you can (with SOS) do neat things like remap it into

DVORK. Or create armies of special function keys. Or teach your Apple to write Chinese.

Its own languages already include Business BASIC, UCSD Pascal™, Assembly and, soon, a powerful new COBOL—and, in emulation mode, most languages available for Apple II.

Look up from the keyboard and you'll see our standard Monitor III green phosphor display (80 char. x 24 lines, u/l). It can show you some of the highest resolution graphics available—560 x 192 in 16 gray scales. Or choose a color monitor, and you could be seeing 16-color graphics in high 280 x 192 resolution.

## HIT LIST.

We have a new edition of that monster hit, VisiCalc® with more modeling space than any other version. Plus AppleWriter III, a powerful new word processing package. Plus a new Business Graphics package. Plus a new Mail List Manager.

Plus a Pascal Utility Library that lets you take full advantage of all UCSD Pascal features.

Plus Access III—sophisticated smart terminal software to access mainframes with asynchronous communications up to 9600 bps.

Plus Apple II emulation to access that vast software library.

Plus, soon, a CP/M® card to access that other vast library.

Even with all this, the Apple III's potential remains essentially untapped.

So we're offering improved documentation, new programmer's aids, expert hotline counseling and an open channel to the industry leader in software publishing. Us.

See your Apple dealer for more information and, perhaps, a little comparison shopping.

We're sure you'll find that between our third generation and their first, there's quite a gap.

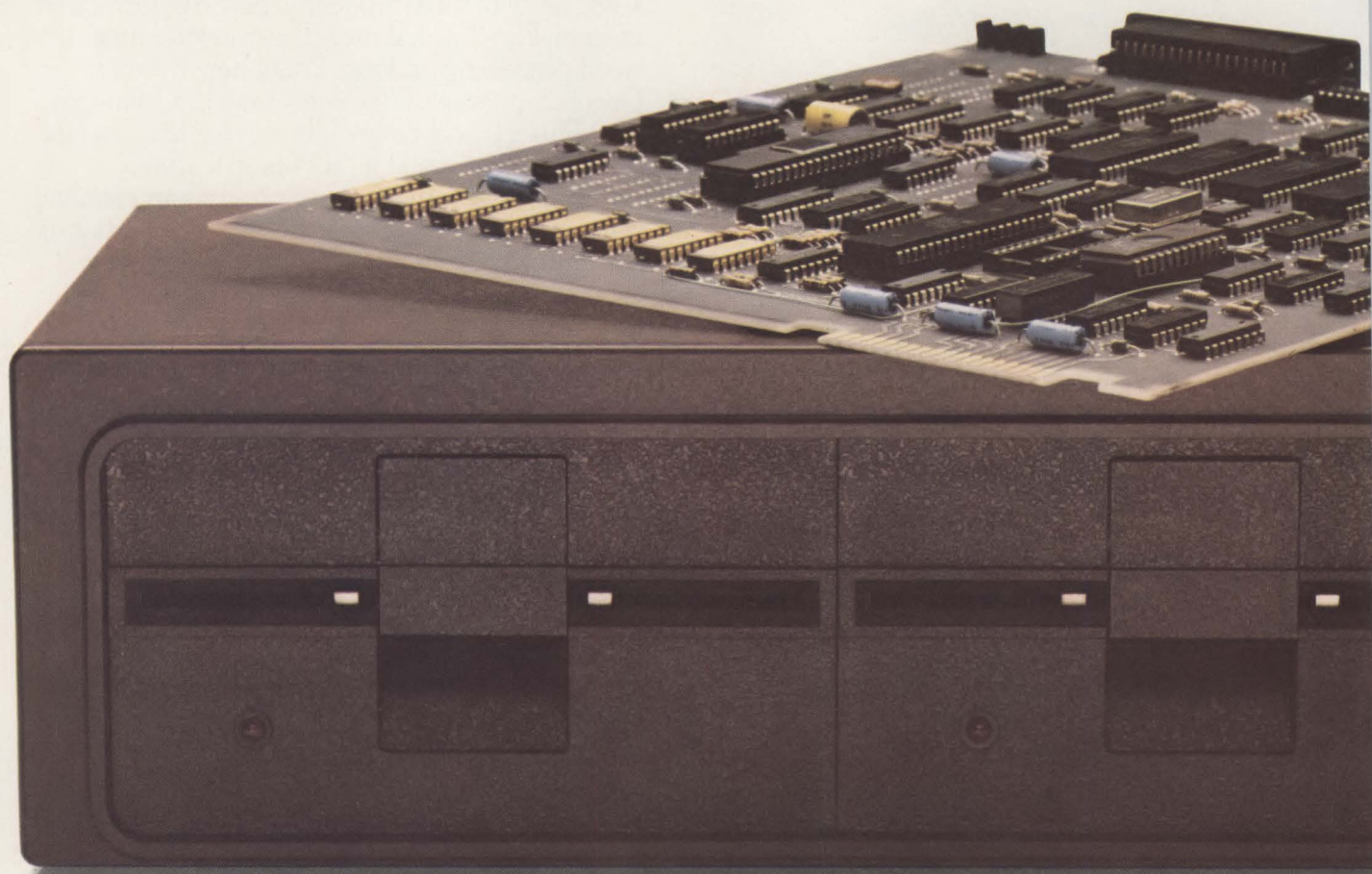
The personal computer.



For the authorized dealer nearest you, call (800) 538-9696. In California, call (800) 662-9238. Or write: Apple Computer Inc., 10260 Bandy Dr., Cupertino, CA 95014. VisiCalc is a registered trademark of Personal Software, Inc. UCSD Pascal is a trademark of the Regents of the University of California. CP/M is a registered trademark of Digital Research, Inc. Apple is a registered trademark.



Here's everything  
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your VT100 a CP/M  
personal computer.







## DIGITAL ANNOUNCES THE VT100 PERSONAL OFFICE COMPUTING OPTION.

If you've made up your mind to add personal computing capability to your office, Digital has good news: the VT100 personal office computing option.

Now you can turn one of the world's most widely used ASCII video terminals into your own personal office computer to run one of today's most popular operating systems: CP/M.®

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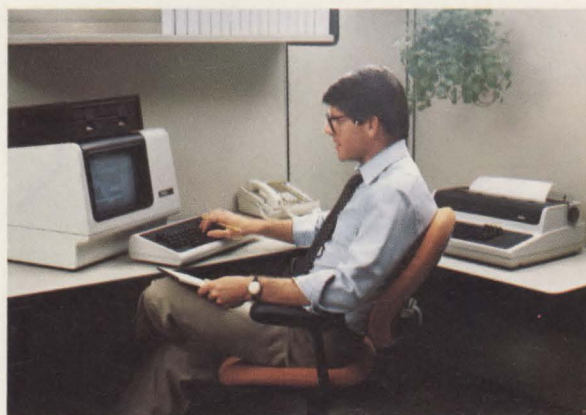
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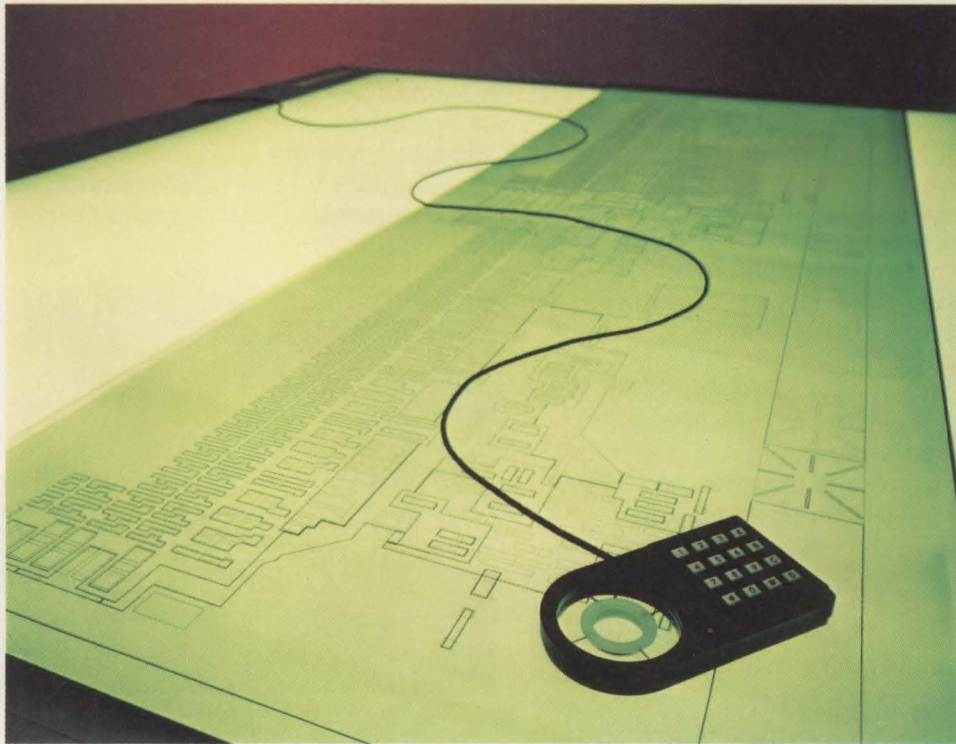
**Digital Equipment Corporation**, Terminals Product Group, MR2-2/M67, One Iron Way, Marlboro, MA 01752. In Europe: 12 Av. des Morgines, CH-1213 Petit-Lancy/Geneva, Tel. 011-41-22-93-33-11. In Canada: Digital Equipment of Canada, Ltd.

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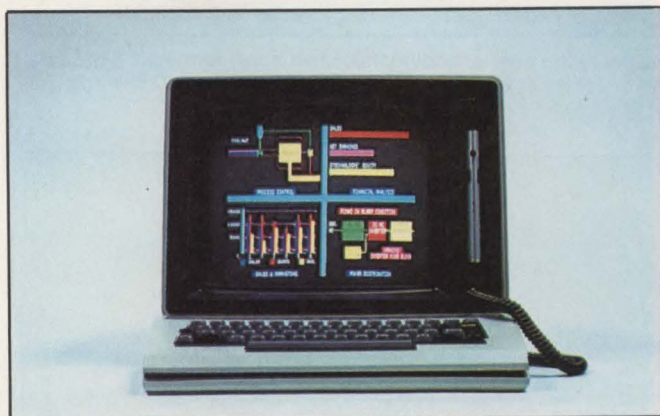
## Color graphics vendors set new price lows

By Frank Catalano  
Assistant Editor

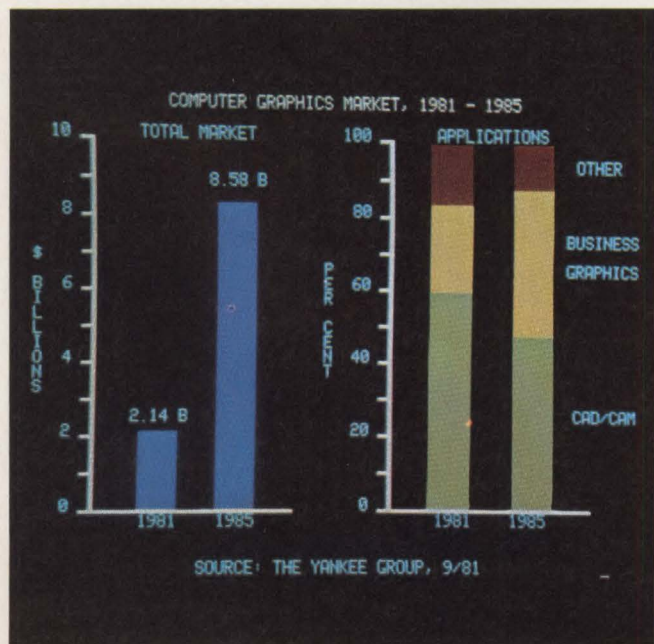
Until recently, the only options available to business-graphics users seeking low-priced color displays were personal computers with low-resolution graphics or dedicated graphics terminals selling for more than \$6000. Unable to offer products at prices affordable by business users, graphics-hardware vendors bypassed the business market and chose instead to aim high-priced displays primarily at scientific and engineering users.

But as technology evolves and graphics-processor and memory prices decline, a new breed of color-graphics displays is emerging with prices as low as \$995. No longer cost-prohibitive to the business market, these terminals are expected to bring new users into the business-graphics fold, and to threaten the monochromatic display market. Frank Gens, an analyst with the Yankee Group, a Boston, Mass., market-research firm, says that, by 1985, color graphics will be a standard office-automation tool. "When you start talking about spending an extra \$200 or \$300 on a terminal for the extra bit planes required for color, you're talking fairly small bucks," says Gens. "Color will eventually be a giveaway on graphics terminals."

Peter Curnin, president of Intelligent Systems Corp., Norcross, Ga., which began shipping a new \$995 color-graphics display in January, says that, although color terminals are still more expensive than their black-and-white counterparts, they are easier to sell. He likens sales of color-graphic displays to those of color televisions. "Color TVs outsell black-and-white sets 20 to one, even though the color sets are more expensive," Curnin says. "People would rather buy something that has more aesthetic appeal." Other



Integrated Terminal Inc.'s model 801 sells for \$3290 and has a resolution of 160 × 96 pixels.



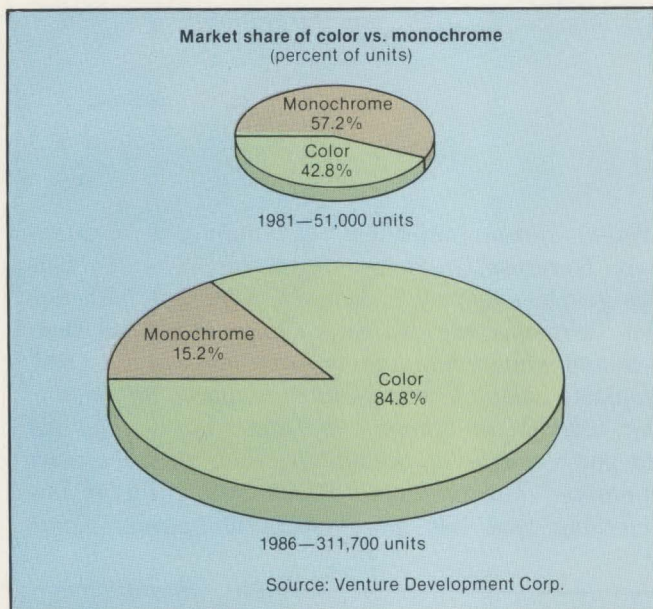
The ISC 2048 is the first color-graphics terminal priced at less than \$1000.

companies producing the first wave of low-priced color-graphics displays include Colorgraphic Communications Corp., Atlanta, Ga., with the \$3500 MVI-7 and the \$2750 MVI-100; Phoenix Computer Systems, Inc., Lafayette, La., with the \$4790 Raster 320 and the \$4995 Raster 640; and Integrated Terminals, Inc., Addison, Texas, with the \$3290 ITI 801. Also getting into the act are alphanumeric terminal leaders Televideo, Inc., which plans to announce a color-graphics terminal within a year, and Applied Digital Data Systems. ADDS officials will not comment about the introduction date of their entry.

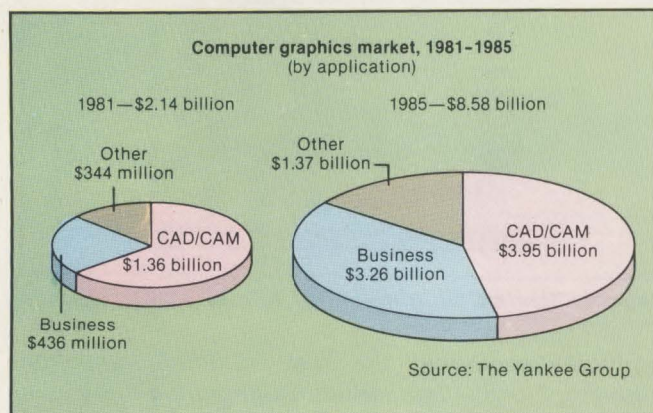
The Yankee Group estimates that these low-end color-graphics displays will help spur the business-graphics market to a \$3.3-billion business by 1985. Gens projects that the business segment of the graphics market will grow at a 65-percent annual rate from \$436 million in shipments in 1981. Further, the number of color raster-scan displays will increase 80 percent over the next four years from 50,000 installed units in 1981 to an estimated total of 250,000 installed units in 1985, Gens says. By 1986, about 85 percent of all graphics



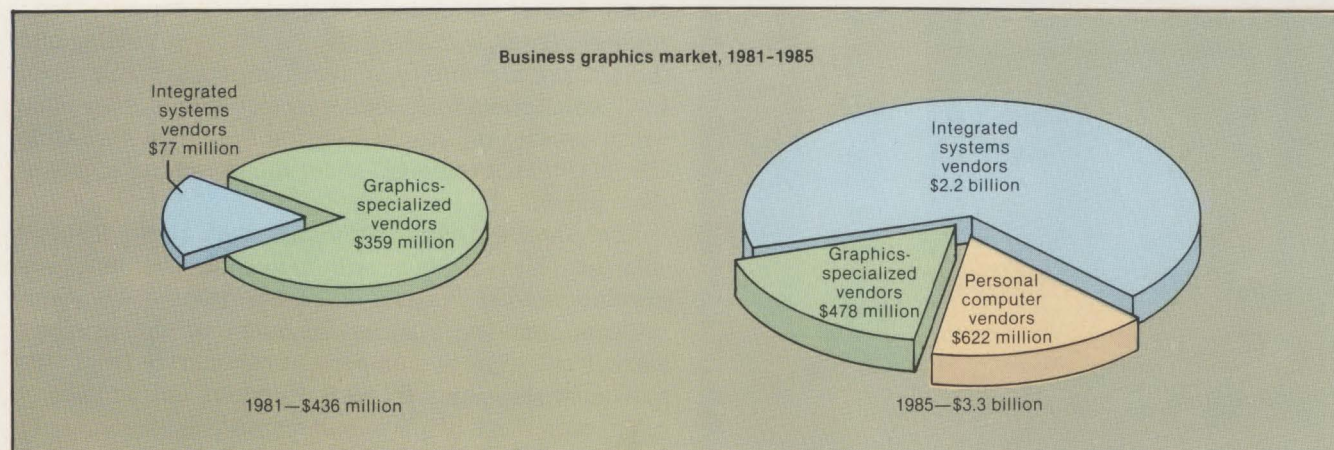
# The Interpreter



The declining cost of adding color to display terminals and users' preference for color will make color the predominant graphics display by 1986.



The Yankee Group projects that, by 1985, the business-graphics segment of the total graphics market will have a 38-percent share, growing at a 65-percent annual rate.



The Yankee Group forecasts that integrated system vendors, including IBM, DEC, DG and Prime, announcing graphics entries for the office environment, will capture the bulk of the business graphics market by 1985.

terminals will include color capabilities, says Wendy Abramowitz, an analyst with Venture Development Corp., Wellesley, Mass.

A leader in the business-graphics market, and first in that market with a color-graphics terminal priced at less than \$1000, ISC hopes to ship 5000 of its new ISC 2048 displays by year-end. That system includes a 13-in. CRT terminal that displays eight foreground and eight background colors, an attached ASCII 72-key keyboard that includes eight function keys, an RS232 interface and selectable baud rates as high as 9600 bps. The 2048 includes firmware for drawing vectors, bar graphs and point plots, and contains 4K bytes of RAM and 4K bytes of ROM.

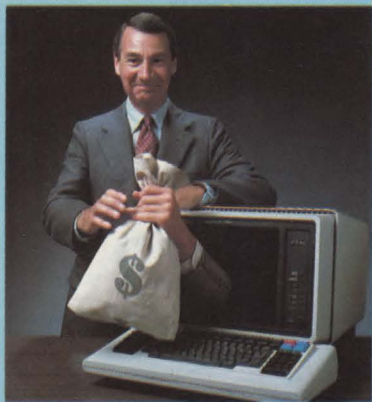
Curnin says the 2048 will be aimed primarily at large OEMs and system integrators. "We're hoping that as business slows down, people will become more aggressive," he says. "A large OEM with special packages for car dealers, hospitals, travel agents, banks or stock brokers can enhance his products with our color-graphics terminal at a minimal cost and reenter the market with a much stronger offering." Curnin says that a fully configured display will probably sell for \$2000 to \$3000 in an OEM package.

He expects end users of the terminal to be middle managers and general office workers, who will use the displays in management-information systems to generate charts and graphs.

Ezra Mintz, co-founder of ISC and now president of Colorgraphic Communications Corp., also aims his company's line of color-graphics terminals at middle managers who will pay \$2000 to \$3000 for a productivity tool. "An executive with a color-graphics terminal on his desk and access to a database will be able to squeeze 100 pages of raw data into a single bar chart," says Mintz. "He'll be able to analyze and understand that graph much more readily than if he were looking at



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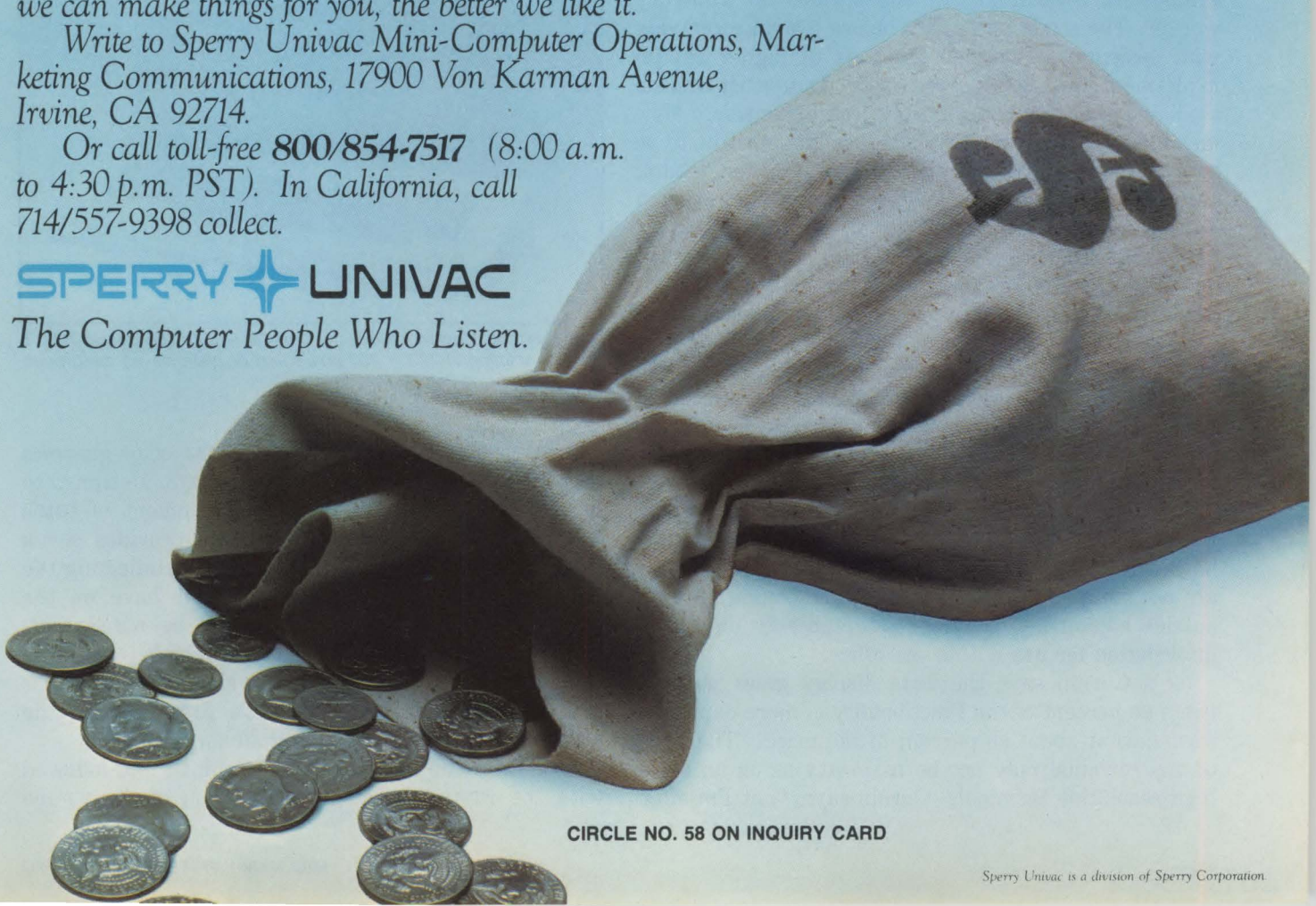
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# The Interpreter



**These graphic representations of Yankee Group market findings were accomplished using an ISC 2048 color-graphics terminal.**

rows upon rows of numbers."

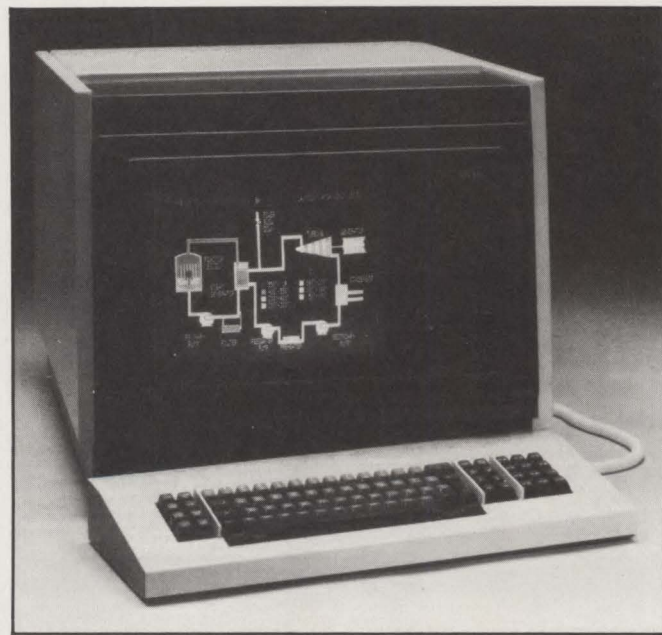
Despite the productivity gains that graphics terminals provide, middle managers historically have been hard-pressed to justify the cost of graphics to their superiors. A Frost & Sullivan study on the graphics market lists the typical capital investment per white-collar worker in the U.S. as only \$2000, compared to \$75,000 for a farm worker and \$32,000 for a factory worker. The study notes that before graphics can gain wide acceptance, "either the idea of higher capital investment must be accepted, or products must become available that are considerably less expensive." How much less expensive a graphics terminal must be to be cost justified by business customers is up for debate. But Gens says that the added price must be minimal. A Yankee Group survey primarily of business managers found that most respondents will not spend more than an additional \$500 for a graphics terminal. "Companies just aren't going to put out \$6000 for a graphics display for every manager's desk," says Gens. "They may spend \$1000 or \$2000, but not a penny more."

Carl Machover, president of Machover Associates, White Plains, N.Y., a consulting firm specializing in computer graphics, notes that color-graphics terminals priced at \$1000 to \$5000 are affordable by middle-management standards, but that such terminals sacrifice resolution or picture quality for low price. He adds, however, that although low-priced graphics displays are not suitable for presentation-type graphics for use outside a company, they are acceptable for displaying information for use within the office.

ISC's Curnin says the 2048 display gives business users 80 percent of the functionality of more expensive terminals at about 30 percent of the price. "The circle on my terminal may not be as pretty as on an \$8000 high-resolution terminal," Curnin says, "but I'm offer-

ing business users a decision-making tool at a price they can afford."

Curnin sees the terminal's only competition as "the tendency of people to buy nothing at all." But the Yankee Group's Gens sees the competition as "imminent" offerings from large data-processing OEMs, such as International Business Machines Corp., Data General Corp., Digital Equipment Corp., Prime Computer, Inc., and Wang Laboratories, Inc. He says such companies have been waiting in the wings for the last two years for graphics-processor and memory prices to come down low enough that competitive price/performance products could be offered. During the past two years, these large OEMs have been introducing retrofitted color-graphic versions of their alphanumeric displays, signaling their interest in the business-graphics market.



**Colorgraphic Communications Corp.'s \$3500 Z80-based MVI 7 has a resolution of 720 x 280 pixels and displays seven foreground and background colors.**

Last year, IBM announced its 3279 color-graphics terminal, a retrofitted version of its 3278. Designed to fit into the clustered-terminal environment of IBM's 3270 line, the 3279 graphics version provides seven colors and is priced at less than \$6000. Reflecting the impact that big-name companies can have on the business graphics market, it should be noted that, while ISC has shipped 20,000 terminals since the company was founded in 1973, IBM shipped at least that many 3279s during the product's first year on the market, according to Frost & Sullivan estimates.

Soon after the release of that terminal, DEC followed with the VT-125, a retrofitted version of the VT-100



# Remex Times

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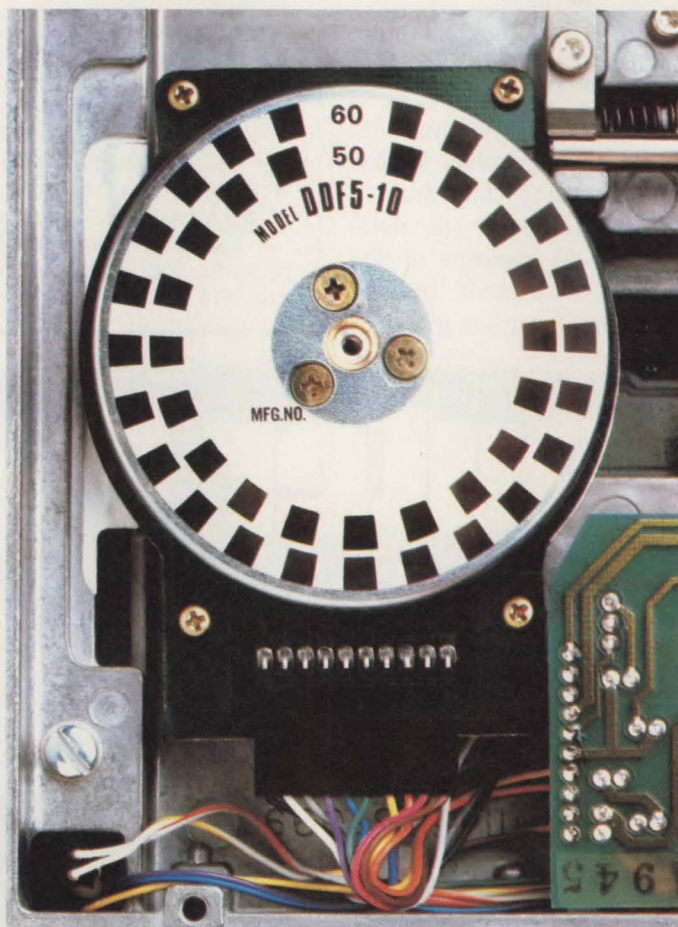
## THE HIDDEN TRUTH ABOUT 5¼ INCH FLOPPYS

### Belts and Brushes Murder on Life Span

The bad news for mini floppy disk drive buyers is that 5¼ inch drives are designed with belt and brush type AC motors ... and they suffer the consequences. The good news according to high level authorities is that there is an exception. The Remex PICO™ 48/96 tpi, 5¼ inch flexible disk drive has no belts or brushes because it is the first mini-sized floppy with a direct drive DC motor. Direct drive means that improper belt seating is non-existent so variations in speed and friction-producing side loading are eliminated. Motor life is also extended. A reliable industry source indicates that the MTBF of the PICO motor is 5 years—typically ten times that of most brush type motors. The President of the United States, in his comments, stated (continued on Page 5).

### Trouble Maker Eliminated

"Tap-tap wear is a thing of the past" according to design engineers evaluating the Remex PICO 5¼ inch flexible disk drive. This major cause of media damage and wear on mini floppy drives, the loading and unloading of the head on the media, has been eliminated with the Remex PICO because the PICO has no head load solenoid. This design innovation also reduces magnetic leakage which may result in data errors. Rumors that PICO will receive an award from the Association for the Preservation of the Sanity of Systems Designers were not confirmed by Remex.



Direct drive DC motor saves life of 5¼ inch floppy.

### Designers Spellbound by Interchange

Reliable interchange of media between Remex PICO drives is enhanced by the precise speed control of the motor's closed loop servo. Speed is regulated to 1% on Remex PICO versus typically 2¼% on other small drives, therefore read/write errors caused by speed varia-

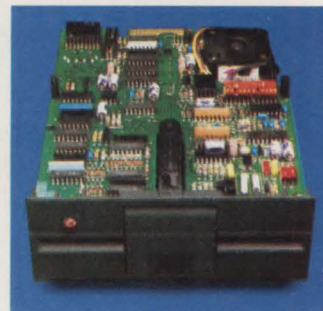
tion are not a major factor with PICO. The drive's speed control may also simplify controller design because phase lock loop requirements are less demanding. Vast crowds of cheering engineers stood outside the office of (continued on Page 11).

### Drives Embezeled!

A choice of bezel sizes on the Remex PICO 48/96 tpi, 5¼ inch floppy makes this drive the appropriate choice for a wide variety of system configurations according to sources. Among the sizes available is a 2¼ inch low bezel which is ideal for space limited micro-systems. An "industry standard" bezel is optional.

### Proud Parent Praises PICO

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# The Interpreter

with limited graphics capabilities, and DG announced the Dasher 280 C, a retrofitted Dasher 200.

"The point is not to look at the capabilities of these systems compared with terminals from specialized graphics vendors, but at the level of activity in graphics these companies are initiating," says Gens. "Now that hardware costs are down and the demand for business graphics is building, these guys are starting to scramble to come out with graphics products."

Gens notes that business users prefer buying graphics equipment from the same vendor who sold them their data- and word-processing equipment. "People want graphics integrated with their mainframe and their word-processing machine," he says. "The guys who know how to integrate office-automation equipment are the large OEMs who have been providing that equipment for years."

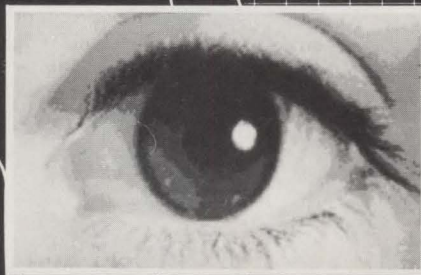
A Yankee Group survey of business users found that 56 percent of respondents would buy a graphics display from a data-processing vendor rather than from a specialized graphics vendor, even though the data-processing vendor's display had 75 percent of the functionality of a less expensive system from a specialized graphics vendor. "When you see graphics

offered as simply and commonly as word processing by the guys who have been dealing with business users since they first got into computing, you'll see the business-graphics market skyrocket," says Gens. He adds that the already-low prices of low-end color graphics products from specialized graphics vendors must come down even further if those vendors hope to compete with the future offerings from large data-processing OEMs, such as IBM and DEC.

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## Explosive growth predicted for color printers

By Eric Lundquist  
Associate Editor

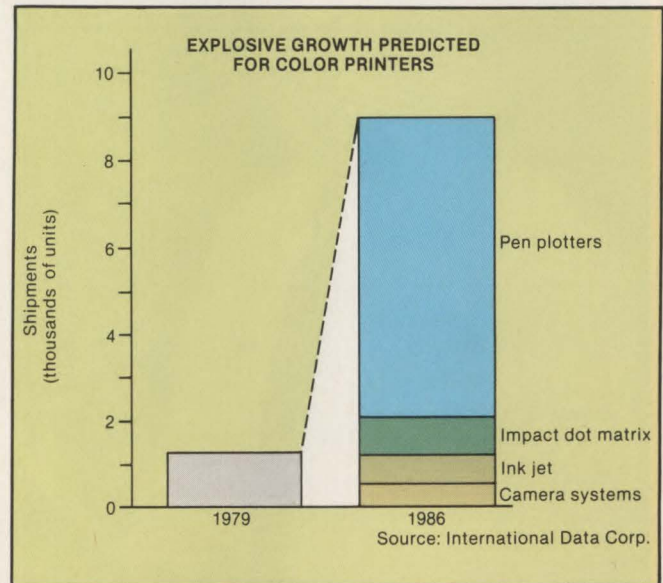
Ever since engineers used Polaroid cameras to take photos of a color VDT screen's display, there has been a need for a low-cost method of preserving a screen's display on hard copy. That's because a low-cost color video display is of limited value unless there is a color peripheral to capture the screen's image.

The color-CRT-terminal market and the color hard-copy-output market are so closely tied, it's difficult to tell who's leading whom. Among the most promising technologies for hard-copy peripherals priced at \$1000 to \$10,000 are pen plotters, color ink-jet, color impact printers and Polaroid-based camera systems.

System integrators know that a hard-copy device can be the driving force in a customer's decision to purchase color over black-and-white systems and are calling on peripheral vendors to offer more low-cost color options. The peripheral vendors are happy to respond to the demand, but are keeping a wary eye on the Japanese firms, which are aggressively attacking the black-and-white printer market.

"The color market is where it's at," says Barry Gilbert, manager of the corporate planning group at International Data Corp. "We have the color-graphics terminals, and, although there will be technological improvements in that line, the real improvements will be in hard-copy color output."

Sales of color hard-copy devices are projected to grow explosively. Strategic Inc., San Jose, Calif., projects that hard-copy devices will account for 25



Explosive growth is predicted for sales of color hard-copy devices. Although there will be technological improvements in color-graphics terminals, "the real improvements will be in hard-copy color output," according to International Data Corp.

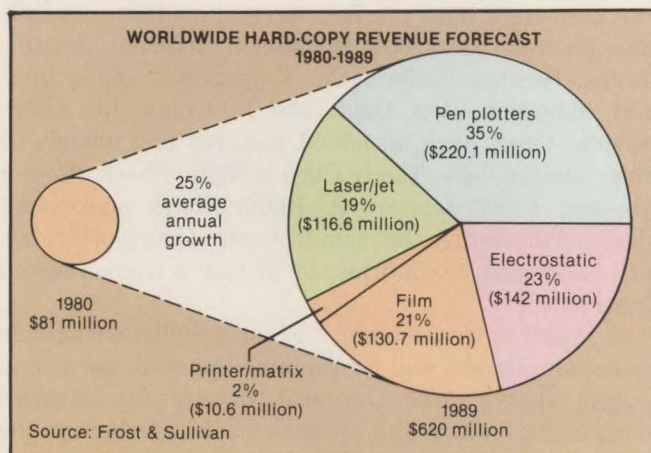
percent of a \$4.65-billion graphics-hardware market in 1985. In 1980, hard-copy devices accounted for 30 percent of a \$1.4-billion market, according to Strategic. The business-information-systems segment is one of the most attractive for low-cost hard-copy peripherals and is expected to grow 49 percent a year from a base of \$254 million, according to Strategic.

IDC's Gilbert predicts that each of the four contenders for the color hard-copy sales will enjoy continued and, in some cases, dramatic, growth over the next several years. Figures provided by IDC predict that:

- Pen-plotter shipments will grow from 11,500 in 1979 to 68,500 in 1986.
- Color impact dot-matrix printers shipped will increase from 200 units in 1979 to 9000 in 1986.
- Ink-jet-printer shipments will grow from 25 in 1979 to 7000 in 1986.
- Camera-system shipments will increase from 100 in 1979 to 4000 in 1986.

While shipments grow, the average per-unit price is dropping, indicating strong growth at the low end of the price scale, Gilbert says. In the past, the lack of hard-copy devices has throttled the growth of the low-end business-graphics market. But that situation is being remedied.

As Datek, Newtonville, Mass., pointed out in a recent *Printout* newsletter: "The growth potential in



Frost & Sullivan forecasts 25 percent annual growth in the 1980s for sales of hard-copy output devices.



# The Interpreter



Doyle Cavin, general manager of the CPI Business Unit at Tektronix's Information Display Division, says Japanese firms are now building and demonstrating color hard-copy devices, but have yet to start aggressively marketing those units.

business graphics hard copy has been stunted, many feel, by lack of low-cost and reliable hard-copy printers. As a result, there has been a good deal of interest and product-development activity in this area over the past several years involving several technical approaches."

Timothy Berry of California research firm Creative Strategies believes that "Having color printers available for less than \$2000 (the price range of some pen plotters and impact printers) will make a market where there hasn't been one." Ken Anderson, publisher of *The Anderson Report on Computer Graphics*, agrees: "Color-CRT technology has just taken over black and white, but how do you get a piece of paper with the same information on it and walk away? The demand for hard-copy output will be tied directly to the growth of color CRTs." Anderson contends that low-end color printers, plotters and other hard-copy devices will each find their own application niches, rather than compete head-on for one market.

One of the first less-than-\$2000 color impact printers to appear is Integral Data Systems Inc.'s, modular Prism printer, which sells for \$1995 to end users. A prototype of the printer was shown at the 1981 National Computer Conference. The 132-column dot-matrix unit produces eight colors using a four-band ribbon. "We're

the first guys with a commercial-grade, low-cost color printer," claims Peter Eisenhower, vice president of marketing for IDS, Milford, N.H. An 80-column Prism, including a color module, is priced at less than \$1300.

Integrex Ltd. of England has developed an impact printer, which also sells for \$1995 in single-unit quantities. That system is based on the Epson TX-80. Other firms with impact color printers include Trilog, Ramtek Corp. and International Business Machines Corp. Mannesmann-Tally and Hitachi have also demonstrated color-impact matrix printers.

Two companies manufacturing low-priced color ink-jet printers based on Siemens Corp.'s PT-80i ink-jet technology are scheduled to start delivering their products this year. Both PrintaColor Corp., Norcross, Ga., and Advanced Color Technology Inc., Chelmsford, Mass., offer printers or "CRT copiers," for less than \$10,000. Another Printacolor offering sells for less than \$5000.

The ACT-1 ink-jet copier from Advanced Color is priced at \$9000 in single-unit quantities. The company's vice president of sales Robert Manning describes the printer as a medium-priced copier aimed at people willing to pay a premium for high-quality print and resolution. Manning says that such high quality is not possible with an impact printer or plotter. Advanced Color is scheduled to start delivering printers this year.

Manning says ink-jet printers are attractive to OEMs, especially for business-graphics applications. "In the OEM market, a number of firms make their own CRTs and are interested in offering our product as an adjunct. There is great interest from the terminal manufacturers and from the business-computer manufacturers, which do not have a hard-copy device to go along with their systems," Manning says. The vendors are still evaluating the hard-copy devices, and Manning will not disclose potential OEM contracts.

Pen plotters continue to command the lion's share of the hard-copy color market. Several models are available for less than \$2000. Houston Instrument, Austin, Texas, Hewlett-Packard Co., Cupertino, Calif., Benson, Mountain View, Calif., and Tektronix, Inc., Beaverton, Ore., have all added features and models to their plotter lines. Tandy Corp.'s Radio Shack offers a six-pen, \$1995 plotter. A Radio Shack spokesman declines to identify the manufacturer of the plotter, but an outside source confirms the plotter is from Houston Instrument.

A report by research firm Frost & Sullivan contends that pen plotters will continue as the main hard-copy output device over the next decade for business computer graphics. But plotters will lose a share in the hard-copy market, dropping from 46 percent in 1980 to 35 percent in 1989.



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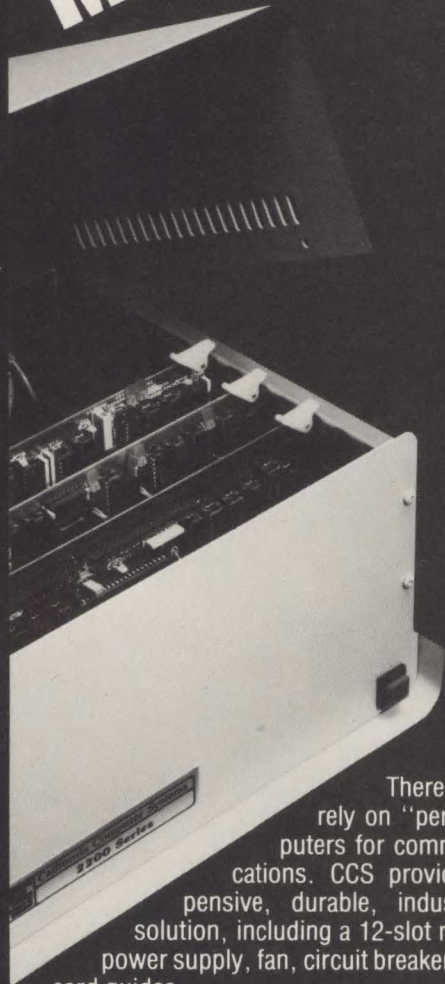
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## The Interpreter

Doyle Cavin, business-unit manager for copiers, plotters and imaging systems at Tektronix, Inc., believes dot-matrix color printers will find their niche in producing copies of graphic material, while plotters will find theirs in preparing presentation graphics or report-quality material. "If you are going to have something presented on an overhead projector, it has to be done on a plotter," Cavin says.

Several companies, including Dunn Instruments, Matrix Instruments and Image Resources, sell Polaroid camera-based hard-copy systems. Prices for these sophisticated descendants of the CRT snapshot start at about \$3000. Dunn's lowest priced system is about \$6000, and Mason Killebrew, marketing manager at the company, says camera systems selling for less than the \$6000 often trade image quality for low price.

"The eye rebels if a straight line no longer looks straight," Killebrew says. The average Dunn system is priced at about \$8000 and offers an image quality and fast exposure time that ink jets and other technologies can't match, Killebrew says. Tektronix's Cavin says one drawback to color camera systems is the relatively high cost of copies. A PrintaColor comparison of per-copy prices of 8- x 10-in. prints shows that photographic copies sell for \$5.50, while other methods are 25¢ or less.

One technology that holds promise for less-than-\$10,000 color copiers is electrostatic plotters. But a product in that price range has yet to appear on the market. A Frost & Sullivan report notes that "Companies like Versatec and Benson have announced at various technical meetings that they have developed prototypes of color electrostatic printer plotters." Frost & Sullivan believes color electrostatic plotters will appear within the next two years and will capture an increasingly larger percentage of the hard-copy market, moving from less than 10 percent in 1980 to more than 20 percent by 1989.

One presence expected before 1989 in the color hard-copy market is Japanese manufacturers. Tektronix's Cavin, who recently returned from Japan, says the Japanese are building and demonstrating color hard-copy devices, but are not yet aggressively marketing them.

At last year's NCC, Japan's Sharp Corp. exhibited two ink-jet printers based on A.B. Dick patents that the company licenses. A.B. Dick also licenses the ink-jet patents to Hitachi, which, in addition to the ink jet, has a color impact printer. More Japanese entrants are expected soon.

"I fully expect to see the Japanese in the market within the next six to 12 months, assuming the market evolves well," says IDS's Eisenhauer. "We'll pioneer the market, and, if it is good, the Japanese will be there." ■



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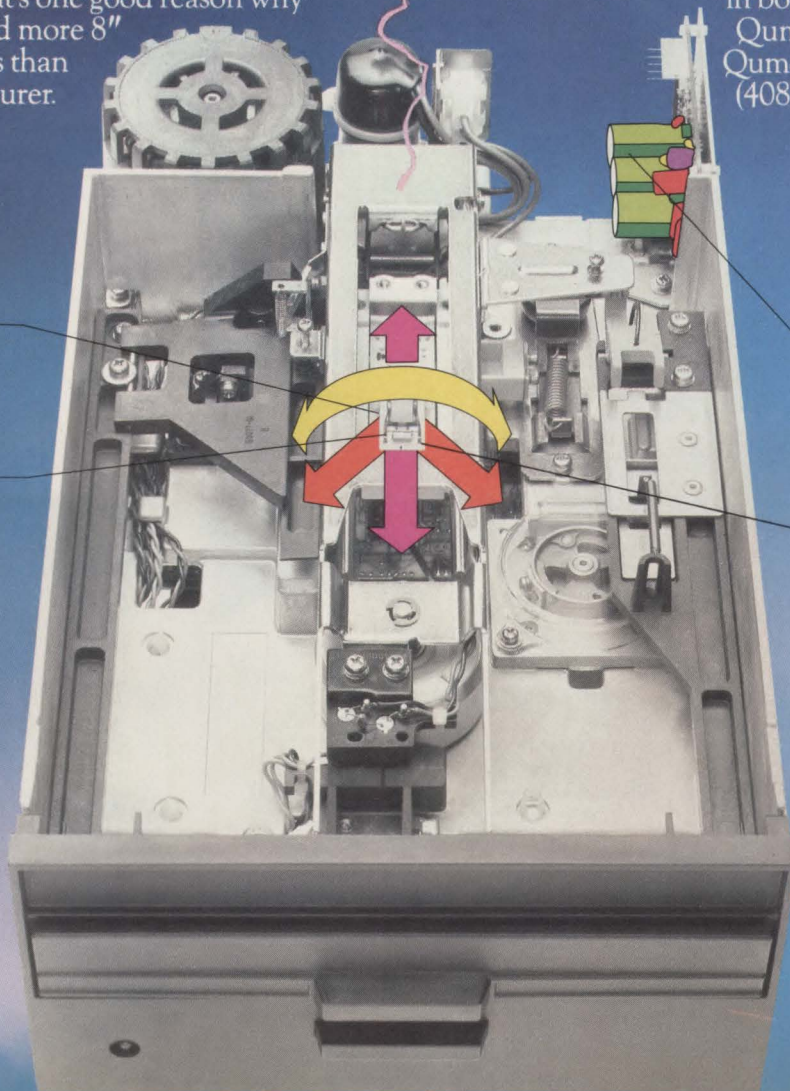
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CIRCLE NO. 66 ON INQUIRY CARD



## IBM may enlarge its remarketer program

By Eric Lundquist  
Associate Editor

In a move to expand its nascent third-party-marketing efforts in the system-integrator channels, International Business Machines Corp. may add several CPUs in addition to the Series/1. If approved by upper management, the additional computers will be added to the remarketing program while the company is in the throes of one of the largest management restructurings in its history. The ongoing changes in the remarketing program reflect changes throughout the company.

"I have requests for 4300s, Datamasters, 5280s and Displaywriters. These are products my prospects have said they would like to have, and I'm recommending it," says George Pavloff, director of IBM's value-added remarketer (VAR) programs. IBM defines a VAR as someone who acquires the Series/1 and adds significant value to the machines in terms of function or capability and remarkets the resulting product to an unaffiliated end user without IBM marketing assistance.

Pavloff says that, although he has requested the additional CPUs, he is still negotiating for the approval of upper management. If the additions are approved, the VAR program may begin to have a more significant impact on the market as company executives put into play some of the hard-learned lessons from their experience with Series/1 remarketing. IBM seems determined to become a company to be reckoned with in the remarketing channels long dominated by large minicomputer firms such as Digital Equipment Corp., Hewlett-Packard Co., Data General Corp. and others. But even with its enormous resources, IBM has a long way to go before it becomes a threat in the multi-billion-dollar remarketer business. One estimate places Series/1 remarketer revenues at about \$30 million for the 1981 calendar year. IBM officials will not comment on that estimate.

The 15-month-old VAR program met a lackluster reception until IBM bowed to pressure from system integrators calling for a better price break. In July, 1981, the company revised its discount schedule (see table). That revision gives purchasers of 50 or more machines a 30-percent discount. Additional discounts are expected.

To woo integrators, Pavloff would like to sweeten some of the discount practices beyond the moves made



George Pavloff, director of IBM's value added remarketer programs: "I am the resident hawk on alternate channels."

last July. "I would like to see some more discounts. All facets of the program are being looked at with great regularity, and we may decide to do something different," Pavloff says. He won't elaborate about what something different might be.

IBM is in the midst of several changes following the company's announcement of plans to reorganize. The VAR program is moving from Atlanta, Ga., to the company's White Plains, N.Y., facility, with all of IBM's alternate-marketing efforts. The VAR, distributor and used-equipment programs will report to the alternate-channels marketing group in White Plains. That group in turn reports to the group director for marketing channels. Some observers suggest that a retail operation for the IBM personal computer may join the White Plains group. Pavloff feels that the central structure gives the VAR program more resources than were provided by disparate groups. "The reorganization provides a high-level focus for alternative channels generally, but especially for value-added remarketing," Pavloff says. "You have to bring it all together. At White Plains, you have the advantage of economies of scale in support, of centralization of resources, of



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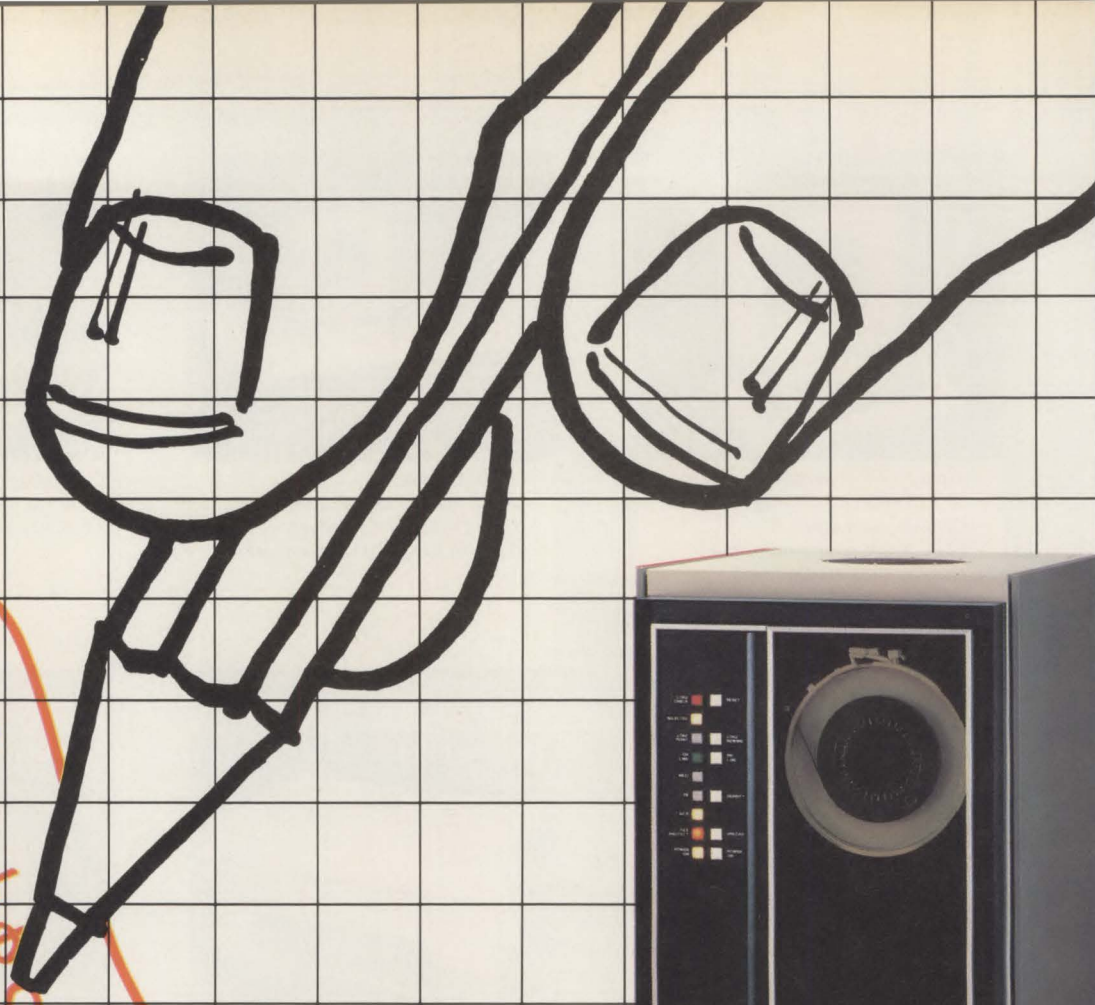
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funding and of specialization. It makes a lot of sense."

The VAR program is built around the Series/1 general-purpose minicomputer, which was introduced in 1976. By 1980, there were about 13,800 domestic installations and about 6000 outside-U.S. installations, according to International Data Corp. How many sales came from the remarketing program is unknown, but the percentage is probably small.

A 1981 Datapro Research Corp. report states that the 13-member Series/1 family of 16-bit processors is based on three  $\mu$ p-based CPUs—the 4952, the 4955 and the 4953. The 4953 and 4955 were introduced in November, 1976, and the 4952 was introduced in February, 1979. A 4952A with 32K bytes of memory and five I/O features or storage slots is priced at \$5060, a 4953A with 16K bytes of memory and four I/O features or storage slots is priced at \$4800, and a 4955A with 16K bytes of memory and eight I/O feature slots is priced at \$7465, according to the Datapro report.

Main memory on the Series/1 ranges from 16K to 512K bytes, and disk capacity ranges to as much as 256M bytes per I/O attachment. As many as eight work stations can be used on each I/O attachment.

Pavloff says the company has "several hundred" VARs. But he would like more VARs to be added. "The VAR is a valuable customer of IBM. We want them; we need them to grow," Pavloff says. Pavloff concentrates on VARs whose added value comes from hardware and software and who offer a specialty in specific market niches. "It's difficult to be all things to all people. We are looking primarily for people who have carved out a vertical niche." These segments include control, telecommunications and special business segments, Pavloff says.

Advocating third-party reselling and discount schedules takes something of a heretic in a company where the dogma of end-user sales has long ruled. The role of third-party advocate has been exuberantly taken by Pavloff, who boasts, "I am the resident hawk on alternate channels" at IBM. Pavloff plans a dramatic growth for the VAR program. "I wouldn't be interested in doing what I'm doing unless I could be doing business in the hundreds of millions shortly," he says. ■

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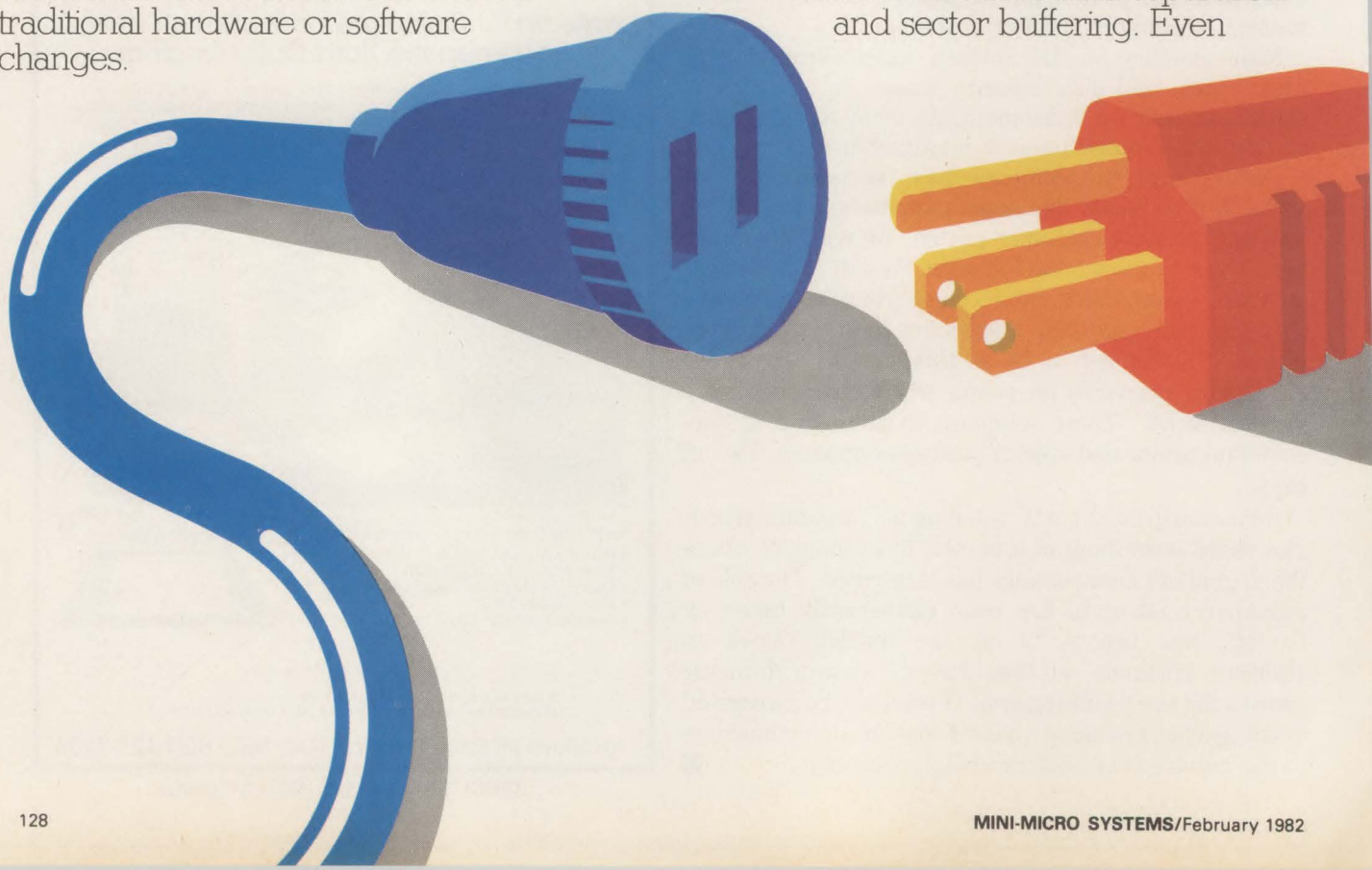
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$$= \sum_{j=1}^K X_j^2 V''(\beta_j)$$





$$=V\left(\sum_{j=1}^K \beta_j X_j\right) + \sigma^2$$

$$= \sum_{i=1}^K \sum_{j=1}^K X_i X_j \text{cov}''(\beta_i, \beta_j) + \sigma^2$$

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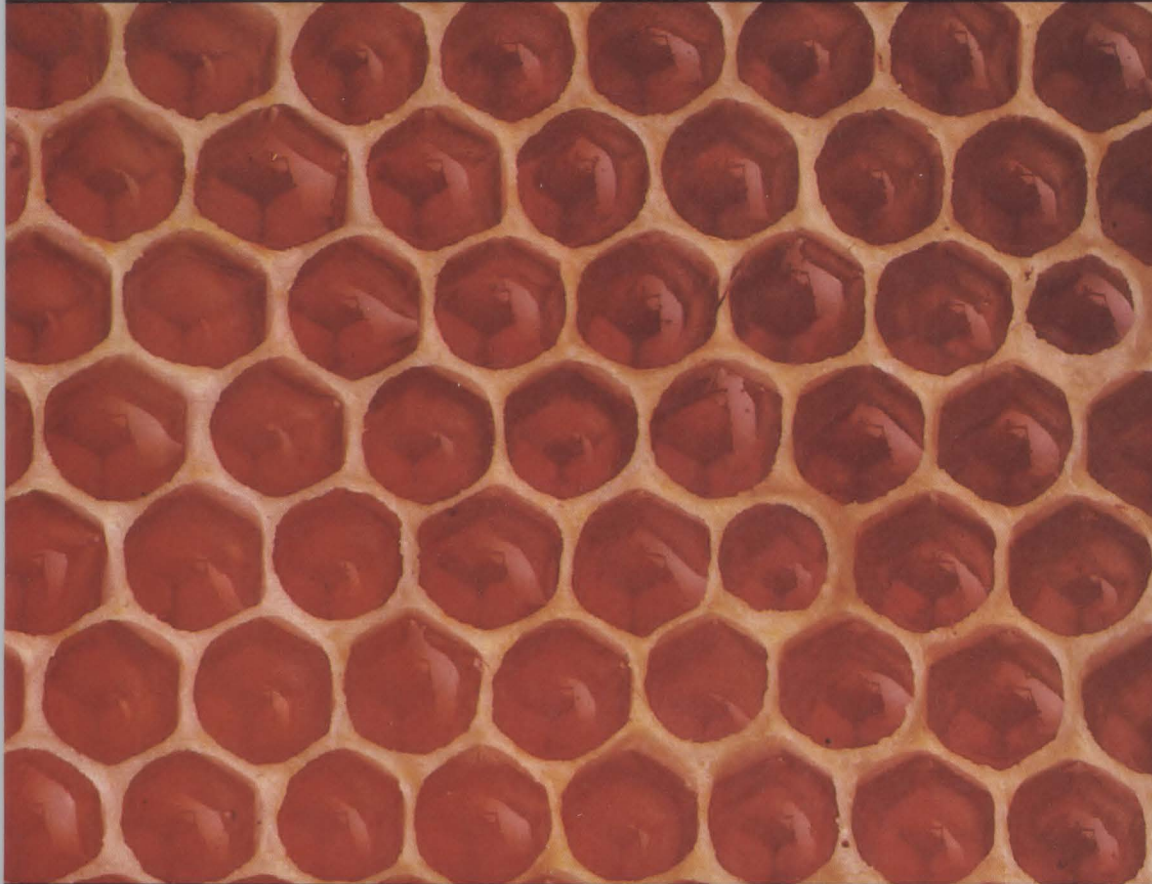
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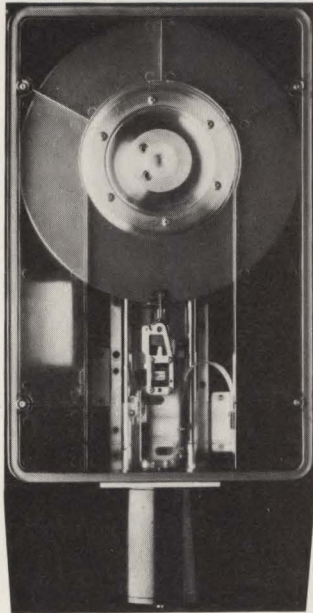


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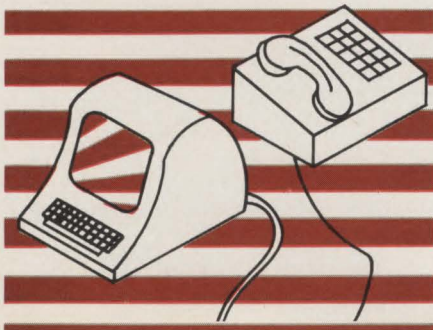




**135** Announced nearly 10 years ago by IBM in the form of a 14-in. stand-alone storage subsystem called the 3340, Winchester-disk drives have since become the driving force in the minicomputer and  $\mu$ c markets, rivaling central-processor technology and software performance as pacing factors in the development of powerful, inexpensive systems. On p. 135, West Coast bureau manager John Trifari describes the evolution of Winchester-disk drives and forecasts the industry's next two years. . . . Disk-drive manufacturers are chasing the  $\mu$ c market even more zealously than they did the minicomputer market in the early 1970s, and rapid product innovations are being matched by rapid market acceptance. That's one of the findings of industry expert James N. Porter, whose Winchester profile begins on p. 145. . . . Other articles offer an in-depth examination of Y-E Data's YD-280 minidiskette drive, which reduces off-track errors that prevent interchangeability (p. 191); a look at closed-loop servo systems, which increase tracking accuracy, boost capacity and reliability (p. 199); and a description of the innovative rotary-actuator design—PosiTrack—in Kennedy Corp.'s model 7300 8-in. Winchester-disk drive (p. 215).



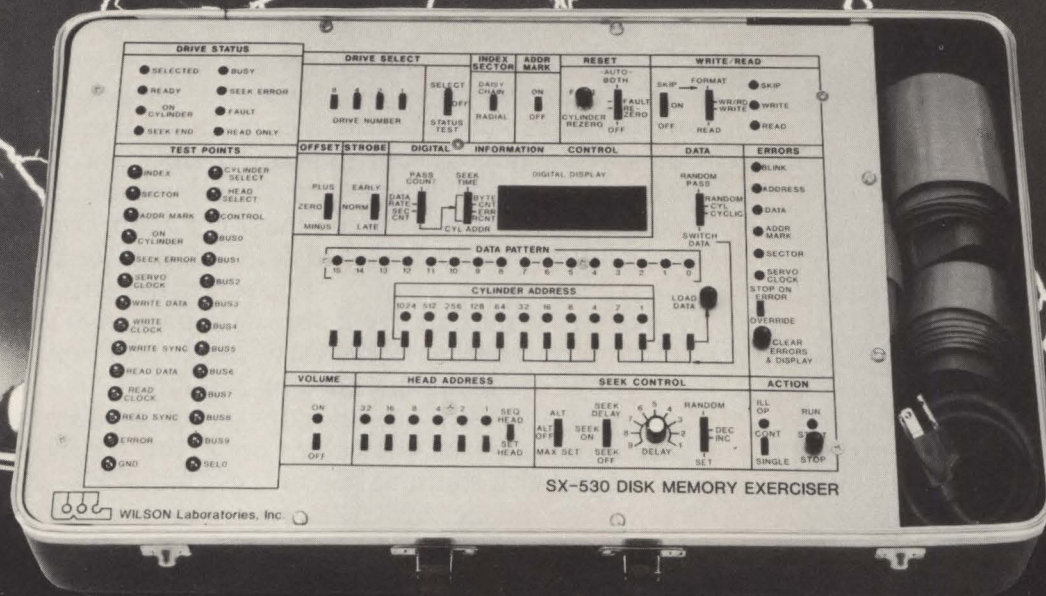
**165** The floppy-disk drive industry is growing rapidly and is changing just as fast. Numerous product developments have appeared in the last few years, and multi-megabyte floppies will soon become a reality. On p. 165, industry expert James N. Porter profiles the floppy market. . . . The cover story (p. 185) describes Shugart Associates' half-height 8-in. floppies, which offer increased capacity and reliability while also maintaining industry-standard compatibility. . . . A subsystem that can stabilize its floppy media and tightly control head-to-disk displacement can achieve recording densities and data-transfer rates that rival those of rigid disks. The Alpha-10, an 8-in. cartridge drive from Iomega Corp., combines aerodynamic and flexible-media technologies to do just that (p. 207). . . . ANSI standards assure interchangeability of floppy disks, but don't assure their performance. That's controlled only by manufacturers' standards. For a look at going beyond ANSI, see p. 219. . . . In other articles, industry expert and consultant Raymond C. Freeman Jr. takes a look at the disk-drive industry's future (p. 175), and disk-drive technology and distribution are analyzed in an article beginning on p. 181.



**227** Local-area communications has become the hottest sector of the data-communications market. More than 80 companies, many of them new, have announced local-network products. The products seem almost limitless in their variety. Although still in its infancy, local-area communications will become a major market in the 1980s. Consultant and contributing editor Walter Levy examines that market in the first of a three-part series, beginning on p. 227. . . . Other articles take a look at the use of interactive  $\mu$ cs in psychological applications (p. 245) and the design of  $\mu$ ps using superminicomputers (p. 251).



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## DISK DRIVES

# Winchester drives to be focus of attention over next two years

JOHN TRIFARI, West Coast Bureau Manager

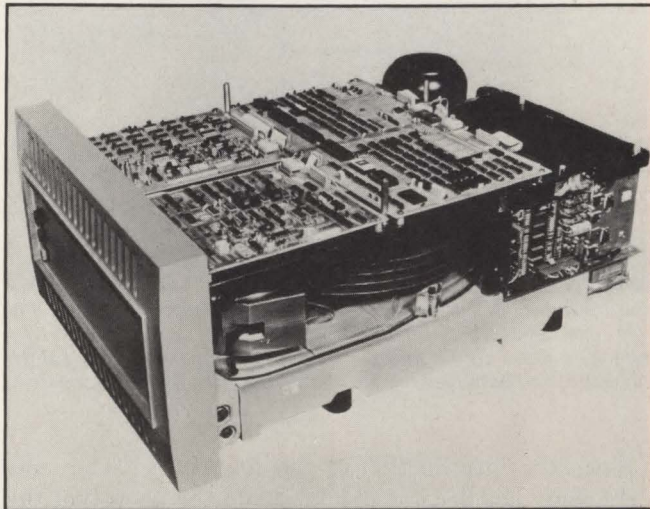
*Winchester-disk drives have become a driving force  
in the minicomputer and  $\mu$ c market*

Announced close to 10 years ago by IBM in the form of a 14-in. stand-alone storage subsystem called the 3340, Winchester-disk drives have since become a driving force in the minicomputer and  $\mu$ c markets, rivaling central-processor technology and software performance as pacing factors in the development of powerful, inexpensive business, graphics, word-processing and desk-top systems.

As announced by IBM, Winchesters incorporated two sealed, removable head/disk assembly (HDA) modules. Each of these modules could store 30M bytes of data (hence, apocryphally, the 30-30 configuration that gave rise to the system's code name Winchester). The 3340 and the highly successful 3350 that used a fixed HDA and that was first shipped in early 1976, gave rise to a plug-compatible peripherals market, and in the form of variants, a market for 14-in. Winchesters aimed at builders of large-scale minicomputer-based systems. These markets continue strong, especially for OEM hardware at the 160M-byte and higher level.

In recent years, however, the attention of system integrators has focused on Winchester drives with smaller diameter disks. The first of these, the 11M-byte 7710 announced in mid-1978 by Cupertino, Calif., start-up International Memories, Inc. (IMI), used 3340 technology and media that was 8-in. (200 mm.) in diameter. The system was slightly larger than a shoe box.

By the National Computer Conference in 1979, a wide range of 3340- and 3350-technology 8-in. rigid-disk drives with both 200- and 210-mm. disks were offered



**Large fixed Winchesters such as this 14-in. model from Tecstor must store much data to survive competition from smaller drives. The OEM unit above stores 160M bytes, operates without air conditioning, provides 35-msec. access times and sells for \$4950 in OEM quantities.**

with capacities ranging from 4M to 34M bytes. Now, 8-in. drives with capacities in the 40M-byte range are routinely discussed, while announcement of hardware in the 80M- to 160M-byte range is anticipated within the year.

In early 1980, the OEM Winchester market went through yet another iteration with the introduction by Scotts Valley, Calif., start-up Seagate Technology of the first 5¼-in. rigid-disk drive. Now being shipped in production quantities at the 6M-byte level, these drives



*Characteristic of all drives tagged with the Winchester name are continuously increasing areal densities at continuously decreasing cost per megabyte.*

have already been pushed to the 10M- and 20M-byte range, and drives with capacities of 40M bytes and more are proposed.



**Integral 5 1/4-in. Winchester backup** is the distinguishing feature of Irwin International's 510. The unit can back up its 12.3M-byte capacity on one cartridge tape in less than 4 min. The unit weighs only 5 lbs. and occupies the same space as one 5 1/4-in. floppy-disk.

Since the introduction of the first Winchester, the technology has become ubiquitous to the point that the term itself is well on its way to becoming generic. "Winchester" originally referred to the 3340. Industry usage extended it to the 3350, and now it appears to be defining IBM's 3380, a 600M-byte, 14-in. drive that uses thin-film read/write heads. The term "Winchester" is also applied routinely to IBM's 3380, a 16-byte, 14-in. drive originally code-named Coronado. In the OEM world, Winchester is applied to any rigid-disk drive using a sealed head/disk assembly (HDA), lubricated media and low-mass read/write heads that land on the surface of the disk as the drive is stopped and take off from the surface of the disk as the drive is brought up to speed.

Characteristic of all drives tagged with the Winchester name are continuously increasing areal densities at

continuously decreasing cost per megabyte. This trend will continue during the coming two years and may become even more pronounced if the use of thin-film media and thin-film read/write heads becomes more commonplace.

#### **Use of thin-film media**

For a number of years, a group of drive designers have pushed the idea that replacing the oxide-coated media common to most Winchester drives with thin-film media manufactured through plating or semiconductor techniques would be the next evolutionary step in building smaller drives with higher capacities. Indeed, this media can handle more flux changes per in. than conventional Winchester disks, and some 5 1/4-in. Winchester vendors already use it. So far, it has not been used on 14- or 8-in. Winchesters.

Its acceptance has been far from universal, however, despite the increased areal densities possible through its use. The prime reason is lack of IBM support. When the first Winchester was announced, builders of plug-compatible disk drives needed oxide-coated disks, and a number of vendors arose to supply their needs. Disk-drive designers working in the OEM market later adopted these disks less of necessity and more of convenience.

As a result, there are relatively few vendors making thin-film media, thus promoting the claim that its availability is limited. Others allege that thin-film disks present reliability problems resulting from an inherent problem with long-term corrosion, and that the disks cannot be manufactured reliably. Still other designers feel that thin-film media may be bypassed in favor of thicker film media with enhanced recording techniques—specifically vertical (or perpendicular) recording. No drives equipped with this media have been announced, but hardware able to handle this type of media may show up this year, using disks supplied by Lanx Corp. (MMS, September, 1981, p. 163).

#### **Use of thin-film read/write heads**

Conventional Winchester ferrite heads lose much of their ability to resolve data once flux densities pass the 12,000-fcpi range. Thin-film heads, manufactured using semiconductor techniques, offer a way around this limitation and will probably be commonplace on OEM high-capacity drives of all sizes within the next few years.

These heads can be repeatably manufactured to smaller and more specific tolerances, and can respond to the changes in the magnetic fields that represent data stored on a disk. Like thin-film media, implementation of these heads on a wide scale has been discussed for some time. So far, however, their use too has been limited. First, the market for high-capacity drives that would need this technology has yet to evolve at the OEM level on a large scale. This will change during the coming two years. Second, production problems have limited their availability in large volumes. Third,



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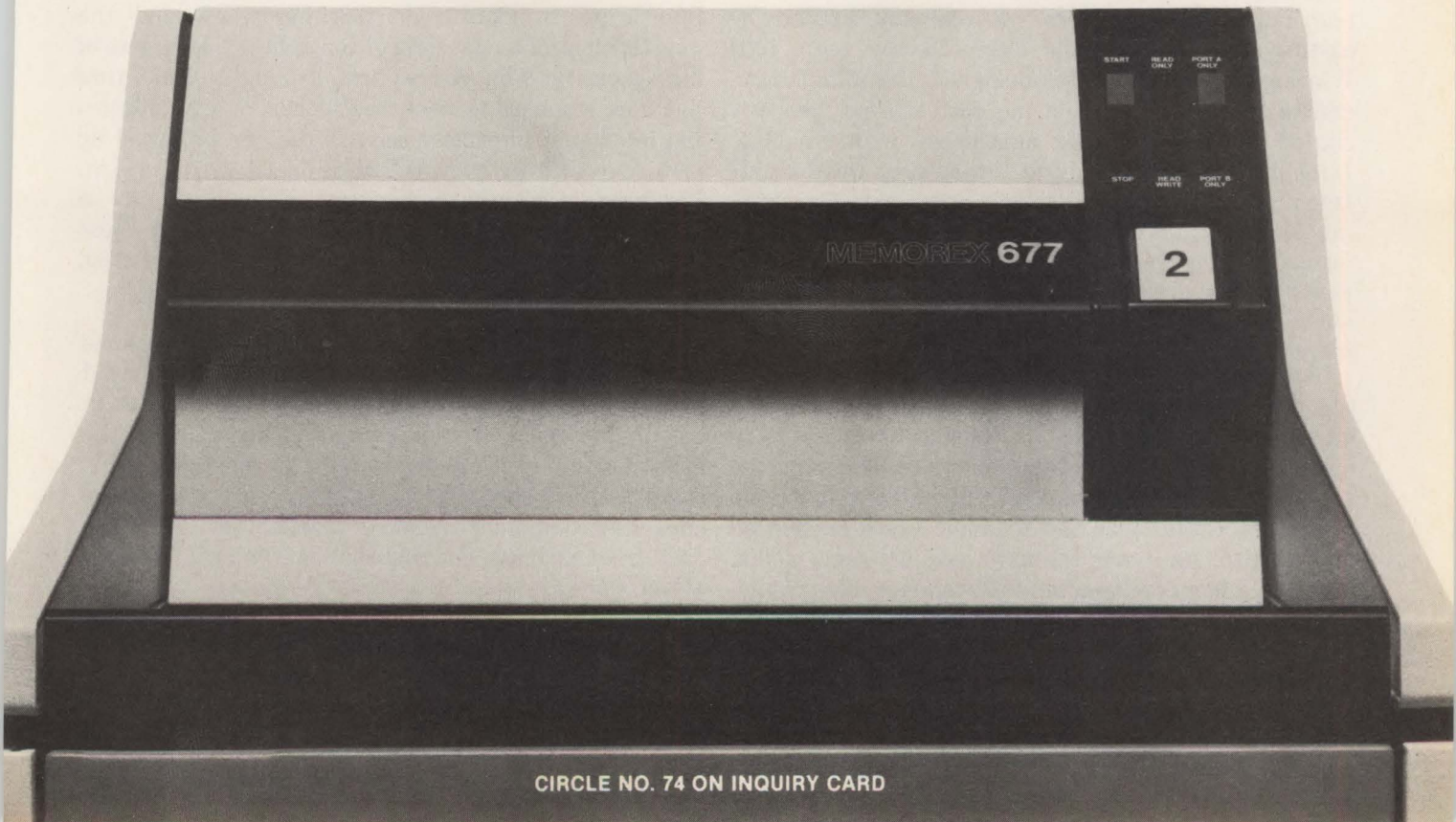
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*Since the introduction of the first Winchester, the technology has become ubiquitous to the point that the term itself is well on its way to becoming generic.*

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thin-film head vendors are waiting for IBM to define the head configuration of the 3380.

#### **Less reliance on IBM standards**

The implementation of thin-film read/write heads points up another trend that will continue to characterize the OEM rigid-disk drive market and that will become accentuated during the next two years. As in the case of oxide-coated media, OEM drive vendors adopted IBM Winchester ferrite-head technology because it was convenient and because the demands of the plug-compatible market ensured that these components would be available from a number of suppliers.

In the case of IBM's newer thin-film drives, however, the plug-compatible market has yet to develop. The reason: head vendors are only now committing to the 3370, while the 3380 has encountered unspecified production problems that have already delayed shipments by close to a year.

As a result, traditional head vendors have held back thin-film offerings, thus limiting the supply available to OEM drive builders, even if they could use the increased capacity these heads offer. This trend is changing, however. Capacities are moving toward the line separating drives with conventional heads from those requiring thin-film technology, and head vendors are responding. Dastek Corp., a company formed by ex-IBM engineers to build large-capacity 14-in. OEM Winchesters using Dastek-designed thin-film heads, and to sell these heads on the open market, recently signed a second-sourcing agreement with InfoMag. InfoMag gets Dastek's head technology; Dastek gets InfoMag's production expertise. Even more encouraging for advocates of thin-film head technology is the formation of several new companies whose business plans call for designing and marketing thin-film read/write heads exclusively to the broad OEM disk-drive market.

OEM drive vendors have taken other steps away from the standards set by IBM. For example, when IMI introduced the 7710 8-in. Winchester, many industry observers felt that its marketability would be impacted adversely if IBM's rumored 8-in. entry, the 3310 Piccolo drive, used other than the 200-mm. media announced on the 7710. As it was the 3310 used 210-mm. media, but only a few OEM vendors followed suit. Meanwhile, 200-mm. media became readily available.

Indeed, almost from the start, a new set of standards was imposed on 8-in. OEM drive vendors that had little to do with IBM. The key design feature of almost all

8-in. hardware announced after the IMI announcement was adherence to the physical dimensions of Shugart Associates' SA850 floppy-disk drive—recognition of the fact that the 8-in. Winchester market initially was viewed as a market for floppy upgrades.

Shugart also set an interfacing standard for this hardware with its 8-in. SA1000, and most drives of this size on the market today conform to that specification. As 8-in. hardware passes the 40M-byte level, however, new standards will evolve. Control Data Corp. can be expected to unveil a series of drives that use 9-in. media this year. Century Data Systems is proposing an 8-in. drive that will use a removable multi-disk pack capable of storing 80M bytes.

In the case of 5¼-in. hardware, the divorce from IBM-imposed standards was even more complete. While existing head and media technology was routinely incorporated into the new hardware, physical size was based on Shugart's SA450—again reflecting the fact that the market for the new Winchesters was (and remains principally today) a market for floppy-disk upgrades. As opposed to the variety of interfacing standards that greeted system integrators when the first 8-in. drives were announced, however, 5¼-in. Winchesters were based on the standards set by Seagate's ST-506 from Day One, and remain designed around this standard today.

The use of a single interfacing standard has expedited controller development for these drives, and it is anticipated that this standard will remain in effect for future hardware in the less-than-40M-byte range. Revisions may be required, however, as 5¼-in. Winchester capacities move about this level, and as data rates increase. The use of servo systems and voice-coil actuators may also require some changes in the interfacing standards for this hardware, and the development of a new class of controllers. Designers of high-capacity 8-in. drives are looking to the ANSI interface standard to meet these needs, or are considering intelligent interfaces such as the one proposed by CDC. No such activity is going on as far as 5¼-in. hardware is concerned, however, although it can be anticipated that controllers capable of handling these higher capacities will be announced by the end of 1983.

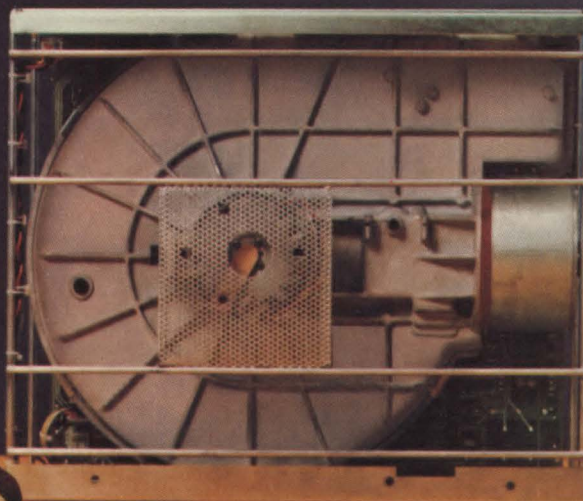
#### **Japanese penetration of the OEM drive market**

Also due in the next two years are increased volumes of Japanese-built Winchesters. Development of 8- and 14-in. Winchesters by Japanese vendors came later in the product cycle for this hardware, and came in the form of higher capacity drives. To many observers, this confirms the belief that the Japanese are not nimble enough to compete in the more turbulent low end of the disk-drive business, and that the same will hold true for 5¼-in. drives.

Others feel that another attitude may be developing on the part of Japanese vendors, however. Japanese system builders are making an all-out attempt to crack the desk-top floppy-disk-based  $\mu$ c market in the U.S.,



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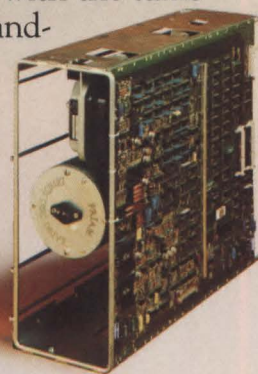
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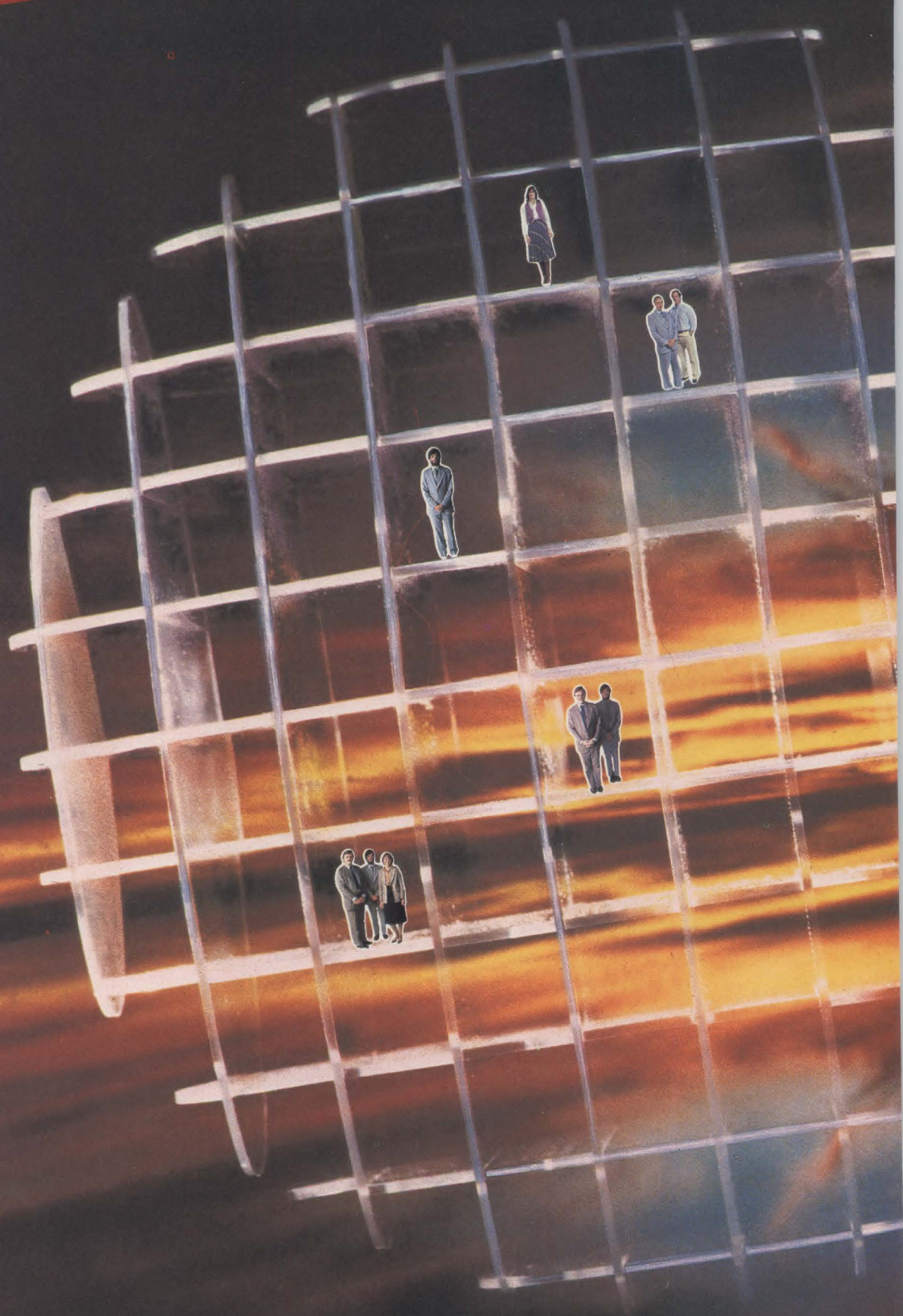
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*OEM drive vendors adopted IBM Winchester ferrite-head technology because it was convenient and because the demands of the plug-compatible market ensured that these components would be available from a number of suppliers.*

and it is routinely expected that many of their offerings will be designed to accommodate hard-disk upgrades. This tie-in between OEM drives and a system's capability could give the Japanese the stable customer base needed to support the sale of low-end 5¼-in.—and smaller—drives in the U.S. market.

Many of the 5¼-in. drives that could show up on the U.S. OEM market were introduced at a trade show in Japan last fall, and some were subsequently shown at the recent Comdex show in Las Vegas. Several were equipped with both proprietary and ST-506 interfacing in a move seen by many as designed to limit U.S. penetration of the Japanese OEM market while expedi-

ting sales of small rotating memories in this country.

#### **Continuously increasing emphasis on quality**

While Japanese marketing strategies in this country are beginning to cause concern among vendors of U.S. drives, there appears to be little that can be done from a legal point of view to bring the Japanese into line. Thus, to remain dominant in the OEM disk-drive market, U.S. vendors will have to become more competitive in the market, stressing not only higher performance, but quality and reliability.

U.S. vendors—particularly those supplying 5¼-in. hardware—will also continue to operate in a highly competitive pricing climate over the next two years. Many will respond to pricing pressures by boosting volumes; others will substitute increased performance in exchange for higher prices and lower volumes.

Other U.S. companies now building drives will cease to exist as independent entities during this time. No one is yet talking about a vendor shakeout, given the huge volumes proposed for small rotating memories. Many do expect, however, to see some drive vendors purchased outright by U.S. systems houses, as the large volumes of hardware required make it more cost-effective to bring peripheral operations in-house. ■

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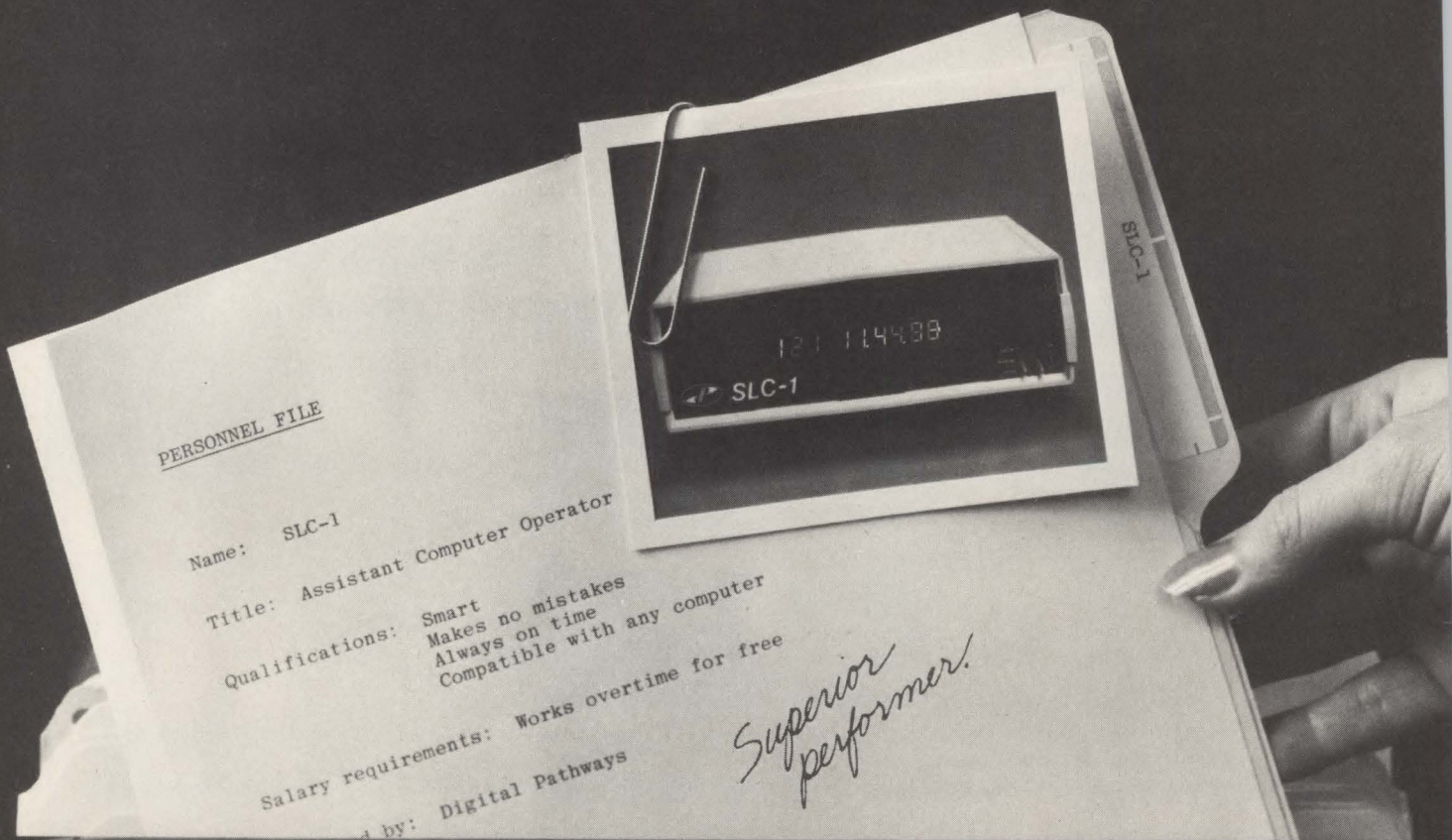
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## DISK DRIVES

# Rigid disks: the new small systems alternative

JAMES N. PORTER, Disk/Trend, Inc.

*New sizes, prices and capacities make Winchester's viable floppy-disk-drive substitutes*

Disk-drive manufacturers are chasing the  $\mu$ c market even more zealously than they chased the minicomputer market in the early 1970s, and their rapid product innovations are being matched by rapid market acceptance. By historical standards, the 5¼-in. Winchester-disk drive has been an instant success, and a major portion of all drives produced by 1984 will be 5¼- and 8-in. models. The international disk-drive market is worth \$7 billion. It will reach \$14 billion by 1984.

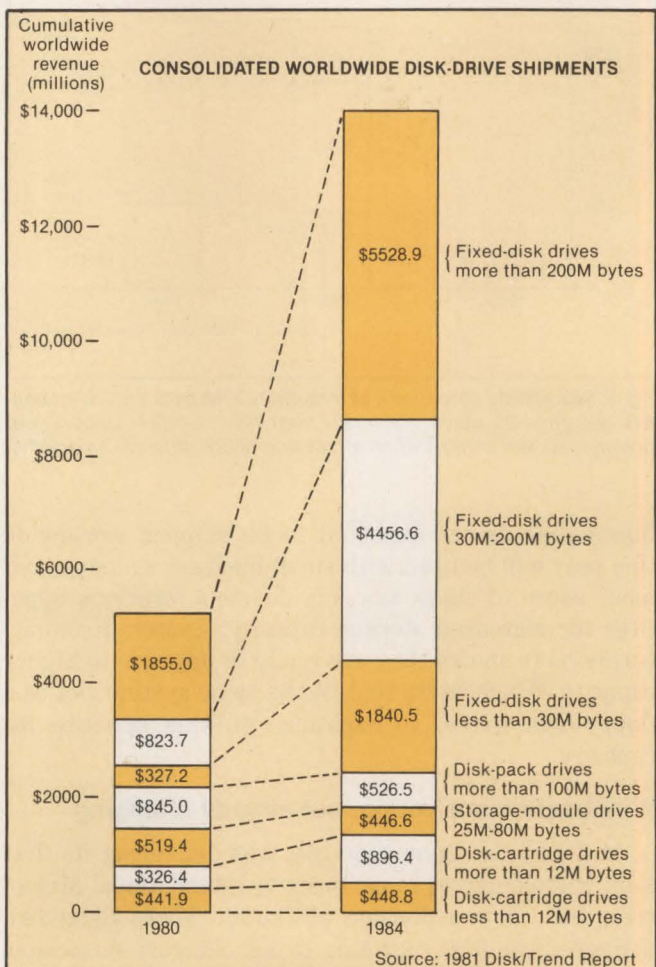
In addition to this continual downward swing in physical size, these trends characterize the disk-drive business:

- Capacities of 5¼-in. Winchester's will soar past the conventional 6M bytes this year and may reach 40M bytes.
- Very-high-capacity drives in the 8-in. range will be introduced this year.
- Drive vendors are making it possible for users accustomed to 14-in. removable disk cartridges to have them in smaller dimensions.

### Floppy drives set the stage for small Winchester's

In 1973, International Business Machines Corp. introduced the 3340, which was developed under the internal IBM code name "Winchester." This drive provided higher densities and better reliability by using low-mass heads and lubricated disks in an environment sealed against outside contamination. The industry has borrowed the term Winchester, and now generally uses the name to describe any disk drive using similar technology, regardless of capacity or disk size.

Also in 1973, IBM introduced the 8-in. floppy-disk-drive format, which immediately set a worldwide



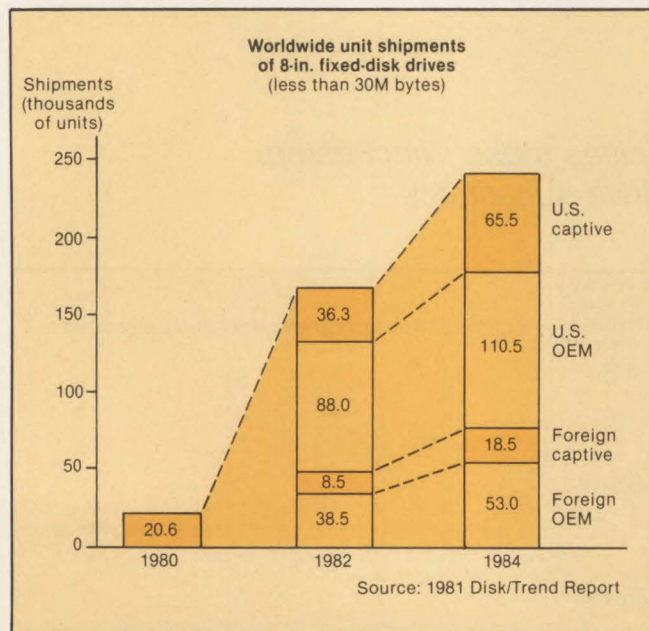
**Fig. 1. Disk-drive revenues will grow at least 29 percent annually through 1984. Strongest growth will occur in the fixed-disk markets, with lower capacity Winchester drives leading the way.**



*Depending on the number of work stations per system, demand for disk capacity and access time may vary from modest to relatively high levels.*

standard. The floppy became the preferred interchange standard for minicomputers and small-business systems within a few years. IBM's 8-in. floppy format was followed in 1976 by Shugart Associates' 5¼-in. version, which was better suited to desk-top computer systems.

The packaging of Winchester technology into the physical dimensions established for floppy-disk drives has been driven by the sharp growth in floppy-disk-drive shipments for small-computers, especially small-business systems. Almost half of the 4.8 million

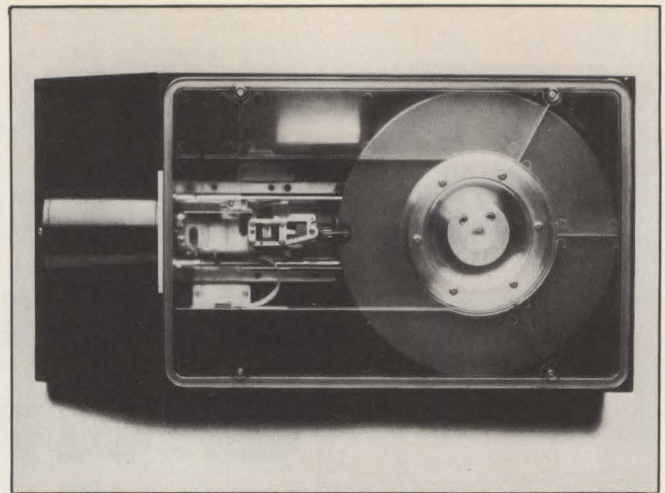


**Fig. 2. Worldwide shipments of less-than-30M-byte 8-in. Winchesters** will grow 39 percent annually from 1981 to 1984. Captive and foreign units will command an increasing share of future shipments.

floppy-disk drives expected to be shipped worldwide this year will be used with small-business systems, and most users of these systems develop voracious appetites for increased storage capacity. System manufacturers have shown they are ready to upgrade to higher capacity Winchesters that fit the same system slot as a floppy-disk drive, to capitalize on this appetite for capacity.

#### Winchesters are young, but already changing

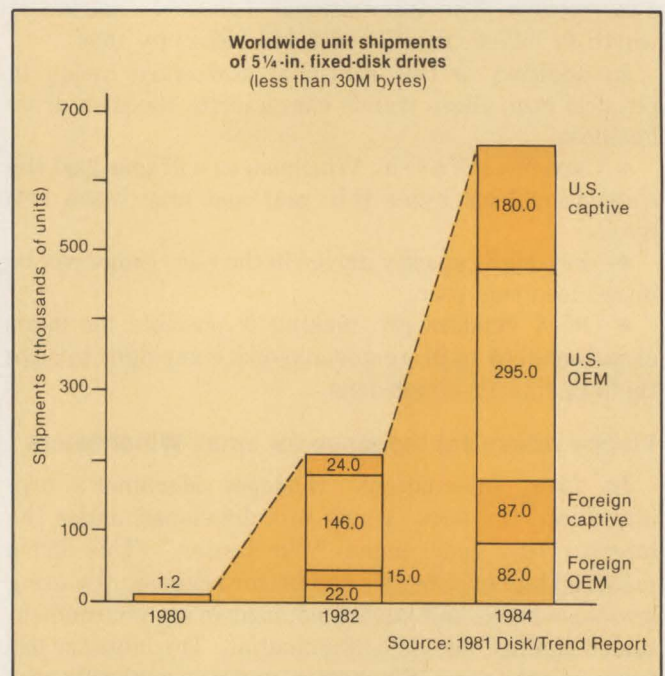
At about the same time IBM was delivering its first 8-in. Piccolo drives in early 1979, International Memories, Inc. (now a division of Dorado Micro Systems), delivered the first OEM 8-in. drive. Shugart Associates with its SA 1000 drives soon joined IMI in this market, and the two firms continue to lead the industry in 8-in. Winchester shipments, most of which store 10M bytes



**Fig. 3. Multi-platter, fixed, 8-in. drives** such as this 6170 series unit from BASF boast large capacities. The unit above stores 40M bytes on three platters and uses a linear actuator to achieve 27-msec. average head-positioning times. The 6170 is driven by a DC motor, has a 10,000-hour MTBF and does not require scheduled maintenance.

of data. Although several other announced manufacturers suffered extended production delays caused by a lack of Winchester manufacturing experience, an estimated 93,000 8-in. drives with less than 30M bytes of capacity were shipped worldwide in 1981 (Fig. 2).

The growth period for low-end 8-in. Winchesters in the 10M-byte range is severely limited by the emergence of 5¼-in. Winchesters in the same capacity range. The future for 8-in. fixed-disk drives is in applications requiring higher capacities and faster access. Numerous system manufacturers are offering



**Fig. 4. Worldwide shipments of 5¼-in. Winchesters** should grow at 117 percent annually from 1981 to 1984. Foreign vendors lag behind their U.S. competitors but will ship one-fourth of all 5¼-in. drives in 1984. Captive manufacturers are expected to jump on the 5¼-in. bandwagon and eventually account for nearly half of 1984 shipments.



Cutting the height of standard 8" floppys in half is a step in the right direction. But our market research said in this age of "smaller is better," it doesn't go quite far enough.

That's why, at MPI, we didn't stop at halfway. We cut the height to 2.0"! And thereby created the new industry standard.

It's our Slimline™ series. The smallest 8" disk drives ever made.

They're designed so you can easily fit one under a CRT or keyboard. Or, where one drive used to go, you can stack two.

Which makes them the perfect size for the microcomputers of the 80s. Because your designs can become simpler, more Ergonomic.

And we start you off with unique, people-designed features of our own. Like an easy opening push-button door. And a one-step disk ejector.

But we don't ask you to rush headlong into the future on our say-so alone. We have 4.62" bezels and doors that will fit your current system. So order evaluation units now.

Then see what you think of a drive that's only 2.0" high and 11.5" deep, weighs but 5 lbs., yet stores up to 1.6 Mb. One that comes with a tiny, reliable DC motor, needs only 28 watts of power and dissipates far less heat than older models.

Take the next evolutionary step into the Age of the 2.0" Drive.

It's a step we've planned for—and brought to fruition—at MPI.



Micro Peripherals, Inc.  
9754 Deering Ave., Chatsworth, CA 91311  
Phone (213) 709-4202, Twx (910) 494-1213

# EVOLUTION OF THE 8" FLOPPY DRIVE.

**OLD  
STANDARD**

**HALF SIZE**

**NEW  
STANDARD**

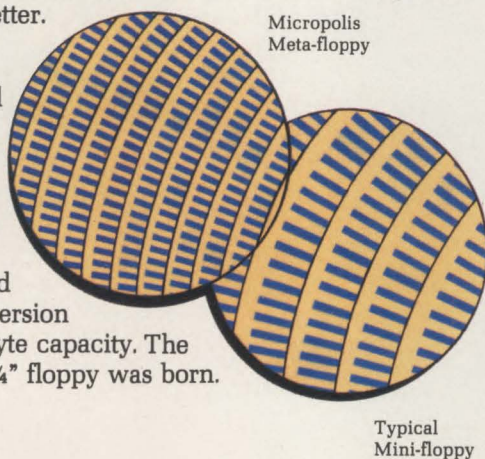


# Some plain 96/100 TPI

## FACT: We invented 1 megabyte technology.

When the mini-floppy, with less than 100 kbytes capacity was introduced in 1976, we had a choice. Go along with the rest or do better.

We chose to do better. Within a year we doubled both bit density and tracks per inch, resulting in a single sided floppy with 0.5 million bytes and a double sided version with one megabyte capacity. The high capacity 5¼" floppy was born.

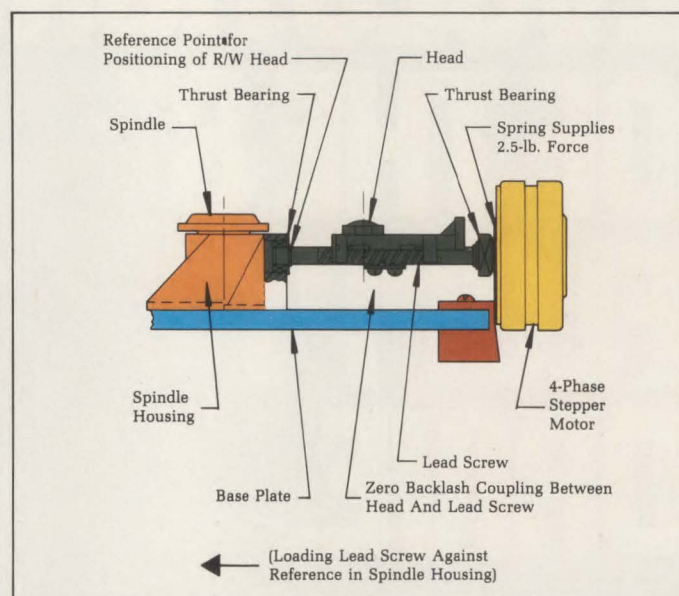


## FACT: It took solid engineering to do this.

To quadruple capacity, yet keep interchangeability at the highest level, was no easy task. It took solid, innovative engineering at all levels. The result:

- **Disk Centering Mechanism** - In our drive, the center of the diskette fits over a profiled spindle and is clamped into place while the spindle rotates to assist centering. This technique assures precise centering to within 250  $\mu$ -inches and eliminates disk crunching problems.
- **Head Positioning Accuracy** - A precision ground stainless steel leadscrew with metal follower provides more precise positioning than the run-out sensitive pulley and belt approach used by others. Use of a four phase stepper motor and four steps per track averages the effects of all stator and rotor poles, resulting in  $\pm 83$   $\mu$ -inches positional accuracy.
- **Temperature Compensation** - Our temperature compensation loop includes only the diskette, pre-loaded leadscrew and spindle housing. The baseplate is specifically excluded since its expansion is compensated

by a proportional change in the preload of the leadscrew. This approach consistently limits temperature variations to  $\pm 250$   $\mu$ -inches.



- **Balance Between Speed & Accuracy** - We chose 10ms track-to-track positioning and 380 kbps transfer rate as an optimum balance between speed on one hand, and accuracy and interchangeability on the other.
- **Silent Operation** - In band type drives an annoying chatter results from the head's travel from track to track. Our precision stainless mechanism eliminates this noisy irritation.

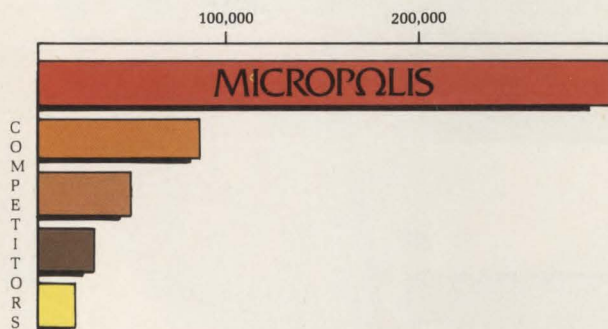
## FACT: Our drives really work.

While others are still learning, our 96/100 TPI drives are operating reliably in systems all over the world. So well, in fact, that we're extending the warranty to 12 months on new OEM agreements. Design and process controls learned years ago, coupled with effective quality control, assures drives ready to work in your system.



# facts about 5¼" floppies

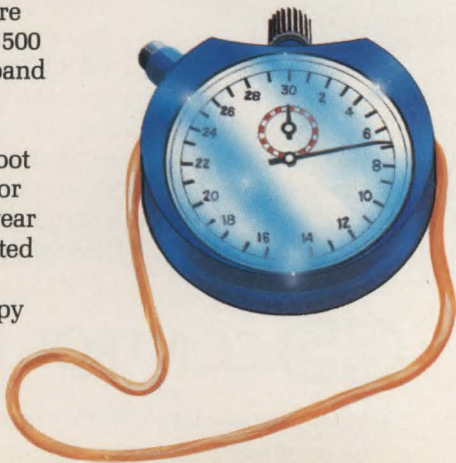
**FACT:** We've delivered more 96/100 TPI drives to OEM's than all others.



To date we've delivered over 200,000 double track density drives; more than all of our competitors combined. Hundreds of manufacturers of successful small business systems have selected Micropolis drives for their cost effectiveness and proven reliability.

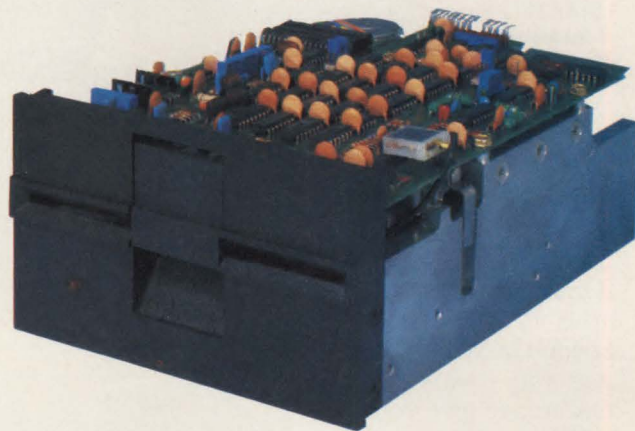
**FACT:** We're producing more than one each minute.

If you need high performance floppies on time, and in quantity, come to Micropolis. We're producing over 500 a day... and expanding. Expansion includes a new 60,000 square foot plant planned for occupancy by year end and dedicated completely to 96/100 TPI floppy production.



**FACT:** We've invented again - A 2 megabyte 5¼ inch floppy.

At NCC we introduced a new 2 megabyte floppy, made possible by again doubling density to 12,000 bits per inch. Micropolis' Model 1117 has 6ms track to track positioning, 500 kbps transfer rate and a host of features including a "chassis within a chassis" for unparalleled electrical shielding and resistance to mounting effect. Industry standard mounting and bezel permit easy introduction into existing systems.



So you win both ways with Micropolis. If you need 96/100 TPI floppies now, order our field proven 1015/1016 series. If you're working on a new system, design in our 2 megabyte Model 1117, the high performance "chassis within a chassis" floppy.

For more information phone us or write on your letterhead.

## MICROPOLIS™

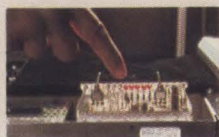
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# Removable storage and larger capacity

## Attach your Series/1 to Control Data Storage Module Drives



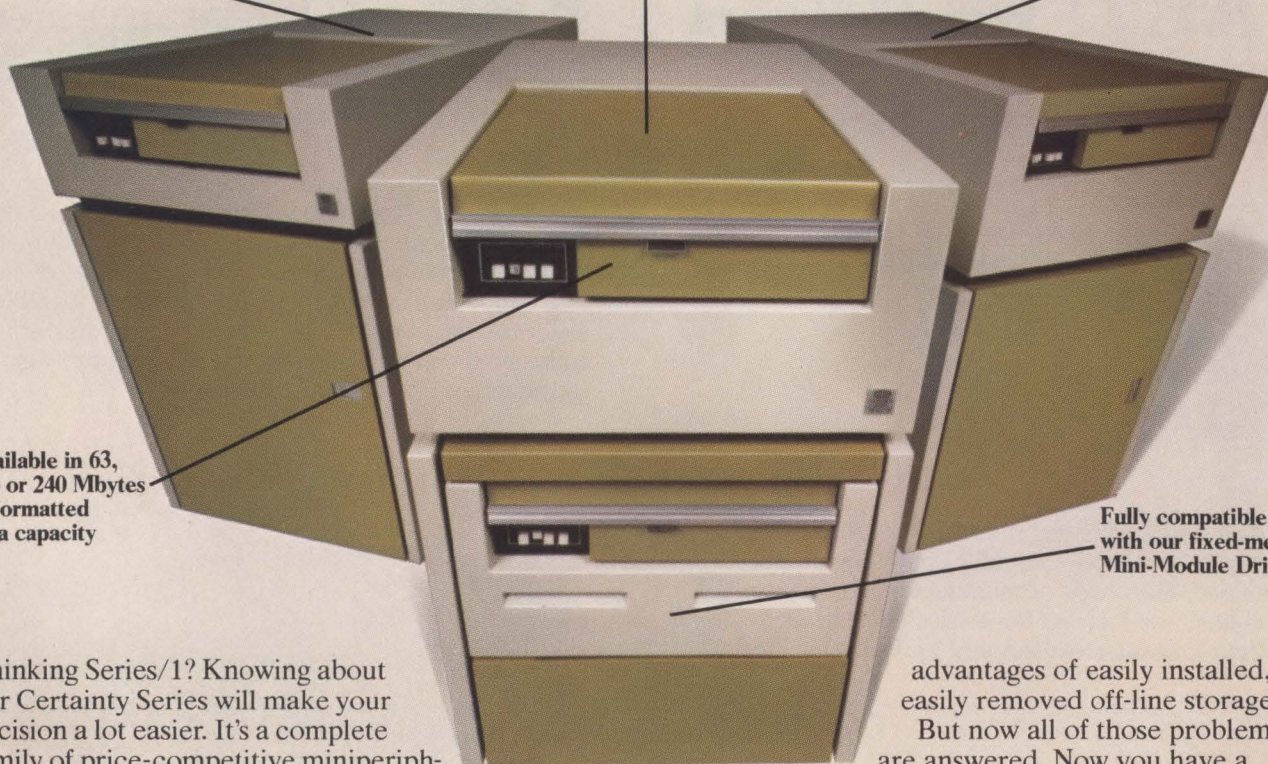
**Microdiagnostics and modularity**  
Lessens your downtime for maintenance and speeds repairs.



**Removable media**  
Gives you off-line storage and back-up advantages over fixed disk



**Proven head technology**  
Low mass design and rigid quality controls bring you high storage density and exceptional reliability.



Available in 63, 126 or 240 Mbytes of formatted data capacity

Fully compatible with our fixed-media Mini-Module Drive

Thinking Series/1? Knowing about our Certainty Series will make your decision a lot easier. It's a complete family of price-competitive miniperipherals. Products that go beyond mere plug compatibility—with added features to give you added performance.

Our Certainty 270 Storage Module Drives are good examples. Because until we made them available, you couldn't buy compatible disk storage units with capacities greater than 64 Mbytes. And you didn't have removable back-up capability, either. (Unless you wanted to back-up 64 Mbytes of fixed storage into 100 or so floppy disks!) Until the Certainty Series, you just didn't have all the

advantages of easily installed, easily removed off-line storage.

But now all of those problems are answered. Now you have a choice of three SMD's. Three models with formatted data capacities of 63, 126 or 240 Mbytes of removable media. All are ready for direct connection to the I/O bus of your Series/1 processor. All are

ready to give you more performance for your money.

You won't have to worry about service, either. More than 4800 Customer Engineers in our worldwide maintenance organization support our products. And Control Data also provides the required software support of all major releases of IBM operating software.



### Available Now

Our Certainty 270 Series is ready to help you get optimum performance from your Series/1. For data sheets and more information, call today, toll free. 800/328-3390.

## CONTROL DATA

*Addressing society's major unmet needs  
as profitable business opportunities*



***Most 60M-byte and larger drives offer the standard SMD interface used with most of today's high-performance 14-in. OEM disk drives, plus a few unique interfaces and the ANSI interface proposed by the ANSI X3T9.3 technical subcommittee.***

distributed-data and/or word-processing systems using clusters of work stations that share higher performance disk drives.

Depending on the number of work stations per system, demand for disk capacity and access time may vary from modest to relatively high levels. A 20M-byte disk capacity and a 70-msec. average-access time might be adequate for a three-terminal cluster, for example, but 25 terminals might require 80M bytes and 25-msec. average-access times.

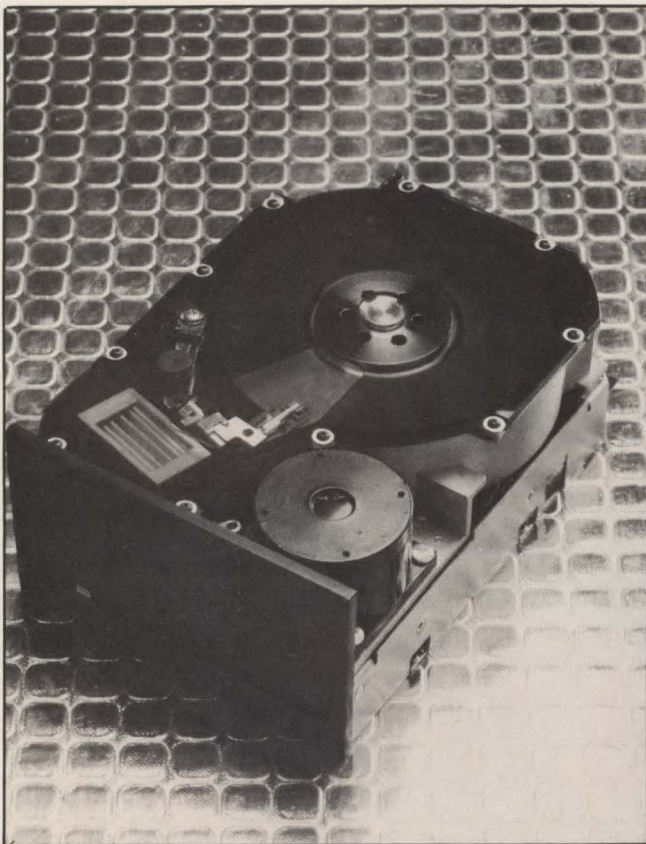
To take advantage of the growing market for small-disk drives for distributed-processing systems, disk-drive manufacturers provide drives with new design features. Several manufacturers ship 8-in. drives with as much as 40M bytes of capacity and 35 to 65-msec. average-access times (Fig. 3). Shugart Associates' SA1000 interface is the standard for drives in this

group introduced by Quantum Corp. and by Shugart itself, but several firms, including IMI, Micropolis Corp., Control Data Corp. and Fujitsu Ltd., offer additional interfaces, including intelligent versions.

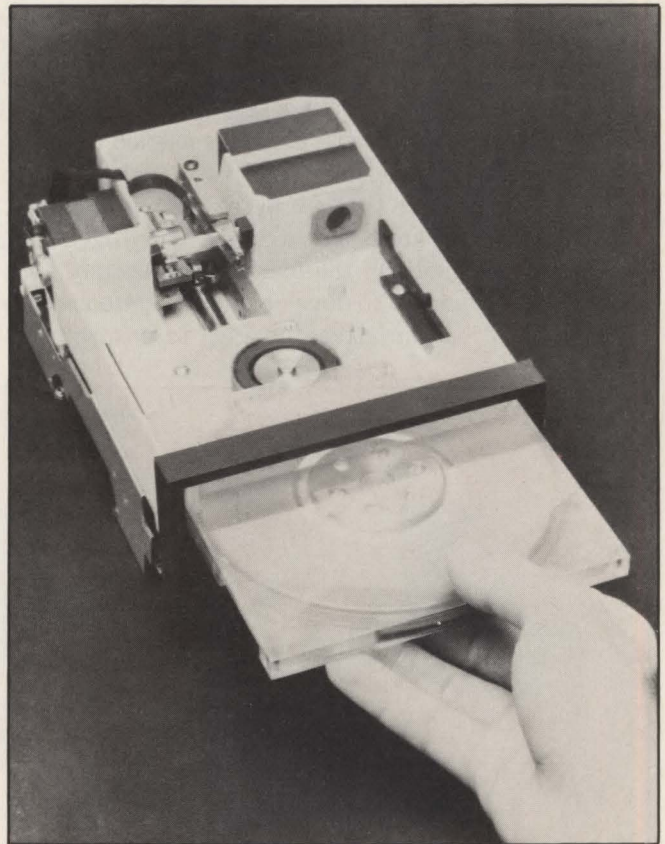
Deliveries of another group of fixed Winchester 8-in. drives is just beginning. These drives emphasize more capacity and faster access, and come from manufacturers known for higher-performance disk-storage technology. The drives range from 60M to 84M bytes with average-access times from 20 to 42 msec. Companies offering these drives include Ampex Corp., Fujitsu, Priam Corp., 3M Co., SLI Industries and IBM, and others are expected.

Further development of high-capacity, fixed-disk drives in the 8-in. range is expected. Drives with capacities of 160M bytes should be introduced in mid-1982. Those drives will use recording technologies available to most manufacturers. Higher density recording will be feasible with the thin-film heads and thin-film media being developed.

Most 60M-byte and larger drives offer the standard SMD interface used with most of today's high-performance 14-in. OEM disk drives, plus a few unique interfaces and the ANSI interface proposed by the ANSI X3T9.3 technical subcommittee. Future intelligent interfaces should make deep inroads in the share held by the SMD standard. Some of the smart interfaces will include a buffering capability so that systems can



**Fig. 5.** Rising 5 1/4-in. disk capacities are exemplified by this 19.14M-byte unit from Computer Memories, Inc. Recording almost 5M bytes on each of its four platters, the model CM 5000 features Winchester technology, industry-standard mounting dimensions and optional transfer rate for 8-in. Winchester compatibility.



**Fig. 6.** Seagate Technology's ST-706, a 5 1/4-in. cartridge-disk drive, stores 6.38M bytes (unformatted). The drive uses thin-film heads and is intended for backup applications with multitasking, multi-user, 16- and 32-bit systems.



***Drive manufacturers saw that the largest and most receptive market for high-capacity 5¼-in. floppies was the small-business-systems market.***

accept data streams at acceptable rates, despite the higher transfer rates made necessary by tomorrow's extremely high recording densities.

**Winchesters dominate floppy-upgrade market**

Almost 2 million 5¼-in. floppy-disk drives were shipped worldwide in 1981, including both single- and double-sided models. By 1984, the total is expected to exceed 5 million drives. The original single-sided 5¼-in. floppy, introduced in 1976, was conceived as a disk for personal computers and word processors with only 110K-byte capacity. However, several developments changed this outlook. Double linear-recording density, double-track density and double-sided recording increased unformatted capacity for the 5¼-in. floppy-disk format to 1M byte. Drive manufacturers saw that the largest and most receptive market for high-capacity 5¼-in. floppies was the small-business-system market.

By 1979, 1M-byte, 5¼-in. floppy-disk drives seemed adequate for most desk-top small-business systems—but a sizable minority of systems needed substantially more disk capacity because desk-top units started to compete for applications previously handled by much larger systems. It was not then practical to push floppy recording technology to the densities needed to satisfy these system requirements, and even today, 5¼-in. floppies storing more than 2M bytes are not imminent.

Sensing the market potential of a 5¼-in. drive using Winchester technology, the founders of Seagate Technology moved quickly to develop one. Seagate used the technology at conservative densities to ensure a fast

startup, held packaging to the standard SA 400 dimensions to fit existing system enclosures and designed an interface similar to the SA 1000 8-in. Winchester drives to take advantage of available controllers. Seagate deliveries started in July, 1980, and touched off a stampede as existing and new disk-drive manufacturers tried to bring competitive 5¼-in. Winchester-disk drives into production.

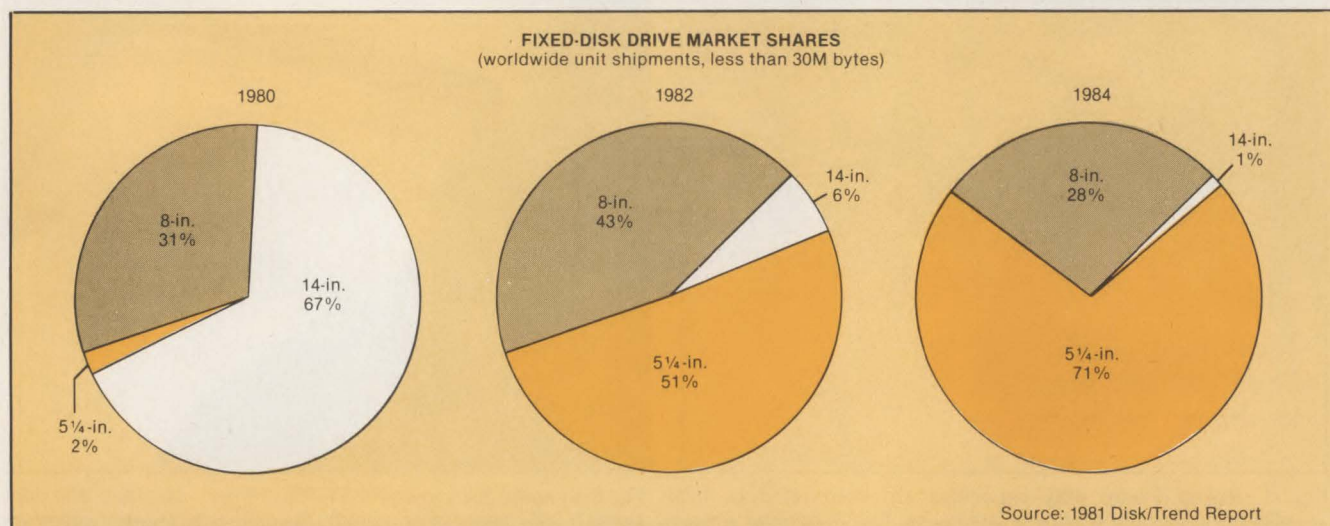
Only 1200 5¼-in. Winchesters were delivered in 1980, all by Seagate, but worldwide shipments grew to an estimated total of 63,000 drives in 1981 (Fig. 4). The *Disk/Trend* forecast of worldwide shipments of 5¼-in. fixed-disk drives storing less than 30M bytes in 1984 is 644,000 drives. More than 20 additional disk-drive manufacturers have followed Seagate into the field.

Most 5¼-in. Winchesters shipped in 1981 were 6M-byte drives. Seagate and most of its competitors have also announced 12M-byte drives, and some product lines planned for early 1982 feature capacities as high as 19M bytes (Fig. 5). At least one manufacturer offers a 50-percent bonus in capacity through a run-length-limited encoding scheme.

Most 6M- and 12M-byte, 5¼-in. Winchesters will probably be used with single-work-station systems. However, 5¼-in. fixed drives in the 30M- to 50M-byte range are expected by 1983, and these drives will compete in a different arena. Just as 5¼-in. Winchesters are becoming the choice of system designers over 8-in. Winchesters for single-user small-business systems, higher capacity 5¼-in. Winchesters are expected to open a new market with multi-user systems. The industry is fast reaching the stage at which a master work station in a five- to 15-terminal cluster need be no larger physically than the individual satellites. And the high-capacity, fast-access 5¼-in. fixed disks necessary for this development will soon be here.

**Cartridge-disk dimensions are shrinking, too**

A generation of minicomputer and small-business-system users have grown up using 14-in. removable



Fixed-disk drive market shares for less-than-30M-byte units are split by disk size. Winchester technology is used in 14-, 8- and 5¼-in. drives, but larger drives are losing popularity as a result of soaring 5¼-in. capacities that reach 38M bytes.



# RMS ANNOUNCES THE 27MB 5 1/4" WINCHESTER



## 27 Megabytes in a 5 1/4" Winchester. All without plated media or thin film flim-flam.

RMS does it again. Our new series boasts capacity to 18 megabytes using conventional Winchester technology. And with our Data Express®-II data separator, capacity increases to a generous 27 megabytes. All without plated media or thin film flim-flam.

Here is the capacity you need. For multi-user systems and networks. For transaction-oriented and data base management applications. For bigger on-line programs. And that capacity is available within 70 ms (average access time).

Only RMS gives you all these features:

### CHOICE OF EIGHT CAPACITIES

STANDARD megabytes	WITH DATA EXPRESS-II megabytes
RMS 518 18	27
RMS 513 13.5	20.25
RMS 509 9	13.5
RMS 504 4.5	6.75

- ☐ Proprietary head positioning system with electronically dampened actuator
- ☐ Buffered step mode
- ☐ Integral microprocessor control
- ☐ All DC voltages
- ☐ Minifloppy form factor
- ☐ Industry-standard 5 1/4" Winchester interface
- ☐ Electrical spindle brake
- ☐ Landing/shipping zone outside the data area
- ☐ Heat dissipation of only 19.4 watts
- ☐ Built-in AGC
- ☐ Industry-standard transfer rate (5 MHz)
- ☐ Data Express-II transfer rate (7.5 MHz)
- ☐ Data Express data separators (optional)

For better cost per byte with the reliability of proven Winchester technology, talk to RMS. Circle the readers' service number for a free brochure. Better yet, call us to order your evaluation unit. We're accepting orders now.

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## Capacity without Compromise



## OEM RIGID-DISK DRIVES

This list includes drives offered for sale in the U.S. to the OEM market, regardless of whether manufactured in the U.S. or elsewhere. Drives made by major data-processing system vendors for sale to their captive end users are excluded, as are subsystems assembled by resellers. Also omitted are 14-in. drives of all capacities in order to concentrate on the newer generation of smaller disks.

Manufacturer Model	Unformatted capacity (M bytes)	Number of data surfaces	Bytes per track	Average access time including latency (msec.)	Transfer rate (K bytes/sec.)	Actuator type	Interface type
<b>8- AND 10½-IN. FIXED DISKS</b>							
<b>Ampex Corp.</b>							
Scorpio 48	49.7	3	20,160	40.3	1209	linear, voice coil	SMD
Scorpio 80	82.9	5	20,160	40.3	1209	linear, voice coil	SMD
<b>BASF Systems</b>							
6171	8	1	13,344	35.3	800	linear, voice coil	BASF SMD, ANSI
6172	24	3	13,344	35.3	800	linear, voice coil	BASF SMD, ANSI
6173	40	5	13,344	35.3	800	linear, voice coil	BASF SMD, ANSI
<b>Cii-Honeywell Bull</b>							
Cynthia D 160/4, D162/4	60.2 (formatted)	4	12,800	48.3	920	linear, voice coil	Cynthia
Cynthia D160/6, D162/6	90.31 (formatted)	6	12,800	48.3	920	linear, voice coil	Cynthia
Cynthia D160/8, D162/8	120.42 (formatted)	8	12,800	48.3	920	linear, voice coil	Cynthia
<b>Control Data Corp.</b>							
9410-8 Finch	8.13	1	13,440	58.3	806	Rotary, voice coil	modified floppy-disk type
9410-24 Finch	24.39	3	13,440	58.3	806	Rotary, voice coil	modified floppy-disk type
9410-32 Finch	32.5	4	13,440	58.3	806	Rotary, voice coil	modified floppy-disk type
<b>Data Peripherals</b>							
DP 100	46.4	4	13,440	68.3	875	linear, voice coil	modified SA1000
Puma DP 400	46.4	4	13,440	68.3	875	linear, voice coil	modified SA1000
<b>Fijitsu America, Inc.</b>							
M2301B/K	11.712	4	12,000	80.1	593	band, stepping motor	Model B:SA4000; Model K: bidirectional
M2302B/K	23.424	8	12,000	80.1	593	band, stepping motor	Model B:SA4000; Model K: bidirectional
M2311K	48.250	4	20,480	28.3	1229	rotary, voice coil	SMD
M2312K	84.439	7	20,480	28.3	1229	rotary, voice coil	SMD
<b>Hitachi America, Ltd.</b>							
DK801-1	6.9	2	13,300	78.5	889	rotary, stepping motor	Modified SMD
DK801-2	13.9	4	13,300	78.5	889	rotary, stepping motor	Modified SMD
DK811-2	24	3	12,800	33.5	904	rotary, voice coil	Modified SMD
DK811-4	48	6	12,800	33.5	904	rotary, voice coil	Modified SMD
<b>Hokushin Electric Works</b>							
CD-8010P	11.5	4	15,151	81.3	900	band, stepping motor	Priam
<b>IBM Corp.</b>							
680	64.5 (formatted)	11	16,384 (formatted)	36.6	1031	rotary, voice coil	IBM
<b>International Memories, Inc.</b>							
7710	11.12	3	10,800	43.3	648	linear, voice coil	IMI
7720	20.5	5	10,800	43.3	648	linear, voice coil	IMI
7740	40	5	10,800	58.3	648	linear, voice coil	IMI
<b>Kennedy Co.</b>							
7300	41.4	5	20,160	38.3	967	rotary, voice coil	SMD, Kennedy, ANSI
<b>Memorex Corp.</b>							
101	11.7	4	12,000	80.1	593	band, stepping motor	SA4000
102	23.4	8	12,000	80.1	593	band, stepping motor	SA4000
<b>Micropolis</b>							
1221-I, 1201-I	8.911	1	15,364	50.3	922	rotary, voice coil	Micropolis, ANSI
1222-I, 1202-I	26.73	3	15,364	50.3	922	rotary, voice coil	Micropolis, ANSI
1223-I, 1203-I	44.56	5	15,364	50.3	922	rotary, voice coil	Micropolis, ANSI
<b>Mitsubishi Electric Corp.</b>							
M2860-1	21.73	3	13,440	43.3	806	linear, voice coil	Trident, SMD, SA1000
M2860-2	50.71	7	13,440	43.3	806	linear, voice coil	Trident, SMD, SA1000
<b>New World Computer</b>							
Mikro-Disk VIII-I	1.8	1	11,300	26.6	675	stepping motor	ST-506, SA1000
Mikro-Disk VIII-ITF	5	1	16,500	36.6	988	stepping motor	ST-506, SA1000



# MITSUBISHI SETS NEW STANDARDS FOR DISK DRIVES

It's harder today to specify the drive your system may need than it may have been only a year ago. Why?

So many manufacturers have marketed the "perfect" drive. More models and styles. But somewhere along the way something was lost. In many instances, the disk drive became just *another* mechanical assembly.

What makes a MITSUBISHI Disk Drive different? The operating efficiency, reliability, and cost-performance ratios are never taken for granted in a Mitsubishi Disk Drive, or any other high-technology product that carries with it the Mitsubishi tradition of quality and integrity. These are the standards OEM's have waited for.

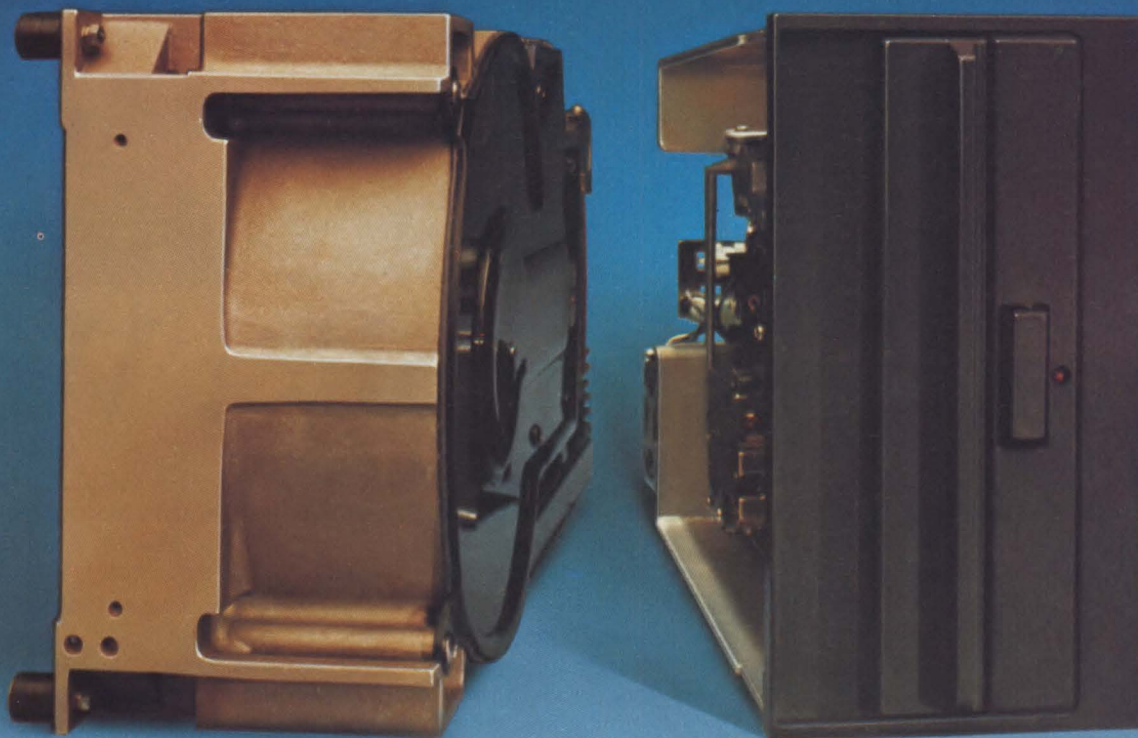
For example, the M2894 8" Double-sided, Double-density Flexible Disk Drive: filled with more than interface compatibility and interchangeability with a Shugart SA85OR. Or, Mitsubishi M2860 Series 8" Fixed Disk Drives with 21.73 or 50.71 MB capacity. Again interface compatible with SMD, Shugart and ANSI.

In each, Mitsubishi innovations abound. On the M2894, carefully engineered positioning of the stepper motor to prevent media damage or disk expansion, and SOFTOUCH™, a proprietary head-loading design that minimizes media wear. And, on the M2860 Winchester drive, high stability, anti-vibration design is inherent. A Mitsubishi LSI micro-processor based system performs RAS functions equal to a 14-inch unit. Together, mechanics and electronics join for maximum operation reliability.

## NEW 5¼" MODELS

Now, ready for OEM consideration, are Mitsubishi's new 5¼" Mini-Flexible Drives. And, there are three new 5¼" Fixed Disk Drives from 3.3 to 10 Mbytes, too. How will these new Mini-Drives fit? Perfect interchangeability!

Call your nearest Mitsubishi Computer Peripherals Representative or write for complete specifications and technical manuals. Whatever the size of your application, let our standards join yours on the bottom line issue . . . Reliability.



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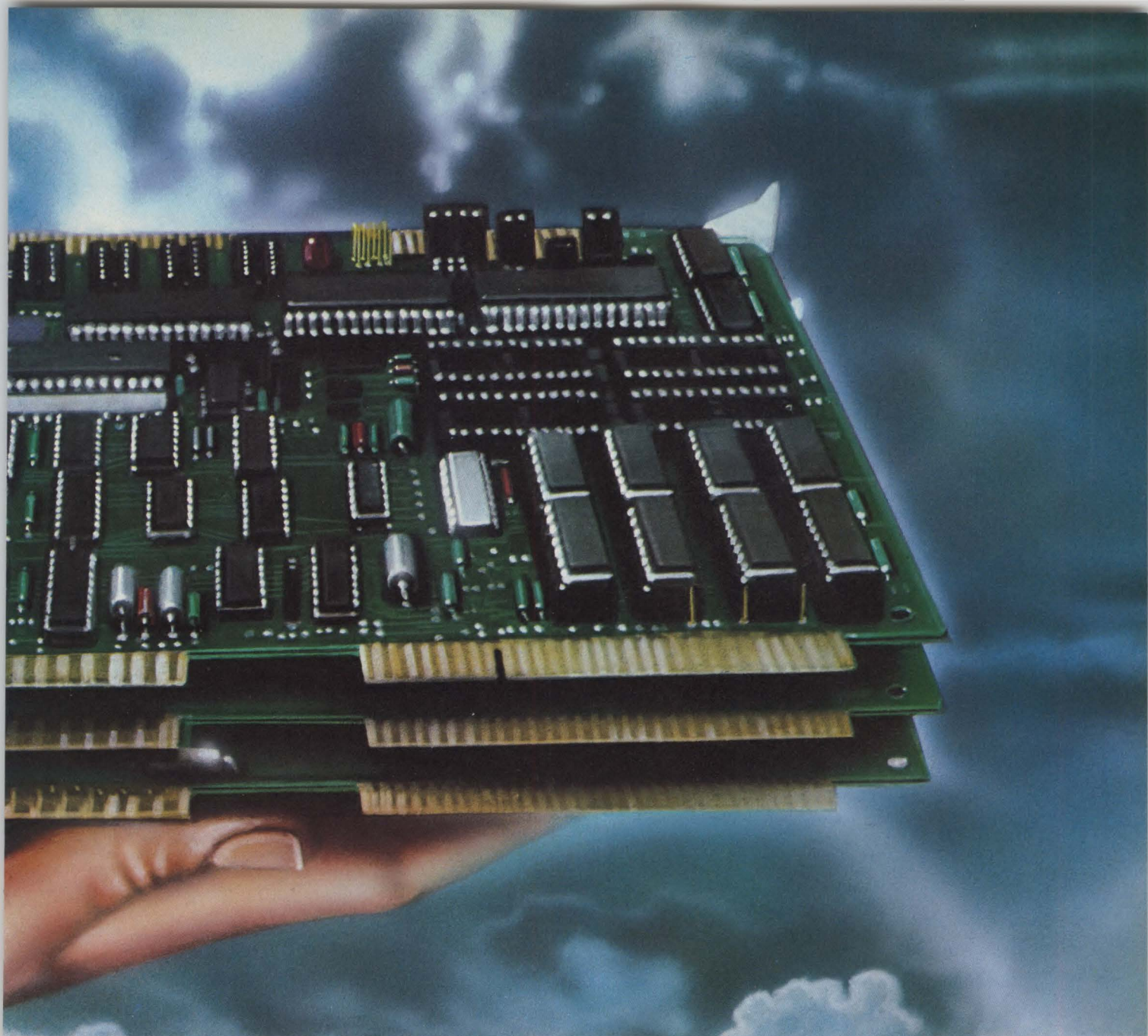
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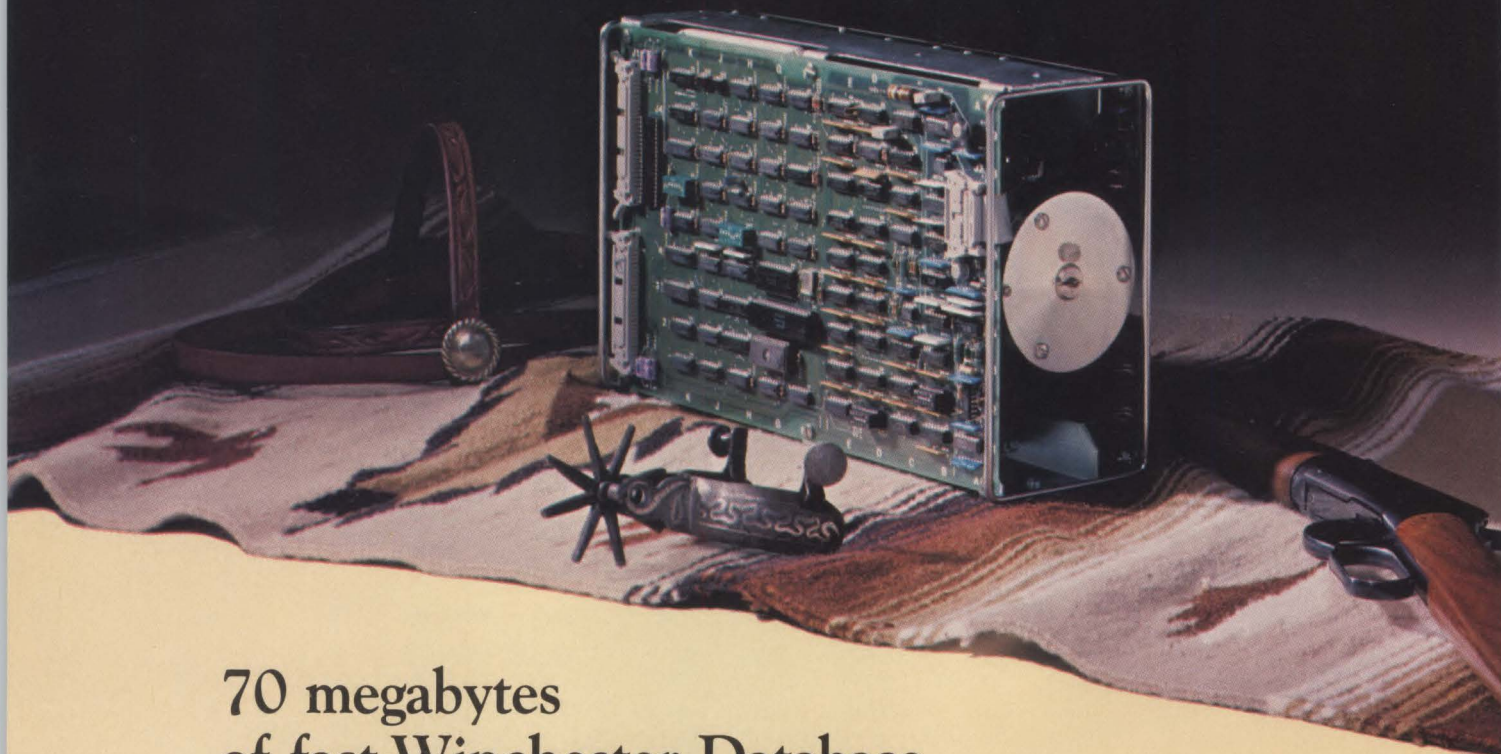
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<b>Nippon Electric Co.</b>							
D2220	25.49	3	20,480	38.55	1198	rotary, voice coil	SMD
D2230	42.49	5	20,480	38.55	1198	rotary, voice coil	SMD
<b>Nippon Peripherals</b>							
NP30-40	36.6	5	19,800	36.6	1031	rotary, voice coil	SMD
NP30-80	80.6	11	19,800	36.6	1031	rotary, voice coil	SMD
NP30-120	120.9	11	19,800	36.6	1031	rotary, voice coil	SMD
<b>Olivetti OPE</b>							
HD 830/1	34.75	3	17,850	48.3	800	linear, voice coil	bidirectional, ANSI
HD 830/2	57.92	5	17,850	48.3	800	linear, voice coil	bidirectional, ANSI X3T9.3
<b>Priam Corp.</b>							
Diskos 1070	10.8	4	15,151	81.4	900	band, stepping motor	Priam
Diskos 3450	35.28	5	13,440	50.3	800	linear, voice coil	Priam, SMD
Diskos 7050	70.49	5	13,440	50.3	800	linear, voice coil	Priam, SMD
<b>Quantum Corp.</b>							
Q2010	10.66	2	10,400	60	543	rotary, torque motor	SA1000
Q2020	21.33	4	10,400	65	543	rotary, torque motor	SA1000
Q2030	32.0	6	10,400	70	543	rotary, torque motor	SA1000
Q2040	42.66	8	10,400	75	543	rotary, torque motor	SA1000
<b>Shugart Associates</b>							
SA1002	5.33	2	10,400	79.6	542.5	band, stepping motor	SA1000
SA1004	10.67	4	10,400	79.6	542.5	band, stepping motor	SA1000
SA1104	20.3	3	10,400	34.6	542.5	rotary, voice coil	SA1000
SA1106	33.9	5	10,400	34.6	542.5	rotary, voice coil	SA1000
<b>SLI Industries</b>							
Cheyenne 7.44	7.44	1	11,340	48.3	602	rotary, voice coil	SMD, SA1000, ANSI
Cheyenne 22.3	22.3	3	11,340	48.3	602	rotary, voice coil	SMD, SA1000, ANSI
Cheyenne 37.2	37.2	5	11,340	48.3	602	rotary, voice coil	SMD, SA1000, ANSI
Cheyenne 52.07	52.07	7	11,340	48.3	602	rotary, voice coil	SMD, SA1000, ANSI
Cheyenne 83.0	83.0	5	20,160	48.3	1200	rotary, voice coil	SMD, SA1000
Cheyenne 116.14	116.14	7	20,160	48.3	1200	rotary, voice coil	SMD, SA1000, ANSI X3T9.3
<b>3M Co.</b>							
8431	10.03	2	17,920	74.6	933.3	rotary, stepping motor	ANSI
8432	20.07	4	17,920	74.6	933.3	rotary, stepping motor	ANSI
8533	60	4	17,920	38.6	933.3	rotary, voice coil	ANSI
<b>Toshiba Corp.</b>							
MK80F-10	15.32	2	20,160	48.3	1210	rotary, voice coil	SMD
MK80F-20	22.98	3	20,160	48.3	1210	rotary, voice coil	SMD
MK80F-30	38.3	5	20,160	48.3	1210	rotary, voice coil	SMD

#### 5¼-IN. FIXED DISKS

<b>Ampex Corp.</b>							
Pyxis 4	4	2	10,417	93.3	625	rotary, stepping motor	ST-506
Pyxis 8	8	4	10,417	93.3	625	rotary, stepping motor	ST-506
Pyxis 12	12	6	10,417	93.3	625	rotary, stepping motor	ST-506
Pyxis 16	16	8	10,417	93.3	625	rotary, stepping motor	ST-506
<b>BASF Systems</b>							
6181	3.19	2	10,416	123.3	625	band, stepping motor	ST-506
6182	6.38	4	10,416	123.3	625	band, stepping motor	ST-506
6183	9.57	6	10,416	123.3	625	band, stepping motor	ST-506
<b>Computer Memories, Inc.</b>							
CM5206	6.38	2	10,400	138.3	625	rotary, stepping motor	ST-506
CM5412	12.76	4	10,400	138.3	625	rotary, stepping motor	ST-506
CM5619	19.14	6	10,400	138.3	625	rotary, stepping motor	ST-506
<b>International Memories, Inc.</b>							
5007	6.72	4	12,000	171.25	960	band, stepping motor	IMI
5006H	6.38	2	10,416	168.3	625	band, stepping motor	ST-506
5012H	12.76	4	10,416	168.3	625	band, stepping motor	ST-506



5018H	19.14	6	10,416	168.3	625	band, stepping motor	ST-506
<b>Irwin International, Inc.</b> 510	12.3	2	10,080	33.32	675	rotary, voice coil	Irwin
<b>Micro Peripherals, Inc.</b> 10	12.06	4	8,900	34.5	625	rotary, stepping motor	SA1000
<b>Miniscribe</b> 1-006	6.4	2	10,417	202.3	625	rack and pinion, stepping motor	ST-506
1-012	12.8	4	10,417	202.3	625	rack and pinion, stepping motor	ST-506
<b>Mitsubishi Electric Corp.</b> M4863-1	3.33	2	10,417	83.3	625	rotary, stepping motor	ST-506
M4863-2	6.66	4	10,417	83.3	625	rotary, stepping motor	ST-506
M4863-3	10.0	6	10,417	83.3	625	rotary, stepping motor	ST-506
<b>New World Computer</b> Mikro Disc V 2/0	2	1	13,000	36.6	782	stepping motor	ST-506, SA1000
Mikro Disc V 4/0	4	2	13,000	36.6	782	stepping motor	ST-506, SA1000
<b>Nippon Peripherals, Ltd.</b> NP05-6	6.66	4	10,400	98.3	625	band, stepping motor	ST-506
NP05-10	10	6	10,400	98.3	625	band, stepping motor	ST-506
<b>Olivetti OPE</b> HD 513	12.3	2	10,080	33.32	675	rotary, voice coil	special
HD 561/1	3.75	2	10,417	94.3	625	band, stepping motor	ST-506
HD 561/2	7.50	4	10,417	94.3	625	band, stepping motor	ST-506
HD 561/3	11.25	6	10,417	94.3	625	band, stepping motor	ST-506
HD 512/1	13	3	10,080	38.3	690	linear, voice coil	bidirectional
HD 512/2	21.7	5	10,080	38.3	690	linear, voice coil	bidirectional
<b>Rodime</b> RO 101	4	2	10,416	93.3	625	rotary, stepping motor	ST-506
RO 102	8	4	10,416	93.3	625	rotary, stepping motor	ST-506
RO 103	12	6	10,416	93.3	625	rotary, stepping motor	ST-506
RO 104	16	8	10,416	93.3	625	rotary, stepping motor	ST-506
<b>Rotating Memory Systems</b> RMS 504	4.5	2	10,417	91.3	625	rotary, stepping motor	ST-506
RMS 509	9	4	10,417	91.3	625	rotary, stepping motor	ST-506
RMS 513	13.5	6	10,417	91.3	625	rotary, stepping motor	ST-506
RMS 504	4.5	2	10,417	91.3	625	rotary, stepping motor	ST-506
RMS 509	9.0	4	10,417	91.3	625	rotary, stepping motor	ST-506
RMS 513	13.5	6	10,417	91.3	625	rotary, stepping motor	ST-506
RMS 518	18.0	8	10,417	91.3	625	rotary, stepping motor	ST-506
<b>Seagate Technology</b> ST-506	6.38	4	10,417	178.3	625	band, stepping motor	ST-506
ST-412	12.76	4	10,417	178.3	625	band, stepping motor	ST-506
ST-538	38.25	6	10,416		625	band, stepping motor	ST-506
<b>Shugart Associates</b> SA602	3.33	2	10,400	84.6	542.5	band, stepping motor	SA1000
SA604	6.66	4	10,400	84.6	542.5	band, stepping motor	SA1000
SA606	10	6	10,400	84.6	542.5	band, stepping motor	SA100 type
<b>Tandon Magnetics</b> 602	6.38	4	10,400	176.3	625	rotary, stepping motor	SA1000, ST-506
602E	9.6	4	10,400	233.3	625	rotary, stepping motor	SA1000, ST-506
603	9.57	6	10,400	176.3	625	rotary, stepping motor	SA100, ST-506
603E	14.3	6	10,400	233.3	625	rotary, stepping motor	SA1000, ST-506



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We made our system hold the tape still while a rotating scanner reads/writes data on tape in the same format as your disk drive. Ingenious!

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**Only 1200 5¼-in. Winchesters were delivered in 1980, all by Seagate, but worldwide shipments grew to an estimated total of 63,000 drives in 1981.**

disk-cartridge drives. These users are very receptive to the idea of staying with the same concept of file organization and data backup, as systems become physically smaller.

A group of disk-drive manufacturers is enabling system manufacturers to stay with disk cartridges as they cut system size. In the 8-in. disk area, CDC introduced the Lark, a drive with 8M bytes fixed and 8M bytes removable capacity, and a double-density version is expected this year. Data Peripherals, a new firm, started shipping an 11M-byte removable-only disk cartridge drive in 1981. Other 8-in. cartridge drives are expected from several manufacturers, including Digital Equipment Corp., with an 8-in. cartridge drive equivalent to the widely used RL101 and RL102 family of 14-in. drives. Cartridge drives in the 5¼-in. size have also arrived on the scene. DMA Systems, another new company, is shipping a 5M-byte fixed, 5M-byte removable drive that meets the height and width standards for 5¼-in. drives.

Seagate has announced a removable-only 6M-byte drive using the same physical cartridge (Fig. 6).

#### RIGID DISK-DRIVE MANUFACTURERS (by location of home office)

	U.S.	Japan	Europe
Disk-cartridge drives (less than 12M bytes)	12	3	4
Disk-cartridge drives (more than 12M bytes)	10	4	3
Storage-module drives (25M-80M bytes)	8	1	1
Disk-pack drives (more than 100M bytes)	9	5	2
Fixed-disk drives (less than 30M bytes)	29	8	7
Fixed-disk drives (30M-200M bytes)	20	8	4
Fixed-disk drives (more than 200M bytes)	8	4	1

Source: 1981 Disk/Trend Report

Both 8- and 5¼-in. cartridge-disk drives will find a ready market among certain types of system manufacturers. Floppies must be used with fixed-Winchester drives when systems needing Winchesters must rely on software published on floppy disks or when lowest possible hardware cost is essential. And tape-cartridge streamers make more sense if convenient end-of-day backup is the prime reason for removable media in a system. But disk cartridges continue to excel for data-processing systems with a heavy save/restore requirement—when applications are frequently moved on and off the system. ■

#### Texas Instruments Inc.

525/61	6.38	2	10,417	123.3	625	band, stepping motor	SA1000, ST-506
525/122	12.75	4	10,417	123.3	625	band, stepping motor	SA1000, ST-506
525/62	6.38	4	10,417	178.3	625	band, stepping motor	SA1000, ST-506

#### CARTRIDGE DISKS

##### Cii-Honeywell Bull

Cynthia D120, D122	10 (formatted) removable	2	12,800	73.3	920	linear, voice coil	Cynthia
Cynthia D135, D137	5 fixed, 5 removable, (formatted)	2	12,800	108.3	920	linear, voice coil	Cynthia
Cynthia D140, D142	10 fixed, 10 removable (formatted)	4	12,800	73.3	920	linear, voice coil	Cynthia

##### Control Data Corp.

9455 Lark I	8.35 fixed, 8.35 removable	4	20,160	58.55	1209	linear, voice coil	SMD
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##### Data Peripherals, Inc.

DP100	11.02 removable	2	13,440	68.3	874	linear, voice coil	modified SA1000
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##### DMA Systems

Micro-Magnum 5/5	5 fixed, 5 removable	4	10,890	58.7	625	linear, voice coil	modified SA1000
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##### New World Computer

Mikro Disc V 2/2	2 fixed, 2 removable	2	13,000	36.6	782	stepping motor	ST-506, SA1000
Mikro Disc V 4/2	4 fixed, 2 removable	3	13,000	36.6	782	stepping motor	ST-506, SA1000
Mikro Disc V 4/4	4 fixed, 4 removable	4	13,000	36.6	782	stepping motor	ST-506 SA1000

##### Seagate Technology

ST-706	6.38	2	10,416		625	band, stepping motor	ST-506
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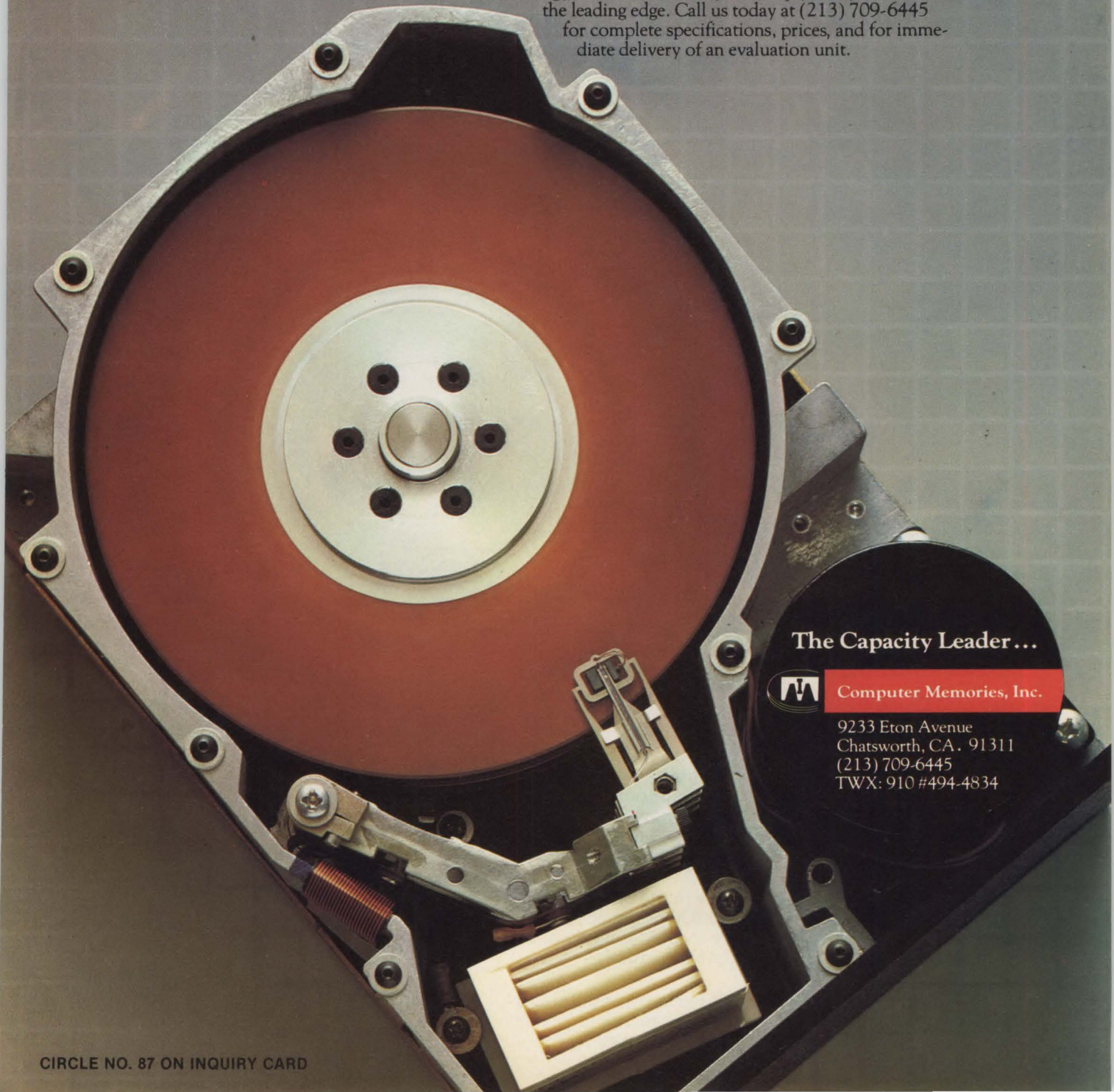
We've shipped hundreds of our high capacity CM 5000 units already. We told you nothing could beat them. For capacity. For reliability. For cost effectiveness.

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TrakStar offers ANSI standard interface to provide ease of integration, using industry-supported controllers. The rotary voice coil positioner, hard/soft sectoring and an 8-inch floppy form factor are part of TrakStar's unique combination of features that set it apart from the others.

Heads, disks and positioner are in the clean sealed section, with an unsurpassed 25,000 hours MTBF. The field-replaceable electronics are located outside of the sealed section, so that down time is virtually eliminated.

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**PERFECTING TECHNOLOGY**  
CIRCLE NO. 88 ON INQUIRY CARD



## DISK DRIVES

# Floppy-disk drives: a truly flexible industry standard

JAMES N. PORTER, Disk/Trend, Inc.

*Small-business-system sales will spur floppy-disk-drive market growth from \$2.3 billion this year to \$4.2 billion in 1984*

Worldwide floppy-disk drive shipments totaled 3.4 million units in 1981 and should reach 8.2 million units by 1984. Market revenues should grow at a compound annual rate of 37 percent through 1984, and shipments should grow at 34 percent annually during the same period.

But while the industry is growing rapidly, it is changing just as fast. Numerous product developments have appeared in the last few years, and multi-megabyte floppies will soon become a reality. Innovative manufacturers have grabbed large chunks of market share, especially with newer configurations of 5¼-in. drives. Changes in industry structure have been signaled by vertical integration such as the joint venture by Tandy Corp. and Datapoint Corp., which now share drive development and manufacturing efforts. Predictably, the floppy configuration that

started the floppy stampede in 1973, the single-sided 8-in. drive, is peaking and faces declining future shipments.

### Response to changing markets

Floppy-disk drives quickly replaced tape-cassette drives as the most popular storage devices for  $\mu$ p-based systems in those systems' earliest days. No other method matches the floppy's combination of low price, random access and removable media. The availability of floppy-disk drives has significantly changed the architecture, software and sales figures for small-business systems, word processors, personal computers and intelligent terminals.

In 1980, small-business systems used 46 percent of all floppy-disk drives shipped worldwide. Business data-processing applications have traditionally been gluttons

### THE DISK/TREND REPORT

Much of the information in this article is taken from the 1981 *Disk/Trend Report*, a detailed annual business review of the worldwide disk-drive industry. In addition to revenue and unit-shipment projections for floppy- and hard-disk drives of all types, *Disk/Trend Report* provides statistics of and analysis of installed drive populations, average

OEM selling prices, competitive market shares of manufacturers and a review of competing data-storage technologies. The report also contains basic specifications on all drives announced as of publication date and profiles on all manufacturers, worldwide.

Subscriptions to the 1981 *Disk/Trend Report*, including both the

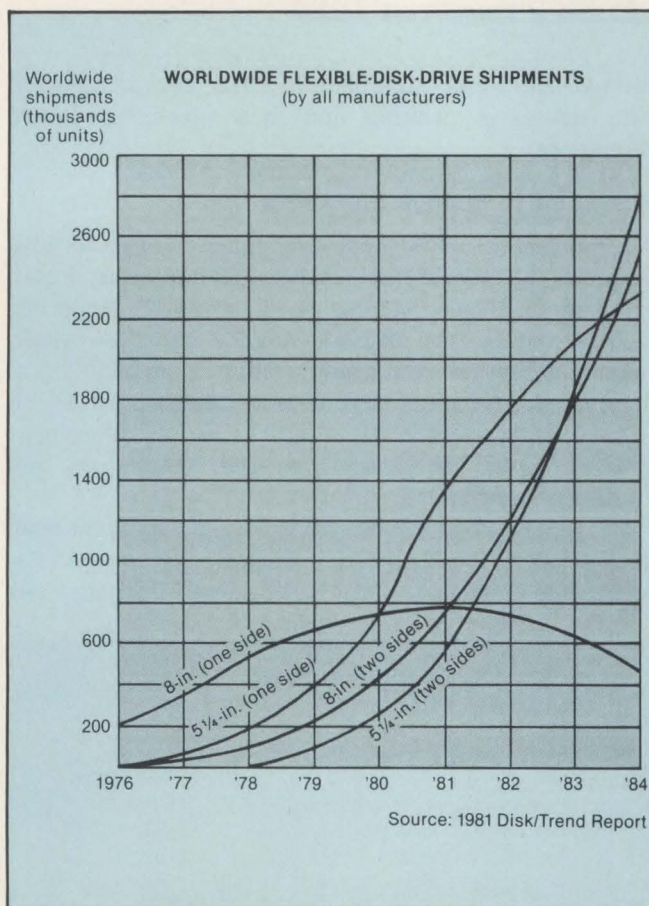
hard- and floppy-disk-drive sections, are available for \$1095 by contacting James N. Porter, Disk/Trend, Inc., 1224 Arbor Court, Mountain View, Calif. 94040. Individual sections are priced at \$730 for the report on hard-disk drives or \$510 for floppy-disk drives.



## Floppy-disk drives quickly replaced tape cassette drives as the most popular storage devices for $\mu$ p-based systems in those systems' earliest days.

for auxiliary data storage, whatever the system size, and this tendency will probably continue, even with desk-top computers. As evidence, 65 percent of worldwide 1981 shipments of double-sided 8-in. drives, the highest capacity floppy configuration, were used in small-business systems. The projection for 1984 sees this proportion growing to 75 percent, but by then double-sided 5¼-in. drives will rival 8-in. drives in the small-business-system market, despite a later start. The double-sided versions of both drive sizes will be leaders in capacity, but 5¼-in. drives will be more widely used with the faster growing desk-top small-business systems.

Word-processing applications accounted for 16 percent of 1980's floppy-disk-drive shipments, with single-sided 8-in. drives still the leader. By 1984, the leadership will have passed to the more compact 5¼-in. drives, both single- and double-sided models, which are expected to dominate the word-processing market.



**Fig. 1. Floppy-disk shipments reflect the trend toward greater floppy-disk capacity.** Shipments of single-sided, 8-in. drives have already peaked. Worldwide shipments of all types of floppy drives during 1980 totaled 2019 units and should be 8259 in 1984, a compound annual growth rate of 42 percent.

Hobby and personal computers made up 9 percent of floppy-disk-drive shipments in 1980. This is probably the most price-sensitive application in which floppy-disk-drives are widely used. The least expensive floppy drive, the single-sided 5¼-in. model, is the biggest seller in this market.

### Evolution of the market

Evolutionary changes such as double linear density, double track density or smaller sizes can occur gradually in response to market demand, but revolutionary advances such as changes in media standards or disk diameters need the sponsorship of an industry leader if rapid industry consensus is to be achieved.

Large quantity shipments of drives with capacities higher than 1.6M bytes for 8-in. drives and 1M byte for 5¼-in. drives have still not occurred, despite a demand for such products. Various drive and media manufacturers are joining forces to offer 5¼-in. drives with higher capacities. The same combinations are imminent in the 8-in. floppy-disk market, with several manufacturers seeking higher capacities with existing or new media. International Business Machines Corp. is the one firm that could solve the problem instantly by introducing a high-capacity floppy-disk drive and medium. But IBM introduces floppy-disk drives to meet its own system requirements and not to help the industry settle standardization questions.

### New floppies answer new system needs

Floppy-disk-drive manufacturers are aggressive in experimenting with new product forms. The first big innovation was the 5¼-in. single-sided drive introduced by Shugart Associates in 1976. Those drives used existing recording technology recast in a smaller package. Because of technical problems with double-sided floppy recording, production of double-sided 5¼-in. drives remained minimal until 1979.

By 1980, demand for compact size and larger capacity for small-business and word-processing systems, had forced production of double-sided 5¼-in. drives to 208,100 units worldwide. The technical problems of double-sided recording had been solved, and system manufacturers were ready to offer systems with still greater capacity. In early 1980, several manufacturers started to ship double-sided 5¼-in. drives with 96 tracks per in., twice the normal density. These devices provided 1M byte of unformatted capacity. Worldwide shipments of double-sided, 5¼-in. drives jumped to an estimated 568,000 in 1981, and this year are forecast to exceed 1.1 million units. In 1981, an estimated 26 percent of these drives had the higher track density, and it is projected that 73 percent of 1984's shipments will be 96-tpi drives.

Drive manufacturers continue to develop hardware to enhance the usefulness of the 5¼-in. disk. Micropolis has announced a double-sided drive that offers a 2M-byte capacity by recording at 96 tpi and 11,937 bpi, and Mitsubishi has announced a 96-tpi, 9621-bpi drive



## AMLYN'S NEW DRIVE IN ACTION

A new 5¼-in. floppy-disk drive from Amlyn Corp. provides high capacity in a small space by combining a five-disk cartridge with unique floppy-disk-handling mechanisms. The result is 8M bytes of storage in a 5¼-in. mounting space.

The Amlyn cartridge floppy-disk drive was designed to have three advantages over other backup devices:

- It stores the full capacity of a typical 6M-byte, 5¼-in. Winchester in one cartridge.
- It has the same interface as most 5¼-in. Winchester-disk drives. One controller and one software driver can easily control the Winchester-disk drive and its associated backup device.
- Because it is interfaced and controlled in the same way as the Winchester, it can stand in if the Winchester fails. Response times will be slower, but the drive can keep its host system up and running.

The main mechanical components of the Amlyn drive are the MiniPac diskette cartridge, the cartridge-articulation tray, a diskette-picker mechanism and a spindle-drive mechanism. All subsystems operate under the control of an Intel 8051  $\mu$ p and associated support chips, including 256 bytes of RAM and 4K bytes of PROM for microcode control instructions. The drive is available in two versions. One emulates an SA850 8-in. floppy-disk drive and appears to the system as if it were five SA850s; the other duplicates the ST-506 Winchester interface and appears to the system as a 5¼-in. Winchester disk.

**Diskette cartridge and articulator.** The MiniPac cartridge holds five single-sided, 5¼-in. floppy disks, each containing 154 tracks with a density of 170 tpi. Floppy disks are selected one at a time by the articulator tray. The cartridge is placed in the tray and, when the door is closed, the articulator mechanism positions the cartridge for selection of a floppy disk. A  $\mu$ p-controlled stepper motor tilts the tray to the proper angle for the picker mechanism to remove and replace the addressed disk.

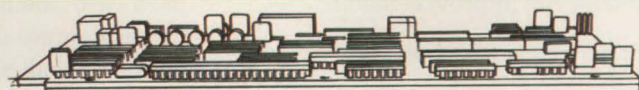
**Diskette picker.** The picker selects the appropriate disk from the articulated cartridge, moves and centers it over the spindle and clamps the diskette to the spindle. This action is simply reversed and then repeated when a different diskette is addressed. The floppy disk on the

spindle is unclamped and moved back to the cartridge, the tray is articulated to present the newly addressed diskette and then picked and clamped in place on the spindle.

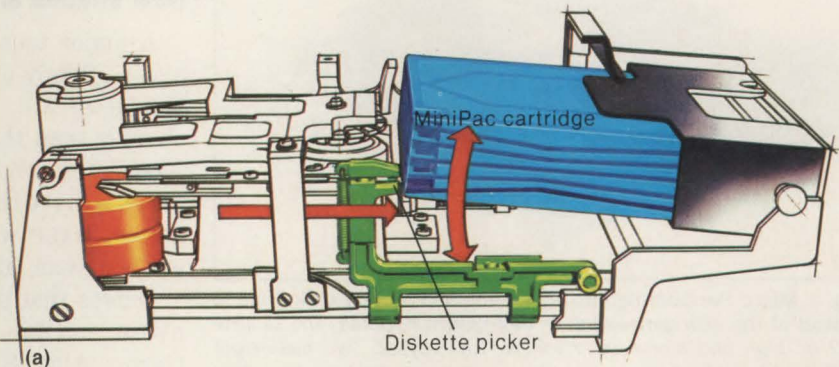
**Spindle drive.** A DC spindle-drive motor rotates the spindle via a belt-drive system. Two rotational speeds are provided, and speed is selected under  $\mu$ p control. Normal operating speed of the drive spindle is 360 rpm. A second speed of 600 rpm

is used to rotate disks recorded at 48 and 96 tpi.

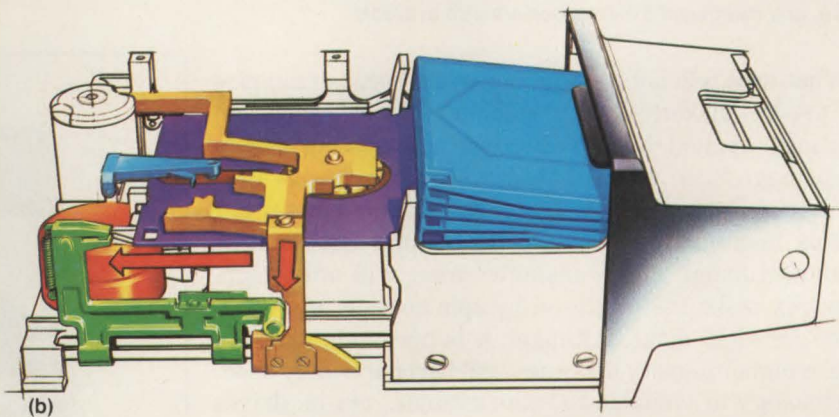
**Reference track location.** The location of the reference track on each diskette is determined each time the diskette is removed from the cartridge and clamped to the spindle. A servo loop samples reference-track eccentricities at eight locations around the disk, and the head/carriage assembly is microstepped as the diskette rotates to follow the data tracks.



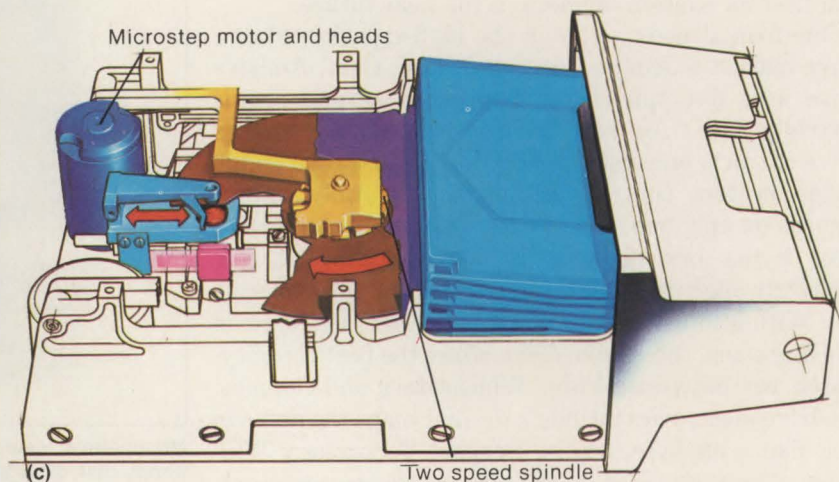
Control Electronics



(a)



(b)



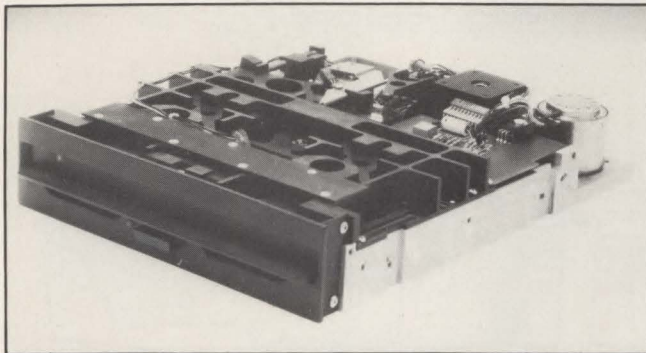
(c)

Two speed spindle



## ***Drive manufacturers continue to develop hardware to enhance the usefulness of the 5¼-in. floppy disk.***

with 1.6M-byte capacity. Their capacities make these drives logical substitutes for 8-in. double-sided drives. When linear recording densities are pushed this high, excessive errors may occur as a result of uneven diskette coating and thermal and hygroscopic distortions of the diskette media, so quantity shipments of these drives and the other proposed super density drives will probably wait for improved media.



**Fig. 2.** Micro Peripherals, Inc.'s slimline 8-in. floppy-disk drive is typical of the new generation of half-height floppies. The slimline is 2 in. high and stores as much as 1.6M bytes. Two half-height floppy-disk drives occupy the same space as one standard 8-in. drive, and half-height 5¼-in. drives are also available.

That wait will not be long, however, because samples of 5¼-in. diskettes with thinner, higher resolution coatings applied by conventional web-coating equipment have been shipped to drive makers by 3M Co., Verbatim Corp., Hitachi Ltd., Maxell Corp. and other media manufacturers. Dysan Corp. and Brown Disk Manufacturing, a new manufacturer, will offer high-capacity diskettes produced by spin coating, a process used for rigid disks. Although it is uncertain which of these higher density diskettes will become widely used, technology is available to make 2M-byte, 5¼-in. drives practical for system builders in the near future.

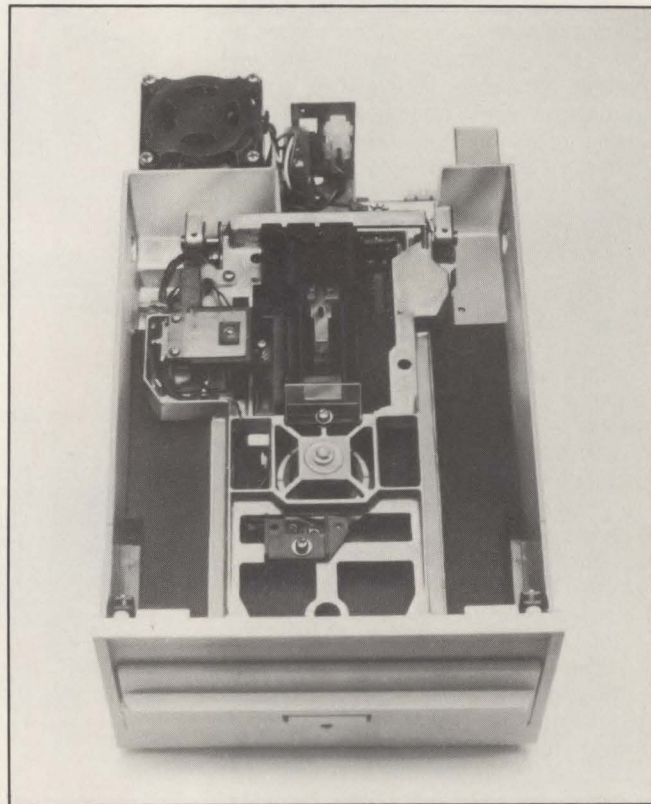
One firm already active in the high-capacity, 5¼-in. drive market is Amlyn Corp., San Jose, Calif. Amlyn's drive uses five spin-coated floppies in a rigid plastic cartridge (see "Amlyn's drive in action," p.167). The drive extracts one diskette at a time from the cartridge under system control. Although the Amlyn drive records on only one side of each diskette, a capacity of 1.6M bytes per diskette is achieved through the relatively high recording density of 170 tpi and 9500 bpi. With a total capacity of 8M bytes per cartridge on five diskettes, the Amlyn drive offers the best capacity-match yet between 5¼-in. Winchesters and floppies. Its drive electronics include a  $\mu$ p that maps the drive to look like a 6M-byte, 5¼-in. Seagate Technology Winchester or a Shugart Associates SA850 double-sided, 8-in. floppy at the interface.

Regardless of floppy-drive configuration—96 tpi (1M byte), 96 tpi (2M bytes) or the Amlyn cartridge-drive approach—demand for high-capacity storage for desk-top small-business systems is high. While most drives will probably be used in floppy-only systems during the next few years, a growing number will be employed as backup for 5¼-in. Winchester disks. Shipments of 5¼-in. Winchesters topped an estimated 63,000 units worldwide in 1981 (see Part I, p. 237), and growth should be rapid. Although tape cartridges and 5¼-in. removable hard disks will also back up small fixed disks, floppies are expected to remain the preferred storage for most desk-top systems because they offer the lowest hardware, media and controller costs, and 1M-byte and larger floppies offer adequate capacity for the files used on most small systems.

### **New shapes and sizes**

A major trend during the last year for both 8- and 5¼-in. floppy-disk drives has been a move to smaller size. BASF A.G. pioneered the concept of making drives shorter than the de facto industry standard—Shugart Associates' 3¼-in.-high SA400. In 1978, BASF introduced a drive that was only two-thirds the height of the SA400. BASF was joined by several other manufacturers last year, all with the same two-thirds height.

Drives that are half the height of industry standard 5¼-in. and 8-in. drives have recently appeared. Tandon Corp., Alps Electric and Mitsubishi Electric Corp.



**Mitsubishi's new M2894 double-sided, double-density, 8-in. floppy-disk drive stresses performance and reliability rather than unit size or capacity. It stores 1.6M bytes and uses a dual gimbal-head assembly to reduce media wear.**



# OEM FLEXIBLE-DISK DRIVES

These listings include drives that are offered for sale in the U.S. to the OEM market, regardless of whether they are manufactured in the U.S. or elsewhere. Captive drives manufactured by system OEMs are not included, nor are subsystems assembled by resellers.

Manufacturer Model	Unformatted capacity (M bytes)	Tracks/surface: tracks/in.	Track-to track head positioning time (msec.)	Dimensions (HxWxD)	Comments
<b>5¼-IN. DISKETTE DRIVES</b>					
Alps Electric Co. FDM2000	.125/.25	40; 48	12	1.61x5¾x8	New half-high model
BASF Systems 6106A	.125/.25	40; 48	6	2.1x5¾x7½	Two-thirds industry standard height
BASF Systems 6108A	.25/.5	40; 48	6	2.1x5¾x7½	Two-thirds industry standard height
Control Data Corp. 9408	.125/.25	40; 48	5	3.38x5.88x8	
Control Data Corp. 9409	.25/.5	40; 48	5	3.38x5.88x8	
Control Data Corp. 9409-T	.5/1	80; 96	5	3.38x5.88x8	
Micro Peripherals, Inc. 91	.25/.5	80; 96	5	3¼x5¾x7¾	
Micro Peripherals, Inc. 101	.24/.48	77; 100	5	3¼x5¾x7¾	
Micro Peripherals, Inc. 52	.25/.5	40; 48	5	3¼x5¾x7¾	
Micro Peripherals, Inc. 92	.5/1	80; 96	5	3¼x5¾x7¾	
Micro Peripherals, Inc. 102	.48/.96	77; 100	5	3¼x5¾x7¾	
Micropolis Corp. 1015-II	.48	77; 100	10	3.38x5.88x8½	
Micropolis Corp. 1015-IV	.96	77; 100	10	3.38x5.88x8½	
Micropolis Corp. 1015-V	.5	80; 96	10	3.38x5.88x8½	
Micropolis Corp. 1015-VI	1	80; 96	10	3.38x5.88x8½	
Micropolis Corp. 1016-II	.585	77; 100	10	3.38x5.88x8½	
Micropolis Corp. 1016-IV	1.17	77; 100	10	3.38x5.88x8½	GCR encoding
Micropolis Corp. 1117-II	1.2	96; 100	6	3.38x5.88x8¼	
Micropolis Corp. 1117-IV	2.175	100; 100	6	3.38x5.88x8¼	Special media
Micropolis Corp. 1117-V	1.1125	89; 96	6	3.38x5.88x8¼	Special media
Micropolis Corp. 1117-VI	2.025	81; 96	6	3.38x5.88x8¼	
Miltope Corp. DD 400	.401/.801	77; 48	6	5.44x8.44x18	Sold as militarized subsystem
Mitsubishi Electric Corp. - M4853	1	80; 96	3	1.61x5¾x8	
Mitsubishi Electric Corp. - M4854	1.6	77; 96	3	1.61x5¾x8	
Olivetti OPE FD501	.125/.25	40; 48	25	2.51x5¾x8	Thinner than industry standard
Olivetti OPE FD502	.25/.5	40; 48	25	2.51x5¾x8	Thinner than industry standard
Pertec Computer Corp. FD200	.125/.25	40; 48	25	3¼x5¾x8	
Pertec Computer Corp. FD250	.219/.438	35; 48	25	3¼x5¾x8	
Philips Data Systems H1100	.438	35; 48	5	2.26x5.9x8.37	
Qume Corp. Qumetrack 542	.25/.5	40; 48	12	5¼x3¼x8	
Remex Division Pico RFD 961	.25/.5	80; 96	5	2.11x5¾x8	Two-thirds industry standard height
Remex Division Pico RFD 480	.25/.5	40; 48	5	2.11x5¾x8	Two-thirds industry standard height
Remex Division Pico RFD 960	.5/1	80; 96	5	2.11x5¾x8	Two-thirds industry standard height
Shugart Associates SA210	.11/.22	35; 48	100	2.05x5¾x7.72	New two-thirds high model
Shugart Associates SA400	.125/.25	40; 48	20	3¼x5¾x8¼	Industry standard for size and interface



Manufacturer Model	Unformatted capacity (M bytes)	Tracks/surface: tracks/in.	Track-to track head positioning time (msec.)	Dimensions (HxWxD)	Comments
<b>5¼-IN. DISKETTE DRIVES</b>					
Shugart Associates SA410	.25/.5	80; 96	6	3¼x5¼x8¼	
Shugart Associates SA450	.25/.5	40; 48	20	3¼x5¼x8¼	
Shugart Associates SA460	.5/1	80; —	6	3¼x5¼x8¼	
Siemens Corp. FDD 100-5	.125/.25	40; 48	20	3¼x5¼x8	
Siemens Corp. FDD 196-5	.25/.5	80; 96	10	3¼x5¼x8¼	
Siemens Corp. FDD 200-5	.25/.5	40; 48	20	3¼x5¼x8	
Siemens Corp. FDD 296-5	.5/1	80; 96	10	3¼x5¼x8¼	
Tandon Magnetics Corp. TM-100-1	.125/.25	40; 48	5	3¼x5¼x8	
Tandon Magnetics Corp. TM-100-3	.25/.5	80; 96	3	3¼x5¼x8	
Tandon Magnetics Corp. TM-100-3M	.24/.48	77; 100	3	3¼x5¼x8	
Tandon Magnetics Corp. TM-50-1	.125/.25	40; 48	35	1.63x5¼x8	New half-high model
Tandon Magnetics Corp. TM-50-2	.25/.5	40; 48	35	1.63x5¼x8	New half-high model
Tandon Magnetics Corp. TM-100-2	.25/.5	40; 48	5	3¼x5¼x8	
Tandon Magnetics Corp. TM-100-4	.5/1	80; 96	3	3¼x5¼x8	
Tandon Magnetics Corp. TM-100-4M	.48/.96	77; 100	3	3¼x5¼x8	
TEAC Corp. FD-50A	.125/.25	40; 48	25	3¼x5¼x7.99	
TEAC Corp. FD-50B	.25/.5	40; 48	25	3¼x5¼x7.99	
TEAC Corp. FD-50C	.241/.481	77; 100	25	3¼x5¼x7.99	
TEAC Corp. FD-50E	.25/.5	80; 96	25	3¼x5¼x7.99	
TEAC Corp. FD-50F	.5/1	80; 96	10	3¼x5¼x7.99	
Toshiba Corp. ND-01	.1094	35; 48	25	3¼x5¼x8	
Toshiba Corp. ND-02D	.291/.438	35; 48	25	3¼x5¼x8	
Qume Corp. Qumetrack 592	1	80; 96	3	3¼x5¼x8¼	
Tokyo Electric FB-202	.25	40; 48	6	3.35x5¼x8.35	

#### 8-IN. DISKETTE DRIVES

Burroughs Corp. MD-122	3.131	139; 150	40	5½x10x20½	Dual drive with single head-positioning system
Caldisk Corp. 142M	.401/.802	77; 48	6	4.9x8.4x15	
Caldisk Corp. 143M1	.401/.802	77; 48	6	4.9x8.4x15	
Caldisk Corp. 143M	.8/1.6	77; 48	6	4.9x8.4x15	
Control Data Corp. 9404B	.401/.802	77; 48	10	4.97x8.78x14	
Control Data Corp. 9406-1	.8/1.6	77; 48	3	4.97x8.78x14	CDC interface
Control Data Corp. 9406-2	.8/1.6	77; 48	3	4.97x8.78x14	CDC size, Shugart interface
Control Data Corp. 9406-3	.8/1.6	77; —	3	4.65x8.55x13¾	Shugart size and interface
Innotronics Corp. 410	.401/.802	77; 48	8	4.38x9x14	
Innotronics Corp. 420	.401/.802	77; 48	8	4.38x9x14	
Memorex Corp. 651	.312	64; 48	10	4½x9x14	First OEM floppy drive, introduced in 1972
Memorex Corp. 550	.401/.802	77; 48	10	4.38x8¾x14	



Manufacturer Model	Unformatted capacity (M bytes)	Tracks/surface: tracks/in.	Track-to track head positioning time (msec.)	Dimensions (HxWxD)	Comments
<b>8-IN. DISKETTE DRIVES</b>					
Micro Peripherals Inc. 41	.401/.802	77; —	3	2x8.55x11½	New half-high model
Micro Peripherals, Inc. 42	.8/1.6	77; 48	3	2x8.55x11½	New half-high model
Miltope Corp. DD450	.8/1.6	77; 48	5	5.44x8.44x18	Sold as militarized subsystem
Nippon Electric Co. FD 1160	.8/1.6	77; 48	5	4.62x8.68x14.45	
Nippon Electric Co. FD-1165	.8/1.6	77; 48	5	2.28x8.68x13.19	New half-high model
Olivetti OPE FD801	.401/.802	77; 48	3	4.52x9.05x12.3	
Olivetti OPE FD802	.8/1.6	77; 48	3	4.52x9.05x12.3	
PerSci, Inc. 277	.401/.802	77; 48	1.2	4.4x8.6x15	Uses voice-coil actuator for very fast access
PerSci, Inc. 299B	.8/1.6	77; 48	1.2	4.38x8.72x15.4	Uses voice-coil actuator for very fast access
PerSci, Inc. 699	1.6/3.2	154; 96	1	4.38x8.72x15.4	Uses voice-coil actuator for very fast access
PerSci, Inc. 899	1.888/3.776 (formatted)	231; 144/150	4	4.38x8.72x15.4	Uses voice-coil actuator and embedded servo for very fast access and high tpi
Pertec Computer Corp. FD 511A, FD 514, FD 510	.401/.802	77; 48	10	3.45x8.6x14.9	
Pertec Computer Corp. FD 410	.401/.802	77; 48	10	3.45x8.6x14.9	DC power
Pertec Computer Corp. FD 650	.8/1.6	77; 48	3	4½x8.55x14	
Qume Corp. Qumetrack 842	.8/1.6	77; 48	3	4.62x8.55x14.57	
Qume Corp. Qumetrack 842 DC	.7/1.6	77; 48	3	4.62x8.55x14.57	
Remex Division RFD 2000, RFD 2001	.401/.802	77; 48	3	4.62x8.55x14	
Remex Division RFD 4000, RFD 4001	.8/1.6	77; 48	3	4.62x8.55x14	
Shugart Associates SA800, SA801	.401/.802	77; 48	8	4.62x8.55x14¼ (801)	Industry standard for size and interface
Shugart Associates SA850, SA851	.8/1.6	77; 48	3	4.62x8.55x14¼ (851)	Industry standard for size and interface
Siemens Corp. FDD 100-8	.401/.802	77; 48	6	4½x8.55x14¼	
Siemens Corp. FDD 200-8	.8/1.6	77; 48	3	4½x8.55x14¼	
Tandon Magnetics Corp. TM 848-1	.401/.802	77; 48	3	2.3x8.55x13¼	New half-high model
Tandon Magnetics Corp. TM-848-2	.8/1.6	77; 48	3	2.3x8.55x13¼	New half-high model
Toshiba Corp. ND-108	.4	77; 48	3	4.9x10x14.4	
Toshiba Corp. ND-20D, ND-20DL	.8/1.6	77; 48	3	4.9x10x14.4	

#### SPECIAL DISKETTE DRIVES

Amlyn Corp. 5850, A506	1.6 per diskette 8 per cartridge	154; 170	3	3¼x5¾x7.88	Uses spin-coated 5¼-in. diskettes in special cartridge
Canon USA, Inc. Micro Floppy CMD-300	.01	16; 25.4	40	2¾x4¼x5.9	Special 4-in. diskette
Canon USA, Inc. Micro Floppy CMD-500	.04	16; —	40	2¾x4¼x5.9	Special 4-in. diskette
Iomega Corp. Alpha-10	13.88	306; 300	12	4.62x8.55x14¼	High-performance drive using 8-in. flexible disk in special cartridge
Micro Peripherals Inc. 51	.125/.25	40; 48	5	3¼x5¾x7¾	
Olivetti OPE	.008	1; N/A	N/A	3½x6x7¾	Single spiral track
Sankyo Seiki FMC-100	.008	1; N/A	N/A	1.96x2.95x4.88	Single spiral track
Sony Corp. of America OA-D30V	.219/.438	70; 135	15	2x4x5.1	Uses cobalt-modified 3½-in. flexible disk in special cartridge
Tokyo Electric MC-116	.008/.016	1; N/A	N/A	1.6x3x4.9	



## ***Floppy-disk-drive manufacturers are aggressive in experimenting with new product forms.***

have all announced 1.6-in.-high, 5¼-in. drives—all designed so that two drives fit in the same space normally occupied by a single industry-standard drive (Fig. 2). Micro Peripherals, Inc., Tandon and Nippon Electric Co. have also announced half-height, 8-in. drives. Two of these drives occupy the same space as one industry-standard SA800, which is 4.62 in. high.

New floppy-disk-drive sizes and technologies usually have been introduced by firms with established leadership in data-processing equipment. IBM pioneered the floppy-disk concept, and the 5¼-in. drive was introduced by Shugart Associates, the leader in OEM floppy-disk-drive shipments. But firms without broad data-processing product lines have introduced several other configurations in the past year. These firms enter the market without the clout of an industry heavy-weight.

Sony Corp., a world leader in magnetic recording technology, has introduced a 3½-in. floppy-disk drive

(MMS, April, 1981, p. 17) with 437.5K-byte capacity using single-sided recording, and a double-sided version is expected in 1982 (Fig. 3). The drive is used on Sony's word-processing system and is offered as an OEM product. Because of Sony's status in magnetic recording and the firm's ambitious plans for the office-equipment market, this drive must be taken seriously, but its impact on the floppy-disk-drive industry remains unclear. System OEMs like to buy hardware for which alternate sources are available. And most small-system manufacturers depend on the large volumes of stock software programs published on standard floppy-disk media. For these reasons, OEM acceptance of the Sony 3½-in. drive will probably depend on completion of second-sourcing arrangements with other manufacturers for the disk drive and media.

Another new drive attracting considerable attention is the unique Iomega Alpha 10 drive (see "Flexible-media cartridge challenges Winchester," p.207), which records 10M bytes on one side of an 8-in. flexible disk enclosed in a rigid cartridge. This high-performance disk drive uses a flying head and a sophisticated internal air-flow guidance system, with 300-tpi and 24,000-bpi recording densities. The Iomega drive does not compete with any existing floppy-disk drive. Its capacity, performance and price place it in competition with small Winchester and hard-disk cartridge drives.

Three manufacturers offer low-priced floppy-disk drives that record on a spiral track instead of concentric tracks. These drives are similar in function to a tape drive, but lack the direct-access capability of moving-head disk drives. Olivetti has used such a drive as a program loader and storage medium for small files since 1977. The Olivetti drive and one offered by Sankyo Seiki have capacities of 8K bytes, while a drive recently announced by Tokyo Electric Co. stores 16K bytes.

### **What happens next?**

The floppy-disk-drive industry seems poised at the starting line for a race to introduce major new improvements, but most of the competitors are not sure which direction to run. Most manufacturers in the volatile OEM drive market know that only firms with major momentum in the industry are likely to see their innovations quickly become industry standards, especially if significant changes are involved.

If IBM does not act quickly by introducing a high-capacity floppy-disk drive, several additional announcements of higher capacity drives, both 8- and 5¼-in., can be expected. This should be followed by an extended period of jockeying for position while standards emerge as a result of market demand. ■

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**James N. Porter** is president of Disk/Trend, Inc., a Mountain View, Calif., firm that provides consulting services to manufacturers of disk drives and related products, and publishes *Disk/Trend Report*, a basic industry reference on worldwide markets for hard- and floppy-disk drives.

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**Fig. 3.** Sony's 3½-in. Micro Floppy disk stores 437.5K bytes per disk and measures 2 × 4 × 5.1 in. For word-processing, personal and business applications, the drive uses a video-type precision head.



# Making the Complex Simple.



## The High-Speed Signal Processor/Microcomputer

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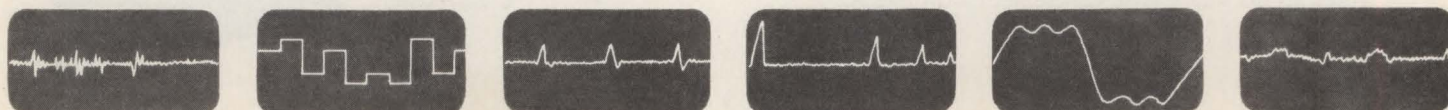
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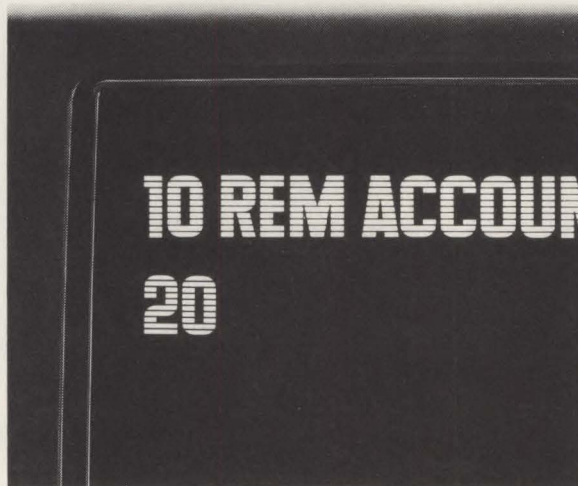
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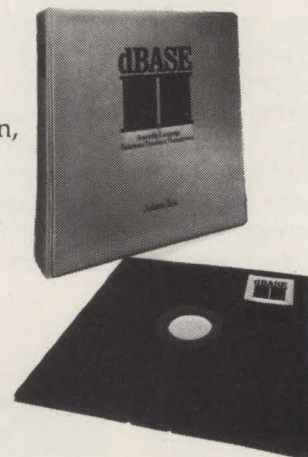
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## DISK DRIVES

# The future of peripheral data storage

RAYMOND C. FREEMAN JR., Freeman Associates

*With random-access storage densities increasing 3000-fold in the next quarter century, many technology changes will occur*

If you think peripheral data storage is approaching its technology limits, prepare for a shock. Recording 1M byte of data 25 years ago required a magnetic surface the size of a double bed. Today, 1M byte fits on a surface the size of a postage stamp, and a quarter century hence, this data will fit on one facet of a grain of salt.

This prediction is based on trends that reliably show ongoing reductions in "real estate" versus data-storage ratios. Independent of technology type, equipment configuration or industry participants, data-storage densities have followed a steady upward trajectory, and there are no signs this trend won't continue. Thus, 25 years from now, there will be a 3000-fold increase in storage density for random-access devices and a 1000-fold increase for sequential-access units.

### Hard-disk storage

International Business Machine Corp. announced its first disk-storage drive more than 25 years ago, in September, 1956. The 350 Mod 1, conceived and developed for the 305 RAMAC system, stacked 50 24-in. disks on a spindle to achieve storage of 5 million characters, although the disks were not operator removable. Storing 105 bits per in. and 20 tracks per in., the 350 started the disk-recording derby at 2100 bits per sq. in. Subsequent introductions have typically doubled disk-storage densities every 2½ years, leading to today's 5000-fold improvement compared with 1956 performance. Table 1 lists representative products in this quarter-century "march to more."

*This article was originally published in the Oct. 14, 1981, issue of EDN magazine.*

DISK-DRIVE PROGRESS		
IBM disk drive	First customer shipment	Recording density (bits per sq. in.)
350	1957	$2.1 \times 10^3$
1311	1963	$5.1 \times 10^4$
2311	1965	$1.1 \times 10^5$
2314	1966	$2.2 \times 10^5$
3330	1971	$7.8 \times 10^5$
3340	1973	$1.7 \times 10^6$
3350	1976	$3.1 \times 10^6$
3370	1979	$7.7 \times 10^6$
3380	(1981)	$1.2 \times 10^7$

**Table 1. Introductions have typically doubled disk-storage densities every 2½ years, leading to today's 5000-fold improvement compared with 1956 performance.**

During the decade from the mid-'50s through the mid-'60s, IBM introduced six storage drives based on 24-in. disks. The last drive in this series, the 2302 Mod 3, increased storage capacity to 12M bytes while reducing the number of platters to 24. In 1963, the firm switched to 14-in. disks with the 1311. Equally important, disks became operator removable for the ensuing decade.

With the first shipment of 3340 Winchester drives in 1973, IBM tried to accommodate users' desires for media removability while sealing the heads in the disk module to ensure needed contamination control. The resulting module was so expensive, however, that users tended to leave it on the spindle as though it were fixed. The 3350 and subsequent IBM hard-disk drives have all used fixed media, giving rise to increased demand for backup products.

IBM made its first change in disk diameter in 16 years



*New classes of products, most likely optical and then holographic, will begin to displace magnetic disks in the next quarter century.*

with the introduction of the Piccolo 8-in. drive in 1979. This device triggered a whole industry class of products, which were in turn followed by even smaller 5¼-in.-diameter drives in the OEM market.

### Random-access projections

During the past 25 years, random-access storage has been provided largely by moving-head magnetic-disk drives. But new classes of products, most likely optical and then holographic, will begin to displace magnetic disks in the next quarter century. Even though these new product forms are not clear yet, storage density can be predicted by plotting past advances and extending them into the future. Coming technology shifts will keep the industry on this ever-upward ramp of recording density.

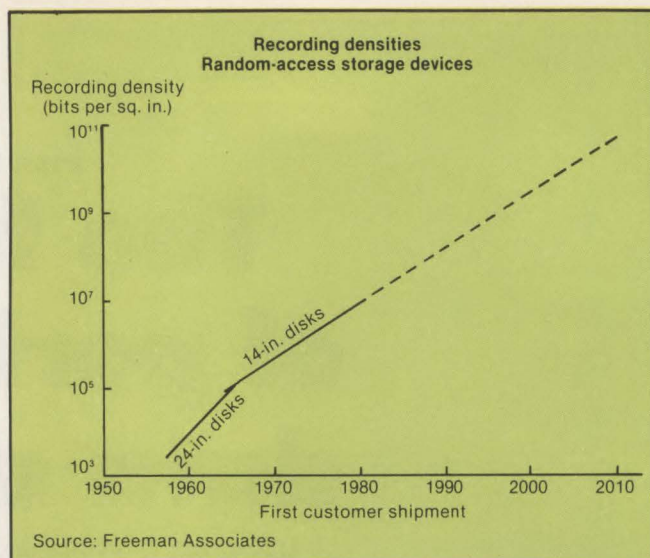
Economics will govern the timing of these shifts. As magnetic disks reach their practical recording limits and become unable to sustain further bit-per-dollar increases, new higher density technologies will supplant them. The resulting growth in recording densities will tend to remain continuous rather than jump abruptly upward.

Fig. 1 illustrates historical and projected recording densities for random-access read/write storage. The solid lines depict disk-drive densities to date, now at about  $10^7$  bpsi. Magnetic-disk recording will continue to dominate the following decade or two. Technology shifts to thin-film heads and media and later to vertical recording will keep magnetic disks at the leading edge of price/performance economics. Optical disks, expected to be active in the market of the 1990s, will principally serve large inquire-only reference-file roles.

By the end of this century, though, magnetic recording will have reached its practical limits, and new technology will take over the role of random-access storage. The most likely choice, viewed from today's vantage point, is solid-state holography. This technique, using no moving parts, holds the promise of achieving the very high storage densities predicted in Fig. 1 and of providing nsec. data-access times. Furthermore, holography will elevate storage to the page level rather than bit or word levels and thus add a third dimension to considerations of areal density (bpi  $\times$  tpi). Table 2 characterizes random-access storage over a six-decade span, listing recording densities and noting the principal technology of each decade.

### Magnetic-tape storage

The first IBM tape drive, model 726, was a seven-track device operating at 100 bpi and 75 ips. This 1953 unit transferred data at 7.5K bytes per sec. and



**Fig. 1. Historical and projected recording densities for random-access read/write storage show that magnetic-disk recording will continue to dominate the next decade or two.**

furnished a 1400-bpsi recording density. IBM made six more advances in recording density over the next two decades, achieving an 80-fold improvement to 112,500 bpsi when the 3420-4, -6 and -8 were shipped in 1973. These units brought 6250-bpi recording to the market and boosted data-transfer rates to 1250K bytes per sec. Traditionally, densities have doubled every 3½ years. Table 3 lists the IBM products that increased advanced tape-recording densities.

Technology advances in computer tape recording essentially ceased in 1973. Research-and-development

Recording densities and technologies: random-access storage devices		
Decade	Recording density (bits per sq. in.)	Principal technology
1950s	$2 \times 10^3$ to $2 \times 10^4$	Permalloy/oxide
1960s	$5 \times 10^4$ to $6 \times 10^5$	Permalloy/oxide
1970s	$6 \times 10^5$ to $10^7$	Ferrite/oxide
1980s	$10^7$ to $2 \times 10^8$	Thin film
1990s	$2 \times 10^8$ to $5 \times 10^9$	Vertical magnetics
2000s	$5 \times 10^9$ to $10^{11}$	Holography

**Table 2. Random-access storage densities and technologies are characterized over a six-decade span.**

Magnetic-tape storage		
IBM tape unit	First customer shipment	Recording density (bits per sq. in.)
726	1953	$1.4 \times 10^3$
727	1955	$2.8 \times 10^3$
729 III	1959	$7.8 \times 10^3$
729 V	1962	$1.1 \times 10^4$
2401-1	1965	$1.4 \times 10^4$
2401-4	1966	$2.9 \times 10^4$
3420-4	1973	$1.1 \times 10^5$

**Table 3. Magnetic-tape storage densities of IBM devices have increased dramatically since the first 726 was shipped in 1953.**



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## Technology shifts to thin-film heads and media and later to vertical recording will keep magnetic disks at the leading edge of price/performance economics.

funding was diverted to disk-storage products for the balance of the decade, and no advance in recording density has yet been brought to market in a high-volume product. The 80-fold improvement in tape-recording densities since the initial product's introduction contrasts with the 5000-times advance in disk-recording densities.

However, the hibernation of magnetic-tape technology in the computer industry appears to be at an end. Many development programs are under way, spurred by demand for new backup products for fixed-disk storage devices. IBM's long-awaited announcement of new drives using higher track and bit densities on  $\frac{1}{2}$ -in. tape is expected to trigger several competitive responses. These moves will establish single-reel cartridge packaging as a new medium standard. Such new products will move tape recording ahead toward Fig. 2's historical projection of recording density. That projection calls for a density in 1981 of 660,000 bpsi, six times today's actual value.

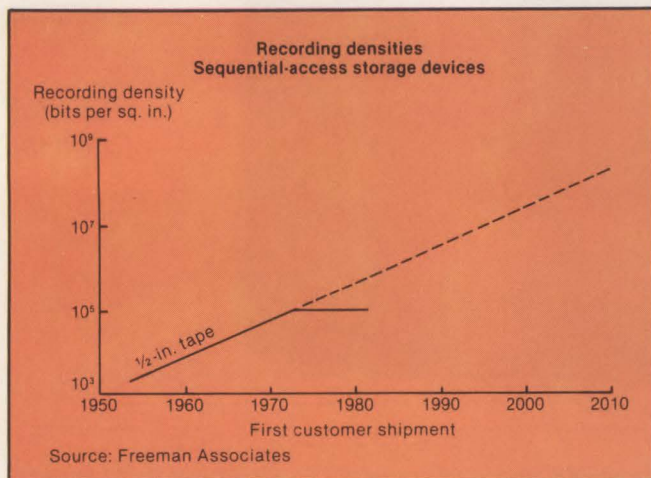


Fig. 2. IBM's long-awaited announcement of new drives using higher track and bit densities on  $\frac{1}{2}$ -in. tape is expected to trigger several competitive responses and move tape-recording densities ahead toward this projection.

### Sequential-access projections

The principal medium for sequential data storage during the past quarter century has been  $\frac{1}{2}$ -in. tape. The shape and direction of future programs is difficult to foretell at this time, because there has not been sufficient R & D in the past several years to establish a recognizable trend. As this product class awakens from its long slumber and flexes its technology muscles, though, the industry will be better able to predict the product's progress.

Even now, however, past accomplishments can be plotted and projected forward to provide at least a guideline of what to expect in the next 25 years. Fig. 2 points out that tape technology should be at the  $1.5 \times 10^6$  bpsi level by 1985 to reach its projected path. Further increases to the  $4 \times 10^6$  bpsi range should occur by the end of the decade. A technology shift to thin-film magnetoresistive read elements should fuel these advances in the 1980s. And densities in the 1990s should move up to  $3 \times 10^7$  bpsi, perhaps abetted by media developments that permit vertical recording techniques.

Recording densities and technologies: sequential-access devices		
Decade	Recording density (bits per sq. in.)	Principal method
1950s	$1.4 \times 10^3$ to $8 \times 10^3$	7-track $\frac{1}{2}$ -in. reel
1960s	$8 \times 10^3$ to $3 \times 10^4$	9-track $\frac{1}{2}$ -in. reel
1970s	$3 \times 10^4$ to $10^5$	9-track $\frac{1}{2}$ -in. reel
1980s	$10^5$ to $4 \times 10^6$	18-track $\frac{1}{2}$ -in. cartridge
1990s	$4 \times 10^6$ to $3 \times 10^7$	?
2000s	$3 \times 10^7$ to $3 \times 10^8$	?

Table 4. Sequential-access recording densities and technologies are summarized decade by decade.

The crystal ball swirls with fog and vapor as the first decade of the next century comes into focus. It's not at all clear that magnetic tape will be the technology choice in the 21st century for the task of sequential data storage. Whatever technology might take its place, however, should achieve at least the storage densities indicated in Fig. 2, or  $3 \times 10^8$  bpsi by the year 2010.

Even if tape and its successors achieve these densities, though, they will still be at a great disadvantage as companion products for random-access storage devices. Random-access densities should be 300 times greater by the year 2010, based on historical projections. Table 4 summarizes sequential-access recording densities and methods decade by decade.

### Other likely developments

The boundary between hard- and floppy-disk drives will become a war zone as diameters of rigid disks continue to shrink and capacities of floppy-disk drives continue to grow. Historically, there has been a capacity gap between the two classes of drives, with each filling a different market niche. That separation is now blurring as 6M-, 8M- and 10M-byte floppy-disk drives appear. Extensions of these technologies will lead to a significant overlap with low-end hard-disk drives. The likelihood of  $3\frac{1}{2}$ -in. hard-disk drives in the form factor of the Sony  $3\frac{1}{2}$ -in. floppy-disk drive will further accentuate capacity overlap between the two classes.

The decade ahead will witness widespread accep-



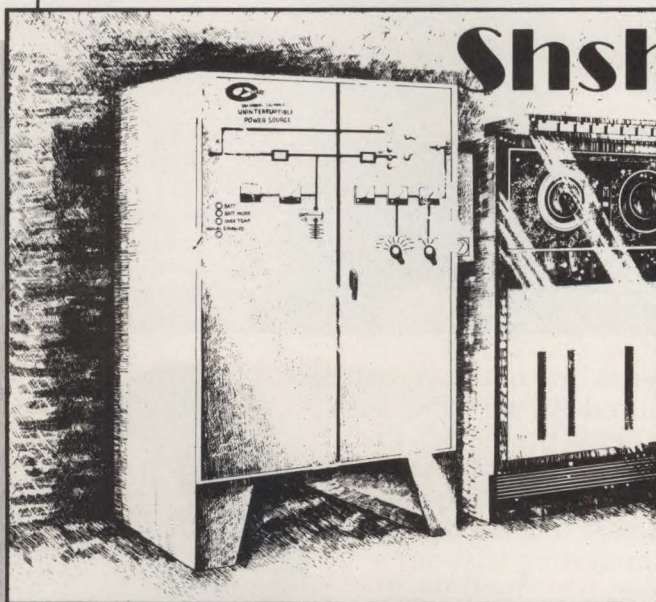
There are those who suggest that new-technology products in the 2000s will blur the distinction between random- and sequential-access products. They contend that very compact, high-capacity, random-access, solid-state, storage devices will sell for so little that they will obviate the need for sequential-access products. This view is probably incorrect; storage should continue to be hierarchical. Economics will continue to pull lower performance, lower cost products into the market for secondary storage.

To summarize, random-access-storage recording densities will increase 3000-fold in the next quarter century. Disk technology will evolve through the 1990s and then give way to new higher performance technology, very likely holography. Additionally, sequential-access storage is undergoing a renaissance as development funding has resumed for tape products. Their

**Table 5. Sequential-access recording densities will be 1000 times greater in 2006 than they are now.**

**Raymond C. Freeman Jr.**, president and founder of Freeman Associates, Santa Barbara, Calif., consults on computer storage products and publishes in-depth industry reports. His recent works include *A Preview of the 8-in. Disk Drive Market* and *Resolving the Backup Dilemma*.

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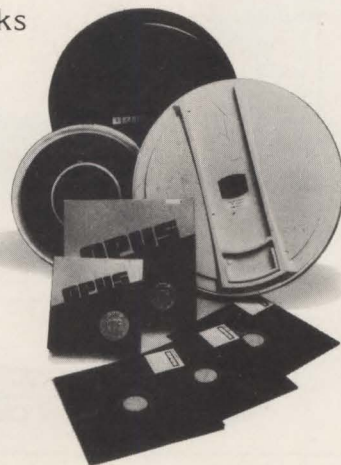
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## DISK DRIVES

# Disk-drive distribution and technology

JAMES F. MOORE, Dataquest, Inc.

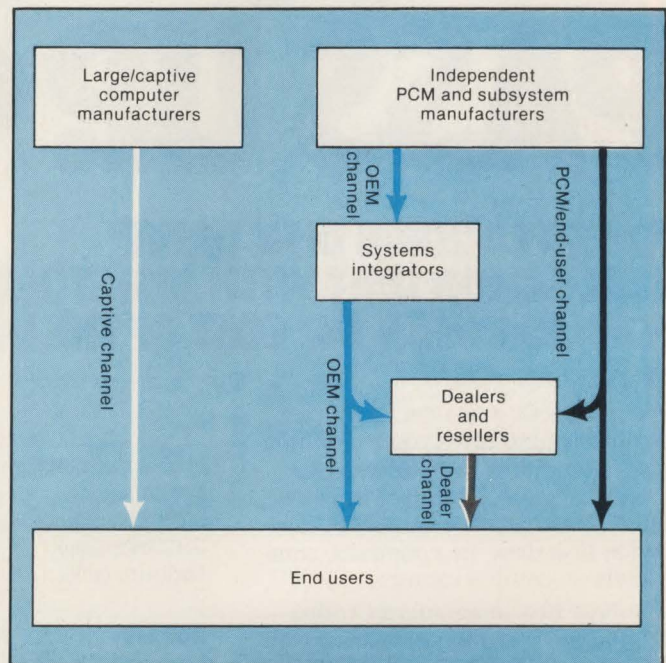
*After more than a quarter century, IBM is still the driving force in the disk industry*

International Business Machines Corp. started the hard-disk-drive industry when it developed the RAMAC 350 for its computers in 1956. The company has been the primary source of new disk-drive technology ever since; its technology base still influences both the application of disk-drive technology to new products and the flow of those products to the market.

Fig. 1 illustrates the basic channels through which disk drives flow on their way to end users. Disks from large computer vendors such as IBM and Digital Equipment Corp. reach end users via the captive channel. Plug-compatible and industry-standard drives and subsystems reach end users through the indirect-OEM and direct-end-user channels. The OEM channel is the most popular among drive manufacturers and carries drives and subsystems to system integrators who build them into data-processing systems and sell them to end users directly or through dealers and distributors. Just as the system integrators add value to disks and create subsystems for applications too small for major manufacturers to serve, dealers provide sales and support to those users too small to interest the manufacturers or system vendors.

The four classes of market participants are: dealers who handle drives of various manufacturers, independent disk manufacturers who design and manufacture plug-compatible and industry-standard disks and complete subsystems, computer manufacturers who build disk drives for their own systems and system integrators who add control electronics and/or software to disk drives and integrate them into data-processing systems.

Development of the OEM channel followed development of the end-user plug-compatible-manufacturer



**Fig. 1. Disk-drive distribution channels** serve system integrators as well as captive and non-captive end users. The white captive channel brings disks from large data-processing manufacturers to their captive customer base. The black plug-compatible manufacturer/end user channel carries drives and subsystems from independent disk manufacturers to end users. The blue OEM channel allows system integrators to customize disk drives for specialized applications and to integrate disks into data-processing systems. The gray dealer channel provides sales and support to the small end user.

channel, which followed the captive-market channel. Independent disk-drive manufacturers have historically borrowed from IBM technology first to produce IBM-compatible disk subsystems, and then to produce systems for use with non-IBM equipment.



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*Product cycles are longer in the OEM channel because it is primarily a purchase (versus lease) market, because lower capacity requirements typically prevail there and because a lag in capacity demand, tending to extend resale product lives, exists in the international market.*

### Technology transfer

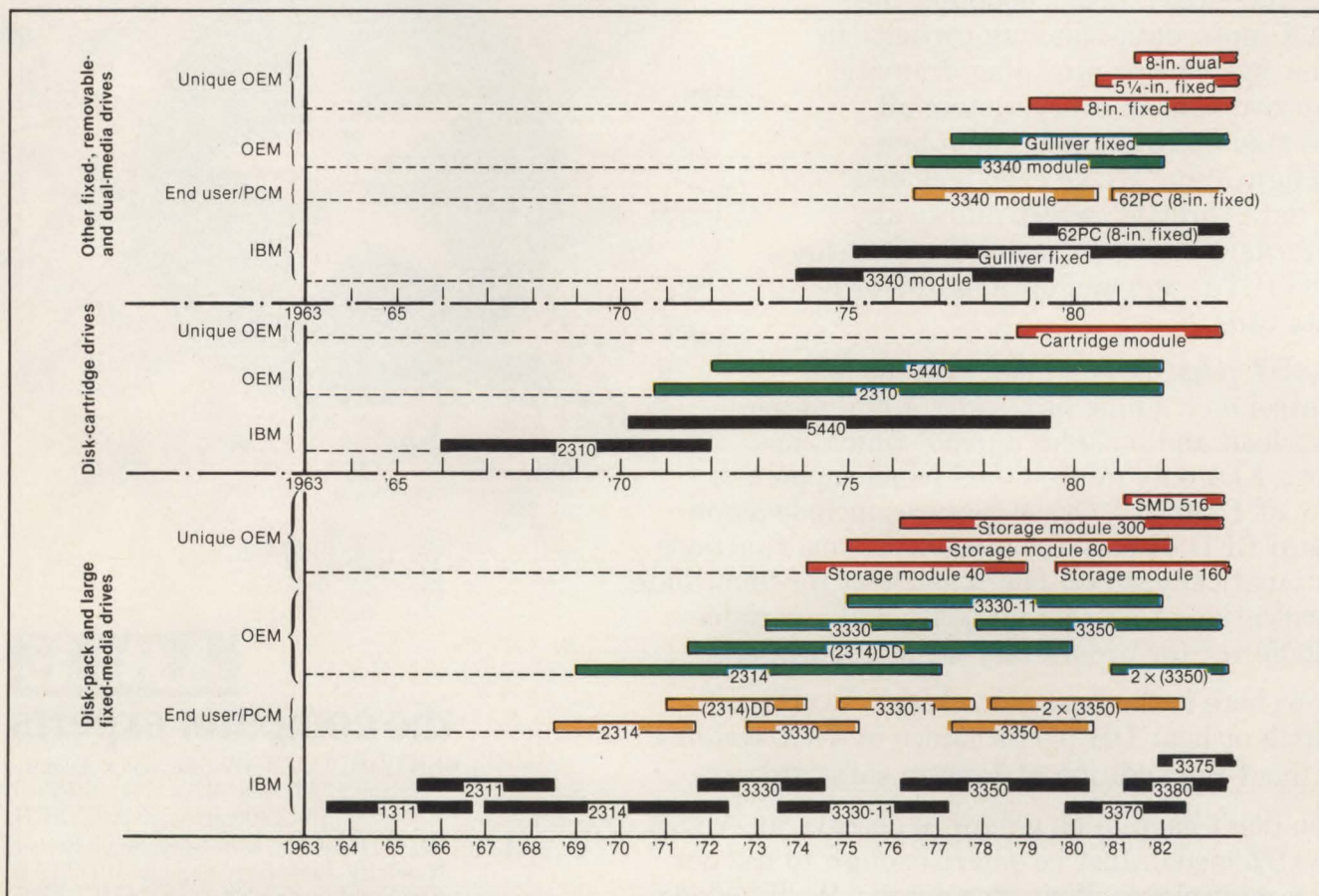
Fig. 2 illustrates the dissemination of IBM technology to other disk markets and resulting product life cycles. The figure shows that IBM-plug-compatible emulators typically reach the market approximately 18 months after a new IBM product introduction (the 2314, for example). Non-IBM-compatible drives using similar technology are available within a few months of the plug-compatible introductions. Every IBM product has not spawned a plug-compatible replacement. With the 2310 and 5440 cartridge drives, for example, slim profit margins did not encourage direct plug-compatible competition for end-user sales. However, OEM manufacturers found a large and lucrative market for similar disks in minicomputers.

Fig. 2 also shows the difference in product-life-cycle length in the captive and end-user plug-compatible-manufacturer market channels compared to those for products in the OEM market channel. Product cycles are longer in the OEM channel because it is primarily a purchase (versus lease) market, because lower capacity requirements typically prevail in the OEM channel and because a lag in capacity demand, tending to extend resale product lives, exists in the international market.

Fig. 2 also shows the increasing trend for independent manufacturers to use basic IBM technologies to develop disk drives that are architecturally unique or employ higher storage densities than IBM products. Examples are the storage-module drives, double-density 3350s, and 5¼-in. Winchester.

Independent manufacturers occasionally make significant departures from IBM technologies, such as the use of thin-film metallic media. While the large-systems market is slow to accept non-IBM approaches, the minicomputer/μc market, encouraged by the systems integrators and dealers, frequently endorses innovative products that meet its diverse needs. ■

**James F. Moore** is manager, computer memory industry service, Dataquest, Inc., Cupertino, Calif.



**Fig. 2. Technology life cycles are longer for OEM disk drives than for IBM or IBM-compatible drives because the OEM products evolve as they age and are sold first to the U.S. market and then to the less advanced overseas market. "Unique OEM" refers to products whose architecture or technology is substantially different from IBM's.**



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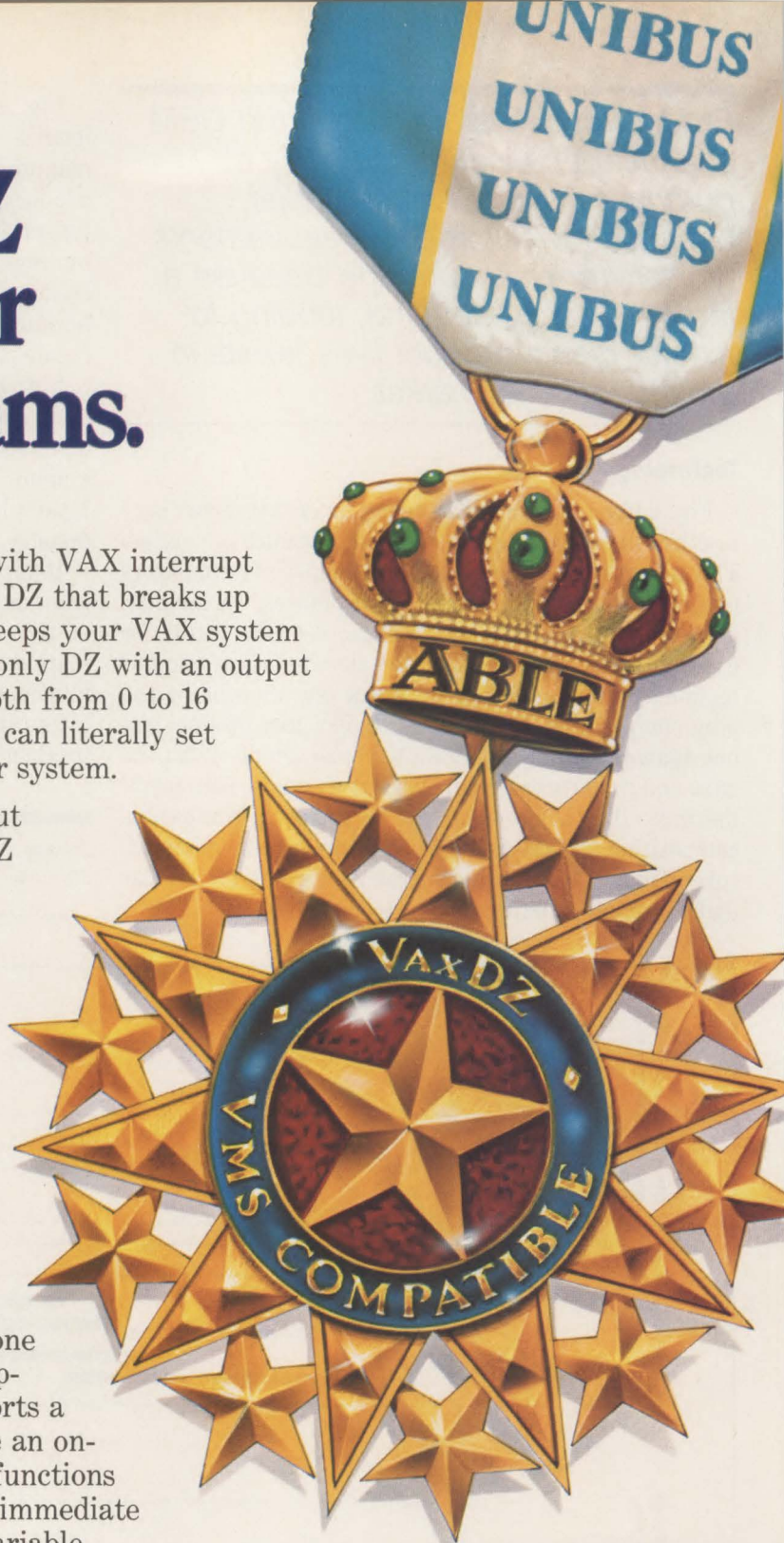
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*Shugart's half-height 8-in. floppy-disk drives offer increased capacity and reliability, while maintaining compatibility*

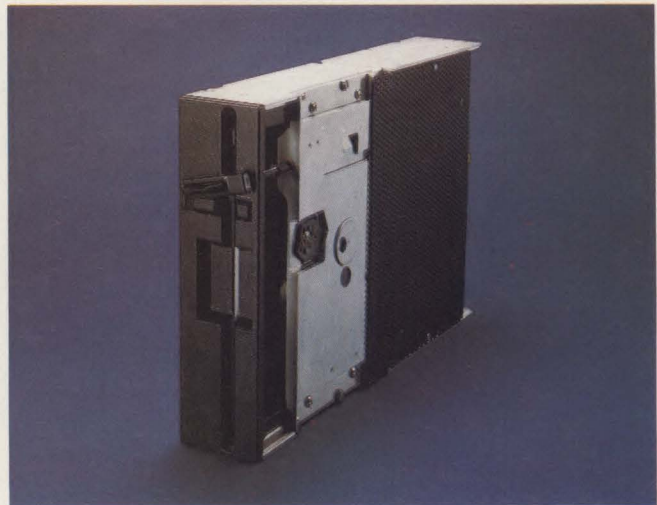
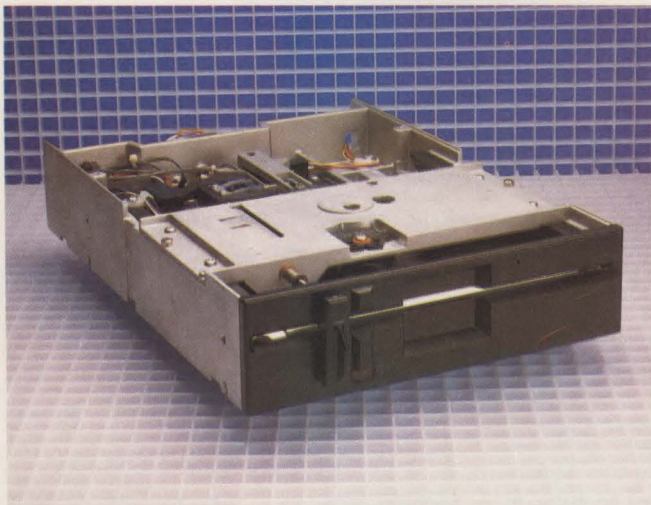
With the growing trend toward desk-top computer systems, two issues of prime importance to system designers have surfaced: minimizing the amount of space occupied by the disk subsystem, and exploiting the huge investment in existing systems designed around some 4 million 8-in. floppy-disk drives installed.

In many cases, 5¼-in. floppy-disk drives have been considered excellent candidates for new or redesigned desk-top systems. But the advent of half-height, reduced-depth, 8-in. floppy-disk drives provides an alternative to redesigning a system to accommodate minifloppies. The decision to use half-height drives previously required designers to sacrifice their investment in software written for, and having compatibility with, 8-in. disks. Shugart Associates' answer to this dual issue is the SA810 single-sided and the SA860

double-sided, 8-in. half-height floppy-disk drives. They are fully compatible with the company's industry-standard SA801/851 series despite improvements over the earlier drives: increased reliability, quieter operation, reduced media wear, DC motors that accommodate worldwide power requirements and the potential to upgrade to higher track densities.

### Achieving half-height

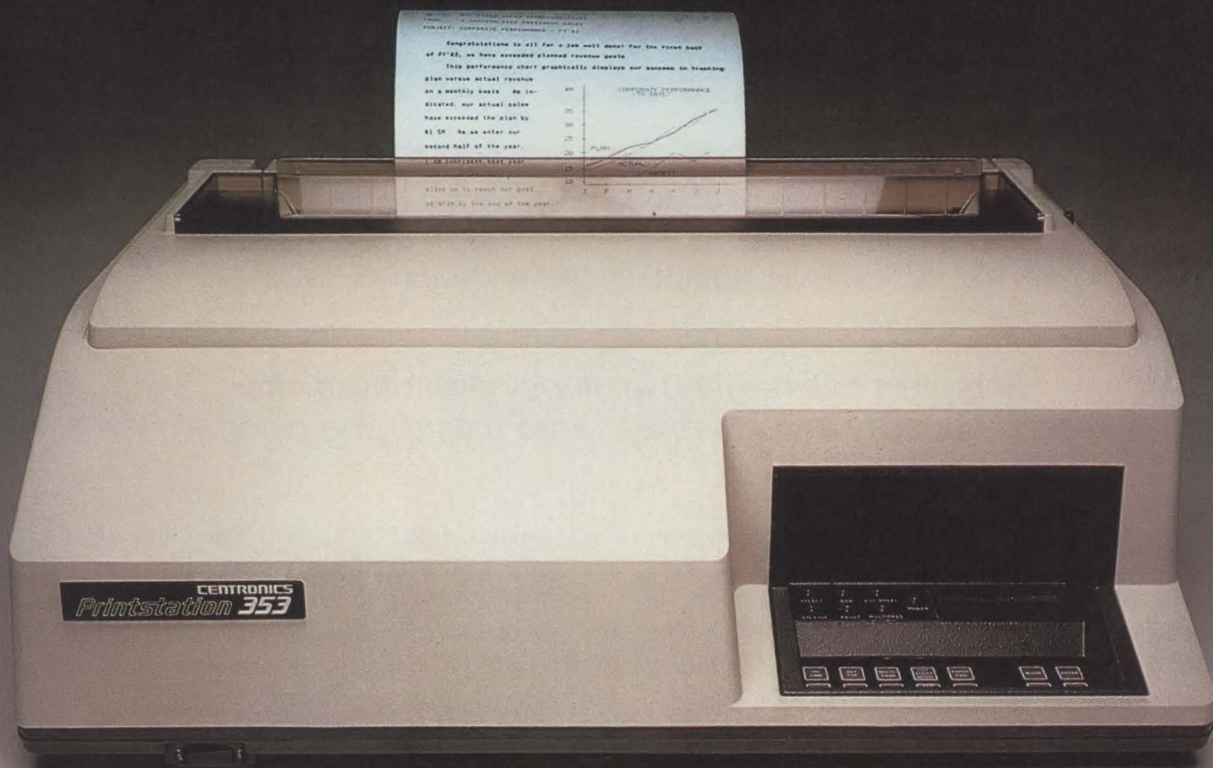
Because of the small-system applications driving today's market, Shugart designed the SA810/860 drives to be exactly half the height of standard 8-in. drives; thus, system capacity can quickly be doubled by replacing one standard-sized drive with two of the reduced-height units. Moreover, system performance can be improved further by replacing two standard



Shugart's SA810/860 8-in. floppy-disk drives are 2.31 in. high, exactly half the height of standard-sized floppies, and are only 12 in. deep, the same depth as a CRT terminal. The SA810/860 is shown with optional metal shields (r.), which protect against external EMI sources such as CRT flyback transformers or switching power supplies that often are next to disk drives.



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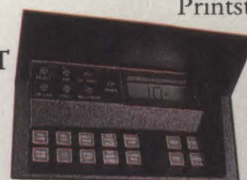
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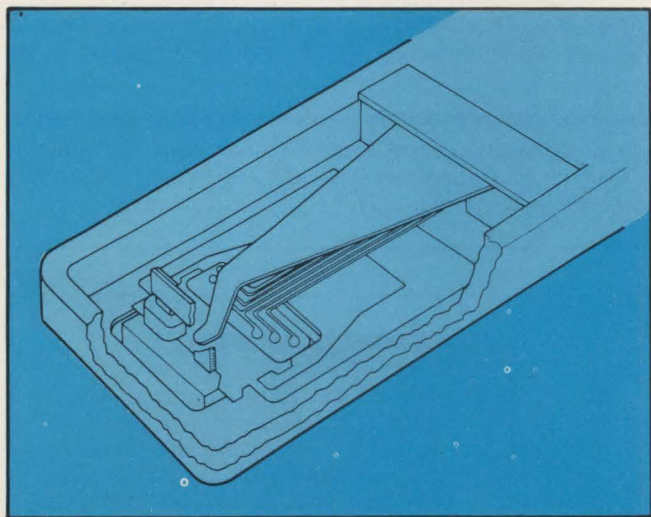
***The clamping approach used in the new half-height drives replaces the cartridge-guide mechanism with two thin, nonmovable side rails, which ensure more accurate diskette positioning.***

floppy-disk drives with two SA810/860 half-height drives, plus an 8-in. hard disk such as the SA1000 or SA1100. Next in importance to height is depth; while some half-height drives measure less than the normal 14¼ in. deep, the SA810/860 series is only 12 in. deep, matching the depth of a standard CRT terminal.

How can the mechanical and electrical components of the original 8-in. floppy-disk drive be packed into half the space? The answer lies primarily in motor technology advances. A cost-effective brushless DC motor, not available when the first 8-in. floppies were designed in 1973 to 1975, is used in the SA810/860, replacing the SA801/851's AC drive motor. The new DC motor is only one-fourth as thick as the AC motor, and occupies about 40 percent of the earlier motor's volume.

The drive's other motor—the stepper—also has changed. With improved mechanical tolerances, this motor can be made smaller—about 60 percent the size of the original—and provides more accurate positioning. Also, this motor's 3-msec. step rate is twice as fast as that of standard-sized single-sided 8-in. floppies.

A related issue is availability of custom LSI circuits.



**The low-mass head design of Shugart's SA810/860 reduces media wear by reducing the force against the diskette; only the head is loaded. Previous systems had to load the complete head-and-arm assembly onto the disk.**

With the prior AC motor, there was no need for electronics to control the motor's speed. The DC motor, on the other hand, requires precision speed-control electronics; use of custom LSI allows the required electronics to fit easily onto the drive board.

A final advance that permits size reduction was the

SA810/860's new diskette-clamping technique. In the standard-height 8-in. drives, a movable cartridge guide lifted the diskette off the spindle when not in use. The clamping approach used in the new half-height drive replaces the cartridge-guide mechanism with two thin nonmovable side rails, which ensure more accurate diskette positioning. Instead of the whole diskette being lifted, only the clamp is moved. And the new mechanism is only about half as high as its predecessor.

### **Smaller size, fewer problems**

Reduced drive size resulting from advances in motor technology has another indirect benefit—increased reliability. First, the belts and pulleys associated with the AC motor no longer are necessary; fewer parts mean fewer breakdowns. Second, because the AC motor took 2 sec. to start, a head-load solenoid was needed to lift the read/write head off the spinning diskette to reduce media wear. With a fast-starting DC motor, the head-load solenoid is not needed, resulting in several advantages. The clicking noise produced by the solenoid is gone. And because the diskette turns only when needed, media wear or damage does not occur, even though the heads are always loaded. Removal of the head-load solenoid has virtually no effect on throughput because of the SA810/860's DC motor, which takes less than one latency time to start (compared to proposed competitive half-height products that take three or more latencies). Speed is especially critical to the growing number of distributed systems in which many users must access data simultaneously.

Reliability is further ensured because elimination of the head-load solenoid means there is no source of electromagnetic interference (EMI) near the heads; in earlier drives, the external magnetic field produced by the solenoid could interfere with the read/write head or a nearby CRT terminal. And optional metal shields on both sides of the drive protect against external EMI sources, such as CRT flyback transformers or switching power supplies that often are next to disk drives.

Another factor in drive-size reduction—the use of LSI circuitry—also indirectly increases reliability. Custom LSI enables the SA810/860 to incorporate two new functions that will be characteristic of the next generation of floppy-disk controllers: “true ready” and buffered seek. True ready is an output line that signals when a drive is ready to read or write, that is, when the diskette is up to speed, all seek functions have been completed, and the ready line is active. Buffered seek allows the host system to send step pulses to the drive at a pulse rate as high as once every 15 µsec. Pulses received at less than 3-msec. intervals are stored in a buffer that then issues step commands to the drive stepper motor at a 3-msec. rate. When used together, the true ready and buffered seek eliminate the need for motor start and seek complete timers, allowing the system to operate at peak efficiency.

Further contributing to reliability in the double-



*Elimination of the head-load solenoid means there is no source of electromagnetic interference near the heads.*

sided SA860 is a new suspension system using a low-mass head design. Rather than loading the complete head-and-arm assembly onto the disk as in past systems, only the head is loaded against the diskette while the arm is mechanically supported. This reduction in load force against the diskette significantly reduces media wear.

Finally, reliability is enhanced through an energy-consumption level reduced by approximately half over the SA801/851. The SA810/860 drives have a typical heat dissipation of 35W, as compared to 60W to 80W typical of the earlier products.

### More capacity and more

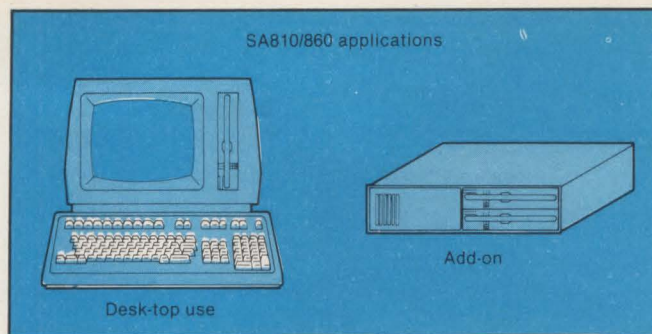
In addition to doubling storage capacity when used in tandem, the half-height drives provide the system designer a choice of floppy or minifloppy. Today's 8-in. systems require a major redesign to incorporate 5¼-in. drives, including new media, controller and cabinets. The SA810/860 does not require any of these changes. It has more capacity—the SA860 offers 1600K bytes, approximately 60 percent more storage than a double-sided 96-tpi minifloppy. It also has faster access times (89 msec. versus 158 msec. average) and data transfer rates (500K versus 250K bits per sec. maximum). And it runs the popular industry-standard CP/M operating system more efficiently because CP/M is designed to run on 8-in. floppy-disk systems.

In addition, when more stable 96-tpi media become available, capacities as high as 3.2M bytes will be possible in the 8-in. size with read compatibility with all previous 48-tpi diskettes.

### Upgrading to half-height

While speed and reliability are important considerations in the design of half-height floppies, the overriding requirement is total compatibility with the huge base of systems designed around the SA801/851 standard-height 8-in. floppies. Because this product will more often than not be the standard against which system designers will evaluate half-height candidates for upgrading their systems, several key questions should be considered:

- Does the half-height product use the same drive/controller interface as the current drive? If not, major hardware, software and controller changes are required, rather than a simple substitution.
- Are the width and mounting holes of the half-height drive identical to those of the current drive, so that both will fit into the same space in the system?
- If the half-height drive eliminates the AC drive



Shugart's SA810/860 half-height, reduced-depth 8-in. floppy-disk drives give a system designer the flexibility of placing the drives within the terminal or as add-ons.

motor, is it at the cost of an increased DC power requirement?

- Does the half-height drive have an on-board FM data separator for single-density operation? Its presence ensures compatibility with systems using single-density full-height drives.

- If hard-sector data formatting is being used, does the drive include the necessary sector separator?

- Does the half-height drive have all jumper options used on the current drive? Dramatic space reductions achieved in the half-height products may lead to varying levels of streamlining, resulting in eliminating some previously available options.

- Does the half-height drive allow sufficient clearance for the insertion of a bezel around the two small drives that will replace the larger one?

- Does the drive include a door lock to ensure data security by preventing media removal while the system is running?

These are the factors a system integrator should consider when choosing an 8-in. floppy upgrade. ■

Ray Heckman is product manager, and Roger Stromsta is director of floppy-disk development engineering at Shugart Associates, Sunnyvale, Calif.

### NEXT MONTH IN MMS

March is data communications month in Mini-Micro Systems, with feature surveys of modems and teleprinters, including comprehensive product listings. Also featured will be part two of a three-part series on local area networks—an in-depth analysis of LAN services, products and applications by consultant and contributing editor Walter Levy.

Also scheduled for the March issue:

- Criteria for selecting local area networks.
- Tutorials on token-passing techniques and cabling.
- Previews of future network designs and of  $\mu$ C-based products for personal communications.
- A comprehensive summary and analysis of electronic mail offerings, including several products not announced before this issue.



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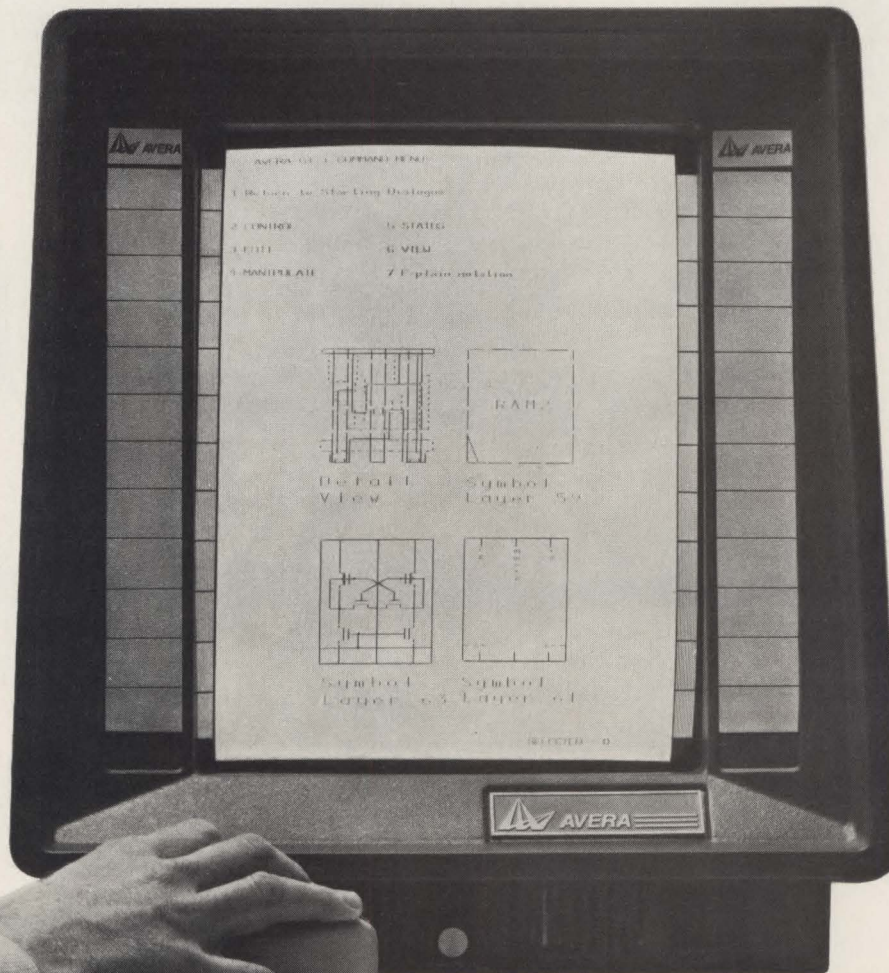
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## DISK DRIVES

# Coping with off-track errors

KUNIHITO HASHIMOTO and SEIICHI YASKAWA, Y-E Data, Inc.

### *Y-E Data's 5¼-in. Winchester-disk drive reduces errors that prevent interchangeability*

Since their introduction by Shugart Associates in 1976, 5¼-in. Winchester-disk drives have become the most popular media for storing programs and data on low-cost  $\mu$ c systems. The reasons are that 5¼-in. Winchesters are portable and can be transferred directly from one system to another. Further, their capacities are still growing. The first Winchesters stored only 10K bytes on an 8-in. disk. Now, with the introduction of Minidiskette from Y-E Data, Inc., Tokyo, Japan, drives store as much as 1M byte per diskette. That tenfold increase was achieved by doubling the amount of data stored per track (data density), recording on both diskette surfaces (double-sided recording) and, most recently, doubling the number of tracks recorded per in. (track density) from 48 to 96 tpi.

Doubled track densities make 5¼-in. Winchesters doubly intolerant of small errors in the positioning of their read/write heads, and the combined effects of read and record positioning errors can cause a diskette to be unreadable by any drive except the one that recorded it. Using a combination of careful design and stringent engineering, Y-E Data believes it has overcome the interchangeability problem in its first double-density unit, the YD-280.

#### Off-track errors affect interchangeability

Off-track head positioning error is the main impediment to disk interchangeability in double-density drives. Consider three adjacent tracks  $N-1$ ,  $N$  and  $N+1$  on a disk (Fig. 1A). Let their pitch (distance between tracks) be represented by  $P$ . Now, suppose the following sequence of events takes place:

- A drive with  $+X$  off-track error writes data A on track  $N$  as serial marks and spaces. The drive's read/write head has a width of  $L$ , and its erase head has

a width of  $2D + L$ . The width of the recorded data is assumed to be  $L$ .

- A second drive with similar head dimensions but a  $-X$  off-track error overwrites new data B on track  $N$  (Fig. 1B).

- The first drive writes data C on track  $N-1$  with  $+X$  off-track error (Fig. 1C).

- The first drive tries to read data B written on track  $N$ , which is now offset by the distance  $2X$  from its read/write head (Fig. 1D).

The diskette in the example above will be interchangeable between the two drives only if the first drive reads what's left of data B. This will happen only

Double-track-density tradeoffs for minidiskette drives

	YD-280 Double-track density Double-sided Double-data density	YD-274 Double-sided Double-data density
Storage capacity	1M byte	437.5/500K bytes
Unformatted	655K bytes	286.7/327.6K bytes
Formatted	16	16
(Sectors/track)	250K bps	250K bps
Transfer rate	5922 bpi	5456/5876 bpi
Recording density	96 tpi	48 tpi
Track density	80	35/40
Number of cylinders	160	70/80
Number of tracks	MFM	MFM
Recording method	300 rpm	300 rpm
Rotational speed	100 msec.	100 msec.
Latency (average)		
Access time	3 msec.	20 msec.
Track-to-track	15 msec.	15 msec.
Settling	95 msec.	248/281 msec.
Average	50 msec.	50 msec.
Head load time	+ 12V DC	+ 12V DC
Power requirements	+ 5V DC	+ 5V DC
	10W	12W
Power dissipation	Vertical	Vertical
Mounting	Horizontal	Horizontal
		Upright

Y-E Data's YD-280 minidiskette drive uses precise mechanical components and  $\mu$ p-based circuitry to reduce the head-positioning errors that make media interchangeability a problem for many 5¼-in. floppy disks.

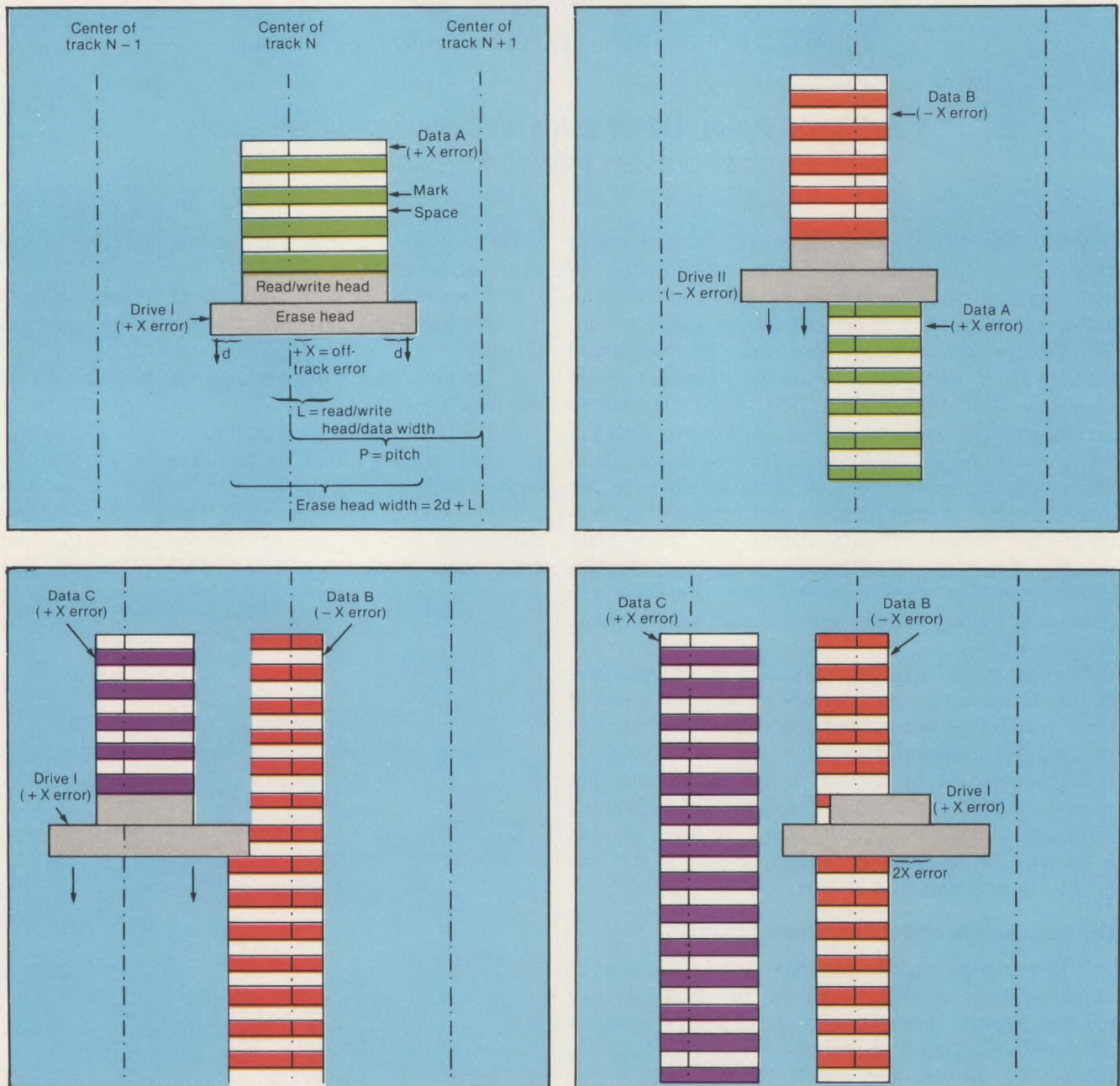


**Off-track head positioning error is the main impediment to disk interchangeability in double-density drives.**

if three conditions are met. First, the second drive must completely erase data A before writing new data B. That will happen only if the maximum track-to-track error,  $X$ , equals  $D/2$ . The second condition is that data B is not erased too much when data C was written on the adjacent track, that is:  $L + D = P$ . The last condition is that the drive's read circuitry be sensitive enough.

After the first three steps, the remaining data B is  $L-2X$  wide and produces signals that the read head sees as  $(L-2X)/L$  times weaker than those from centered data.

The three conditions above show that the acceptable off-track-error range can be increased by increasing the read/write-head width and the erase-head width. However, their maximum widths are limited by the track pitch. The YD-280's design meets all three of these data-interchangeability conditions (Fig. 2). Its combined read/write head width,  $L=165\text{ }\mu\text{m.}$ , plus its erase-core overhang,  $D=100\text{ }\mu\text{m.}$ , equals the 96-tpi track pitch of  $265\text{ }\mu\text{m.}$   $1/96\text{ in.}$  Its off-track error margin is  $\pm 50$



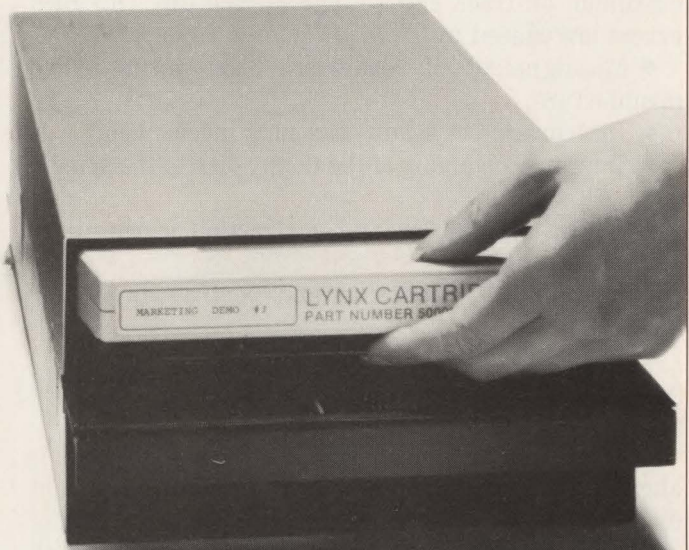
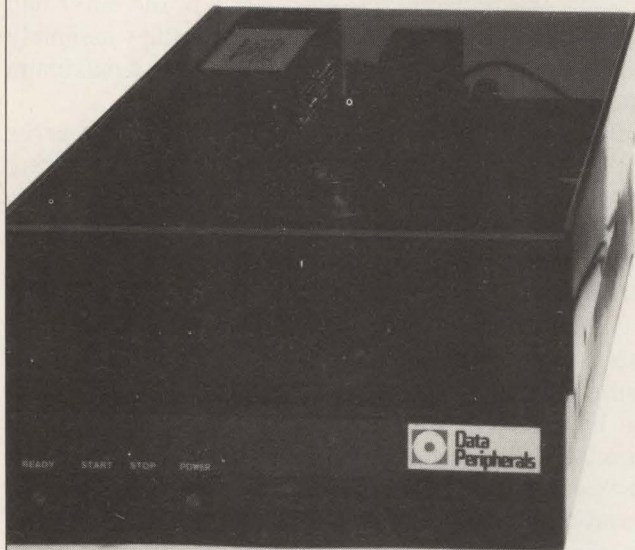
**Fig. 1. Off-track errors** occur when diskette drives with incompatible head-positioning errors try to read or write one another's diskettes. The drive in A writes data A on track N with a  $+X$  off-track error. A second drive in B writes data B on track N with a  $-X$  off-track error, erasing data A. In frame C, the first drive writes data C on track N-1 and partially erases data B as it does so. In frame D, the first drive tries to read data B that is partially erased and off-center from the write head by two times the error margin  $X$ . Unless the read circuit in the drive is sensitive enough to reliably read what's left of data B, off-track errors will occur. The diskette in the case above is not interchangeable between the two drives.



# EVOLUTION

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**The acceptable off-track-error range can be increased by increasing the read-write-head width and the erase-head width.**

$\mu\text{m.}$ , half the erase-head width. Its read circuit is sensitive enough to handle the 39.4-percent reduction in head output resulting from that off-track error.

**Reducing electromechanical error**

The head dimensions in Y-E Data's design required a maximum off-track error range of  $\pm 50 \mu\text{m.}$  Off-track errors are caused by

- Misalignment of read/write head during drive manufacture,
- Inaccuracies in head-positioning mechanism,
- Improper clamping of the floppy disk to the spindle hub,
- Thermal expansion and contraction of the drive and diskette,
- Hygroscopic expansion and contraction of the diskette,
- Improper drive-mounting position.

Y-E's engineers took measures to combat each source of error individually.

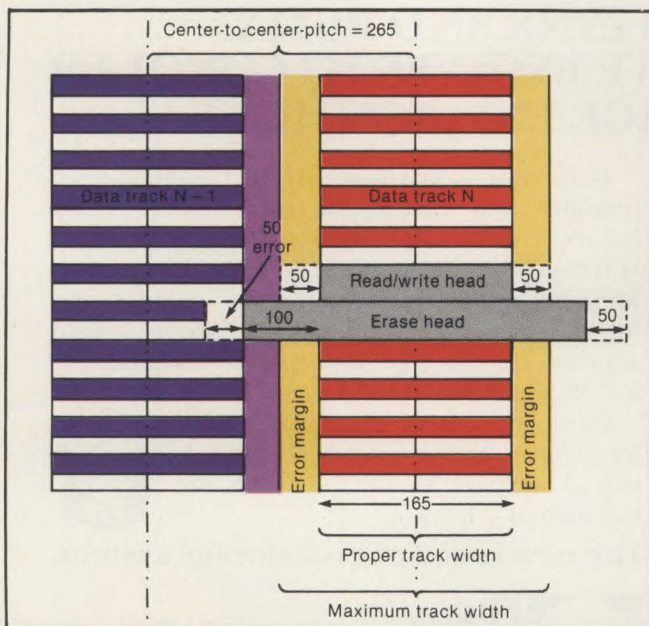
During drive manufacture, the read/write head is aligned at track 32, using a Y-E Data alignment diskette. Head-alignment error is  $\pm 20 \mu\text{m.}$ , half that of 48-tpi drives. The diskette is made and calibrated with a standard drive in a chamber kept in a standard environment ( $23^\circ\text{C}$ , 50 percent relative humidity) for a year. Although the alignment diskette degrades with

use, the diskette used in Y-E Data's factory is always checked with the standard drive to assure continuing accuracy.

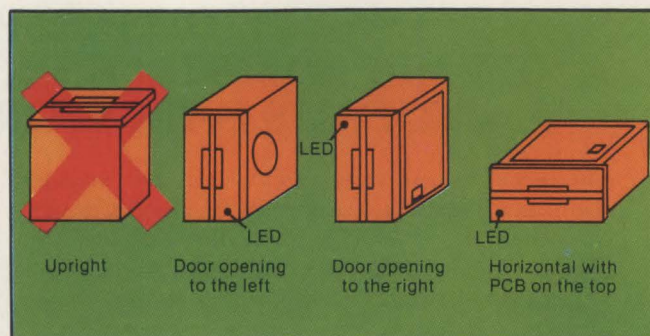
To reduce head-positioning errors, the YD-280 uses a pulley-steel-band head positioner. The hybrid stepper motor that drives the positioner band has a 1.8-degree step angle. Typical accuracy of this type of stepper motor was previously  $\pm 5$  percent at best. The change from four- to eight-pole motor stators results in  $\pm 3$  percent accuracy. The accurate band head positioner also yields 3-msec. track-to-track access times compared to the 20-msec. time for the lead-screw positioner in the YD-274. Additionally, the reduction of shaft run-out, the reduction of eccentricity in the outer and inner diameters of the pulley and shaft/pulley assembly improvements have produced a pulley with a maximum run-out of  $10 \mu\text{m.}$

Steps were also taken to minimize off-track error caused by diskette expansion and contraction resulting from temperature changes. The thermal-expansion coefficient for minidiskettes is specified by the International Standards Organization as:  $(17 \pm 8) \times 10^{-6} \text{ mm./mm./}^\circ\text{C.}$  The drive also expands and contracts with variations in temperature. The link between the spindle hub center and the head positioner in the YD-280 consists of aluminum, stainless steel and plastic, and the link's thermal expansion coefficient matches the diskette's. To calculate the temperature-related off-track error, therefore, only the  $8 \times 10^{-6} \text{ mm./mm./}^\circ\text{C.}$  deviation of the diskette must be considered. The specified operating temperature is about  $40^\circ\text{C}$  ( $5$  to  $43^\circ\text{C}$ ). The maximum off-track error that occurs is  $57.15 \times 8 \times 10^{-6} \times 20 \text{ mm.}$  or  $\pm 9 \mu\text{m.}$

While thermal expansion can be offset by matching



**Fig. 2.** YD-280's head dimensions and the 265- $\mu\text{m.}$  track pitch of 96-tpi double-track-density minidiskettes allow an off-track error margin of  $150 \mu\text{m.}$  In the worst case, off-track errors could total  $100 \mu\text{m.}$ , leaving at least  $65 \mu\text{m.}$  intact. The YD-280's read circuit can reliably read such narrow data.



**Fig. 3.** Mounting positions are critical to dual-track-density minidiskette drives. Upright mounting is not permitted because the weight of the drive's head assembly produces biased recording patterns. In the other three positions, head assembly weight has no effect on recording accuracy, and interchangeable diskettes are produced.

the head's thermal-expansion coefficient positioning mechanism to the diskette's, nothing can be done directly about hygroscopic expansion. Hygroscopic diskette expansion coefficients are specified in the ISO standards as  $0-15 \times 10^{-6} \text{ mm./mm./percent rh}$  (relative humidity). The figure measured by Y-E Data is  $(6 \pm 3) \times 10^{-6} \text{ mm./mm./percent rh.}$  Therefore, the maximum humidity-related off-track error is  $57.15 \times 9 \times 10^{-6} \times$



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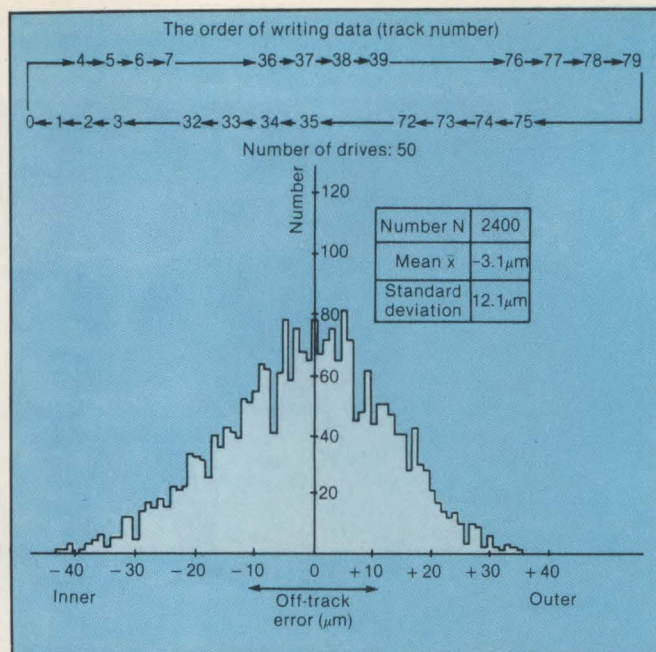


## To reduce head-positioning errors, the YD-280 uses a pulley-steel-band head positioner.

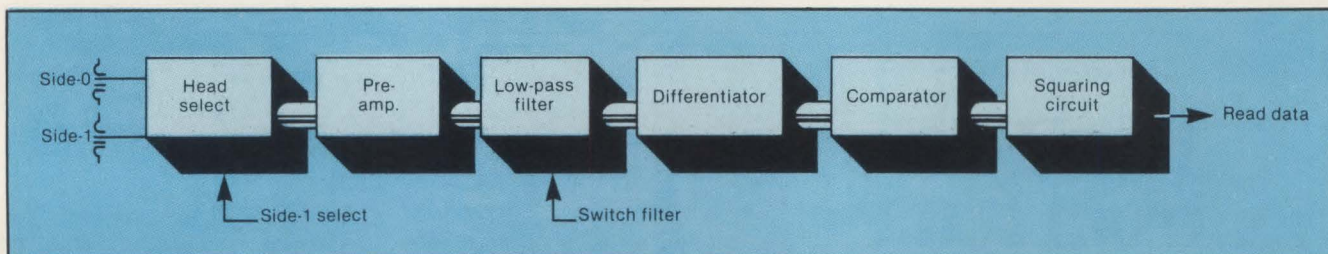
30 or  $\pm 15 \mu\text{m}$ ., with a  $\pm 30$ -percent variation in relative humidity.

While single-track-density diskette drives can be mounted vertically (door opening to the left or right), horizontally or in an upright (top-loading) position (Fig. 3), the upright position cannot be used in the YD-280, primarily because that position causes off-track errors resulting from the weight of the head carriage. The magnitude of off-track error caused by mounting position is determined by the torque equal to the carriage weight exerted on the stepper shaft, and the angle-torque characteristics of the stepper. In the horizontal and vertical positions, this factor has an error distribution with a zero average. In the upright position, the average becomes a non-zero value (a static bias), which increases off-track margins and can cause interchangeability problems.

To determine the YD-280's track-positioning accuracy, Y-E Data measured total off-track error (excepting



**Fig. 4. Positioning accuracy test results for the YD-280 show that Y-E Data surpasses its  $\pm 5\text{-}\mu\text{m}$  off-track error specification. Precise electromechanical components and careful assembly produce an average off-track error of  $-3.1 \mu\text{m}$  for 2400 track samples. While all errors were within the  $\pm 50\text{-}\mu\text{m}$  range, the majority were within  $12.1 \mu\text{m}$  of the track center.**



**Fig. 5. Read-circuit sensitivity in the YD-280 is enhanced with custom LSIs. To increase read margins, the circuit employs a switched-filter post-compensation method developed by IBM.**

thermal and hygroscopic expansion) in 50 drives. For each drive, data were written under the standard environment ( $23^{\circ}\text{C}$ , 50-percent rh), and the center position of data was measured on 12 tracks on the inner, outer and middle portions of both sides of each diskette. The total number of measured tracks was 2400. The results were a mean error of  $-3.1 \mu\text{m}$ ., with a standard deviation of  $12.1 \mu\text{m}$ . (Fig. 4). In other words, the average data track was written with a  $-3.1\text{-}\mu\text{m}$  error, and, while the maximum off-track error range was  $\pm 50 \mu\text{m}$ ., most errors were within a  $\pm 12.1\text{-}\mu\text{m}$  range. The results exceed Y-E's design specs and meet its second diskette-interchangeability condition easily.

### Better circuits complement better mechanicals

Having set head dimensions to meet the first condition and brought off-track error to within the range of the second condition, Y-E had only to improve its read-circuit performance. The data written on the diskette are picked up by the head, amplified by the preamplifier, filtered by the low-pass filter, peak-detected by the differentiating circuit and the cross-over detector, squared up and transmitted to the

controller as the read data (Fig. 5). To increase read margins, the YD-280 read circuit uses a post-compensation method (switched filter) developed by International Business Machines Corp. for its 8-in., double-sided, double-density drive.

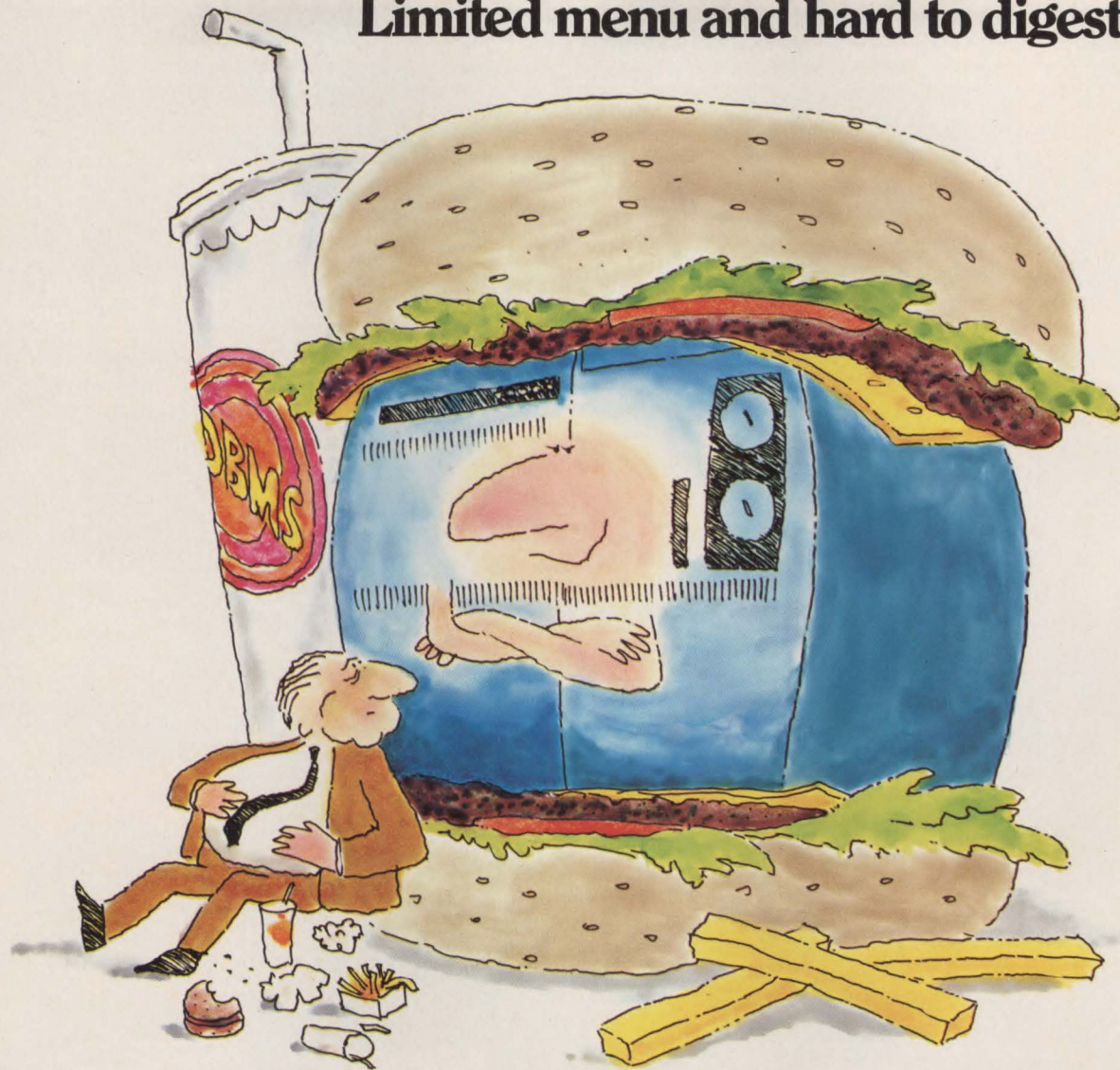
The switched filter widens read-circuit bandwidth to compensate for bit shift on inner tracks, narrows the bandwidth in outer tracks and increases the timing margins (window margins) of the data separator. This gives the read circuit the sensitivity to cope with the drive's off-track error range. Implemented via custom LSIs, the circuit is small and uses little power. The result of Y-E's efforts are drives that read and write truly interchangeable minidiskettes anywhere within acceptable temperature, humidity and vibration ranges. ■

**Kunihiro Hashimoto** is memory products development manager at Y-E Data, Inc. He previously served as an automatic control researcher for Yaskawa Electric, the parent company of Y-E Data. **Seichi Yaskawa** is international marketing manager at Y-E Data. He was previously a process-control systems engineer for Yaskawa Electric.



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## DISK DRIVES

# Servos keep 5¼-in. Winchester on track

T. DAVID COLWELL and HUBERT SONG,  
Rotating Memory Systems, Inc.

*Closed-loop servo systems increase tracking accuracy,  
boosting capacity and reliability*

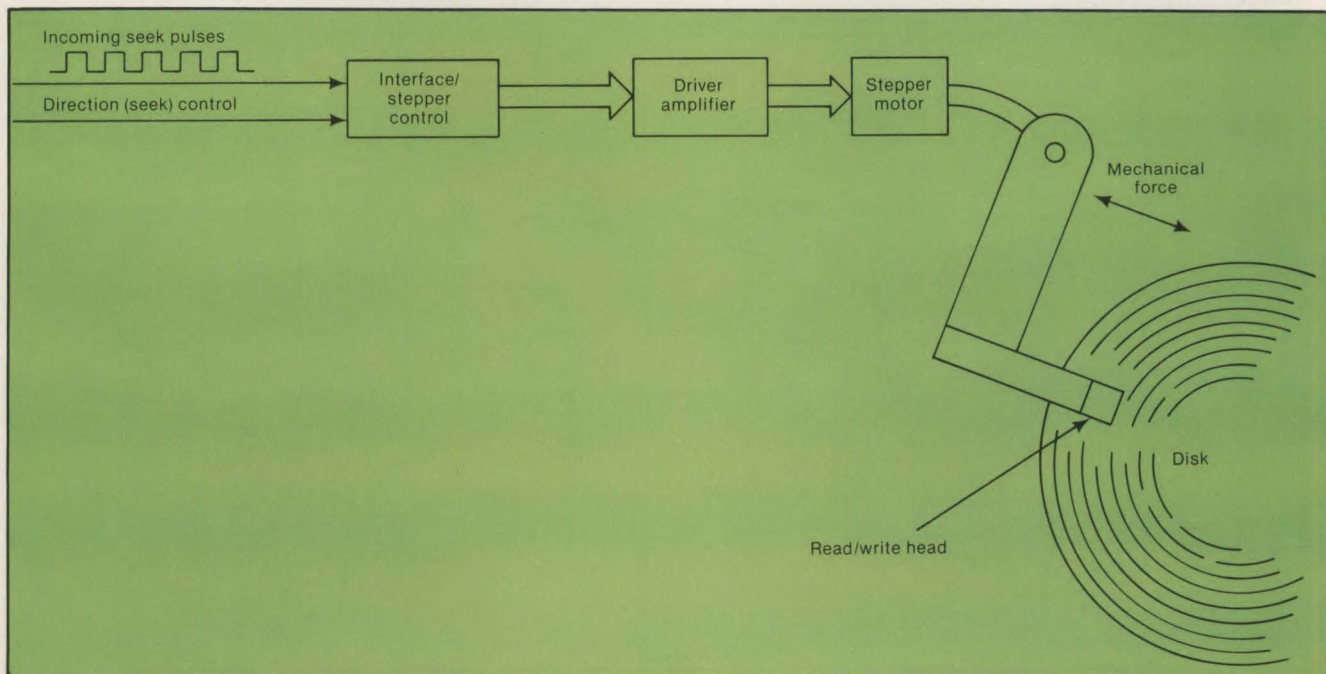
Servo mechanisms govern head positioning and tracking precision, and consequently are critical subsystems for high-density disks. Non-position-sensing (open-loop) stepper-motor mechanisms have proven very effective in low-capacity Winchesters with track densities of 300 tracks per in., but the considerably greater capacities (as high as 600 tpi) of newer mini-Winchester models indicates a shift to closed-loop, voice-actuator designs in future products.

### Open-loop limitations

Disk track density is limited by resolution of the

disk's actuator system. For open-loop systems, mechanical considerations such as spindle run-out, stepper-motor delay (hysteresis), stepper settling and, most importantly, thermal expansion dictate the guidelines for a reliable product.

Disk-drive actuators typically employ two axes of motion with a supportive bearing system. The bearings generate non-repeatable errors that result from random mechanical shifting in the bearing construction. The stepper motor contains inherent hysteresis and ringing problems that add to the non-repeatable error category during the recording operation. In addition,



**Fig. 1. Open-loop stepper systems receive seek commands from the disk's actuator-control circuitry. Receipt of one such pulse causes the head to move one track. The direction-control line determines the direction of seek motion. An interface/stepper controller converts the positioning signals to stepper-motor commands.**



*For open-loop systems, mechanical considerations such as spindle run-out, stepper-motor delay (hysteresis), stepper settling and thermal expansion dictate the guidelines for a reliable product.*

stepper motors also contain repeatable step-position errors typically around 5 percent of the step size. These predictable, repeatable off-track errors must be accounted for in the determination of the track pitch during design.

The most difficult problem to overcome in an open-loop design is difference in thermal-expansion characteristics between different drive components. For instance, the first-order coefficient difference between a steel head flexure and the aluminum disk and base plate is about 8  $\mu\text{in. per } ^\circ\text{F per in.}$  All these non-repeatable errors restrict track density and govern minimum head-gap widths.

Nothing in a typical open loop actuator system ensures that the read/write heads will locate and remain over a desired data track (Fig. 1). The data read during a read operation is the only reference information indicating where the read/write heads are, and this information does not directly control the actuator system.

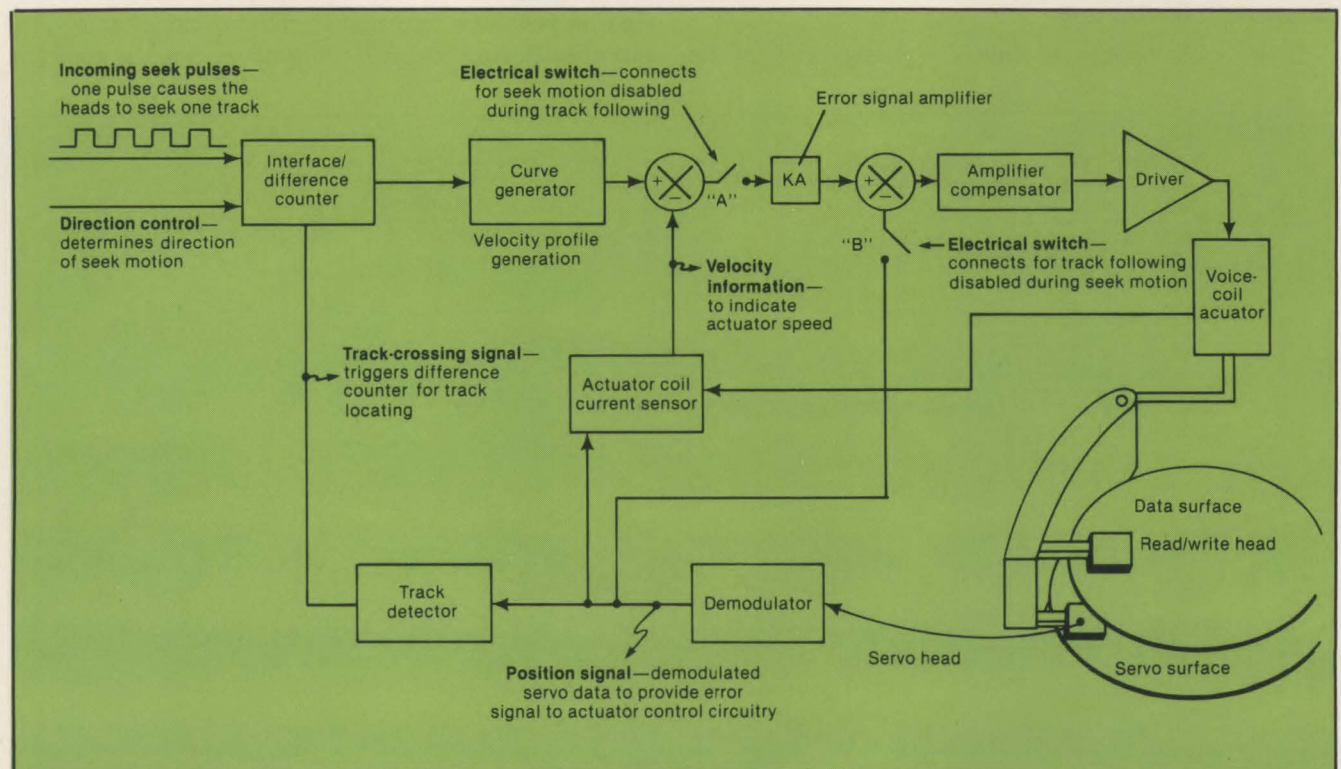
To overcome these problems and allow increases in track densities, designs must incorporate semi- or fully

closed-loop positioning systems. Fully closed-loop, track-following head-positioning systems permit the greatest track density and the most accurate positioning, but require special head-positioning information, or servo patterns, to be precisely prerecorded on the disk during the drive assembly. The semi-closed-loop head-positioning system provides for predetermined degrees of offset motion from a track center. Some semi-closed-loop systems simply employ trial-and-error track-finding motions, while others reference abbreviated servo patterns in the disk's outermost track, then micro-step the actuator for better positioning accuracy.

### Closed-loop servo components

A closed-loop servo system provides reference information from a servo surface back to the actuator control electronics (Fig. 2). This ensures that the read/write heads always follow a desired track by compensating for off-track problems normally encountered with mechanical actuators. The position information from the servo surface also generates a track-detecting indication for track locating and is used to determine actuator speed. Using a closed-loop track-following system allows designs to incorporate more efficient actuator-drive mechanisms. Stepper motor actuators, or micro-steppers, perform the small head movements required to follow a track accurately, but more versatile voice-coil actuators provide the fast access times desired in high-capacity disk drives.

Micro-steppers rely on special control circuitry to enhance the accuracy of the step movement. A common 1.8° stepper motor controlled by micro-step generator



**Fig. 2. Closed-loop servo systems receive seek commands from the disk's actuator control circuit just as open-loop systems do. But once a specified track has been located, a servo head constantly reads positioning information stored on a dedicated servo surface. The demodulated servo signals are relayed to the voice coil, which continuously makes corrections to keep the heads on track.**



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**Fully closed-loop, track-following head-positioning systems permit the greatest track density and the most accurate positioning, but require special head-positioning information, or servo patterns, to be precisely prerecorded on the disk during the drive assembly.**

circuits can increase step resolution to allow actuator-head movement to vary inside one track width. Position information causes the control circuitry to micro-step the actuator for accurate track following.

Voice-coil-driven actuators commonly used in large, high-performance Winchester-disk drives offer increased accuracy and faster access times. Voice-coil motors operate on the same principle as audio speakers. A voice coil is basically a permanent magnet surrounded by an electrical coil. Current flow through the coil generates a mechanical force that makes the magnet move into or out of the coil. The direction of movement

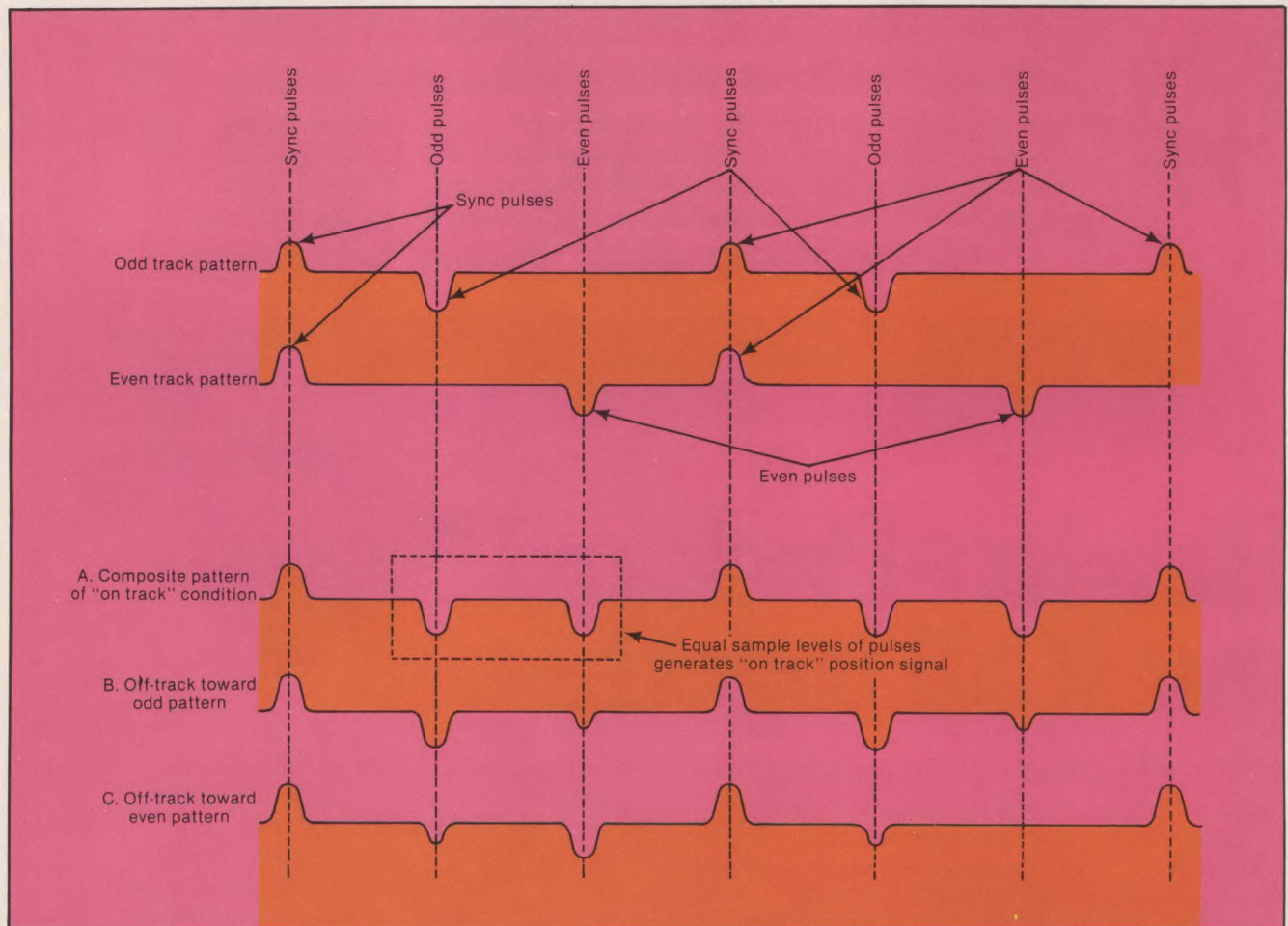
depends on the direction of current flow, and the amount of movement depends on the amount of current flow. A voice-coil actuator, then, does not rely on a finite number of magnetic stops, but moves the magnet and read/write heads attached to it continuously in either direction.

The open- and closed-loop designs each have advantages. The low cost of the open-loop system is the result of simple control electronics and less complex production techniques. Closed-loop systems are more expensive but allow higher capacities, faster access times and a wider range of operating temperature for the high-performance market.

### How closed-loop servos work

To understand how the closed-loop system operates, visualize the servo data. Assume a disk surface is reserved for servo information and is called the servo surface. A space, called a servo byte, is designated within a track of the servo surface (size is irrelevant), and one complete servo pattern falls within this space. A servo pattern is designed to provide an electrical signal describing head position.

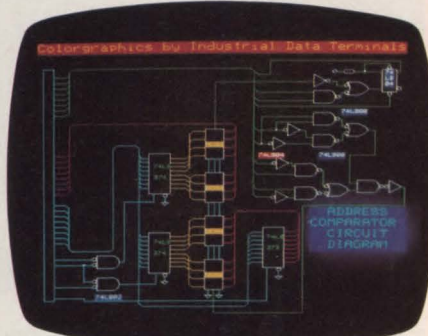
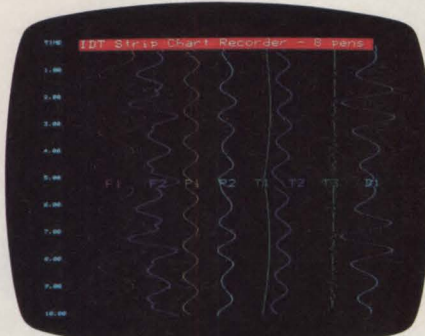
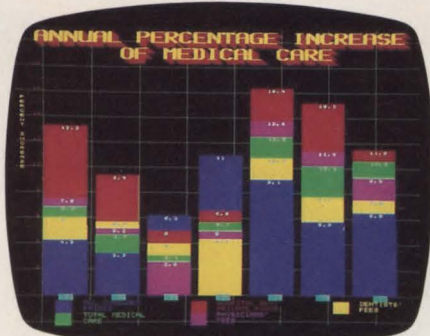
Two types of servo patterns commonly used are di-bit



**Fig. 3. Tri-bit servo patterns are used to keep disk heads on track.** They consist of synchronizing pulses and odd or even positioning pulses. Patterns are written on a dedicated servo disk surface—odd patterns on odd tracks, even patterns on even tracks—and are read by a dedicated servo head connected to the read/write heads. When the servo head is exactly between servo tracks, the read/write head is exactly centered on a data track. When the servo head is exactly between tracks it picks up equally strong odd and even pulses as in line A. When it is not centered, it picks up unbalanced signals as in lines B and C, and the servo system causes the head actuators to adjust head position. The new embedded servo technology puts servo patterns on every data track.



# Bubble Breakthrough

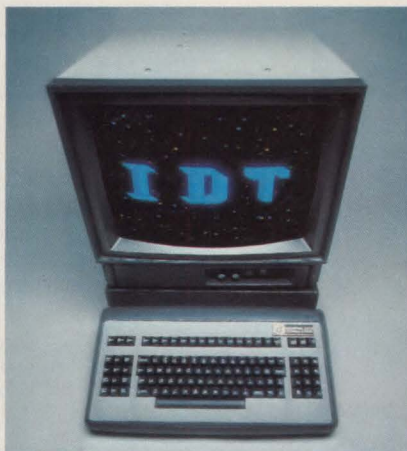


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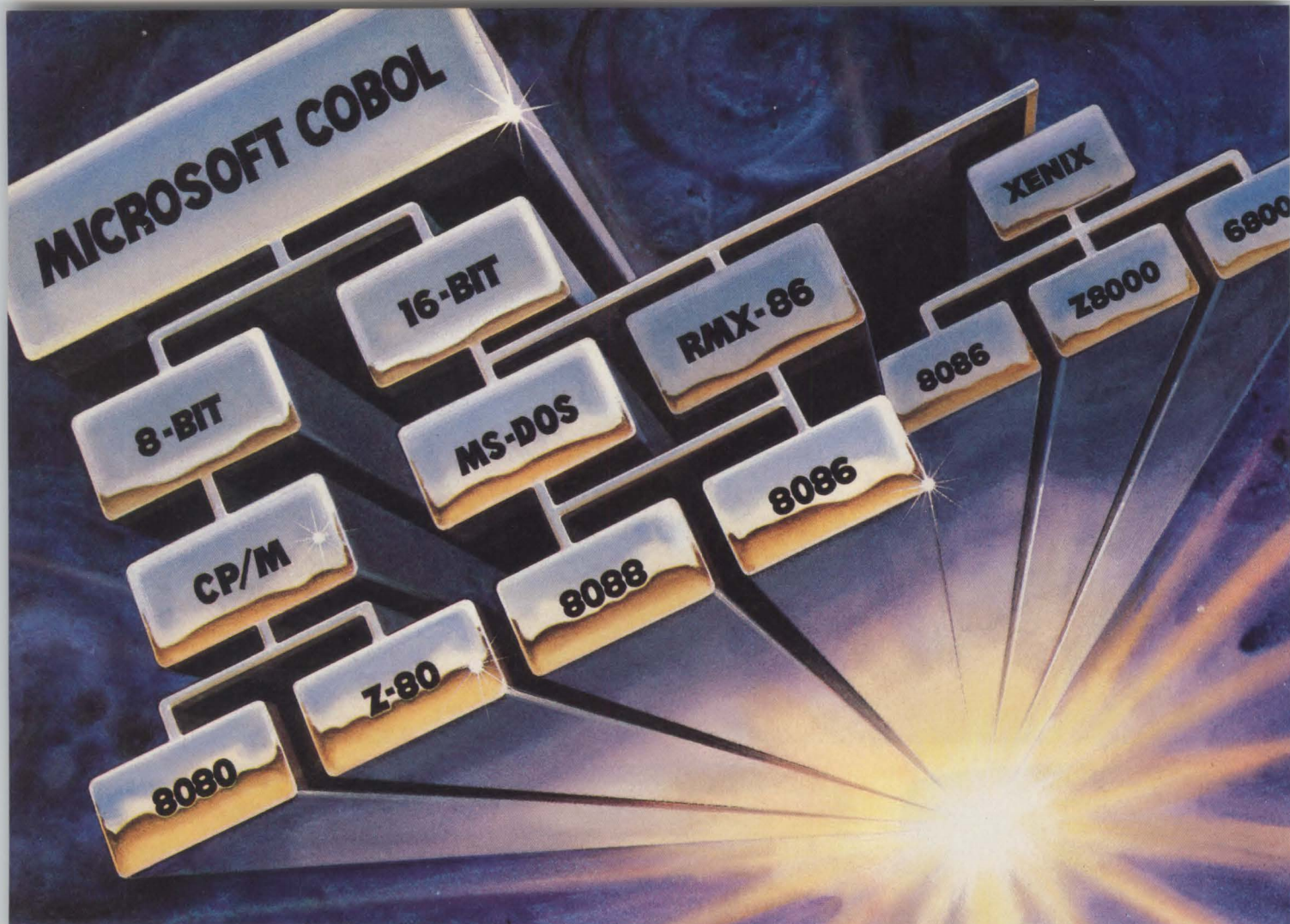


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***A common 1.8° stepper motor controlled by micro-step generator circuits can increase step resolution to allow actuator-head movement to vary inside one track width.***

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and tri-bit patterns. The tri-bit pattern contains a sync pulse with odd or even pulses (Fig. 3). The di-bit pattern contains only odd or even pulses in the servo byte. The tri-bit pattern's built-in sync pulse allows ready synchronization to a demodulation circuit. This simplifies positioner-circuit design, but because of signal-shift problems in the properties of a read head, pulse distortion occurs with the tri-bit configuration. This introduces off-track errors into the system, thus limiting track density. The di-bit configuration provides very symmetrical position information and allows higher track densities, but a complex demodulation circuit provides reliable synchronization with the servo data.

A very precise servo writer accurately records and verifies the servo data on the disk during manufacture. The servo information is written with servo tracks that alternate in phase relation with each other onto dedicated space. Two types of closed-loop head-positioning systems are dedicated servo systems and embedded servo systems. They involve different placements of the servo patterns.

A dedicated servo system uses a complete disk surface as the servo surface. The system accommodates a high-bandwidth servo that provides excellent resolution for high track density. The servo head, a read-only head, provides a high percentage of security for the servo data.

During operation, the dedicated servo head constantly reads the servo surface and relays its information to the position processor circuit. The demodulated signal will equal a zero-level DC when the servo head reads 50 percent of an odd and 50 percent of an even servo track. A corresponding data track on another surface is located at this point (between two servo tracks). If the servo head drifts from this point because of thermal expansion, for example, the demodulated position signal will vary positively or negatively, depending on direction. A non-zero signal fed to the actuator circuitry will cause the head assembly to shift toward or away from the center of the disk, keeping the data heads "locked on" the selected track.

This same signal-processing circuitry also generates a track-crossing pulse when the servo head crosses the midpoint between two servo tracks (a data-track location). This pulse is delivered to a difference counter that measures how far the actuator has gone in a seek routine or how much further the actuator has to go to the desired track.

Embedded servo systems do not require a complete disk surface to hold position information. By "embed-

ding" the servo information within the data tracks, this class of servo disk drives can use this vital surface for data storage as well.

At the beginning of every data track and every sector (equal portions of the circular track; normally 32 sectors), a short burst of servo information is written. This servo information is prerecorded by a servo writer and sets permanent sector lengths. Once specified for production, a consumer cannot alter the number of sectors and their size. Embedded servo operation is identical to the dedicated scheme. Di-bit or tri-bit patterns written 50 percent off-track of the data-track locations provide the same position information to the signal processor for track locating and following.

Dedicated servo systems are less accurate than embedded systems because their servo heads are mechanically separated from their read/write heads. But dedicated servos are more popular than embedded servos because the embedded servo has three main drawbacks. First, the security of the servo data is sharply reduced because it passes under read/write heads rather than dedicated, read-only servo heads. Second, disk I/O is reduced because read/write heads must read positioning information as well as stored data. Third, the embedded servo data imposes fixed hard-sector lengths on the user, sector lengths conflicting with the de facto industry-standard, ST 506 5¼-in. Winchester interface.

Widespread adoption of embedded servos for 5¼-in. Winchesters will depend on new interface standards that permit multiple sourcing of interfaces and controllers. Dialogue between mini-Winchester makers is encouraging, and new standards may emerge this year. Small Winchesters with 40M-, 60M- and 100M-byte capacities and 35 msec. access times are in development and will probably rely on these and similar closed-loop servo technologies. ■

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**T. David Colwell** is product manager and **Hubert Song** is servo manager at Rotating Memory Systems, Inc., Milpitas, Calif.

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#### **NEXT MONTH IN MMS**

March is data communications month in Mini-Micro Systems, with feature surveys of modems and teleprinters, including comprehensive product listings. Also featured will be part two of a three-part series on local area networks—an in-depth analysis of LAN services, products and applications by consultant and contributing editor Walter Levy.

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- Tutorials on token-passing techniques and cabling.





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## DISK DRIVES

# Floppy-disk cartridge challenges Winchester

DAVID NORTON and PAUL LOSEE, Iomega Corp.

*A new 8-in. floppy cartridge uses aerodynamic principles to improve density by reducing head-to-medium distance*

The evolution of mass data-storage subsystems has led many potential users to believe that high-density, high-performance recording is the exclusive domain of rigid- or hard-disk media. But there is nothing that inherently limits flexible media from sharing that domain. A subsystem that can stabilize its floppy media and tightly control head-to-disk displacement can achieve recording densities and data-transfer rates that rival those of rigid disks.

The Alpha-10, an 8-in. cartridge drive from Iomega Corp., Ogden, Utah, combines aerodynamic and flexible-media technologies to do just that. Its 10M-byte formatted capacity—equal to that of comparably sized Winchesters—results from a further reduction in the distance between head and media.

### Flying height dictates bit density

Recording bit density depends on the number of magnetic flux changes that can be reliably written and read on a medium. There is a direct relationship between bit density and the distance between the read/write head and the media, or "flying height." At flying heights in excess of 80  $\mu\text{in.}$ , for example, bit densities are approximately 3000 flux changes per in. At heights lower than 10  $\mu\text{in.}$ , however, International Business Machines Corp.'s 3380 drive subsystems achieve bit densities in excess of 15,000 fcpi (Fig. 1).

To bring the head and media closer, the rigid-disk drive manufacturers must now deal not with a head flying in an air-bearing region, but one that begins to enter the media-lubricant-bearing region. The object is to get as close as possible to the media without making significant frictional contact. The heads fly because of the aerodynamic forces set in motion by a rapidly spinning disk. Under these circumstances, frictional contact drastically diminishes media life.

Flexible media (disks and magnetic tape) have

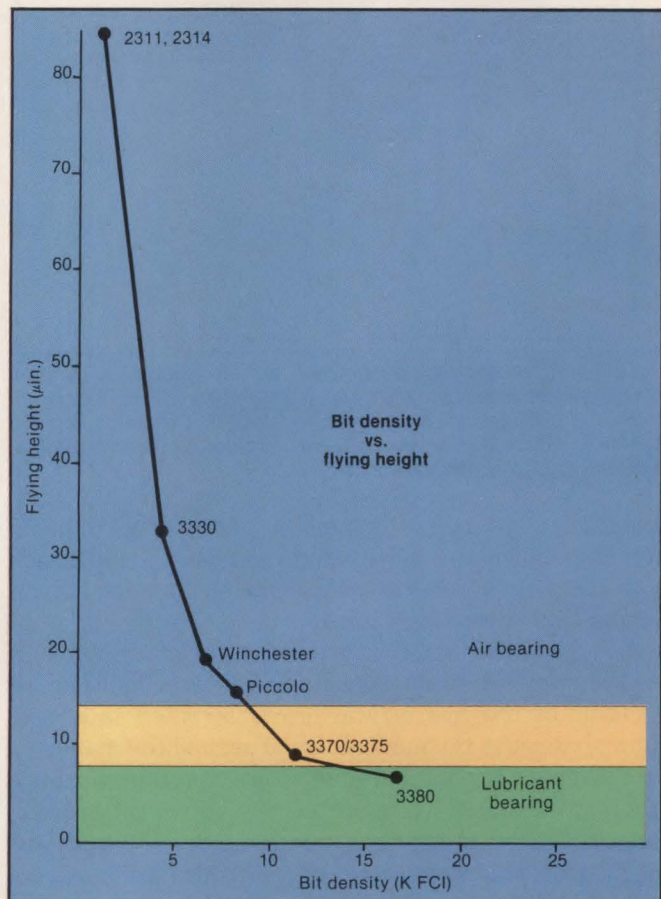


Fig. 1. Evolution of IBM disk products shows order of magnitude difference in flying height of head.

traditionally been used with contact recording systems. The head-to-disk contact helps keep the flexible material stable, but forces a performance/wear-factor trade-off on these systems. Manufacturers working toward a flying-head, or noncontact, approach require tight control of the head-to-media interface to achieve

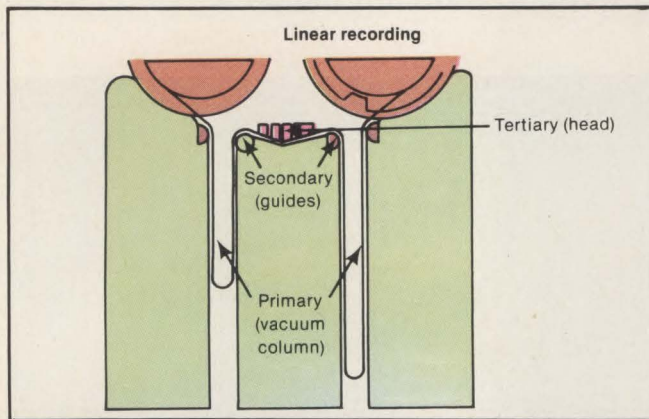


***The pumping that occurs when a disk spins over a Bernoulli plate causes air to be drawn between the surfaces and an opening on the plate.***

bit densities of 10,000 to 20,000 fepi. This forces a stringent requirement for media stability.

### Achieving stability

Two approaches to noncontact recording and stability include linear and helical. A linear recording device (high-performance magnetic-tape drives) has three levels of stabilization. The primary one is a vacuum column. Secondary stability is accomplished by the tape guides, the wrap angle around them and the distance between them. Tertiary stability results from the air bearing created between the head and tape during high-speed recording (Fig. 2). During random-access



**Fig. 2. Linear recording system uses vacuum columns to provide primary stabilization of flexible (tape) medium. The guides, their wrap angle and separation are a secondary stabilizing element. Tertiary stability is established by the air bearing created between head and tape during high-speed transport.**

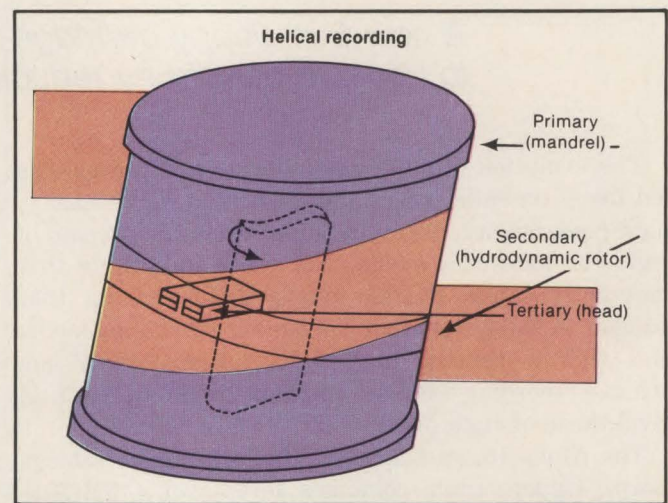
operations, however, the media is repeatedly stopped, breaking down the air bearing and permitting head/tape contact. Considerable head and media wear occurs during this "shoe-shine" mode.

A helical recording device achieves primary stability via the mandrel. Secondary stability is accomplished as a result of the hydrostatic forces between tape and rotor that cause the media to bend around the mandrel, producing a very stable region (Fig. 3). Again, tertiary stability is created by an air bearing between head and tape. However, every time the head exits or enters the media area, this air bearing is broken down and must be reestablished. Thus, the entry and exit zones of the media become exposed to high wear. Similarly, pressure perturbations are introduced in stepping from track to track. This also causes a breakdown in the head-to-media interface with resulting media wear. In both the linear and helical recording approaches, fundamental designs preclude eliminating these wear mechanisms and impose limits on performance and durability.

A traditional floppy-disk medium, packaged in a thick paper jacket, also has three levels of stabilization. Primary stability is achieved by bending the cartridge slightly in the drive, but this puts the medium in continuous contact with the jacket, causing continuous wear. Secondary and tertiary stability are achieved through the head and pressure-pad apparatus (Fig. 4). This mechanical loading device holds the media close to the head and produces wear. Because it is a continuously rotating system, the floppy-disk medium is not subject to the same faults as tape systems, but its wear mechanisms have yet to be overcome.

### Bernoulli technology provides wear-less stability

A radically different approach to flexible media stability uses Bernoulli's principle, a 200-year-old idea. A floppy disk spinning in open space typically has a



**Fig. 3. Helical recording devices use the mandrel for primary stability, and hydrostatic forces between tape and rotor provide secondary stability. Tertiary stability, as with linear devices, is created by the air bearing between head and tape. The spindle turns the rotor and heads.**

great amount of instability and flutter. According to Bernoulli's principle, however, if a disk spins close to a stationary surface, a negative pressure is generated between the two (Fig. 5) and the stabilizing effects cause the disk to fly at a determined distance above the rigid "Bernoulli plate." The distance is approximately  $\frac{1}{1000}$  to  $\frac{7}{1000}$  in. This effect is the primary stabilization technique, reducing disk flutter to less than  $\frac{1}{1000}$  in.

The pumping action that occurs when a disk spins over a Bernoulli plate causes air to be drawn between the surfaces and an opening on the plate. Fig. 6 shows that air is drawn in at the motor hub region and the slot for the read/write head. The air movement between the disk and surface creates the negative pressure region.

A miniature Bernoulli surface, the read/write head "coupler," protrudes slightly above the surface of the Bernoulli plate and attracts the media over a small, localized region, creating secondary stabilization. The coupler is aerodynamically shaped to keep flying height and disk flutter to 50 to 100  $\mu$ in. This secondary stabilization produces a small dimple or deformation of



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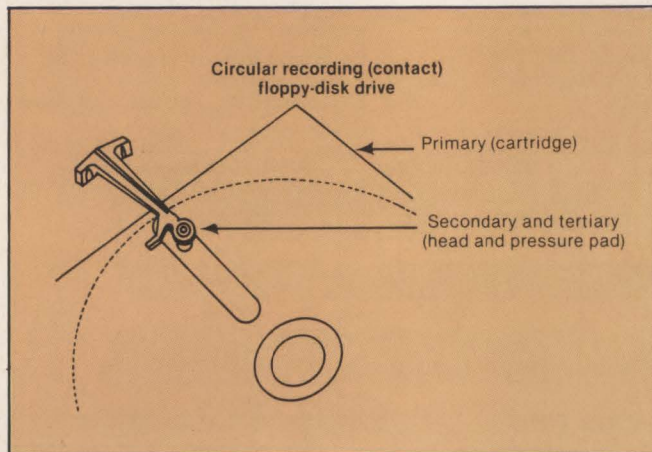
CIRCLE NO. 106 ON INQUIRY CARD



*The Bernoulli system permits a wide range of control over the aerodynamic coupling forces and the resulting flying heights.*

the media in the region just below the coupler (Fig. 7).

Protruding just above its coupler, the head is the third stabilization element. Because of its contour and



**Fig. 4.** The floppy-disk establishes primary stabilization via its jacket, which is also an immediate cause of wear. The head/pressure-pad combination provides both secondary and tertiary stabilization.

aerodynamic grooves, the head creates a coupling between itself and the media, with a displacement of about 10  $\mu$ in. This spacing permits bit densities of 10,000 to 20,000 fcpi.

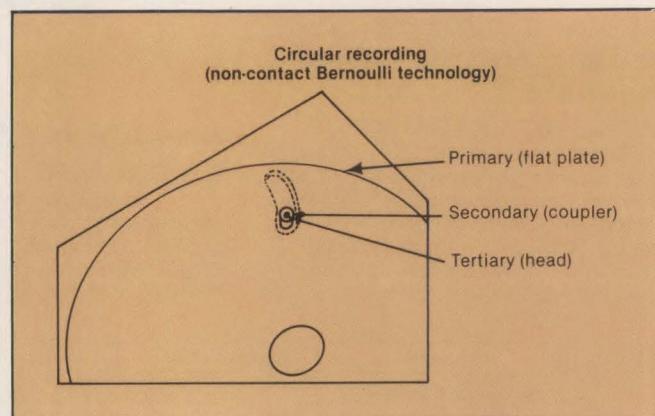
### Bernoulli advantages

**Self-purging.** The air-pumping action during primary stabilization purges the cartridge of contaminants.

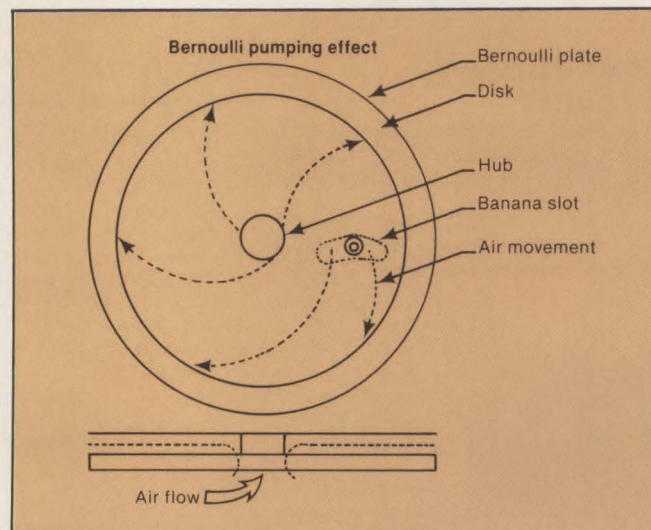
In rigid-disk systems, a collision between the head and a particle on the media surface causes the head to rebound, then crash into the disk surface, damaging both head and media surface.

The Bernoulli concept prevents this because the

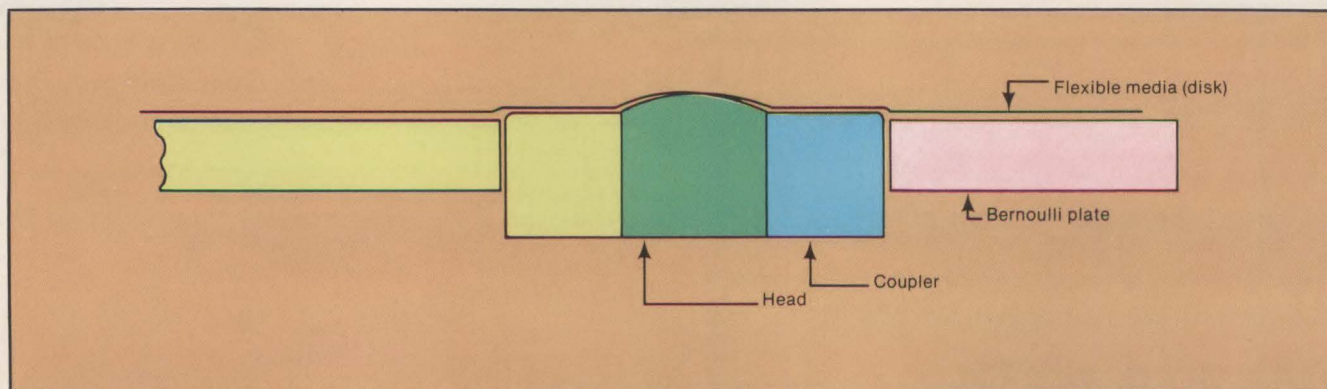
coupling between the head and media is "compliant." Should debris enter the coupler region, an influx of air causes the head/coupler and the media to separate as a result of the relatively weak aerodynamic coupling



**Fig. 5.** Stabilization in the Bernoulli system is achieved using a read/write head "coupler" to create a limited, secondary Bernoulli effect. The head element provides tertiary stability.



**Fig. 6.** Bernoulli pumping effect. As the floppy disk rotates above the Bernoulli plate, air is drawn in at the hub and the "banana slot" and pumped out centrifugally through the disk's perimeter. This air movement causes a negative pressure between medium and plate and pulls the medium to within 0.004 to 0.007 in. of the plate.



**Fig. 7.** Bernoulli system's secondary stabilization of the floppy disk is achieved through the head coupler, which protrudes above the plate surface and creates a secondary region of Bernoulli-effect coupling between it and the medium. The head, protruding just above its coupler, provides a third level of stabilization.



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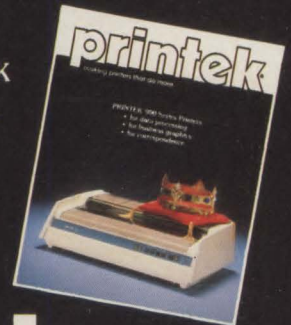
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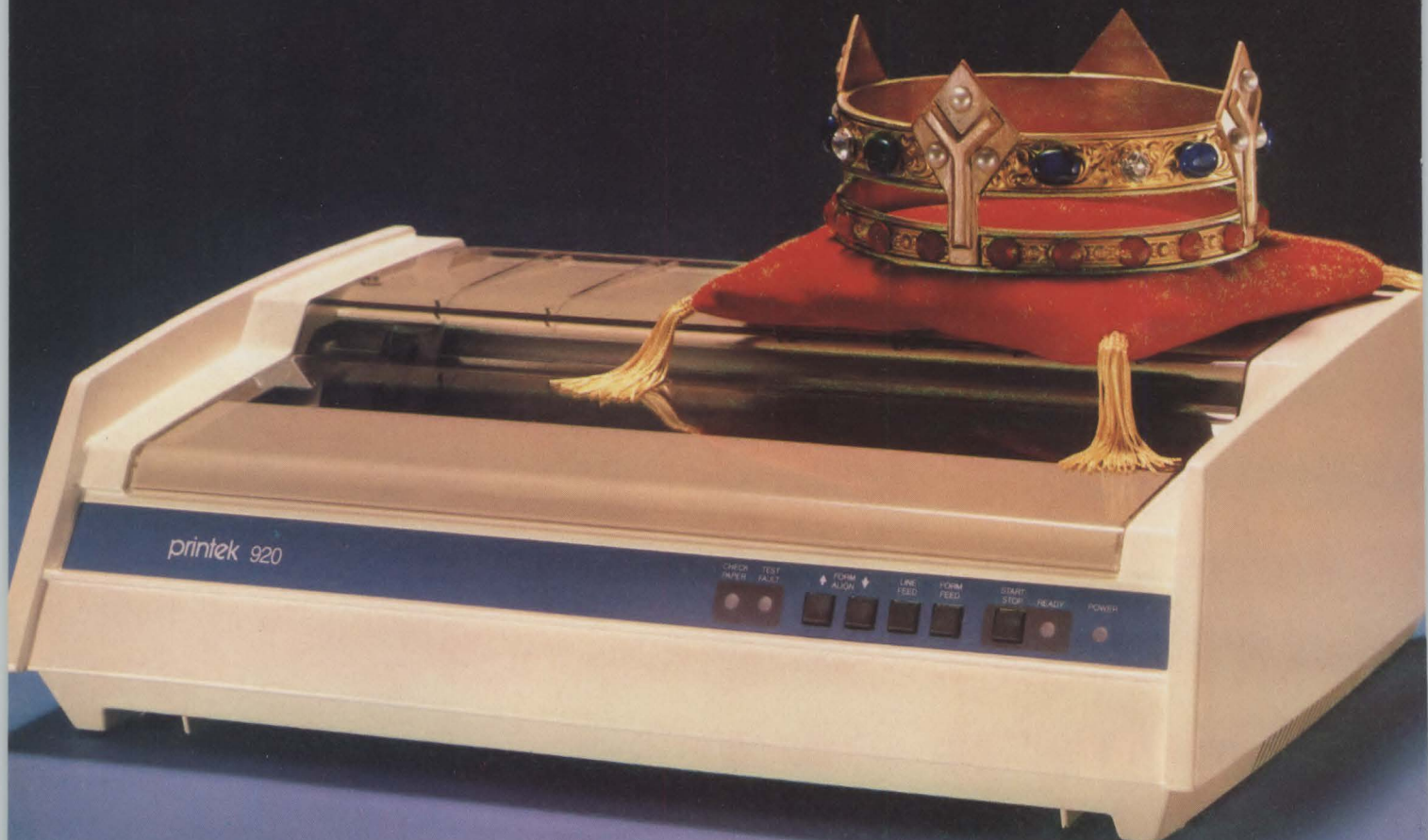
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*In rigid-disk systems, a collision between the head and a particle on the media surface causes the head to rebound, then crash into the disk surface, damaging both the head and media surface.*

between them. This allows the debris to flow through without making head contact. After the contaminant leaves the coupler area, the media and head resume their aerodynamic coupling. This typically results in a soft error, but no damage to media or head (Fig. 8).

To demonstrate the effectiveness of this scheme, cigarette smoke was blown for several minutes into a system in a continuous-read mode. This caused no errors of any kind and no damage to either head or media.

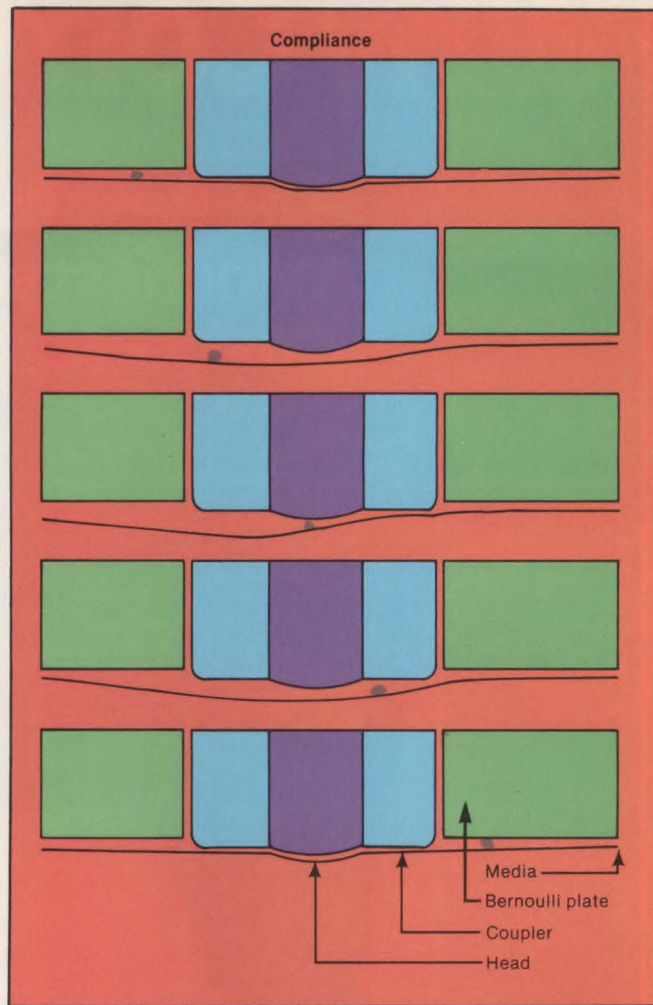
In a rigid-disk system, head flight requires rotating the medium at relatively high speeds. At speeds lower than a minimum rotation level (during starts and stops), the head comes in contact with the media unless the system has a spring-loaded mechanical head loader. In the Bernoulli approach, there is no coupling between head and medium when the medium is not turning. Therefore, there is no contact between head and medium during starts and stops, and no added system mechanics are required to prevent contact.

In a rigid-disk system, both the medium and the head are basically in elastic masses. Vibration or shock can play havoc with such a system and result in severe head or medium damage similar to a particle-caused head crash. The compliant nature of the head/medium interface in the Bernoulli system permits shock and vibration that would incapacitate a rigid-disk system. The only effect they have on the Bernoulli system is to decouple the head momentarily from the media, causing a soft error during that period.

The rigid-disk subsystem requires a minimal rotational speed before the head can fly. Consequently, any system variation has an inherent low rotational-speed sensitivity.

With floppy-disk subsystems, however, increased speed increases frictional wear of the medium resulting from the disk's rubbing against its jacket. Furthermore, higher speeds increase the disk surface boundary layer of air resulting in a greater separation between the head and media and a lower bit density. To prevent separation, higher clamping forces between the head and pressure pad must be applied, which in turn cause increased head and medium wear.

The Bernoulli system permits a wide range of control over the aerodynamic coupling forces and the resulting flying height by changing the head and head-coupler design parameters. These systems can be designed to work effectively at 300 to 3200 rpm.



**Fig. 8.** As a particle on the medium approaches the coupler (top), an inrush of air breaks the coupling, and the medium pulls away, or "compiles." This permits the particle to traverse the head-coupler region without making contact with the head. Coupling is then reestablished, leaving only a read or write soft (non-repeatable) error.

### No load spikes

The sudden pinching of the media between head and pressure pad in a floppy-disk drive whenever a recording is to occur produces media wear, or "load spikes." The smooth coupling that occurs between head and media in a Bernoulli-based drive produces no similar effects.

The Alpha-10 is Iomega's first product based on the Bernoulli principle. Its disk rotates at 1500 rpm, and the data rate is 1.13M bytes per sec. System latency is 20 msec., and track-following servo permits track-to-track access rates as low as 10 msec., with an average access time of only 35 msec. The Bernoulli technology and the head-to-medium separation it produces allow an 18,000-fcpi bit density and a 300-track-per-in. track density. ■

**David Norton** is vice president, research and development, and **Paul Losee** is development engineer, at Iomega Corp., Ogden, Utah.



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## DISK DRIVES

# Actuator design improves head positioning

MARC FELLER, Kennedy Co.

*Kennedy's PosiTrack overcomes traditional precision and vibration problems by relocating the voice actuator coil*

Most Winchester-disk-drive designs have failed to solve the twin problems of unsatisfactory head positioning and susceptibility to vibration. An innovative rotary-actuator design in the Kennedy model 7300, 42.4M-byte, 8-in. Winchester-disk drive improves head positioning and tracking while reducing power requirements and head dissipation. Dubbed the PosiTrack, the design enables the drive to operate in any position and to withstand shock and vibration. The unit sells at \$2240 in quantity.

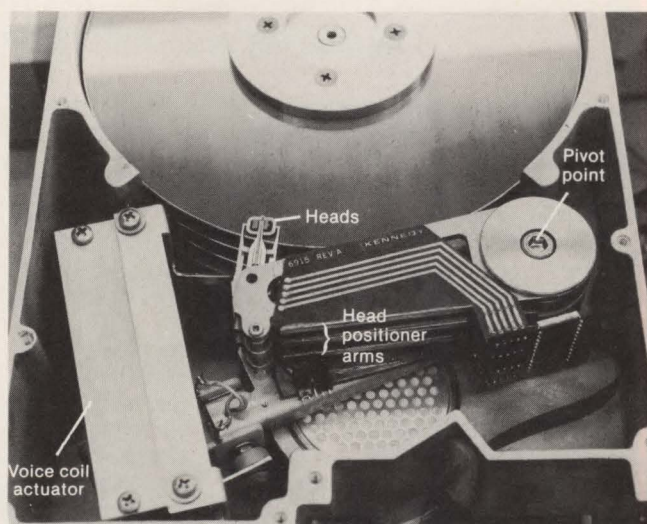
### Proximity promotes precision

The model 7300 has a voice-coil actuator 2 in. away from the read/write heads at the end of the positioner arm opposite the pivot point. This actuator-to-head proximity provides close mechanical coupling, virtually eliminating inaccuracies caused by pivot-bearing tolerances and arm resonance. Tracking error is  $\pm 100 \mu\text{in.}$ , about half that of conventional rotary actuators.

By comparison, conventional rotary actuators in Winchester-disk drives employ a d'Arsonval-type design, in which the pivot point is between the actuator coil and the heads. Space requirements dictate that the actuator level arm be short, requiring increased actuator power. Additionally, the long head lever arm requires expensive bearings and structurally rigid actuator-arm design to prevent bending and resonance (see "Actuator designs: their strengths and weaknesses," p.216).

### $\mu\text{P}$ speeds seek times

The PosiTrack design also reduces actuator power requirements and simplifies servo-drive electronics.



The rotary actuator design of the Kennedy PosiTrack, in which the voice coil actuator is only 2 in. from the heads, achieves high precision and stability. The unit sells for \$2240 each in OEM quantities.

Head positioning is accomplished by a closed-loop servo system using servo tracks on the bottom of the lower disk. The  $\mu\text{C}$ -controlled model 7300 employs an 8049 with firmware to modify servo characteristics.

The  $\mu\text{P}$  ascertains the number of tracks the head is to be moved, the optimum arm velocity and the "staircase" acceleration servo signals. Calculating the distance remaining to the selected track, the 8049 adjusts the staircase deceleration signals for the shortest seek times. A 1-KHz servo bandwidth reduces setting time to less than 3 msec.

One-track access time is 6 msec., average access time is 30 msec., and maximum access time is 55 msec.



*The  $\mu$ p ascertains the number of tracks the head is to be moved, the optimum arm velocity and the "staircase" acceleration servo signals.*

Average latency time is 8.33 msec., based on a disk speed of 3600 revolutions per min.

Using technology developed from Kennedy's 14-in. Winchester-disk drives, the model 7300 uses 3350-type heads and media and modified frequency-modulation techniques with 9.67-MHz data-transfer rates. A preamplifier near the read heads reduces noise for improved data integrity. Read-to-write recovery time is 0.3  $\mu$ sec., and write-to-read recovery time is 10  $\mu$ sec.

The disks have a density of 7130 bits per in. on the outer cylinder and 9420 bpi on the inner cylinder. The three-disk drive has five recording surfaces, each with 404 data tracks and seven spare tracks. Track density is 480 tracks per in. Heads fly 14 to 17  $\mu$ in. above the recording surface with a loading of 9.5 grams.

#### More $\mu$ c monitoring

In addition to drive control, the  $\mu$ c provides internal

fault detection and diagnostics. It continuously monitors spindle speed and power, inhibiting write electronics, retracting the heads and braking.

The  $\mu$ p also monitors seek errors, CPU faults, read/write faults, head current and head location. Out-of-tolerance conditions are indicated by LED displays on a maintenance panel. Diagnostics include a series of seek exercise tests and  $\mu$ p self-test routines. The combination of fault monitoring and diagnostics assures a repair time of 0.5 hours.

Recoverable error rates are less than 1 in  $10^{10}$  bits, and hard error rates are less than 1 in  $10^{12}$  bits. Mean time between failures is expected to exceed 5000 hours.

Reduced actuator power and a low-power brushless DC spindle motor, combined with advanced thermal design, limit temperature within the chamber to 6°C over ambient. Vanes on the spindle motor direct air over the power components at the rear of the unit.

The model 7300 is an all-DC drive requiring  $\pm 5$ V,  $\pm 12$ V and 24V. Maximum power consumption is only 75W. The unit is no larger than a floppy-disk drive. ■

**Marc Feller** is manager of disk engineering, Kennedy Co., Monrovia, Calif.

### ACTUATOR DESIGNS: THEIR STRENGTHS AND WEAKNESSES

There are two major approaches to disk-drive read/write head positioning: linear actuator and rotary actuator. Each has its own advantages and disadvantages.

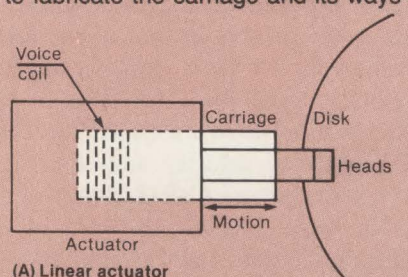
The classical linear actuator (A) employs a carriage that accesses the tracks radially. The carriage, which supports the heads at one end and the voice coil at the other, rides on precision-ground cylindrical ways and is usually a complex die casting optimized for stiffness and low mass. In operation, the carriage is subjected to extension and compression forces only; its resonant frequency, and, therefore, the servo bandwidth, can be very high, reducing sensitivity to shock. However, the linear actuator does not lend itself to compact designs, and the precision machining to fabricate the carriage and its ways

makes this an expensive approach.

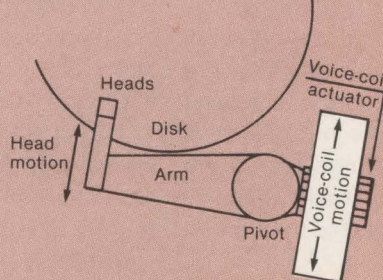
Most rotary actuator designs (B) employ a pivoting arm that carries the heads at one end and the voice coil at the other. Such actuators allow a smaller drive enclosure and are usually less expensive, although precision bearings must be used for the pivot. The arm is subjected to bending forces, which cause the system to exhibit less stiffness, lower resonant frequencies and reduced servo bandwidth. The voice coil must usually be placed near the pivot because of size limitations. Thus, this actuator also suffers from poor mechanical advantage and requires a strong voice coil. Finally, the heads move along an arc rather than a radius of the disk, so they cannot intersect every track at 90 degrees.

The resulting angular error, known as head skew, has a detrimental effect on head stability, flying height and signal-to-noise ratio.

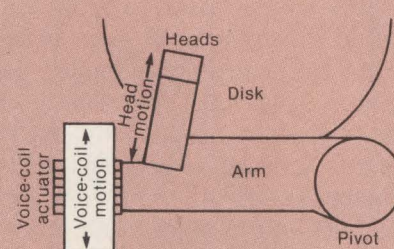
The Kennedy PosiTrack actuator (C) places the heads and the voice coil at the same end of the arm, with the pivot at the other end. Essentially linear coupling between the heads and voice coil is achieved, resulting in the high bandwidths of the linear design with the compactness of the rotary. Because neither the arm nor the pivot is inside the servo loop, resonances and deflections of these elements have little effect on servo performance. Greater mechanical advantage keeps power low, and, because the heads are farther from the pivot point, head skew is also minimized.



(A) Linear actuator



(B) Conventional rotary actuator

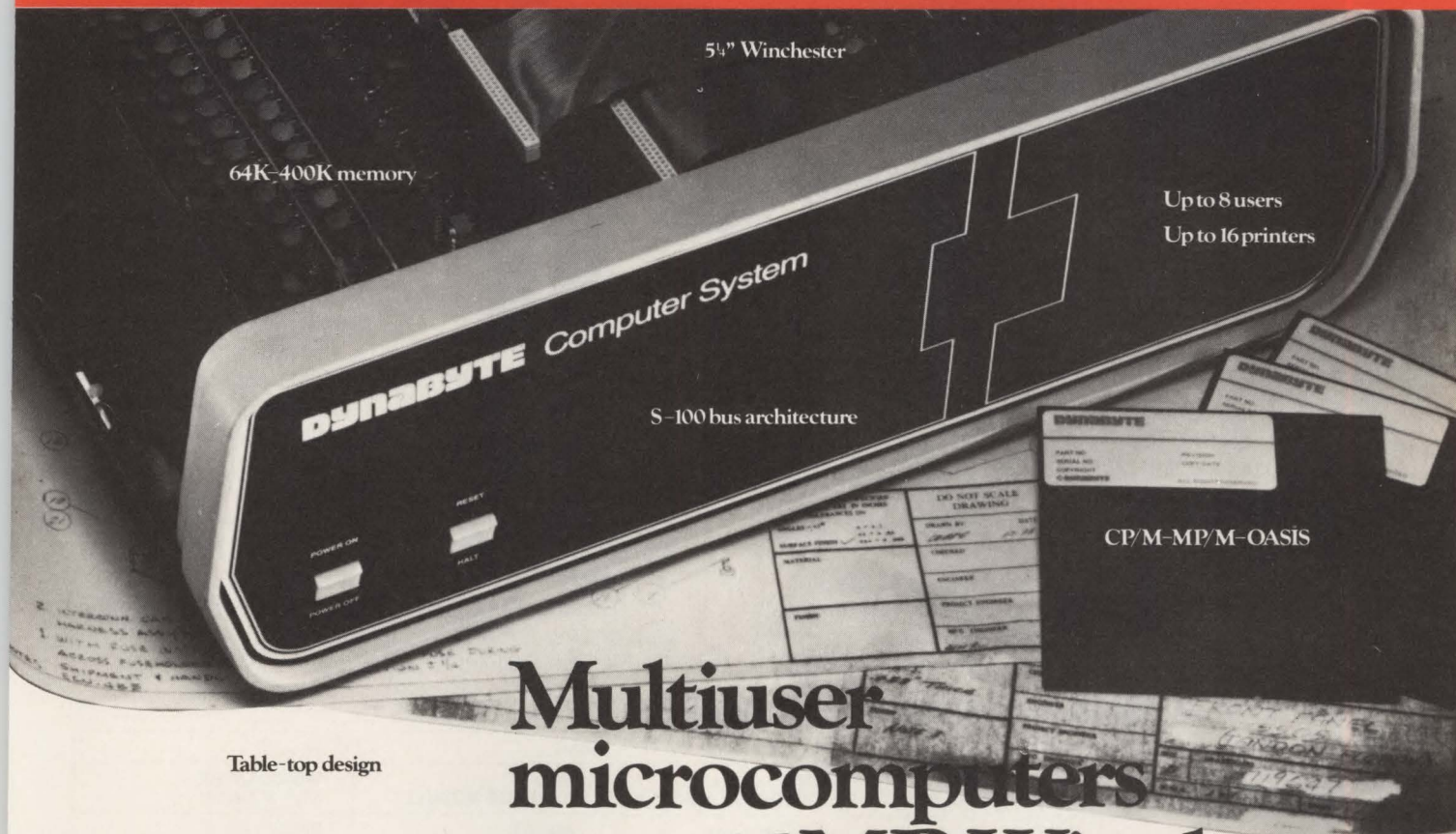


(C) Kennedy PosiTrack actuator

**A comparison of rotary-actuator designs shows that the Kennedy PosiTrack situations the voice-coil actuator closer to the read/write head. This results in improved head positioning and tracking, as well as lower susceptibility to shock and vibration.**



# Product Highlight: Dynabyte 5505.



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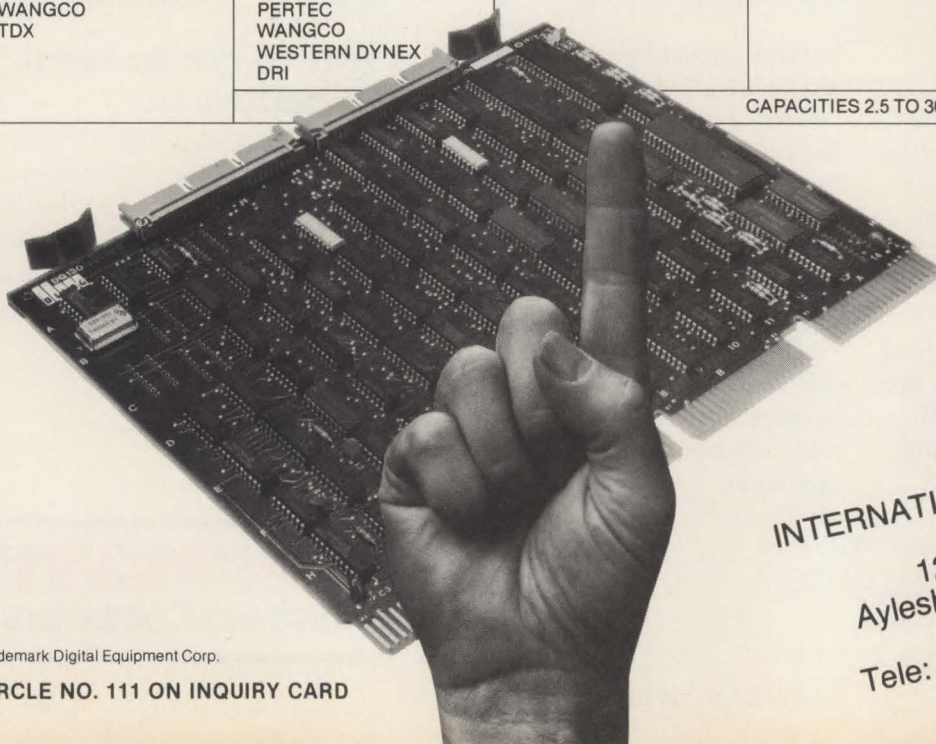
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CIRCLE NO. 111 ON INQUIRY CARD



## DISK DRIVES

# Quality standards: going beyond ANSI

JIM ZINTEL, Verbatim Corp.

*ANSI standards assure interchangeability, but only manufacturers' high standards assure performance*

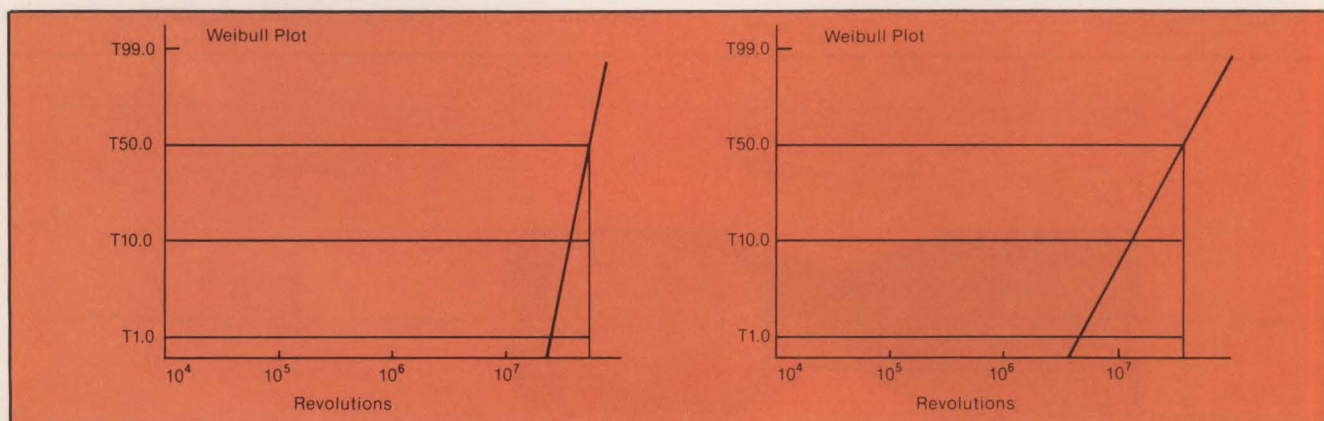
Why do floppy-disks perform so differently from each other despite the fact that they conform to the American National Standards Institute media standards? Shouldn't those standards ensure performance consistency among the various brands of floppies? No, ANSI standards ensure only the interchangeability of products from different media manufacturers and the compatibility of their products with various disk drives. Those interchangeability standards place heavy emphasis on physical characteristics, little on magnetic characteristics and none on performance characteristics. On performance, a user is at the mercy of the floppy-disk supplier's quality standards, especially those standards that apply to durability, certification, raw materials and cartridge assembly.

### Durability is increased, but...

Durability is a major industry concern, yet is often

poorly understood. No standardized way exists to test and predict durability. Disks can be tested until failure in simulated use or tested only for a certain number of revolutions. The results of durability testing can be expressed in relation to data reliability or to sudden failure. Durability claims in terms of how long it takes from 10 percent or 50 percent (T10 or T50) of a given sample to fail are not as useful as those that tell the time period during which all failures will occur. The most meaningful statement of durability is one that tells a user the number of revolutions to expect before 1 percent of the disks fail, either by sudden failure or by the onset of data errors. Two products can have the same T50 value, but one may start showing failures after 1 million revolutions, while the other may not start showing failures until several million revolutions (Fig. 1).

Manufacturers can increase durability, but often at a



**Fig. 1. Durability predictions** in terms of how many failure-free revolutions can be expected from 1 percent, 10 percent, 50 percent and 99 percent of a disk sampling are more meaningful than those that tell only median failure time (T50). For example, although both Weibull plots above show the same T50, the sloping durability line of the plot at left indicates more consistent results than that of the plot at right.



***The most meaningful statement of durability is one that tells a user the number of revolutions to expect before 1 percent of the disks fail.***

sacrifice. For a given coating formulation or process, durability can be increased by increasing the thickness of the coating, but doing so results in poor performance at high data-recording densities. Durability can also be increased by adding abrasive particles such as aluminum oxide, chromium dioxide or silicon carbide to the coating formulation so the read/write head is continuously polished. A polished head decreases the sudden failures when a thin film of the recording medium is transferred to the read/write head, resulting in an unlubricated medium-to-medium interface, increased functional heating and eventual tearing away of medium from the base film. Unfortunately, abrasives also increase head wear. Excellent durability can be achieved without adding abrasive particles to a coating formulation, but this requires expensive formulation development, and is becoming more difficult as higher recording densities require thinner coatings.

Disk durability can also be increased by lubrication. Two methods are available: one incorporates a lubricant in the coating formulation and the other overcoats the lubricant onto the medium with it. Lubricant must be present to achieve even minimum durability. Overcoating adds another manufacturing step that can produce surface irregularities that adversely affect data reliability. Incorporating the lubricant into the coating formulation avoids overcoating, but requires increased investment in formulation development.

Durability need not concern all users equally. It is typically of less concern to users of 8-in. floppy-disk drives because nearly all such drives load the read/write head onto the disk only during reading or writing operations. Many 5¼-in. floppy-disk systems, however—particularly less expensive ones—load the head onto the disk anytime the door of the drive is closed, and for users of that kind of equipment, durability standards are more important.

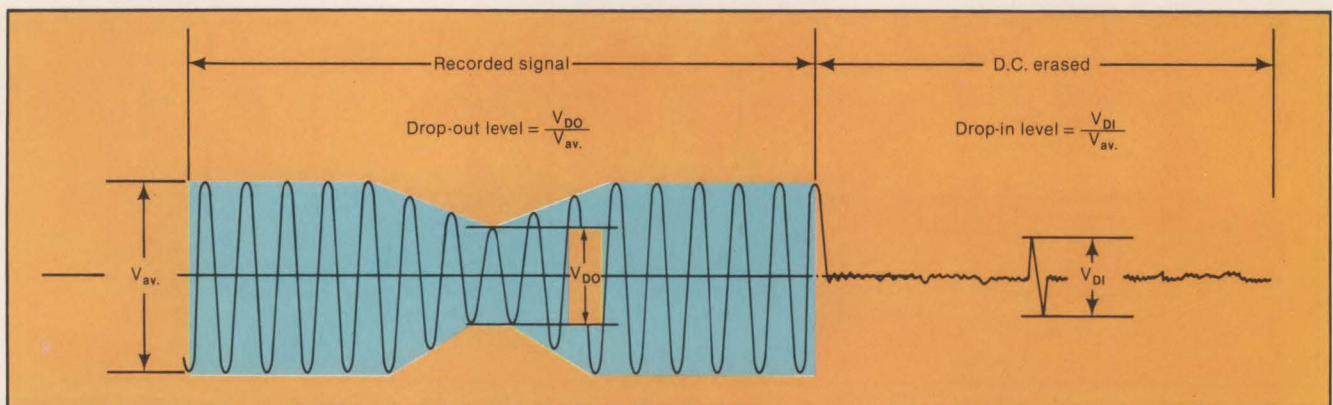
Storage temperature: 50°F to 125°F  
at R.H. 8% to 80%  
Shipping temperature: -40°F to 125°F  
at R.H. 8% to 80%  
Liner: No part to protrude > 0.008 in.  
Jacket (5¼ in.): Square; 5.250 ± 0.015 in.  
(8 in.): Square; 8.000 ± 0.015 in.  
Disk (5¼ in.): I.D.; 1.125 ± 0.001 in.  
O.D.; 5.125 ± 0.003 in.  
Disk (8 in.): I.D.; 1.500 ± 0.001 in.  
O.D.; 7.880 ± 0.005 in.  
Troque (5¼ in.): 1.0 to 3.5 oz.-in.  
(8 in.): 4.0 to 10.0 oz.-in.  
Average signal amplitude: 80-130% of standard  
Resolution: > 90% of standard  
Missing bit: Signal ≤ 40% of average signal  
Extra bit: Signal ≥ 30% of average signal

**ANSI interchangeability standards** proposed or adopted for disk products. ANSI is the American National Standards Institute.

### Certification remains unclarified

Every major manufacturer of floppy disks claims its product is certified error free. Should a user concern himself with what that means? Yes, because as with durability, the test procedures used for certification result in considerable differences among products in their propensity to produce data errors.

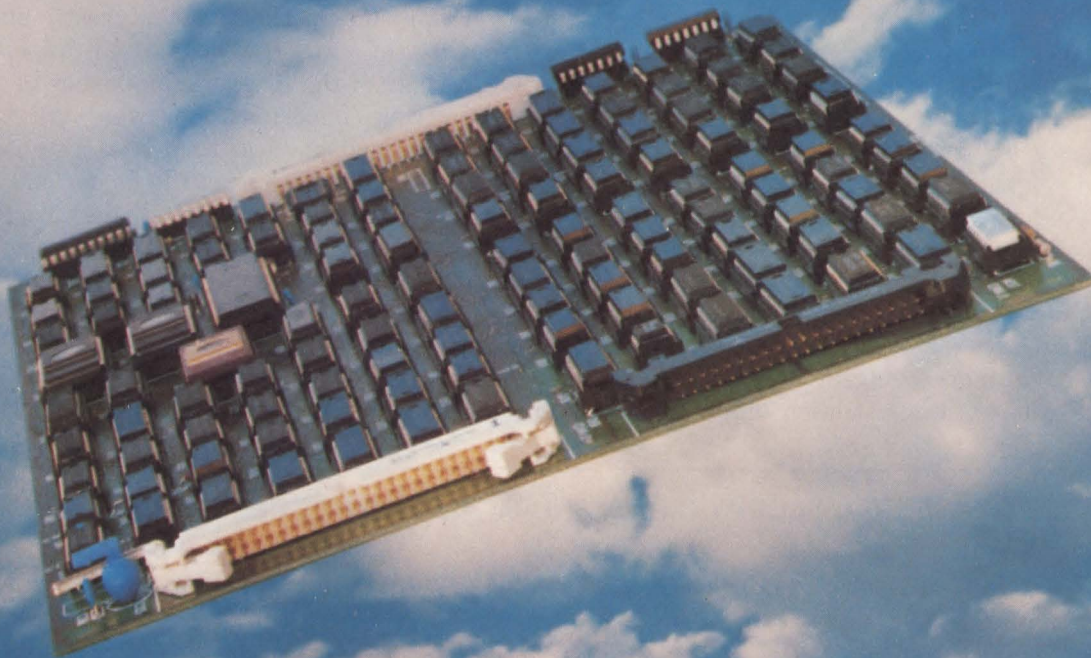
Certification means that a disk has been tested to ensure that it does not cause missing bits in the write/read cycle, but can also mean that it has been tested to ensure that it does not cause extra bits. Industry jargon for a missing bit is a drop-out, and for an extra bit, a drop-in (Fig. 2). After deciding whether certification will apply only to drop-outs or to both drop-outs and drop-ins, a manufacturer next chooses the clipping level at which these tests will be run. ANSI standards for floppy disks include a specification that sets the clipping level for drop-outs at 40 percent and for drop-ins at 30 percent. At these levels, a drive manufacturer's system should not miss a bit unless the signal amplitude for that bit is less than 40 percent of the average signal amplitude, nor should it detect an extra bit unless the signal amplitude is greater than 30 percent of the average signal amplitude. In more



**Fig. 2. Drop-outs and drop-ins.** These sketches of oscilloscope tracings show a drop-out (missing bit) and a drop-in (extra bit). ANSI defines a drop-out as a signal level 40 percent of the average signal, and a drop-in as one 30 percent of average.



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## Every major manufacturer of floppy disks claim its product is certified error-free.

expensive systems using floppy disks, single-bit errors are not a major problem, because the controllers have error-detection and -correction capability. Lower priced systems, however, may only have error detection, and single-bit errors could be a serious problem. Multi-bit errors will probably result in data errors in all systems. Because there are many sources of variation in testing and in the write/read operations of drive systems, products that are tested to the ANSI proposed specification have a greater propensity for errors than those tested at more stringent clipping levels. Similarly, because of track-registration differences between

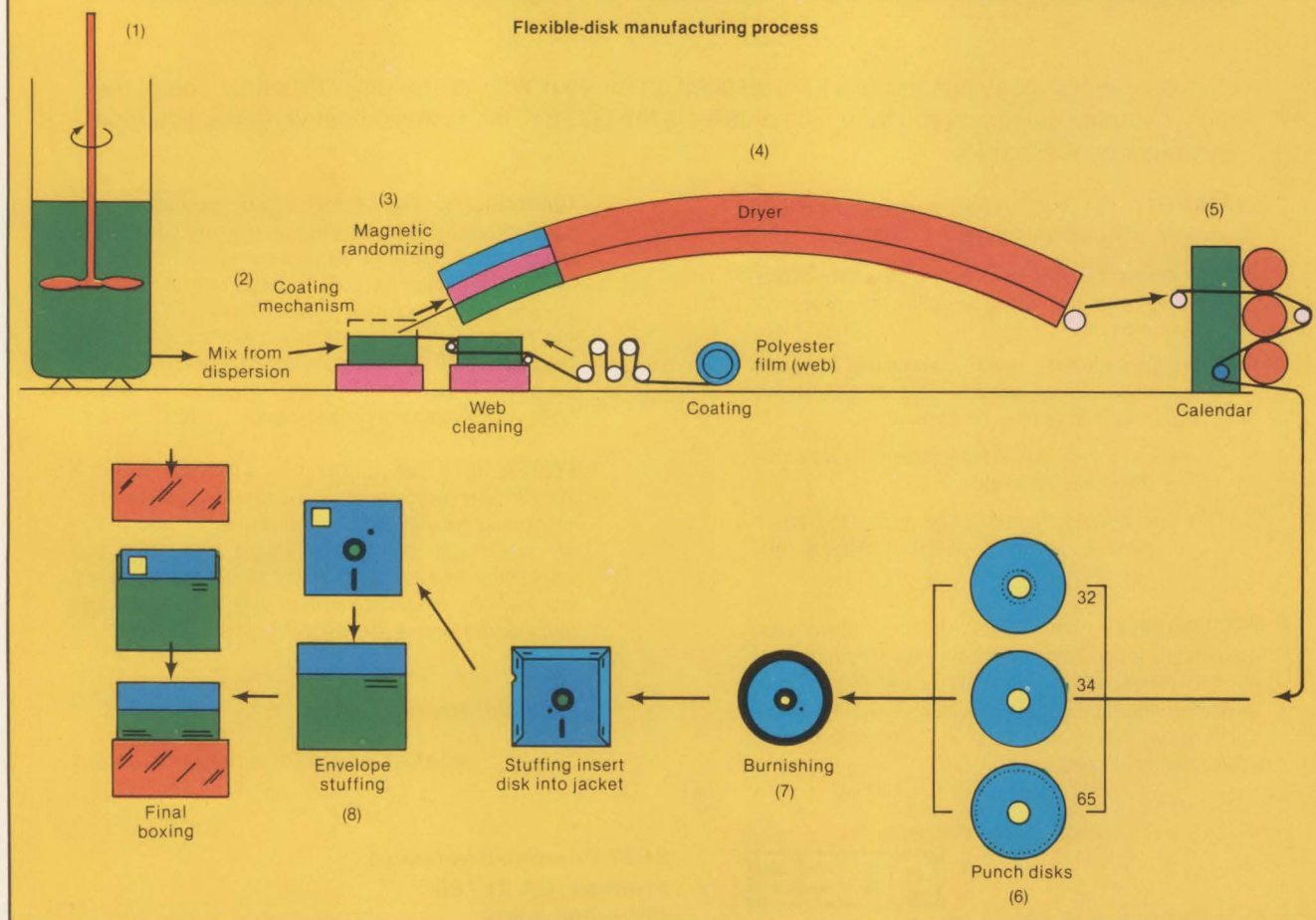
manufacturers' and users' equipment, on-track certified disks tend to produce more errors than full-surface certified disks.

### Raw materials must be pure

Floppy-disk performance is greatly affected by the quality of raw materials used in manufacturing, especially of the magnetic properties of the particles. Also very important, however, are the particles' chemical and physical properties because they affect the chemical reactions of the binder and must be held securely within the coating. Binders are polymers, and to function consistently in a formulation there must be tight control over molecular weight as well as over chemical properties. Consistent lubrication and durability require tight quality standards and rigorous testing to assure conformity to those standards. Even solvents used as carriers during coating and that do not

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- The disk is burnished for additional smoothness.
- The disk is then jacketed, enveloped and boxed.





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*Certification means that a disk has been tested to ensure that it does not cause missing bits in the write/read cycle, but can also mean that it has been tested to ensure that it does not cause extra bits.*

remain in the final product must be exceedingly pure to avoid interfering with the chemical reactions of the binder.

The high standards for raw materials mean that a less expensive off-the-shelf item probably will not be adequate. Testing to ensure conformance to standards is performed with new and sophisticated analytical instrumentation. For that reason, the testing is more costly than the raw materials themselves.

### Cartridge assembly must be controlled

No matter how high quality the recording media is, the performance of the final product depends on the quality standards of the jacket and liner, which, with the disk, constitute the disk cartridge. The uniformity of linear materials, the heat stability of the jacket and uniformity of jacket dimensions require careful development of quality standards.

The thickness and surface uniformity of the linear material must be carefully controlled. Although ANSI does not specify liner thickness, the manufacturer must control it to maintain the ANSI specification for cartridge thickness or torque. More importantly, the liner must be free of lumps or foreign material, which can wear or scratch the disk surface. The jacket is made of polyvinyl chloride (PVC), which can be deformed by heat. To ensure stability against heat resulting from use, storage or transportation, and to avoid permanent disk warping, manufacturers must set a standard for internal stress and test the PVC raw materials for conformance to that standard. ANSI specifies the dimensions and tolerances of the cartridge, but the tighter the tolerance used by a manufacturer, the better the disk performance. Variation in dimension will affect turning torque, which ANSI specifies for interchangeability.

To assess the quality of disk products, a user must know the quality standards of the manufacturer and that his quality systems ensure compliance. Compliance to ANSI standards does not guarantee a quality product. ANSI's intention, rather, is to set interchangeability standards that can be used as a starting point in assessing quality. Large users will benefit by discussing specifications and standards with the manufacturer, to determine the best product for a particular application. ■

**Jim Zintel** is manager, quality operations, Verbatim Corp., Sunnyvale, Calif.



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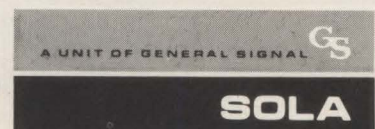
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Sola Mini-UPS	Yes	Yes	Yes	Yes	Yes	Yes

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## LOCAL-AREA NETWORKS

# Searching for the 'right' approach

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

*The first in a comprehensive series of local-area-communications product profiles, this article is based on a survey of more than 60 vendors*

Local-area communications has become the hottest sector of the data-communications market. More than 80 companies, many of them new, have announced local-network products. The products seem almost limitless in their variety. New technology is evidenced in coaxial-cable-based systems; old technology appears in port-contention systems and private automatic branch exchanges with data switching. Some systems are large in scope, suitable for a rich environment; others are small and specialized. The field is new and still unstructured. Users and suppliers alike are searching for the "right" approach.

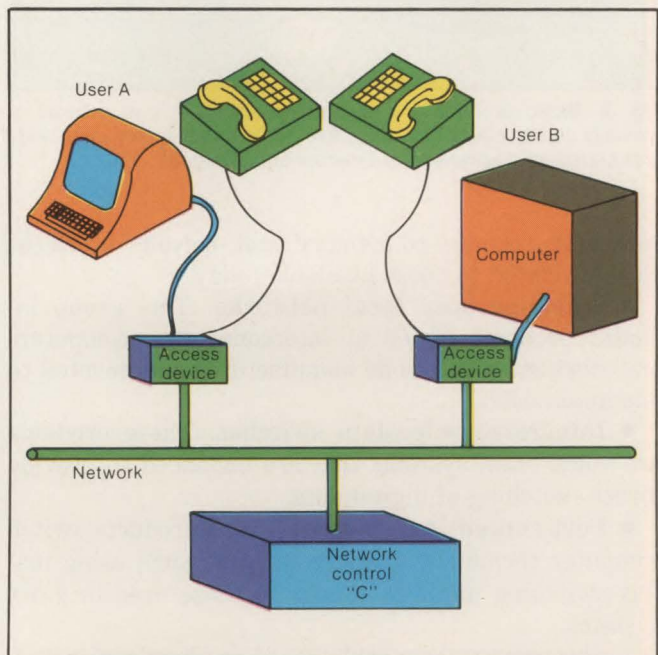
Although still in its infancy, local-area communications will become a major market in the 1980s, with thousands of networks expected to be installed. Computer users—dissatisfied with telephone technology because of performance limitations and steadily rising service costs—are willing to try innovative technology. The rise of distributed-processing office automation has also created a strong demand for local-networking products.

### Structure of the local-area-network market

Local-network products are intended to connect digital equipment across distances ranging from dozens of yards to miles. Many employ coaxial cable and baseband and broadband (radio-frequency) technologies. They encompass dedicated and shared channels and both centralized and distributed control. Some techniques are unique to individual systems. Others,

such as Xerox Corp.'s Ethernet scheme, are promoted as industry standards.

Suppliers of older products, recognizing the market's potential, are scrambling to reorient their products. Almost all voice-oriented PABX systems use digital methods internally. Their suppliers have enhanced these systems to perform direct digital data switching and are marketing them as "integrated voice/data switches." Port-contention systems have been in wide use for years, switching terminal populations among computer ports. These systems are legitimate local-



**Fig. 1. Basic architectural elements of local-area networking.** All cable-based networks use a common medium, or cable, through which all user devices communicate. Terminals, computers and other devices gain access to the cable through an access device, which is part of the network.

*Editor's Note: This article is the first in a series of profile articles on local-area communications products. The series is based on a survey of more than 60 vendors conducted by the authors. This article briefly surveys the entire range of available products and profiles general-purpose local-network products. Subsequent articles will profile special-purpose networks, integrated voice/data switches and port-contention systems.*

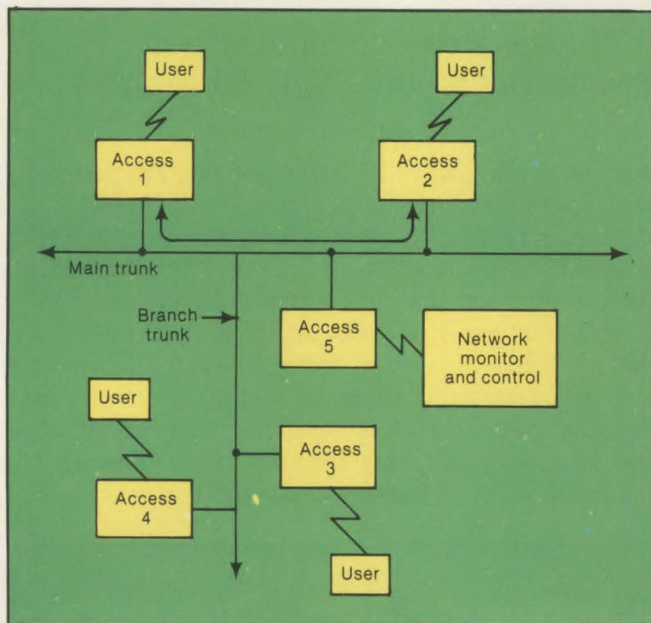


**Local-network products are intended to connect digital equipment across distances ranging from dozens of yards to miles.**

area-network products that offer the less-proven cable-based products some heavy competition. Over the long term, users can expect to see radio introduced as yet another powerful local-area-network technology.

Available products can be classified into four groups, based on their applicability and technology.

- **General-purpose local networks.** This group includes products intended to link a large community of different terminals and computers. They should support any data-transmission speed from Teletype to



**Fig. 2. Basic architecture of bus networks.** A bus network is typically constructed of coaxial cable and can have many segments and branches. Examples are Ethernet and Wangnet.

computer memory-to-memory and permit interfaces closely related to those available today.

- **Single-purpose local networks.** This group includes products aimed at interconnecting computers and work stations of one manufacturer and devoted to one application.

- **Integrated voice/data switches.** These products are voice PABX systems that are enhanced to provide direct switching of digital data.

- **Port-contention systems.** These products switch computer terminals among computer ports using matrix-switching methods similar to those used in PABX systems.

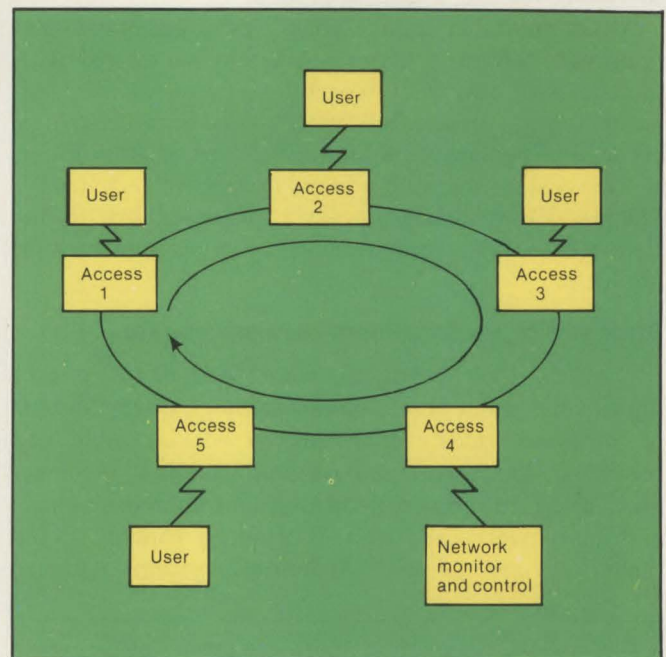
In this survey, only cable-based products are included in the first two groups. Integrated voice/data switches and port-contention systems have most of the attributes of general-purpose local-network products but are considered separately.

The cable-based systems of 14 of the survey respondents are classified and listed in the product-profile table as general-purpose products. Other cable-based products, classified as single purpose, will be reviewed in a later article. The distinction between general purpose and single purpose depends on a combination of technical and judgmental factors. A system is considered general purpose if it is suitable as a utility providing services to a reasonably large population of terminals and computers, if the network is reasonably independent of its user equipment and if its supplier provides users with a reasonably complete working end product. End users might be required to write interface programs for their equipment, but should not have to develop any part of the network itself.

A product is considered single purpose if it fails any of the criteria given above, that is, because it supports the equipment of only one manufacturer, is limited in capacity to rather small networks, is intimately a part of the end-user devices or applications or requires end-user-provided development. Classifying a system as single purpose does not imply a value judgment. Single-purpose systems may be more cost effective and easier to use in dedicated applications than general-purpose systems.

### Cable-based local networks

Historically, end users built local networks using standard telephone techniques and RS232C-type interfaces, conventional modems and point-to-point, twisted-pair wiring. The advent of cable-based local networks has changed all this. Users are now delving into exotic time-division multiplexed (TDM) and frequency-



**Fig. 3. Basic architecture of ring networks.** A ring network can be constructed of any type of cable. Its principal distinguishing characteristic is that signals pass through user-access devices rather than in front of them as with bus networks. Examples are the Logica and Electrosound systems.



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*There is almost no limit to the possibilities for implementing multi-access data channels, and the products available offer a variety to examine.*

division multiplexed (FDM) schemes; mixing voice, data, video and instrumentation on one facility; and planning data transmissions between computer systems at virtually any speed in the megabit-per-sec. range.

All cable-based networks use a common medium, a cable, through which all user devices communicate (Fig. 1). Terminals, computers and other devices gain access to the cable through an access device, which is part of the network. Some networks also include a central controller to supervise and regulate traffic. A user desiring to communicate with another first requests a connection with the other user (call setup). The two parties then exchange data. This two-step process is termed a data call—analogue to a “voice call.” In many systems, but not all, data calls are set up by the computer or terminals that subsequently exchange data.

Two important cable-distribution schemes are the bus (Fig. 2) and ring (Fig. 3). Because access devices usually must be close to user equipment, the common cable must range through the entire area covered by the network. A bus network is typically constructed of coaxial cable and can have many segments and branches. It can be passive, consisting only of physical cable, or active, containing signal-boosting amplifiers. Some types of bus networks can survive a break in the cable with only a partial loss of service. Others cannot. From a control viewpoint, a most important characteristic of bus networks is that a signal placed on the bus by any device can be detected almost instantaneously by all other devices.

A ring network can be constructed of any type of cable. Its principal distinguishing characteristic is that signals pass through user-access devices rather than “in front” of them as with bus networks. A ring network will not survive a cable break because continual circulation of the signal is essential to its operation.

Cable-based local networks use either CATV coaxial cable, baseband coaxial cable, twisted-pair wire or existing power lines.

• **CATV coaxial cable.** This type of system is

## ETHERNET CONTROL PRINCIPLES

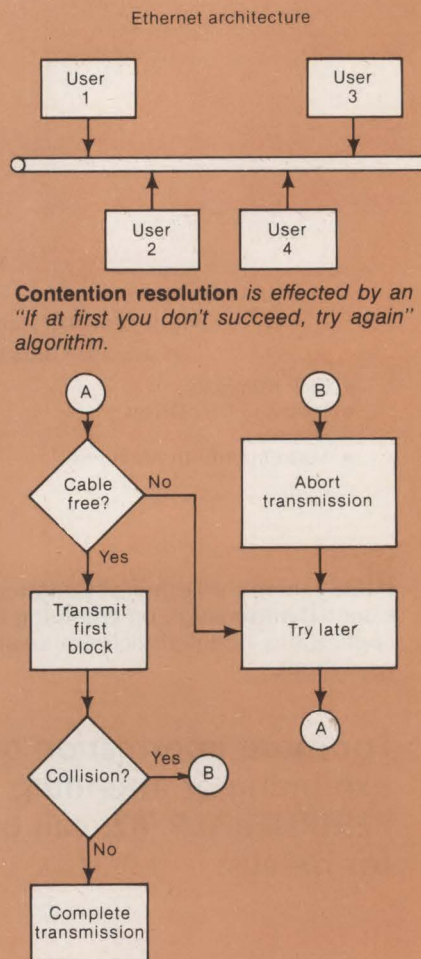
The Ethernet control scheme, developed by Xerox Corp., uses a contention system to permit multiple users to share a common facility without requiring central control. Contention systems have been used in communications for many years (Western Union Teletype party-wire systems of the 1940s, for example). Ethernet embodies the basic concepts in a modern form. A user device, seeking access to the cable, first listens to determine if the cable is free. If the cable is busy, the user waits and tries again later. When the cable is free, the user transmits a message addressed to another user. All users are always listening to the cable, so the addressed user will hear the message. With this scheme, users may occasionally initiate transmission simultaneously, causing their messages to collide. Each user, therefore, must check signal conditions on the cable to determine if such a collision occurred and, if so, retransmit the message later when the cable is free. To assure that such retries do not resynchronize, each user agrees to retry later at some randomly determined time.

Collisions are rare, even in a heavily loaded system, because they

can occur only during the brief window of time it takes for a user to assert control of the cable, that is, from initiation of the signal until it reaches the most distant device on the network. During this period, other devices will perceive the cable to be free and hence available for transmission.

Contention systems work well as long as traffic levels remain lower than a reasonable threshold. As traffic mounts, users will perceive increased incidence of “cable busy,” and transmissions will be delayed. Because cable access depends on statistical properties of the traffic, contention systems cannot guarantee that every user device will be granted adequate use of the cable. Opponents of this type of system contend that centrally controlled methods must be used to assure service to all devices. However, the seriousness of the problem depends on the environment, traffic levels and user experience.

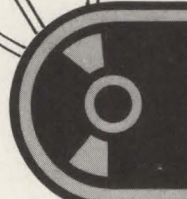
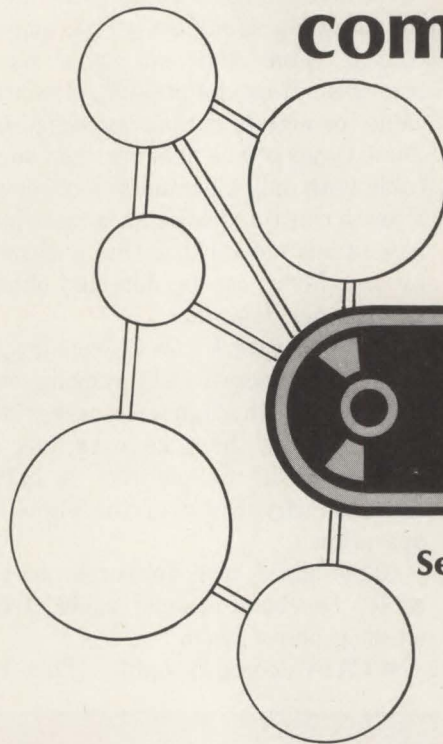
**Logical architecture of Ethernet is contention type.** All users share a common facility without requiring central control.





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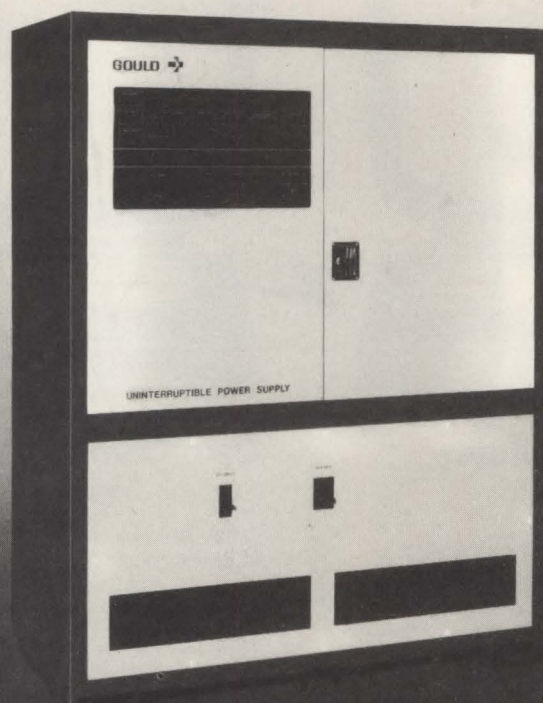
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**Baseband methods, whether bus or ring, are well suited to applications in which user devices are computers, rather than terminals, and the network interface is a computer I/O or DMA port, rather than an RS232C data-communications port or equivalent.**

standard in the CATV industry and is in common supply. A wide range of cable-system components is available: connectors, taps, signal splitters, line amplifiers and the like. The equipment is reasonably rugged because CATV systems are frequently installed outdoors. CATV coaxial cable has a potentially usable bandwidth as high as 350 MHz and distance limits approaching 50 miles. CATV-cable technology is best used in broadband systems so that the full capacity of the cable can be available for data transmissions and possibly for other applications at the same time. The spectrum of the cable is allocated among the various data (and other) channels by frequency-division methods, and data access is granted through radio-frequency modems.

- **Baseband coaxial cable.** Coaxial cable can be employed for simple baseband transmissions, providing a single data channel. This technology is limited to shorter distances than are possible using CATV methods, typically no more than one mile. The interface devices to drive a baseband coaxial cable are simpler and less expensive than CATV RF-type modems, while permitting data transmission at speeds in the 1M-bps range.

- **Twisted pair.** Conventional twisted-pair telephone wiring is used in some multi-user systems. It can also support baseband data transmission at 1M-byte speeds given suitable interface electronics.

- **Power-line carrier.** Some systems rely on existing power-line wiring as a medium, transmitting data between locations on a carrier frequency.

### The balancing problem

All forms of cable technology must cope with the problem of balancing signal levels. Transmitted signals must be strong enough to meet the distant receiver's minimum signal-level requirements, yet not so strong as to overload the transmitter's circuitry, creating harmonics and other spurious signals. In point-to-point transmission schemes, this problem is easily solved because there are only two devices a fixed distance apart. But in a multiple-device distributed-cable network, the problem of signal balancing can be severe. Unless the network is very small, it is impossible to balance all possible pairings of devices against each other because of the variability of inter-device distances along the cable, which can range from tens to thousands of feet. In multiple-device broadband sys-

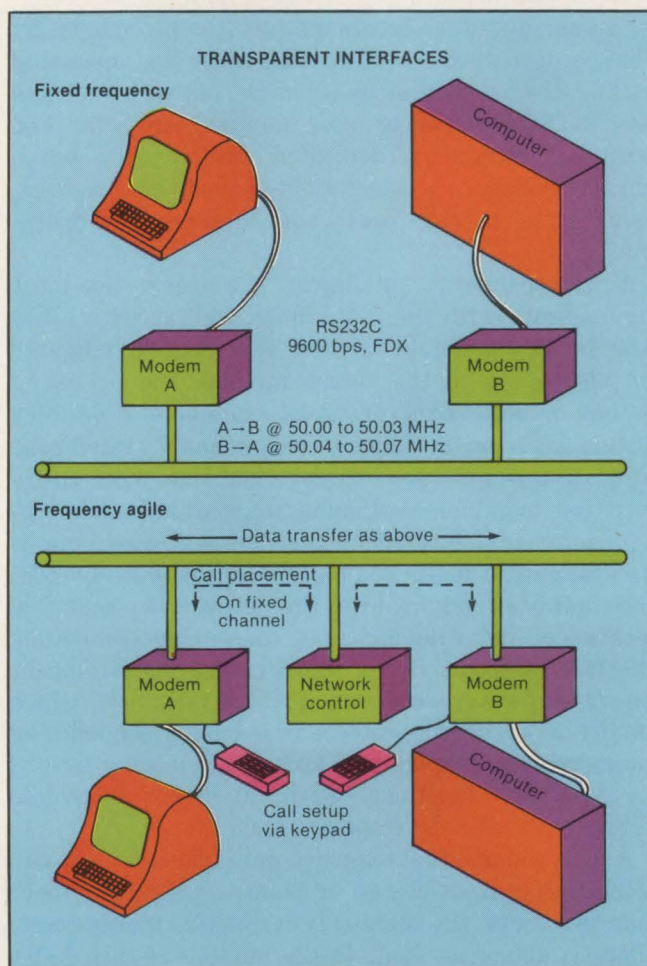
tems, the problem is further complicated because of the possibility of radio-frequency-signal interference between channels that are theoretically well separated on the spectrum.

Cable-based systems cope with the problem of multiple-device signal balancing by dividing the cable into segments within which device-to-device balancing can be achieved, and by using line-extender amplifiers or repeaters between segments. Careful adjustment of signal levels on all network devices is necessary to assure reliable trouble-free transmission.

### Data channels and protocols

Local-area-network products offer a rich variety of data-channel types and characteristics, justifying a new taxonomy. Very few of the well established terms of the data-communications industry can be used without changed meaning in discussing local-area networking products. Some formal definitions are necessary.

In local-area networks, a data channel is a set of facilities combined with some portion of the bandwidth



**Fig. 4. Two kinds of transparent interfaces based on the WangNet interconnect band.** In the fixed-frequency mode (top), the two communication devices do not need to be aware of the medium between their modem interfaces. In the switched-frequency mode (bottom), users are assigned a pair of companion frequencies by the network controller and thereafter transmit to each other transparently. The call setup procedure is also transparent because it occurs over a separate channel without involving any terminal-keyboard or computer-program functions.



*The product survey indicates that broadband bus-type systems are the best cable-based technology for general-purpose local-area networks with a large population of terminals.*

of the supporting medium (cable) to which two or more user devices can place data calls. In simple systems, one data channel can use all the physical facilities of the system. In complex systems, many data channels with various operating methods and capacities can share the facilities. Xerox's Ethernet is the most familiar example of a system with a single data channel that supports many user devices. Wang Laboratories, Inc.'s Wangnet is an example of a system with a variety of data channels (MMS, November, 1981, p. 247).

Data channels are available in two basic varieties. A data channel is "transparent" if a user device (terminal and/or computer) performs its functions without being aware of the network's existence (Fig. 4). Transparency can pertain to the access method (the procedures by which a user device sets up data calls), the operating method (the procedures by which the network supports data exchanges among user devices) or both. For example, Wangnet's dedicated interconnect band, which permanently assigns FDM channels to user-device pairs, is transparent both in access and operations.

A data channel is "intelligent" if a user device must communicate with the network as well as with other user devices to obtain service. The term "intelligent" can also apply to the access method, the operating method or both. Ethernet is an example of a network system with an intelligent data channel. Intelligent interfacing is software intensive and thus more costly for a user to implement than is transparent interfacing.

A number of intelligent-interface software options are available. The use of a bisynchronous protocol (Fig. 5) to link user equipment to the network is economical because of the availability of reasonably compatible interface methods. Some networks provide intelligent interfaces for asynchronous Teletype terminals, which require a keyboard protocol based on a sequence of commands and responses. The trend is moving toward X.3-type PAD functions. Such intelligent interfaces relieve users of a development task.

A data channel that supports only two end users can be classified as dedicated or point-to-point. For more than two users, the channel is designated multi-access. There is almost no limit to the number of techniques that can be used in multi-access data channels, and many have been implemented. Virtually every company that has entered this new market claims to use a new and superior multi-access technique.

Both frequency-division and time-division methods are being applied to multi-access channels. A frequency-division multi-access (FDMA) system allocates a

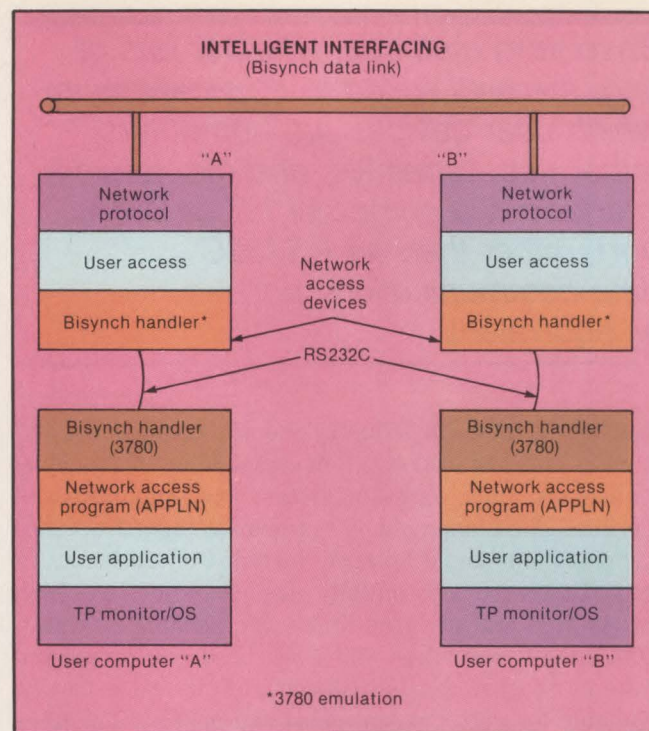


Fig. 5. Bisynchronous intelligent interfacing in a hypothetical system represents many announced products.

portion of the frequency spectrum to a pair of user devices requesting service for the length of their data call. Wangnet's switched interconnect band is an example of this type of data channel.

In a time-division multi-access (TDMA) system, a portion of the transmission time of a data channel (typically high-speed) is allocated to a pair of user devices. Transmission within the network usually occurs at a rate much greater than that at which the user devices communicate with the network, so user-access devices must include data buffers.

Many TDMA channel-allocation methods are available. Channel allocation can be performed centrally by a master control station (polled) or non-centrally by contention. (see "Ethernet control principles," p.231). It can also be performed plurally by rotating control among user devices ("token passing").

The general-purpose local-network products listed in the table fall into three broad categories: broadband bus systems, baseband bus systems and baseband/ring systems. Although the products in each group differ in many ways, they share certain characteristics.

Broadband bus systems all use standard CATV cable and components as their medium. These systems typically support multiple data channels, each channel being assigned a frequency band. The data channels operate independently of each other, and several different channels can coexist on one cable. Cable capacity can also be shared with other non-data applications, such as video for teleconferencing or surveillance. Access to the common cable is provided through RF modems that translate digital signals to modulated radio-frequency signals at a suitable point in the overall spectrum of the cable. For simple point-to-



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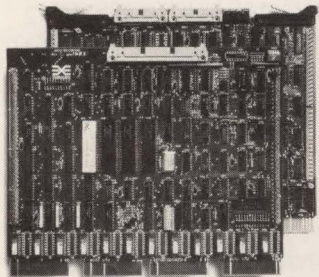
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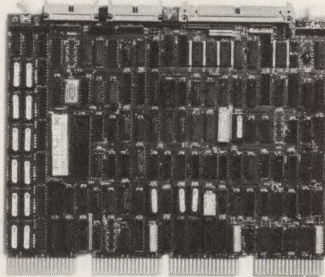
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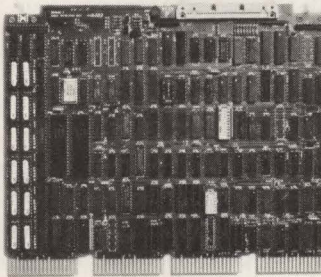
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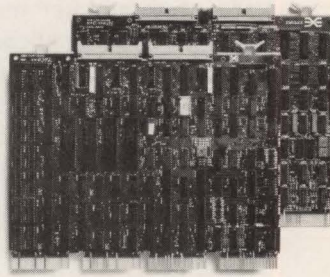
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***Because access devices usually must be close to user equipment, the common cable must range through the entire area covered by the network.***

point transparent data channels, other equipment is not required. Additional  $\mu$ p-based node controllers are required for intelligent, multi-access channels.

Baseband bus systems use a variety of coaxial-cable or twisted-pair-wiring approaches. They typically provide a single data channel, which is shared among multiple-access users by one of several forms of allocation: contention, central control or token passing. Access to the cable is provided by baseband line drivers or modulators. These systems require a  $\mu$ p-based node control for user access because of the multi-access control scheme and the need to provide buffering between user devices and the network.

Baseband ring systems use a ring architecture that enables data and control information to pass through each user-device access point rather than in front of it (Fig. 3). The ring-type control scheme requires  $\mu$ p-based control at each node. The products surveyed use twisted-pair wiring at very high-speed transmission rates.

### **Trends and conclusions**

The product survey indicates that broadband bus-type systems are the best cable-based technology for general-purpose local-area networks with a large population of terminals. The ability of these systems to handle a wide variety of data channels and to be shared with non-data communication gives them an "open-ended" character that other systems lack. All broadband systems offer multiple types of data channels—evidence not only of their greater capacity, but of their flexibility. New channel types can be added to a broadband system without interfering with the older types. Phased transitions can occur.

Baseband bus systems have their place in local-area networking, but their use is more appropriate in limited single-purpose network applications. This technology can support multiple user devices only by complex TDMA methods because of the limitations inherent in a single data channel, however fast. Baseband systems cannot support multiple transparent channels. That baseband systems are being considered for general-purpose applications is a result more of Xerox's promotion of Ethernet as an industry standard and the momentum generated by this effort than of considerations of technical suitability or use.

Baseband methods, whether bus or ring, are well suited to applications in which user devices are computers, rather than terminals, and the network interface is a computer I/O or DMA port rather than an RS232C data-communications port or equivalent. In such cases, the ability of baseband methods to support

data transfers at near computer memory-to-memory speeds is well matched to the application, and the relatively simple network architecture minimizes the advantage that broadband methods enjoy in environments with large terminal populations.

Local-area networking is a new industry, and many announced products are still in development. Field experience with a product will become an increasingly critical factor in selection decisions. Which products succeed in the long run depends as much on the financial strength of their suppliers as on any technical characteristics—a caution not lost on users wary of "new-ground" technologies.

### **The table explained**

The product-profile table lists 20 products from 14 suppliers and provides summary data on system features. Definitions of the column headings and a commentary on the significance of the data are provided below.

### **Cable characteristics**

- **Type.** This indicates the physical cable used in the system. CATV identifies an entire family of cable types, connectors, signal splitters, taps and the like. The characteristic impedance of CATV-type cable is 75 ohms. Other types of coaxial cable are identified by a standard designation or by the characteristic impedance.

- **Overall length.** This figure should not be interpreted simplistically or too literally. In every case, the size (diameter, length and maximum end-user-to-end-user distance) can be determined only by a system layout, performed by the vendor or an engineer. The figures provide a general ideal of a system's range.

- **Length between repeaters.** All listed systems require repeaters unless specifically noted by "not required." Repeater spacing generally depends on device-to-device distances, which can be determined only by layout, especially when complex multiple-branched bus networks are involved. Figures should not be taken literally, but they give a rough idea of repeater spacing.

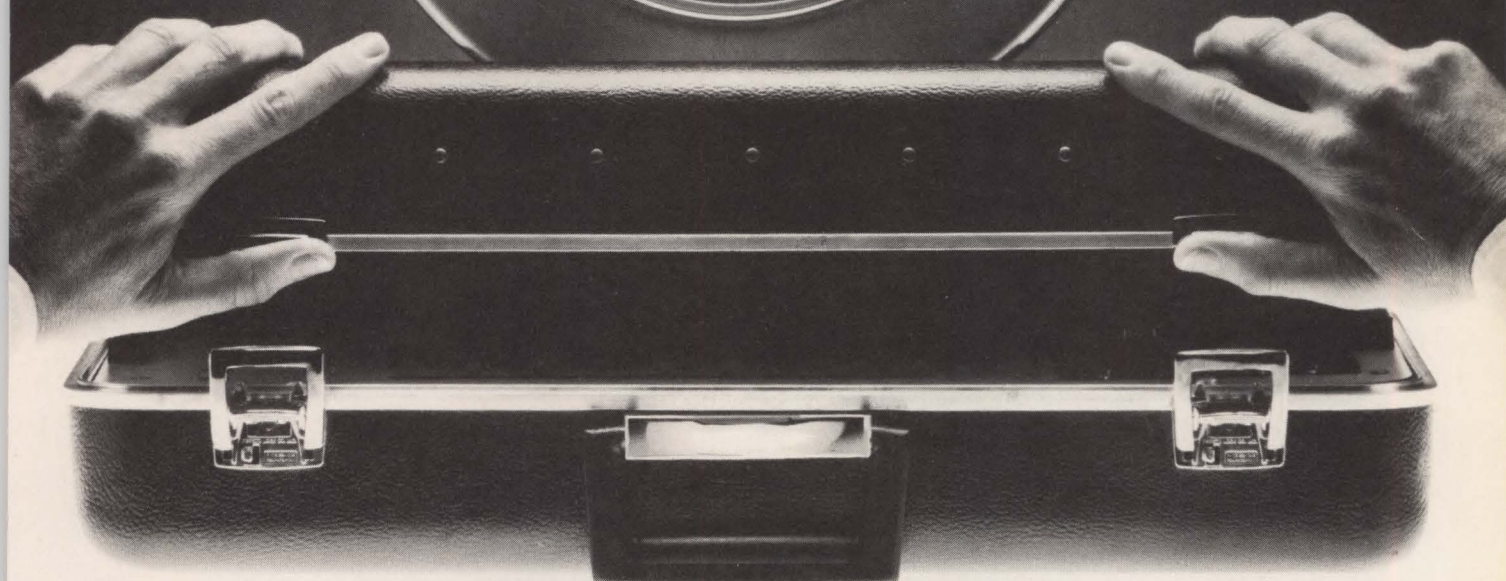
### **Data-channel characteristics**

- **Number of channels.** This indicates the number of independent data channels of a given type that are supported by the product. Specifications to the right of this figure give the performance and capacity of each channel. Many products offer more than one type of channel. A separate line in the table is used for each channel type. The data channels of a multiple-channel system always operate independently of each other. Some products, however, permit channels to be combined.

- **Maximum data-transmission speed.** This indicates the maximum speed at which data can be transferred between two points on a data channel at any time. If a channel is transparent to data transmission, typically operating point-to-point between two



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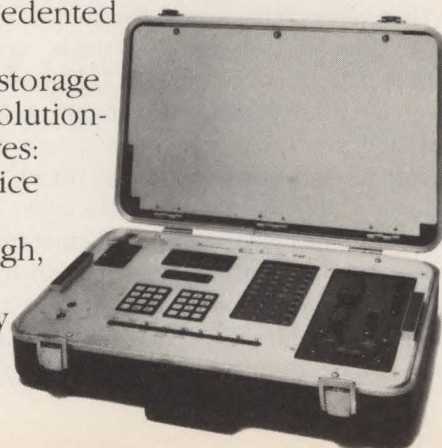
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## THE DISK DRIVE QUALIFIER

By Pioneer Research

CIRCLE NO. 150 ON INQUIRY CARD





*Historically, end users built local networks using RS232C-type interfaces, conventional modes and point-to-point, twisted-pair wiring.*

end-user devices, the full capacity of the channel is available to the user devices. If the channel is TDMA, the capacity of the channel may be available to the end-user devices for a short time, but no assumptions can be made about the effective channel capacity available to users. The long-term rate at which data can be exchanged between a pair of devices depends on the amount of competition for channel capacity, the control system and the capacity of the interface between user equipment and network.

• **Maximum number of devices per channel.** The number of devices that can be serviced by a channel depends first on the control scheme. For transparent point-to-point channels, the answer is simple: two devices. For more complex TDMA or FDMA multi-point polled channels, the answer depends on a number of factors: the addressing scheme, the capacity of the channel in relation to a potential multi-user population and the physical capacity of the cable to support interconnected devices (circuit loading). A large addressing scheme does not guarantee large capacity. Numbers provided in the table are quoted by manufacturers. In some cases, the term NPL is used to signify no practical limit when a number was not available. NPL does not mean a system can support any conceivable number of devices, only that it can probably support as many devices as a user would probably need to attach.

#### User interface characteristics

• **Channel-access method.** This identifies the technique by which a user device requests and is granted access to a data channel. In transparent systems, the method can be quite simple—select the frequency/band on which to operate a pair of RF modems. In intelligent systems, the procedure is more complex and typically involves stored-program functions in user equipment and network.

• **Data-transmission method.** This identifies the method by which two user devices exchange data across the network once channel access has been granted. If the channel is transparent, the answer is obvious. With TDMA channels, various methods are available to support data transmission. The channel can be given to a user for a full message, or it can packetize the data, interleaving several independent data calls. The channel-control scheme can allocate fixed portions of the available time to individual data calls, guaranteeing a transmission capacity, or the channel can require users to contend for capacity on a packet-by-packet basis. The data-transmission method may be the same as the channel access method. Ethernet, for example, uses the same principles of control—CSMACD (Carrier Sense

SUPPLIER & PRODUCTS	CABLE CHARACTERISTICS		
	Type	Overall length	Length between repeaters
<b>Amdax Corporation</b>			
CableNet	CATV	50 mi.	—
Transparent	CATV	50 mi.	—
<b>Interactive/3M Co.</b>			
Videodata Autopoll	CATV	40 mi.	1/2 mi.
Videodata IBM 3270 attach	CATV	4000 ft.	not required
Videodata point-to-point	CATV	40 mi.	1/2 mi.
<b>International Computing Corp.</b>			
The Intelligent Cable	CATV	7 mi.	—
<b>Sytek, Inc.</b>			
LocalNet 20	CATV	30 mi.	—
LocalNet 40	CATV	30 mi.	—
<b>Wang Laboratories, Inc.</b>			
Wangnet			
Interconnect Band, dedicated	CATV		1000 to 1400 ft.
Interconnect Band, switched	CATV	2 mi.	1000 to 1400 ft.
Wangband	CATV		
<b>Computrol Corp.</b>			
Megalink	RG-11 coaxial BNC connectors	32,000 ft.	not required
<b>Morgan Data Systems</b>			
TIE Terminal interface equipment	50 ohm/70 ohm coaxial vendor furnished taps	1 mi.	not applicable
<b>Network Systems Corp.</b>			
HYPERchannel *Multiple cables (trunks) can be used at a computer site.	CATV	5000 ft.	not required
<b>Ungermann-Bass, Inc.</b>			
Net/One	RG-8 or Ethernet cable	4000 ft.	1500 ft.
<b>Valmet, Inc.</b>			
Dataway	RG-11 coaxial	30,000 ft.	6000 ft.
<b>Xerox Corp.</b> (and others)			
Ethernet (Network only, excludes Xerox office automation equipment)	Ethernet coaxial, 50 ohm	1.5 km. on coaxial plus 1 km. on VF line	500m.
<b>Electrosound Systems</b>			
Data Loop Exchange	twisted pair	0.5 mi.	not applicable between nodes
<b>Logica, Inc.</b>			
Polynet	three twisted pair	50 km.	100m. between nodes
<b>Proteon Associates</b>			
Pronet	twisted pair or RG-58 coaxial		2 km. between nodes



DATA CHANNEL CHARACTERISTICS			USER INTERFACE CHARACTERISTICS			
No. of channels	Maximum data transmission speed	Maximum no. of devices on channel	Channel access method	Data transmission method	Electric interface characteristics	Interface protocols
two	14M bps	NPL	TDMA reservation	packet switched	RS232C, RS449	intelligent
nine	56K bps	56	point-to-point or multi-drop	transparent	RS232C, V.35	transparent
32	100K bps	248	polling	Autopoll TDM	RS232C, parallel I/O	intelligent
13	2.358M bps	32	polled	IBM 3270 coaxial link	IBM coaxial	not applicable
225	100K bps	six	dedicated, point-to-point	transparent	RS232C, 20-mA current loop	transparent
five	1M bps	255 nodes (two to four devices per node)	CSMA, contention	packet switched	RS232C, RS366, DC Teletype	intelligent or transparent
extras		two	point-to-point, dedicated	transparent	RS232C, RS366, DC Teletype	transparent
120	128K bps	200	CSMA/CD, contention	packet switched	RS232C	intelligent
five	2M bps	200	CSMA/CD, contention	packet switched	RS232C, host processor I/O channel (Unibus)	intelligent
32	9.6K bps	two	transparent	transparent	RS232C, RS449	transparent
16	64K bps	two	transparent	transparent		
256	9.6K bps	two (of 512 on band)	keyboard or autodial to central control FDMA	transparent	RS232C	intelligent
one	12M bps	NPL	CSMA, contention	packet switched TDM	Wang proprietary tri-axial cable	intelligent
one	1M bps	255	CSMA, contention	full message, transparent	computer I/O channel, (Unibus, Multibus)	intelligent
one	1.544M bps	NPL	CSMA/CD, contention	packet switched	RS232C	intelligent
one*	50M bps	16	CSMA/CD, contention and assigned time slot	message	computer I/O channel or DMA (many interfaces available)	computer-resident driver program
one	10M bps	250	CSMA/CD, contention	packet switched	RS232C, 8-, 16- or 32-bit parallel; DEC DR-11 B/W, IEEE-488	intelligent
one	250K bps	more than 100	polled	packet switched	RS232C, RS449, IEEF-488, DC Teletype	intelligent
one	10M bps	1024 addressable, 100 per cable segment	CSMA/CD, contention	datagram	Ethernet transceiver (four twisted pair)	intelligent
32	9.6K asynchronous or 19.2K synchronous	two per channel out of large population	contend for available channels	32-bit interleave, TDM, transparent to end user	RS232C	transparent
one	10M bps	255	contend for empty time slot	circulating 38- or 40-bit time slot, TDM	RS232C, Unibus, Q-bus	intelligent
one	10M bps	255	token passing/recirculating ring	packet switch	Unibus, Q-bus	computer-resident driver



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*Local-area-network products offer the user a rich variety of data-channel types and characteristics, justifying a new taxonomy.*

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Multiple Access/Collision Detection)—for both functions. Other systems frequently use different methods.

- **Electrical-interface characteristics.** This indicates the electrical characteristics of the interface between the network and the end user's computer or terminal equipment. Most systems offer the traditional data-communication interfaces—RS232C, DC Teletype and RS449. Some also offer interfaces more suited to instrumentation environments, such as IEEE-488, and computer-channel interfaces for the more popular minicomputers, such as the Unibus and Q-bus of Digital Equipment Corp.'s PDP-11 product line. One supplier, Network Systems Corp., specializes in networking for large multiple-computer data centers and offers a range of computer bus adapters for popular large-scale computers.

- **Interface protocols.** This indicates the basic protocols required by end users to obtain service from the data channel. The term transparent indicates that the user equipment can obtain service without using special procedures or software-based protocols. The fact that a user may have to perform a function using

the network to set up a data call does not disqualify a product from this category. The term intelligent means that an intelligent protocol must be implemented in the user's equipment to obtain service from the network. When this is required, the network vendor specifies the protocol for the user to implement. In the case of products designed to support computer-to-computer memory transfers, the interface protocol is usually embodied in a computer program furnished by the vendor and installed by the user and an operating-system enhancement. ■

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

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#### **NEXT MONTH IN MMS**

March is data communications month in Mini-Micro Systems, with feature surveys of modems and teleprinters, including comprehensive product listings. Also featured will be part two of a three-part series on local area networks—an in-depth analysis of LAN services, products and applications by consultant and contributing editor Walter Levy.

Also scheduled for the March issue:

- Criteria for selecting local area networks.
- Tutorials on token-passing techniques and cabling.

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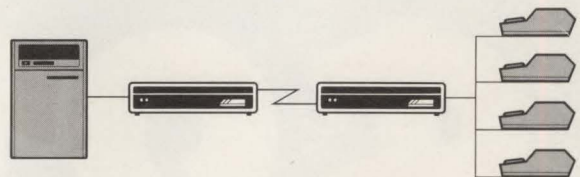
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CIRCLE NO. 123 ON INQUIRY CARD



## APPLICATIONS: MICROCOMPUTERS

# Interactive $\mu$ c speeds psychological testing

*LSI-11-based system provides psychological test results in minutes rather than weeks*

Most people can wait a few weeks for remote-computer scoring of vocational or career-assessment tests, but psychologists and psychiatrists need immediate information when a patient is suffering severe mental dysfunction. Thus, to effect prompt treatment, the traditional interview and personal-evaluation technique has been most effective.

Traditional thought is changing rapidly, however, thanks to the ubiquitous  $\mu$ c. Individuals now sit at a terminal responding interactively to true-false or multiple-choice questions. A few minutes after testing, the  $\mu$ c scores, interprets and prints concise, comprehensive psychological evaluations.

The "FastTest" equipment that enables this was developed by Psych Systems, Inc., Baltimore, Md. Based on an LSI-11  $\mu$ c from Digital Equipment Corp., the FastTest system ranges from a stand-alone model to a large system that supports 16 terminals.

Psych Systems' on-line testing programs measure a variety of aspects from vocational interests and motivation to personality, psychopathology, family adjustment and social styles. Others include an intellectual-screening battery, programs for obtaining a person's social or somatic history and a routine that alerts clinicians to possible patient-suicide risks.

Another test determines if a patient can handle interactive testing. Depending on the program, test administration, scoring and evaluation require 5 min. to 1 hour.

Psychological testing began in the late 19th century, and computer scoring has been around since the 1960s. Although on-line testing started in the 1970s, the efforts were limited to large machines. Consequently,



**Automated psychological testing system** incorporates Digital Equipment Corp. LSI-11/23  $\mu$ c with 256K bytes of main memory and two 10M-byte RL02 disk drives. Garcia loads disk with interactive psychological testing programs.

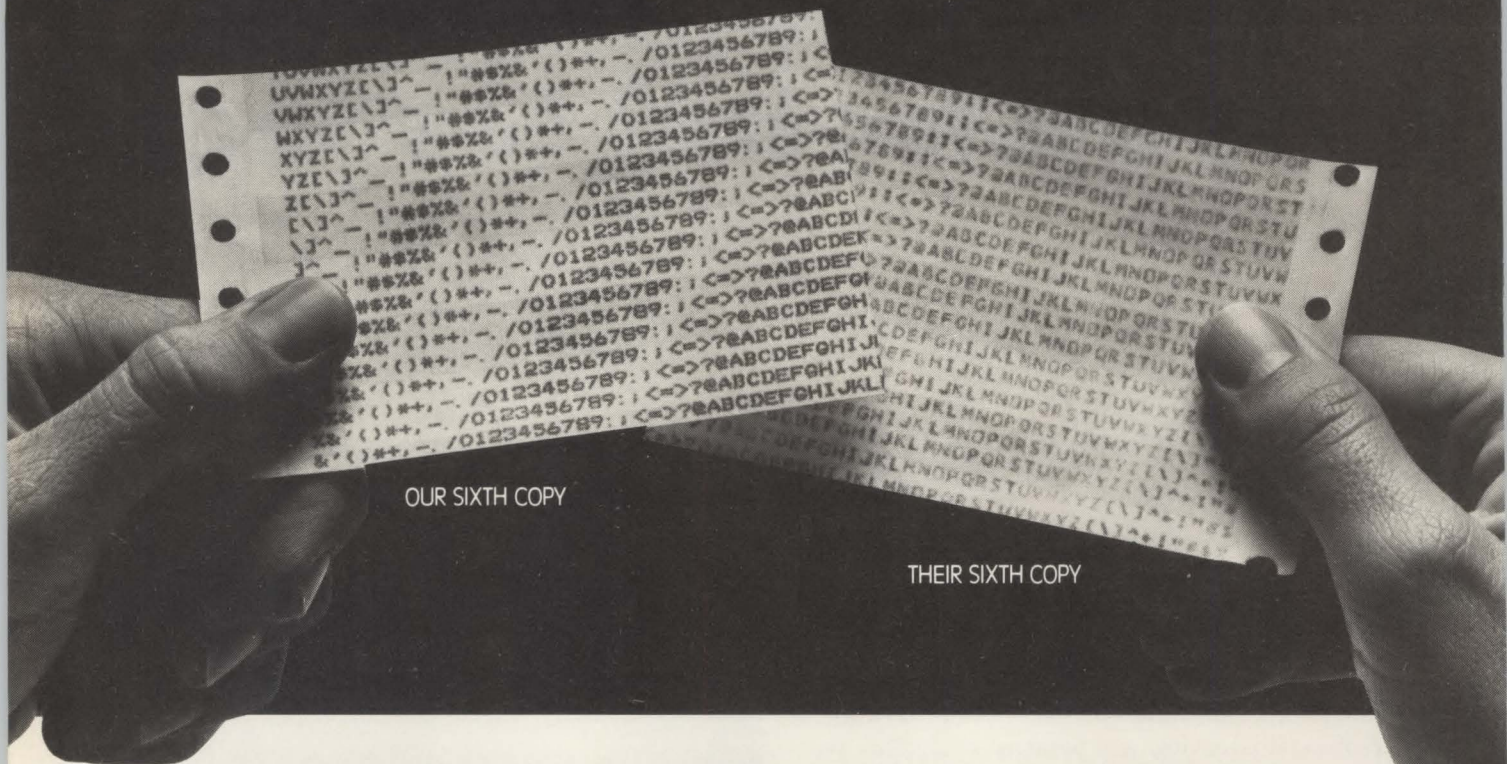
most automated testing relied on mark-sense forms that had to be mailed for scoring. The new system permits on-line testing in a psychologist's or psychiatrist's office with almost immediate results.

### **System provides interactive testing**

One user of the new FastTest system is the Behavior Therapy and Research Institute, Newport Beach,



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CIRCLE NO. 124 ON INQUIRY CARD



*People are more willing to respond to sensitive questions on the terminal than to answer them face-to-face with another individual.*

Calif., which is headed by Stephen K. Marcus, Ph.D. The group, with a staff of psychologists, psychiatrists, dietitians, nurses and biofeedback specialists, handles both individual patients and corporate clients.

The clinic treats a variety of problems, including emotional stress, family difficulties, interpersonal relationships and overweight. Corporate-client programs range from evaluating prospective employees to pinpointing potential mental problems among their workers.

The Institute's testing center uses a Psych Systems' LSI-11/23-based Lab-V with 256K bytes of main memory and dual RL02 disks, each with 10M bytes of storage. Two VT-100 video terminals are in the center's facilities with others on-line via modems and dial-up telephone lines in a hospital, a private psychiatric practice and three psychological-testing locations.

The center also administers interactive testing for other psychologists, colleges for career assessment, industries for vocational testing, schools for intelligence tests and for the courts to determine an individual's mental capability.

"The computer helps make rapid evaluation so treatment can be started quickly," Marcus says. A person initially confers with a clinician who obtains preliminary information, including age, sex, marital status and ethnic background. The clinician then enters

```
Name: Doe, Jane-----
Physician: Stephen_Marcus-----
Age: 35
Sex: f (m/f)
Ethnic group: 1      1 - White
                   2 - Black
                   3 - Mexican American
                   4 - American Indian
                   5 - Oriental American
                   6 - Other
Inpatient: ☐ (Y/N)
```

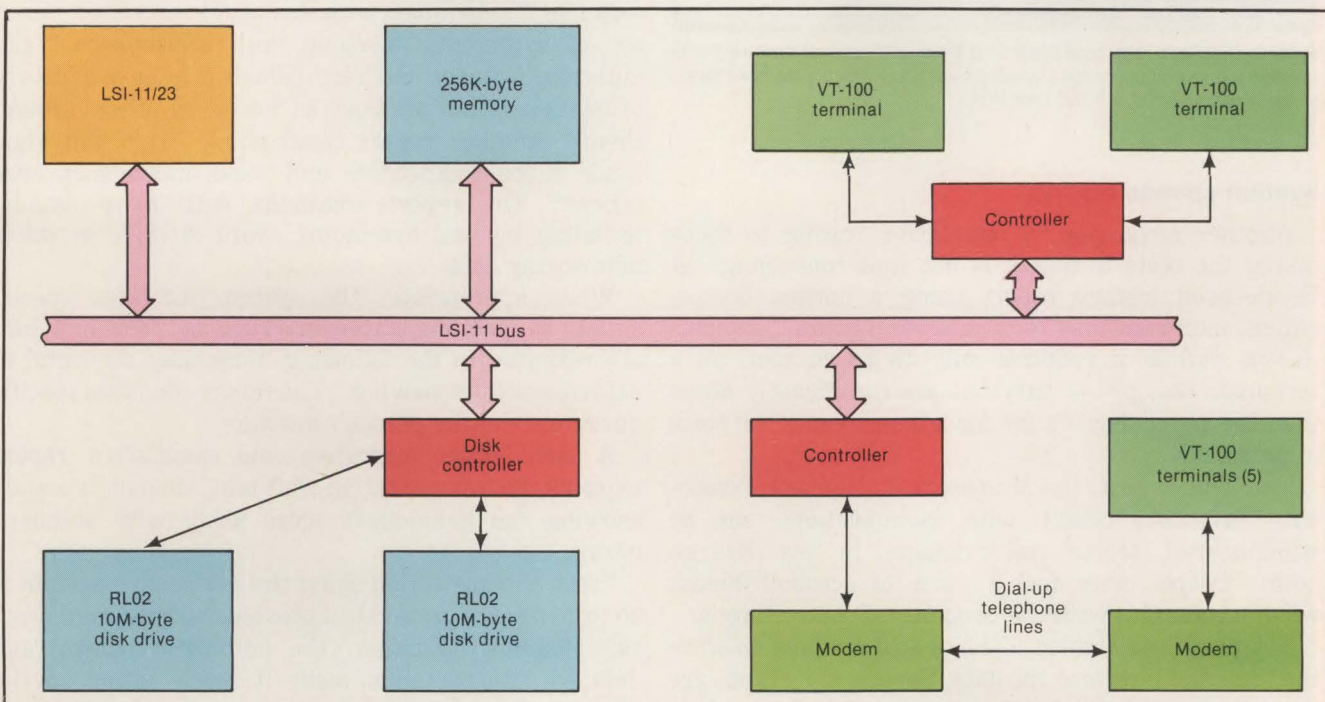
Testing begins with clinician entering personal and demographic information into VT-100 terminal. Data controls algorithms used to evaluate psychological traits. All tests are identified only with code numbers to ensure individual's privacy.

this data into LSI-11/23 files and selects any of 13 tests in the Institute's Library."

Testing follows in a conversational mode, with one question at a time appearing on the screen. The person answers using labeled keypads that correspond to the question.

"People are more willing to respond to sensitive questions on the terminal than to answer the same question face-to-face with another individual," Marcus notes. "In addition, they cannot omit questions, which is a major problem with paper-and-pencil tests. The computer will not continue until the question is answered."

Questions are formulated to require yes/no, true/



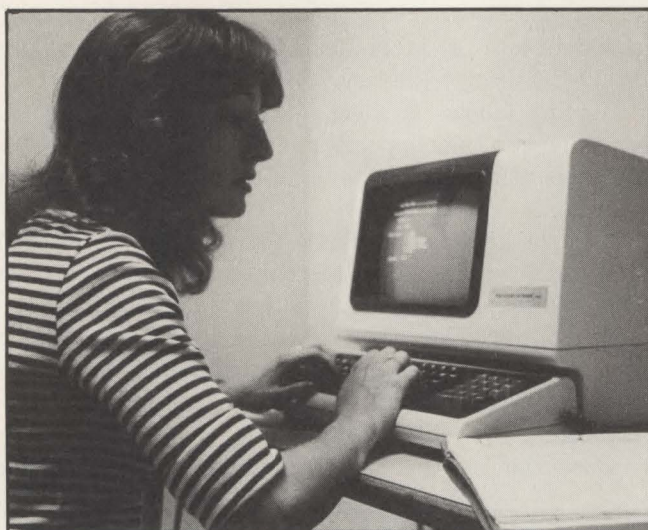
**Automated psychological testing system** at Behavior Therapy and Research Institute has LSI-11/23  $\mu$ c, 256K bytes of main memory and two 10M-byte RL02 disk drives. Two VT-100 video terminals (with five more on-line via modems) and dial-up telephone lines complete the system.



## ***The use of the DEC LSI-11/23 permits linear equation solutions, a cumbersome evaluation technique that is virtually impossible to solve manually.***

false or multiple-choice answers. They might ask, "Did you have trouble in school before or after you were 12? Others may ask the individual to select a preference from a list of occupations.

"Some tests provide social-history reports or summaries of patient's health," says Julie Garcia, testing center director. "These employ branching to eliminate redundancy. If, for example, the person is male, the program does not ask female-oriented questions. Similarly, unmarried individuals are not questioned about their spousal relations."



**System displays one question at a time and will not proceed until answer is given to preclude skipping questions. Garcia demonstrates procedures on DEC VT-100 terminal.**

### **System speeds testing**

Another advantage of interactive testing to those taking the tests is that it is not time-consuming. "A Psych-social history report using a normal doctor-patient interview may require several hours," explains Garcia, "while it requires only 15 to 20 min. on a terminal. Test prices vary but are significantly lower than the psychologist's fee for administering the tests in person."

The longest test, the Minnesota Multiphasic Personality Inventory (MMPI) with 550 questions, can be administered, scored and evaluated in less than an hour. "People often feel a sense of accomplishment when interacting with the computers," notes Garcia.

The programs employ sophisticated methods to score the tests and interpret the data. Several algorithms are typically used, depending on the nature of the test and the person. In the Psych Systems MMPI, for example, there are several interpretive routines: The first checks

whether the person is an adult or an adolescent and scores the test accordingly. Another routine determines if the profile generated matches a well-known type; if so, it prints a profile based upon that configuration. If not, the program employs other clinical interpretations. Other routines check for valid answers, distinguish between out- and in-patient answers and scores differently for each sex.

The use of the DEC LSI-11/23 permits linear equation solutions, a cumbersome evaluation technique that is virtually impossible to solve manually. The Psych Systems' MMPI evaluates more than 100 special scales.

A clinician does not often attempt an evaluation of this depth. Confidentiality is ensured because an identification number is entered into the computer. Only authorized clinicians can relate the number to the person's name.

### **Reports are qualitative or narrative**

Marcus emphasizes that interactive testing is a tool that aids a skilled psychologist or psychiatrist in making a diagnosis. Reports prepared by the LSI-11/23 in the FastTest system are qualitative, narrative or a combination. Qualitative reports provide graphical or tabular information, with standard norms that allow the clinicians to make judgments based on test scores. A typical graphical presentation gives an x-y plot with specific items on one axis and test values on the other. This is essentially a "snapshot" giving the psychologist or psychiatrist an accurate view of the patient in a relatively short time.

In-depth narrative reports provides scores and interpretation routines that trigger accepted standard descriptors stored in memory. A report might state, for example, "Individuals with this profile present a mixed set of symptoms, showing both schizophrenic and antisocial features. Such individuals may have a history of behaviors that are seen as 'crazy' by others around them." Another report could start, "This individual tends to be competitive and seeks ascendance over others." The report continues with more details, including medical symptoms, work attitude or other noteworthy data.

When appropriate, the system indicates special situations, printing statements such as, "This individual's response to the following items may be useful in subsequent interviewing." The report then lists specific questions and the person's answers.

A combination narrative and qualitative report explains the interpretation with text, then plots a scale showing the individual's score along with standard norms.

"Test administration using the interactive system is 30 to 40 percent faster than previous written methods," says Marcus. "Further, the automatic scoring and detailed interpretation make it much easier on the clinician. The substantial information we receive from the tests helps improve the quality of care we can give."





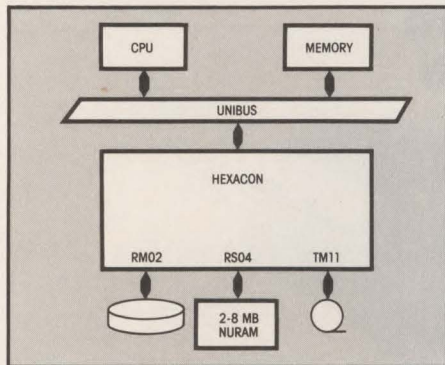
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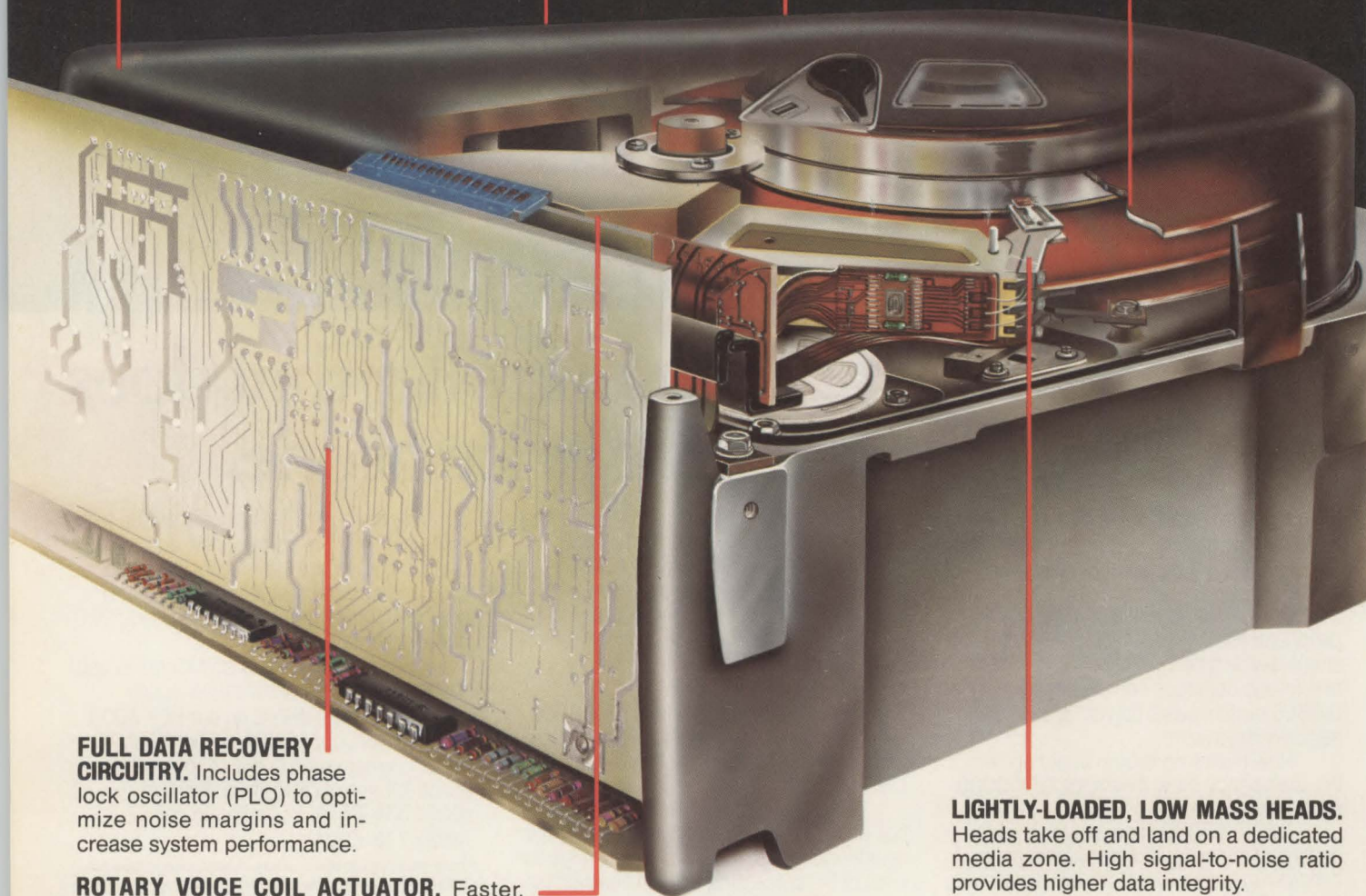
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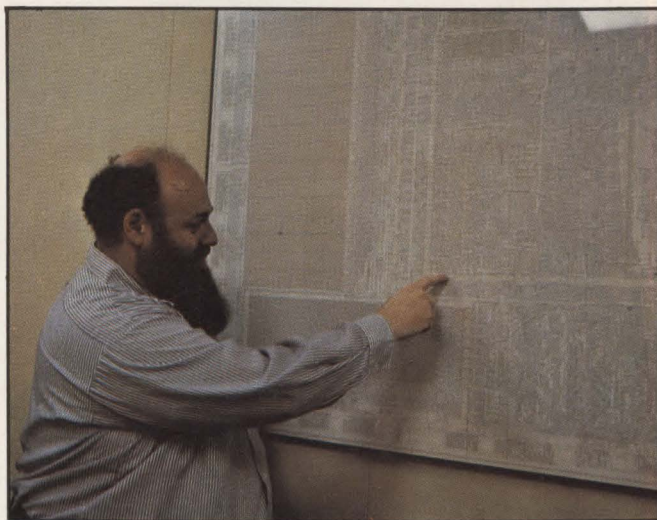
# Designing $\mu$ ps with superminis

*Intel uses eight VAX-11/780s to lay out VLSI devices  
that would otherwise require 60 man-years each to develop and debug*

When planners at Digital Equipment Corp. considered applications for the 32-bit VAX-11/780 a few years ago, they figured that computer-aided design would be a natural for the superminicomputer's speed and abundant memory. The experience of designers of very large-scale integrated circuits at Intel Corp. shows that DEC planners were accurate. Intel has installed eight of the VAX systems in its extensive CAD facilities in California, Oregon, Arizona, Israel and Japan.

"With very large-scale integration, the complexity is such that no human can build a working device in any reasonable time without computer assistance," declares Richard Gruen, manager of CAD systems at Intel.

He notes frequent estimates that a 100,000-device VLSI system would require 60 man-years to lay out and 60 man-years to debug. "But even if we put 300 people on the job, they still couldn't communicate with one another without CAD techniques."



**CAD systems manager** Richard Gruen points to a 70,000-transistor 8051  $\mu$ c photomicrograph.



Each VAX provides computational capability for a number of Applicon Inc. graphics systems. These support as many as four graphics terminals. Communications between the graphics systems and superminis are through packet-switching systems at 50M bps. A Digital RM03 disk drive and a Control Data Corp. drive make a total of 1.2G bytes of storage available under the virtual-memory operating system.

## Top-down vs. bottom-up

Device development is both a top-down and a bottom-up procedure at Intel. The design starts when

**Mask designers** Zahia Mazloam (left) and Mary Campbell examine a schematic for a VLSI  $\mu$ c before laying out on a graphics terminal.



## *The bottom-up development procedure begins when functional sections of the chip are assigned to mask designers for layout.*

architecture and device specifications are defined. "We place special emphasis on making new  $\mu$ p software compatible with previous  $\mu$ ps," Gruen says.

Next a "chip plan" is formulated, which indicates general locations for processing units, RAM, ROM and I/O sections. At this time, the methods of implementation—such as programmable logic arrays, register banks or random logic—are selected. While still in the planning stage, the new device is thoroughly simulated on a large computer. Once simulation testing is completed, a complete system diagram and schematic are developed and entered into the database.

"As a continuing procedure," Gruen notes, "other groups are updating VAX-11/780 databases with device geometries and the processors used to fabricate them. The geometric considerations, called design rules, indicate size, configuration and spacing of various cell types and associated intraconnect lines. "Process



**Designer Cahil Un Tak** uses applications graphics terminal to lay out section of VLSI circuit. He locates circuit elements, then transfers section to a DEC VAX-11/780 supermini for design-rule and continuity checking.

specifications define masking steps, heating procedures, oxide and silicon layers, etching, cleaning and deposition necessary to fabricate the wafer."

The bottom-up development procedure begins when functional sections of the chip are assigned to mask designers for layout. Using the graphics terminals and digitizing tablets, they display individual circuits on the screen, based on the schematics, specifications and chip plan.

The graphics system is more than a drafting aid because it automatically places all layers and intraconnects in the proper location as the device is defined from tables in memory. If the circuit is repetitive—an array for example—the graphics system replicates on command the number of devices necessary. Random logic sections are individually designed and laid out.



**Intel senior staff engineer Scott S. Nance** examines a chip layout generated by a CAD system.

"Size is always a paramount consideration," Gruen explains, "because it determines both device speed and yield. Based on experience, the mask designers fine-tune the circuits on-line."

Using a wand and digitizing tablet, designers move components around on the screen to pack devices as tightly as possible. For random logic, they may decide that higher density can be achieved by changing

### **$\mu$ P MAKES CAD POSSIBLE**

It's only fitting that computer-aided design and manufacture should be applied to  $\mu$ ps: It's the  $\mu$ p, and its dramatically declining price, that makes CAD feasible.

In 1971, the year Intel Corp. produced the first  $\mu$ p, turnkey CAD/CAM systems in the U.S. numbered in the low hundreds, with three or four work stations per system. By

the end of this year, 20,000 work stations will employ CAD/CAM in the U.S., says Timothy O. Gauhan, director of design and manufacturing automation at Dataquest Inc.

CAD/CAM sales, which reached \$80 million in 1971, will exceed \$700 million this year, Dataquest predicts. The compound annual growth rate over the next five years should

approach 45 percent, the company adds, and some suppliers already are experiencing growth of more than 80 percent per year.

A \$2.5-billion market in 1985 is predicted by L.F. Rothschild, Unterberg, Towbin, a New York investment firm.



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*Once all sections have been checked and verified, the program converts the layout geometrics, layer by layer, into instruction tapes for use by mask-making machines.*

geometries—making some elements L-shaped rather than rectangular, for example. The circuit layout is periodically transferred to the VAX-11/780 for design-rule checking.

### Compressing days into minutes

Computational programs are where the computer's 32-bit word length and floating-point arithmetic come to the forefront. "The VAX automatically determines quickly whether the layout meets design rules," Gruen says. "We can check about 100 devices in a few minutes and a 1000-transistor array in about half an hour. That means the designers can execute the program, go to lunch and have the results when they come back." Erroneously placed devices are highlighted on the screen, plotted or indicated on a printout.

"We previously had to transfer the layout to magnetic tape, then run the design-rule program on a large-scale computer. The process required several days, so there was a tendency to make checks less frequently and with larger sections," Gruen recalls. A section that did not meet criteria often required a completely revised layout. The ripple effect could add substantially to the overall development time. "Now, with the VAX, we quickly perform the tests on much smaller portions," he continues. "It is more efficient to debug an easily recognizable entity and make changes while the section is still small. At this point, the ramifications on other circuits are not so severe." Individual sections are design-rule checked in increasingly larger portions until the complete system has been debugged.

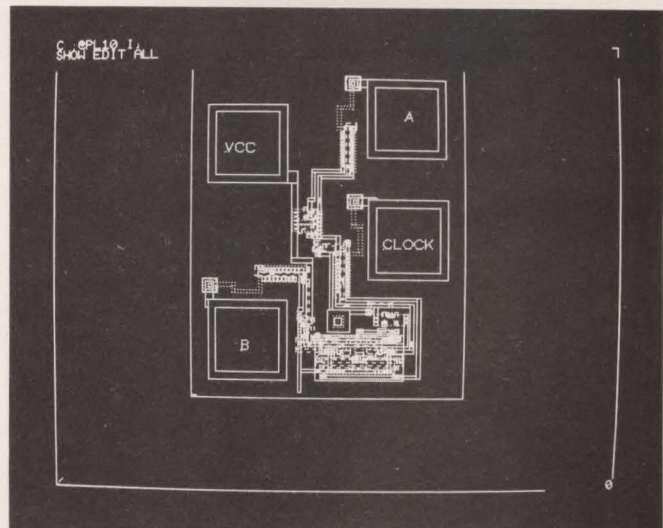
### Logic and continuity are verified

The computer also verifies logic and continuity. During initial design phases, schematics are entered into VAX memory, where they are compared with logical sections transferred from the graphics-system layout. These programs, like the design-rule checks, are performed on small sections initially.

"This is a more complicated process than one might think," Gruen observes. "Because of multiple, often overlapping, layers on the chip, we sometimes find that we have created transistors where we didn't intend to have them." These are shown as unconnected devices, highlighted on the graphics-terminal screen. The mask designer must then revise circuit geometry to eliminate extraneous devices.

The VAX-based programs also verify interconnections from the schematics in the database. Bus, signal and power lines are labeled, using the graphics terminals as the circuits are developed. The layout is

then transferred to the VAX, where the schematic is compared with the circuit. The programs check not only continuity but also signal sense, to ensure that inverters are not omitted between sections designed by different people.



A circuit on a video screen appears as sharp white on a dark background.

Once all sections have been checked and verified, the program converts the layout geometrics, layer by layer, into instruction tapes for use by mask-making machines. Depending on the devices, three to 11 high-quality masks must be produced. The VAX-based CAD programs are massive by any standard, requiring from 50M to 1000M bytes of storage.

### Importance of being first

"The first new product to market commands premium prices," Gruen notes. "Then, as volume increases and competition sets in, prices drop sharply—sometimes to the point where the instruction manual costs more than the part."

Development time is a critical factor in bringing a  $\mu$ c to the market. "At one time, it required six to eight preliminary chip fabrications, or 'steppings,' to get a functional device," Gruen continues. "We would make the masks, process the chip, test it and find it didn't work. Then we had to find the problems, fix them, re-lay out the chip and start over again. Since each stepping required six to 12 weeks, it was possible for a year or more to pass before we had a working device. That is why we place a heavy emphasis on CAD. Just cutting the number of steppings dramatically decreases development time."

CAD gives Intel a cost advantage with mature products as well as with new ones. Officials point to the 8048H, a high-speed version of the 8048  $\mu$ c. Following redesign using advanced CAD techniques and Intel's HMOS II fabrication process, the 8048H is 27 percent as large, 33 percent faster and 16 percent less expensive than the original version.



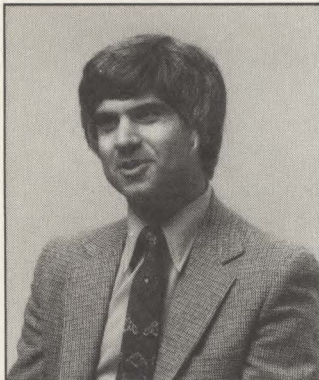
# Ada: How to Get Started

NO. 1 IN A SERIES

Interest and activity in Ada, the new programming language, is gathering momentum. Now, two prominent computer science professors have prepared an Ada textbook and an intensive three-day programming course based on the recently announced Western Digital MicroAda compiler. Dr. Richard Sincovec and Dr. Richard Wiener, professors at the University of Colorado at Colorado Springs, and co-founders of Western Software, talk about the advantages of evaluating Ada now.



*"You can't really appreciate how Ada can cut your software development and maintenance costs until you evaluate it in an applications context."*



*"Ada has the features — separate compilation, generics, dynamic dimensioning of arrays — that enable it to overcome the limitations we discovered with Pascal."*

**WD:** How did you first get interested in Ada?

**SINCOVEC:** Actually, we first became interested in Pascal, for its structural modularity and ease of software maintainability. We wrote the nucleus of a mathematical programming library in Pascal. But, as a language, it had some limitations. Such as the inability to dynamically dimension arrays.

**WD:** Ada solves that?

**SINCOVEC:** Absolutely. Ada is a natural evolution of Pascal. It has unique features — unconstrained arrays, separate compilations and generic packages, for example, that

are too attractive to ignore. We're upgrading all our existing programs to Ada. And it should make additional programs for our library much easier to implement.

**WD:** You seem sold on the language. Wouldn't some argue that it's a bit too early to commit to Ada?

**WIENER:** The U.S. Government has clearly committed to it. Both here and in Europe. Ada is gaining acceptance as a universal language. The sooner you evaluate Ada, the sooner you'll understand the potential impact and benefits it can have on your software development. And those who begin developing Ada programs now are likely to reap the rewards that accrue to early adopters of new technology.

**WD:** What makes Ada so attractive?

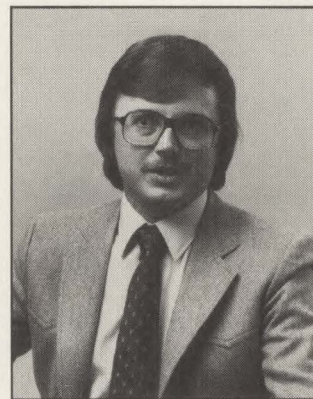
**WIENER:** Sheer economics. It should lower the cost of software development and maintenance for anyone who uses it. It's simple, yet powerful. And it's highly standardized, so your software costs really become a good investment.

**WD:** How does one get started?

**SINCOVEC:** There's no substitute for getting your hands on a compiler and beginning to write actual programs.

**WD:** That sounds like a plug for your course.

**SINCOVEC:** It is. We've structured a hands-on, three-day class focusing on programming in an applications context, using Western Digital's



*"There's no substitute for hands-on programming for learning a new language. It's the quickest way to get started, and the foundation for the course we've put together."*

MicroAda compiler and SuperMicro computer work stations. Participants will get instant feedback for practical, effective learning.

**WD:** How did you choose the SuperMicro?

**WIENER:** We've used Western Digital systems for over a year to develop our mathematical, statistical and data base programs, originally in Pascal. Frankly, we're impressed with its performance — typically 1,000 lines per minute compilation speed. Our evaluations indicate compilation and execution speeds tenfold what you would expect from a microcomputer, more along the lines of the performance of a multi-user mainframe.

**WD:** Tell us more about your course.

**SINCOVEC:** It's designed for scientific programmers, systems programmers, D.P. professionals, computer science educators, researchers, software managers and anyone with either commercial or military interest in Ada.

**WIENER:** We've scheduled a number of sessions in cities across the country to make it possible for a broad cross-section of people to attend.

**WD:** One final question. What can a participant expect to get from your class?

**WIENER:** A detailed insight into actual programming techniques. Our aim is to provide people with a basis for beginning their Ada projects. In the move to Ada, they'll be in a position to lead, not follow.

Western Digital is sponsoring this series of reports to keep you abreast of important Ada issues and developments. For details on the SuperMicro systems, the MicroAda compiler or the Wiener/Sincovec ADA courses, write:

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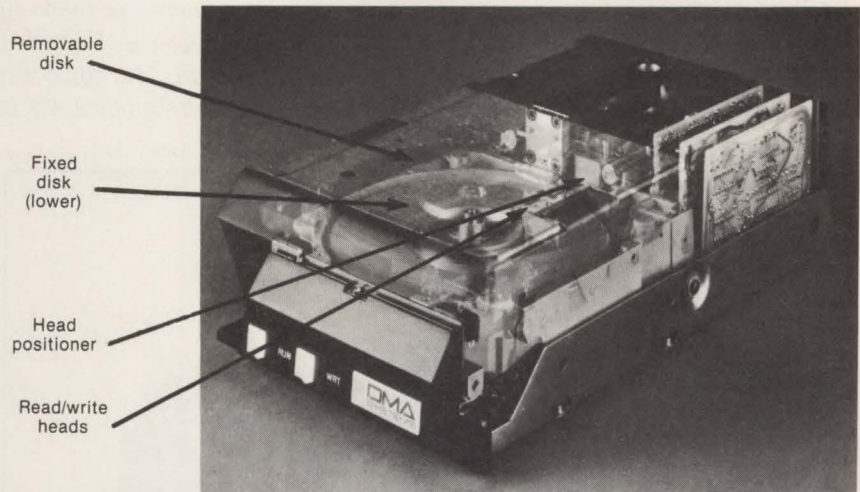
For Ada Seminar details and dates call (714) 966-7818



## 5¼-in. Winchester and cartridge store 5M bytes each

Reliable 5M-byte Winchester-disk drives are hardly news, but adding a reliable 5M-byte 5¼-in. cartridge in the same box is. DMA Systems Corp.'s (Santa Barbara, Calif.) Micro-Magnum dual 5¼-in. drive incorporates several novel design features to provide as much capacity in its removable cartridge disk as in its fixed disk.

Unlike most servo-positioning systems that require a dedicated surface and head for track-following data, the Micro-Magnum's closed-loop servo-positioning system shares its track data with program data. The track data are pre-recorded with the track identification and fine position information recorded at the beginning of each sector. This method compensates for slight misregistrations of the disk center resulting from disk interchange of temperature variation because the head is always servoed directly to the track of interest. It also makes physical alignment of the heads less critical.



**DMA Systems' Micro-Magnum** combines a 5M-byte, 5¼-in. Winchester-disk drive and a 5M-byte, 5¼-in. cartridge in one box.

DMA Systems' "Cushionaire" heads are glass-boarded, surrounded with a ceramic outer layer and mounted in a Z-axis-only flexure assembly that is spring-fastened to the one-piece arm. The head does not contact the media, even during start/stop operations.

Protection from contaminants is a key consideration for high-density

media. The Micro-Magnum's cartridge is normally sealed. On insertion, the head port opens to let air circulate through the cartridge and purge it prior to head loading. The air is moved by an impeller at the bottom of the spindle motor, and the air is filtered for contaminants down to 3 µm.

Circle No 460

## Ampex's Pyxis enters low-end market

Ampex Corp., Cupertino, Calif., has entered the 5¼-in. Winchester-disk drive market with a line of 4M- to 16M-byte devices licensed from Rodime, Ltd., Glenrothes, Scotland. Called the Pyxis, the new hardware follows Ampex's recent announcement of its Capricorn line of 165M- to 330M-byte 14-in. Winchester-disk drives and its line of 8M- to 80M-byte 8-in. Scorpio Winchester-disk drives.

Pyxis completes the low end of the Ampex Winchester family. The Seagate ST-506-compatible drive is available in four capacity ranges: the single-disk 4M-byte version, the dual-disk 8M-byte version, the three-

disk 12M-byte version and the four-disk 16M-byte version. Using brushless DC motors, the 5¼-in. floppy offers an average access time of 85 msec. and a data-transfer rate of 5M bps. Recording at 260 tpi and 8060 bpi densities, the drive operates at 10,417 bpi on 192 cylinders. An on-board 8048 µp enables microstepping for full- or half-step final track settings. Control functions include motor speed and fault monitoring, a 12-indicator status display and index selection.

Ampex is the second vendor to move into the 5¼-in. Winchester-disk drive market through licensing. Anaheim, Calif.-based Seimens Corp. showed its small Winchester, a design licensed from Rotating Memory Systems, Sunnyvale,



**Ampex's Pyxis** is available in four capacities, ranging from 4M to 16M bytes.

Calif., at the recent Comdex Show in Las Vegas.

Prices range from \$740 for the 4M-byte version to \$1290 for the 16M-byte version. **Ampex Corp., Memory Products Division**, 200 N. Nash St., El Segundo, Calif. 90245.

Circle No 459



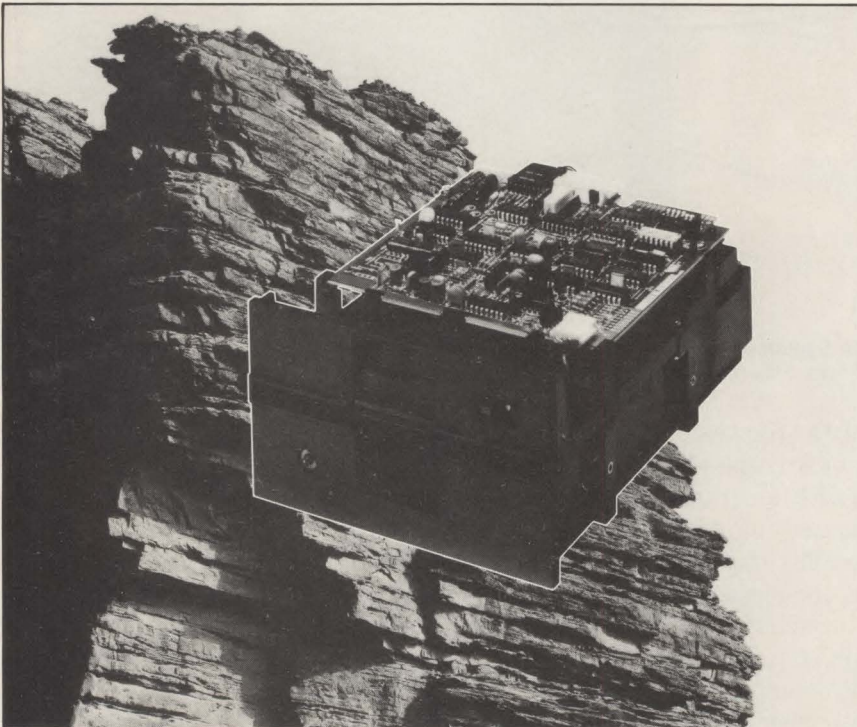
# New Systems

## MDS announces HASP work-station emulator

The HASP multileaving/interleaving terminal emulator allows operators of the Series 21 line of distributed-processing systems at remote job-entry sites to transmit source programs for compilation, input data files for processing and

receive processed output for report generation, by duplicating the communications characteristics of an IBM remote work station. The emulator supports transmission rates as high as 9600 bps (4800 bps concurrently) over switched or leased lines (two or four-wire facilities). The unit supports EBCDIC

transmission with or without transparency. Other features include data compression/decompression, message blocking of as many as 4096 characters and operation of multiple input or output devices, including console, readers, printers and card punches. An operator console allows users to display communication messages, enter JCL statements and monitor data streams. The emulator is available on a perpetual-license basis for \$25 per month per system, or \$2500 per customer for unlimited use, plus \$25 per month for software maintenance. **Mohawk Data Sciences**, Seven Century Dr., Parsippany, N.J.. **Circle No 458**



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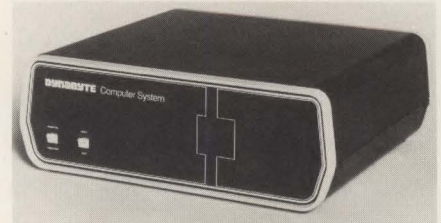
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## Dynabyte system stores 16M bytes

The model 5505 multi-user, table-top business computer incorporates a 5¼-in. Winchester-disk drive that stores 6M, 10M or 16M bytes, and a 5¼-in. floppy-disk drive that stores 0.5M or 1M byte. On-line storage capacity is expandable to 61M bytes. Other features include the CP/M, MP/M and OASIS operating systems; S-100 bus architecture; 400K bytes



of RAM; and RS232C I/O ports. The system accommodates as many as eight users and 16 printers. Available programs include Business Manager, an integrated accounting package; WordStar, a word-processing system for single- and multi-user environments, and Business Planner, a financial-modeling package. The 5505 with 6M bytes of hard-disk storage is priced at \$6995, the 10M-byte version sells for \$7695, and the 16M-byte version sells for \$8495. **Dynabyte**, 521 Cottonwood Dr., Milpitas, Calif. 95035. **Circle No 457**



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# New Products

## memories

### Adac introduces nonvolatile memory

The model 1816 16K-word nonvolatile CMOS memory board plugs into the DEC LSI-11 backplane. The device includes on-board 18-bit address-decoding circuitry and write-protect dip switches that permit accessing memory at any 4K word boundary and write protection in 4K-, 8K-, 12K- or 16K-word segments. When power is applied, on-board automatic switching and recharging circuitry keeps two self-contained NiCad batteries charged; when power is removed, the batteries retain data for as long as 168 hours at 25° C. Price is \$1295 in single-unit quantities. A depopulated 8K-word version, CMOS-8 is \$795. **Adac Corp.**, 70 Tower Office Park, Woburn, Mass. 01801.

Circle No 455

### Motorola introduces memory-I/O module

The Micromodule 16 provides RAM, ROM, I/O or timer expansion for the vendor's 8-bit single-board µcs. The module incorporates 2K bytes of static RAM, with an external battery and power-fail detect circuit and four 24-pin sockets for as much as 32K bytes memory. The unit also includes parallel I/O via a Centronics-type interface that can be configured as a buffered PIA port, and serial I/O via an asynchronous communications interface adapter, with 50- to 19.2K-bps baud rates. Other features include a triple, programmable, 16-bit counter/timer; 1-MHz or 2-MHz operation; and on-board address, data and control-bus buffers. Price is \$575 in quantities of one to five units. **Motorola Semiconductor Products**, P.O. Box 20912, Phoenix, Ariz. 85036.

Circle No 456

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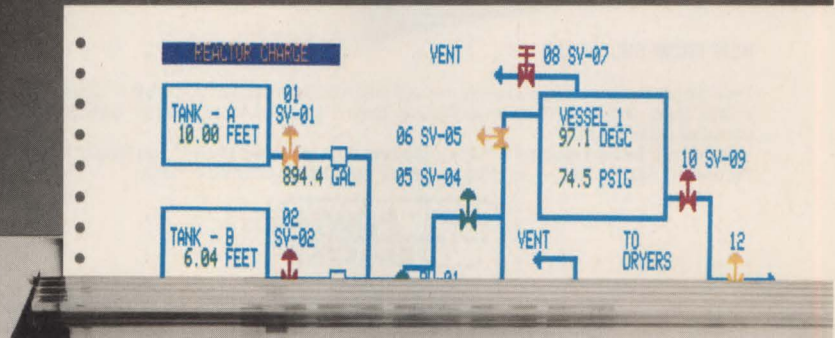
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☐ **YES**, please send free color catalog!

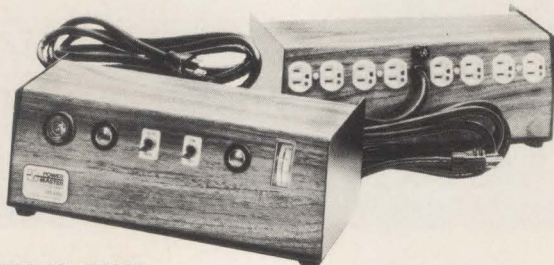
Name \_\_\_\_\_ Title \_\_\_\_\_  
 Firm \_\_\_\_\_  
 Street \_\_\_\_\_ Phone (\_\_\_\_) \_\_\_\_\_  
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CIRCLE NO. 131 ON INQUIRY CARD



**NEW**

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The electricity that powers your sensitive mini and micro computer systems is "polluted." Filled with voltage spikes and noise interference that can cause information loss, incorrect readings and premature circuit failure.

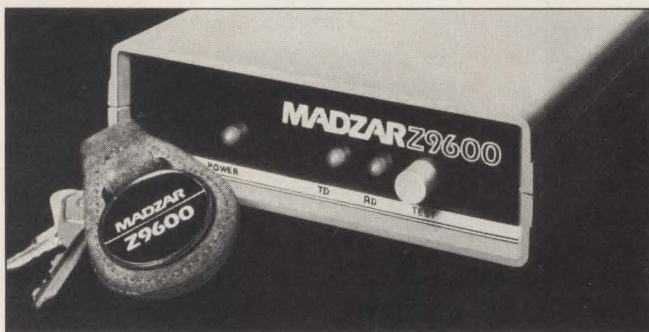
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For further information call or write  
MADZAR Corporation, 37490 Glenmoor Dr.,  
Fremont, CA 94536, (415) 794-7400.



CIRCLE NO. 133 ON INQUIRY CARD

## New Products

### terminals

#### Hand-held terminal features 40-channel LCD

This hand-held terminal includes a 1600-character memory, a 40-character 5 × 7 matrix LCD, cursor-controlled editing and 11 selectable baud rates as high as 2400 bps for continuous transmission or 9600 bps for bursts. The unit is powered from rechargeable NI/CAD batteries that give as much as 30 hours of continuous operation and retain data in memory for several months. The unit sends and receives the 128-character ASCII set, and the baudot code set is optional. The unit can be used in conversational full-duplex line mode or edit mode. It also features RS232 and 20-mA interfaces. **G.R. Electronics**, 1640 Fifth St., Santa Monica, Calif. 90401. **Circle No 453**

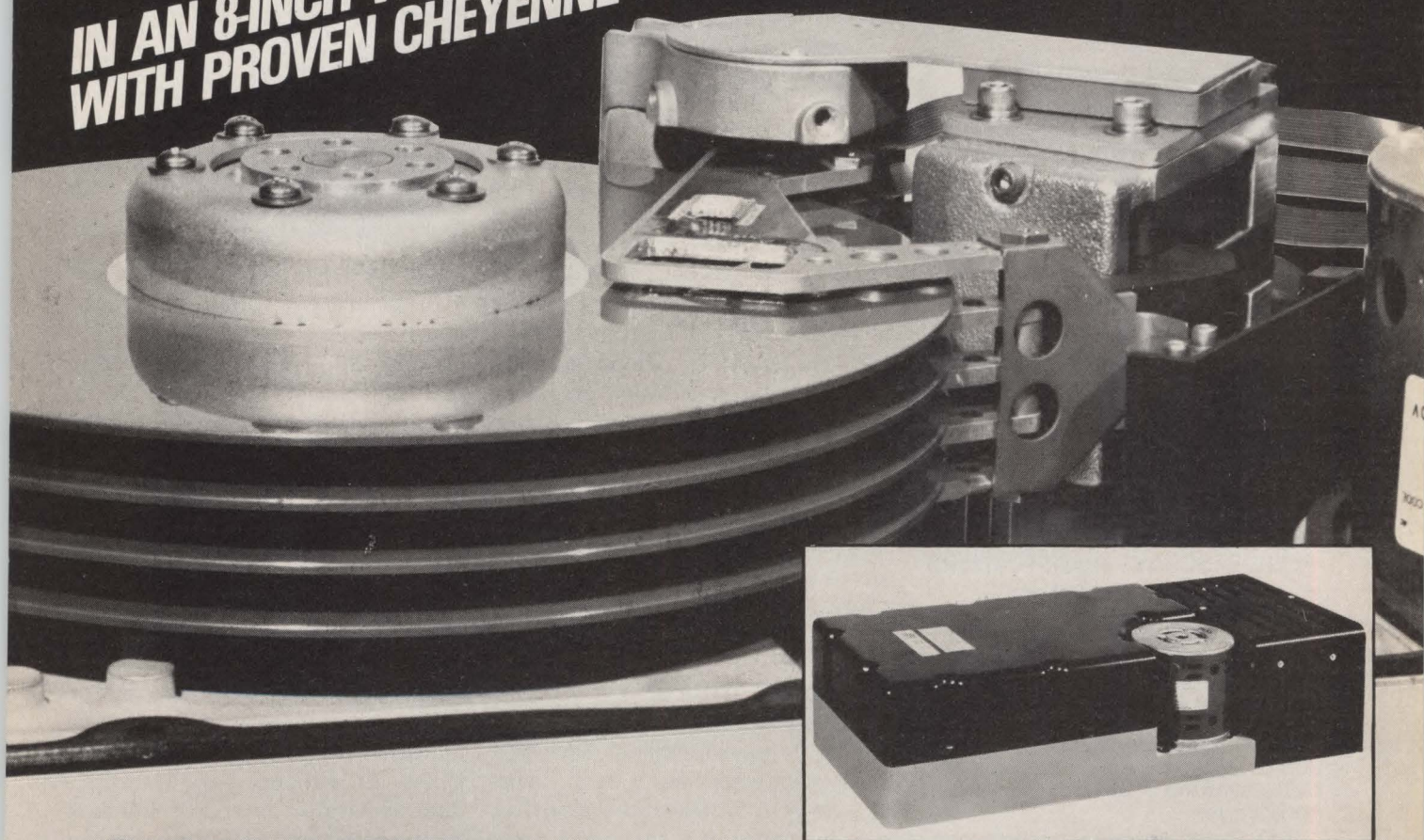
#### Gandalf introduces terminal board

The model 135AA terminal board enables the vendor's private automatic computer exchange systems to provide auto-answer capabilities for remote terminals. The terminals use 103/113-type modems over the switched network via DAA over dedicated lines using two-wire voice grade channels. The board handles asynchronous speeds as high as 300 bps at any distance and operates in the answer mode only. Each board incorporates four FSK modems, compatible with LDS 135 and other 103/113 modems. Received data, received carrier and carrier latch diagnostic indicators are provided for each channel. The unit also provides communications channels that are transparent to the code and format, enabling them to handle several arrangements at the remote end. Price is \$720, and four necessary cables sell for \$20 each. **Gandalf Data, Inc.**, 1019 S. Noel, Wheeling, Ill. 60090. **Circle No 454**



# 7.3 to 83 Megabytes

IN AN 8-INCH WINCHESTER-TYPE DRIVE  
WITH PROVEN CHEYENNE RELIABILITY



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**Making it more reliable  
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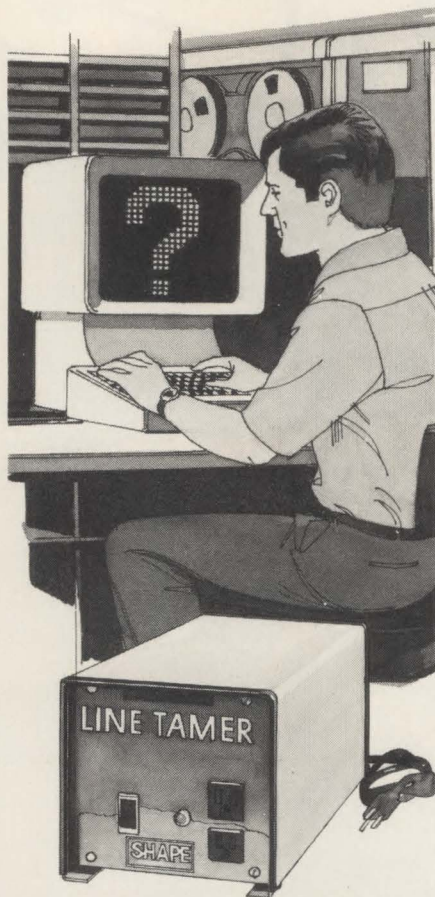
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Power line spikes, brownouts and inaudible noise can wipe out all or part of computer memory, leaving you the arduous task of reconstructing your data. Line Tamer™ ferroresonant transformers protect sensitive computer equipment from such power pollution by isolating the noise and stabilizing the voltage.

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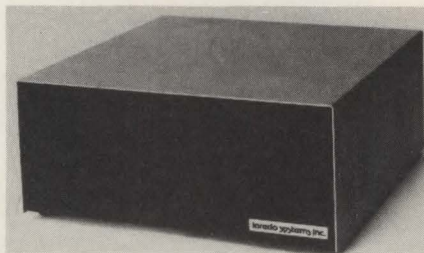
264

## New Products

### disk/tape

#### Laredo announces hard-disk subsystem

The LS525 hard-disk subsystem, for use with TRS-80 I and II personal computers, incorporates a Seagate ST506 5¼-in. disk drive with two magnetic disks, four read/write



heads and a 10-MHz  $\mu$ p controller. The device operates under the LDOS operating system, and requires 100V, 120V, 220V and 240V AC of power,  $\pm 10$  percent selectable and 47 to 63 Hz, at 100W. Features include RS232 drivers, a keyboard type-ahead buffer, printer spooling and multiple keystroke programs for key redefinition. The unit can be daisy-chained with as many as three 5¼-in. Winchester-disk drives for total storage of 20M bytes. Price is less than \$3000. Laredo Systems Inc., 2264 Calle de Luna, Santa Clara, Calif. 95050-1198.

Circle No 446

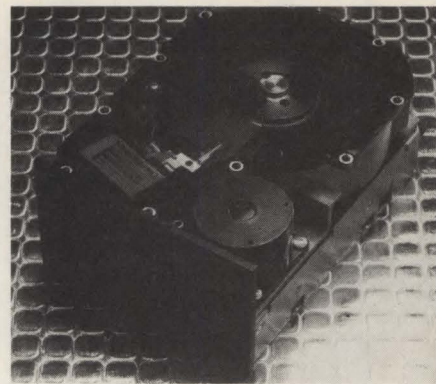
#### Microtech offers disk subsystem

The Nova-compatible Dart-MS1 subsystem comprises a 14-in., 34M- or 64M-byte Winchester-disk drive, a ¼-in., 20M-byte, streaming tape-cartridge drive for backup, a controller board and a power supply. The device also includes four multiplexer ports, a printer port and a real-time clock. The device's controller supports as many as four daisy-chained disk drives for a total capacity of 272M bytes. Other features include IRIS and RDOS operating-system drivers. Prices are \$8700 for the 34M-byte version, and \$9500 for the 64M-byte version. Microtech Business Systems, 3180

Pullman St., Costa Mesa, Calif. 92626. Circle No 447

#### Computer Memories unveils 5¼-in. Winchester

The CM 5000 5¼-in. Winchester-disk drive is available in 6.38M-, 12.76M- and 19.14M-byte versions and features a Motorola 6803 8-bit



$\mu$ p. The device offers a 130-msec. average access time, a 3-msec. track-to-track access time and a 5M-bps data-transfer rate. Other features include step-pulse buffering, head-velocity profile control and off-track positioning. Computer Memories, Inc., 9233 Eton Ave., Chatsworth, Calif. 91311.

Circle No 448

#### RMS announces Winchester-disk drives

The RMS 518 5¼-in. Winchester-disk drives, available in 4.5M, 9M, 13.5M and 18M bytes, offers 270-tpi track densities and 70-msec. access times. An optional Data Express I data separator provides standard MFM coding and a 5-MHz transfer rate. An optional Data Express II data separator offers a 7-MHz transfer rate. The drive sells for



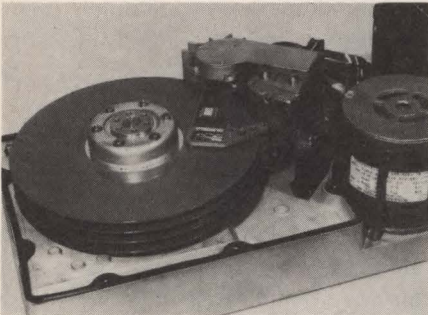
MINI-MICRO SYSTEMS/February 1982



\$1460, the Data Express I for \$197, and the Data Express II for \$250. **Rotating Memory Systems, Inc.**, 1701 McCarthy Blvd., Milpitas, Calif. 95035. **Circle No 449**

## SLI introduces 83M-byte disk drive

The 83M-byte Cheyenne Winches-



ter-disk drive offers SMD interfacing, a closed-loop track-following positioning system and a rotary voice-coil positioner. The unit has a 11,500-bpi bit density, a 600-tpi track density and a 45-msec. average access time. Other features include self diagnostics, a Z80A  $\mu$ p and 3600-rpm spindle speed. **SLI Industries**, 21040 Victory Blvd., Woodland Hills, Calif. 91367.

**Circle No 450**

## Quentin offers Winchester subsystem

The Q80 disk subsystem includes a disk controller and an 80M-byte Winchester-disk drive. The device offers a 1M-byte-per-sec. transfer rate and a 38-msec. average access time. A fixed-head option adds as much as 2.4M bytes of storage and 10-msec. access times. Price is \$8000; the fixed head sells for less than \$4000. **Quentin Research, Inc.**, 19355 Business Center Dr., Northridge, Calif. 91324.

**Circle No 451**

## Micro Sci announces floppy subsystem

The 286K-byte A-70 5¼-in. floppy-disk drive subsystem emulates the

Apple II or Apple II Plus drives. An optional second drive boosts total capacity to 572K bytes. The drive includes a controller board, casing, cabling, a software utility package and a manual. Track-to-track access time is 5 msec., and track density is

16 sectors per track. Software is compatible with DOS 3.3, Pascal and the CP/M operating system. Price is \$699; the second drive sells for \$599. **Micro-Sci**, 17742 Irvine Blvd., Suite 205, Tustin, Calif. 92680.

**Circle No 452**

## Plug-In Productivity.



## Put your Cable System to work as a high speed data communications network using Comtech Coaxial Cable Modems.

Here's how . . .

Connect the Comtech M500 Cable Modem to your system. You can now transmit high speed data (56 Kb/s to 7 Mb/s) bi-directionally on your CATV or broadband coaxial system. Aggregate data transmission rates of up to 500 million bits per second are possible.

Applications include high speed computer graphics, data collection and processing, process automation, robotics and transmission of high speed composite streams for multiplexors, as well as digitized voice between PBXs. The M500 is totally compatible with existing CATV systems and requires no external filtering.

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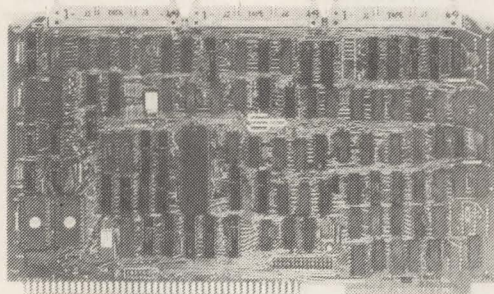
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CIRCLE NO. 135 ON INQUIRY CARD



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All "ANSI" compatible disks  
8 and 14 inch PRAM disks

### TAPE CONTROLLERS

All 1/2 inch formatted start/stop or  
streaming drives  
1/4 inch cartridge drives

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Both disk and 1/2 inch tape on single board  
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CIRCLE NO. 136 ON INQUIRY CARD

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# MULTI-CAGE®

CIRCLE NO. 137 ON INQUIRY CARD

## New Products

### datacomm

#### Micom announces modem/concentrators

The Series 2 Micro8000 concentrator modem comprises a statistical multiplexer and a matched MOS/LSI modem in one unit. Three versions are available; a two-channel concentrator with a 2400-bps modem, a four-channel, 4800-bps unit and a 16-channel, 9600-bps version. The devices support as many as 16 terminals, each operating as fast as 9600 bps. Features include statistical multiplexing of as many as four synchronous channels concurrently with asynchronous channels, a command port for on-line troubleshooting, terminal-activated channel test, terminal-initiated channel configuration, speed conversion and data compression. Options include asymmetrical data rates, satellite compatibility and background printer priority. Prices are \$2500 for the two-channel version, \$4850 for the four-channel unit and \$8800 for the 16-channel device. **Micom Systems, Inc.**, 9551 Irondale Ave., Chatsworth, Calif. 91311.

Circle No 444

#### Micromation introduces synchronous interface

The  $\mu$ p-based M/Link communications interface transmits synchronous data at speeds as high as 2400 bps and allows alternate data and voice communications. The device uses dibit differential phase-shift keying, which encodes data 2 bits at a time to differentially shift the phase of an 1800-Hz carrier. The unit provides touch-tone or pulsed-line dialing, auto-dialing and auto-answer. Other features include -9-dB m transmit levels, 0- to -40-DBm receive levels and jumper-selected 25- or 150-msec. RTS/CTS delay. Price is approximately \$1500 in single-unit quantities. **Micromation, Inc.**, 1620 Montgomery St., San Francisco, Calif. 94111.

Circle No 445



# Esprit<sup>TM</sup>

*has a timely announcement  
on buyer protection for only*

Any terminal can claim to be reliable. Esprit<sup>TM</sup> backs it up! Each Esprit is backed by two warranty options that protect owners against repair cost.

They're warranties that are unavailable with any other low cost terminal. Unavailable with any terminal at any cost.

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### TWO WARRANTY OPTIONS.

HAZELTINE, IN COOPERATION WITH WESTERN UNION, NOW OFFERS:

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THESE SERVICE OPTIONS ARE AVAILABLE ON ESPRIT TERMINALS PURCHASED AFTER FEBRUARY 1, 1982, FOR SERVICE RENDERED THROUGH DECEMBER 31, 1982.

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COMPANY-----

ADDRESS OF TERMINAL LOCATION-----

-----ZIP-----

PHONE AT TERMINAL LOCATION-----EXT-----

NUMBER OF TERMINALS AT LOCATION-----

TERMINALS PURCHASED FROM-----

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Now, that's a very smart idea!



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CIRCLE NO. 154 ON INQUIRY CARD



# May We Help?

In house, across the street or across your complex, we have the solution to your limited distance data communication problems. For 12 years we've been supporting some of the largest companies in the U.S.

DEI produces highly reliable local synchronous and asynchronous high speed data sets, converters, interface adapters, modem eliminators, fiber optics and diagnostic devices. We also offer technical/application assistance and can provide off-the-shelf delivery of all products.

Give us a call. Be pleasantly surprised by our expertise and willingness to help. DEI is committed to service.



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## A New Magnetic Tape System, The DMT3500 Series for LSI-11 and PDP-11.

Reel Size: 10.5"  
Tape Speed: 45 ips  
Recording Mode: PE/NRZI

- Emulates TM11
- Can be connected with LSI-11 Qbus and PDP-11/ VAX-11 Unibus.
- RT-11/RXS-11M software compatibility.

Tension Arm

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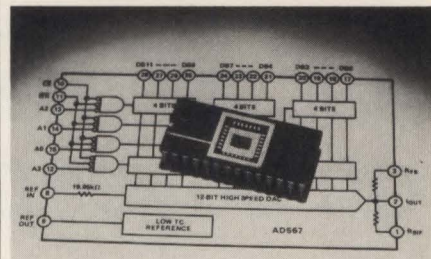
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## New Products

### components

#### D/A converter features double-buffered latch

The AD567 monolithic D/A converter features an on-chip double-buffered data latch and a  $\mu$ p bus



interface. Settling to  $\pm 0.01$  percent in 500 nsec., maximum, the AD567 accepts data in 4-, 8- or 12-bit words. Applications include vector-scan graphics, character generation, automatic test equipment and process-control systems. The unit has guaranteed maximum linearity error of  $\pm 1/4$  LSB and  $\pm 1/2$  LSB for J and K grades, respectively, over the 0 to 70°C temperature range. The unit sells for \$14.95, and the DK grade sells for \$22.95, in 100-unit quantities. Analog Devices Semiconductor, 804 Woburn St., Wilmington, Mass. 01887.

Circle No 435

#### Optic-electronic sensors feature plug-in wiring

The RT7 series of optic-electronic sensors with plug-in wiring connections operate with a modulated infrared beam. Sensitivity can be adjusted without unplugging the sensor. Models are available for retroreflective operation, direct detection of objects and emitter-receiver systems. AC models (120V AC) include SPDT relay output, and DC models (10V to 30V DC) include transistor outputs. Each sensor features a dark or light mode-selector switch and a visible LED indicator. Gould R.B. Denison, Controls Division of Gould Inc., 103 Broadway, Bedford, Ohio 44146.

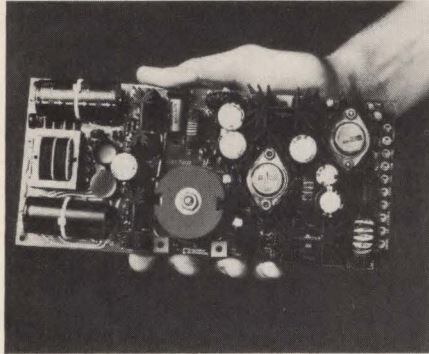
Circle No 436



## power supplies

### Power General offers 100W switchers

The series 5100 100W off-the-line switching power supplies provide as many as five output voltages.



Output is provided over an ambient temperature range of 0°C to 40°C with a 2 percent per °C derating to 71°C. Four versions are available. Model 5100-1 produces outputs of 5V DC at 10A, -5V DC at 1A, +12V DC at 1.5A, -12V DC at 1.5A and 12V to 30V DC at 0.4A to 1.0A. Pin-strappable inputs are 85V to 130V AC or 170V to 250V AC at 47 Hz to 470 Hz. Other specifications include  $\pm 0.1$ -percent line regulation,  $\pm 0.2$ -percent load regulation, 300- $\mu$ sec. transient-response time to 1 percent of the final value, 1200V AC input-to-output isolation, 16-msec. holdup time, 15A input-surge current and 5- to 80-percent relative humidity. Price is \$179. **Power General**, 152 Will Dr., Canton, Mass. 02021. **Circle No 437**

### Power Mate offers multiple-output switchers

The EVD-130 and EVD-165 series of multiple-output switching-regulated power supplies consists of 14 models with as many as four outputs each. Standard outputs are +5V at 11A or 15A, +12V or +15V at 2A or 6A, -12V or -15V at 2A, and -5V, +12V or +24V at 2A. Maximum input-line regulation is  $\pm 0.2$  percent from 90V to 132V AC or 180V to 264V AC strappable, 47 to 440 HZ.

Maximum load regulation of the +5V output is  $\pm 0.2$  percent, and maximum outputs are  $\pm 3$  percent. Noise and ripple is less than 2 percent maximum peak to peak, 40 mV maximum RMS, minimum, and hold-up time is 20 msec. Both

models feature 80 percent typical efficiency. Prices of the EVD-130 and EVD-165 are \$269 and \$299, respectively, in quantities of one to 10. **Power/Mate Corp.**, 514 S. River St., Hackensack, N.J. 07601.

**Circle No 438**

## TWO VERSATILE RS232 DATA HANDLING TERMINALS FROM WTI



### for cost savings, performance & reliability ...THEY'RE THE PERFECT MATES!

WTI offers a choice of RS232 Minifloppy storage devices to help solve data your handling problems. DataMate II has extensive editing & search features for store & forward applications. The new MiniMate III is ideal for bulk storage & data collection. Both are packed with features for easy operation, system configuration—and above all—reliability you can depend on!

#### APPLICATIONS

- Save on-line costs: Prepare & edit data off-line, transmit stored data to computer at speeds to 9600 bps.
- Transfer data from one computer system to another.
- Store demo programs for exercising data terminals and equipment.
- Store program code for microprocessors and Eprom programmers.
- Record data from PBX systems and electronic instruments.
- Store parts & address lists, sales information or any data changed or updated often.

#### IMPRESSIVE QUALIFICATIONS

##### Both units include;

- A 5-1/4" floppy drive, system controller, software and power supply.
- Dual RS232 ports for easy insertion between your Terminal and Modem.
- Easy to use File Management system.
- Automatic and Manual controls for "stand alone" applications.
- 12-month factory warranty!

#### DataMate II Features:

- Up to 328K of storage on a single sided diskette.
- High speed single and continuous search modes.
- Global search and replace, delete, erase functions.
- Extensive text editing features.

#### MiniMate III Features:

- Low cost
- Up to 408K of storage on a single sided diskette.
- 7 bit ASCII or 8 bit binary operation, code switchable.
- Automatic disk motor timeout to extend disk life.
- Power up restart in case of AC power failure.
- Dual baud rates and answerback message.

#### LET WTI HELP

Call WTI **toll free** and let us help solve your data handling problems. Our solutions have helped hundreds of customers—after all we've been designing and manufacturing floppy disk storage devices longer than anyone!

Outside California call toll-free **800-854-7226**

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**western telematic inc**

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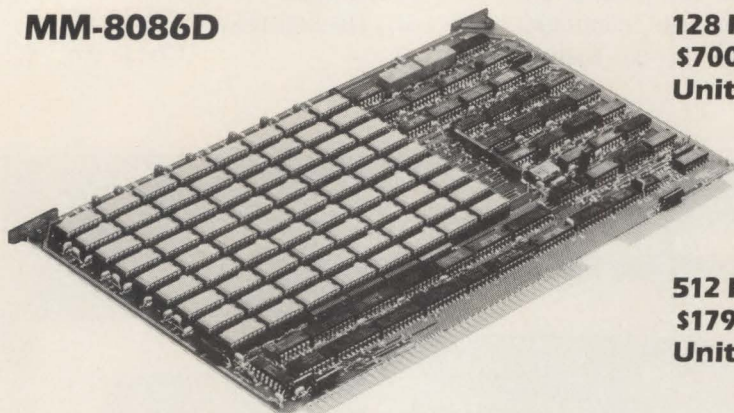
CIRCLE NO. 141 ON INQUIRY CARD



# MULTIBUS\* MEMORIES

## DYNAMIC RAM

**MM-8086D**



**128 Kbytes  
\$700 each  
Unit Qty.**

**512 Kbytes  
\$1795 each  
Unit Qty.**

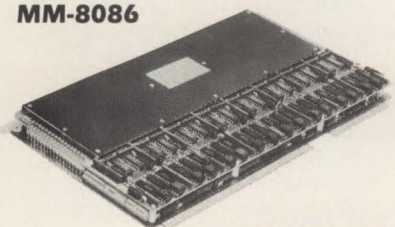
- 32 Kbytes to 512 Kbytes on a Single Board
- Multibus\* Compatible with 8 and 16 bits processors
- Cycle Time 400 nsec, Access Time 250 nsec
- Even Parity with output selectable to any of the Bus interrupts
- Module Select on 4 Kbyte Boundaries in the 16 Mbytes address
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\*Multibus is a trademark of the Intel Corp.

## CORE MEMORY

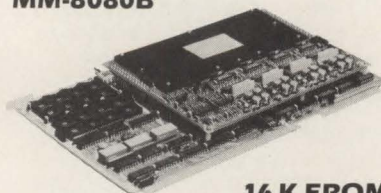
NON-VOLATILE • WRITE-PROTECT • POWER-FAIL INTERRUPT

**MM-8086**



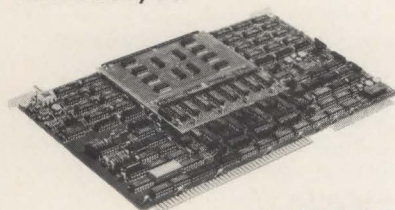
**32 KBYTES**

**MM-8080B**



**16 K EROM  
& 8 K CORE**

**MM-8086/16**



**16 KBYTES**

**MODEL**

**PRICE**

MM-8086/16	\$875.00
MM-8086	\$1275.00
MM-8080B	\$790.00
MM-8080/16	\$849.00

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## New Software

### Virtual Systems unveils Pascal cross compiler

The Microbench Pascal ISO Pascal cross compiler for the Intel 8086/8088  $\mu$ ps operates on DEC PDP-11, LSI-11 and VAX-11 computers. Extended features include external compilations, the ability to link to assembly language subprograms, support of single- and double-precision integers, support of underscore as a letter in identifiers and the ability to compile program assertions conditionally to facilitate debugging. Generated machine instruction code is reentrant, making Microbench Pascal suitable for real-time environments in which code segments are to be shared among multiple tasks. The prerequisite Microbench 8086 cross assembler provides assembly and linking facilities. Prices start at \$3500, not including cross-assembly software. **Virtual Systems, Inc.**, 1500 Newell Ave., Suite 406, Walnut Creek, Calif. 94596. **Circle No 439**

### Multiprocessor is available for 68000 $\mu$ c

MTOS-68K real-time, multitasking, multiprocessor operating system is ROM-able, with all modules coded in assembly language. It manages task coordination, memory pools, I/O priority scheduling, interrupt processing and multiple processors. The system runs on as many as 16 processors sharing a common memory. All processors are equivalent. MTOS-68K is sold in source form for a one-time license fee. **Industrial Programming Inc.**, 100 Jericho Quadrangle, Jericho, N.Y. 11753. **Circle No 440**

### Micropro announces report generator

InfoStar, a report-generator/file-processor program for CP/M-based  $\mu$ cs, is intended as an application-development tool to produce business reports and to tailor pre-existing application programs.



Under the specification process, a user designs the format of the report on the screen and then answers questions about the data relationships; InfoStar then writes the code. InfoStar can query files written in BASIC, print information in a user-designed format and update or open new files based on data already processed. The package also provides automatic documentation for reports and files it processes. List price is less than \$1000. **MicroPro International Corp.**, 1299 Fourth St., San Rafael, Calif. 94901. **Circle No 441**

## Data manager announced for TRS-80 model II

IDM-X, the first in a planned series of interactive database managers, runs on the Radio Shack TRS-80 model II computer under the TRSDOS operating system. Features include a sort/merge routine with as many as 10 sort keys; a key-access method using a new hashing algorithm; support for string, double-precision floating decimal, integer and date data types; and formatted numeric fields, using BASIC formats. The package includes a database-initialization program, a database-manipulation program, a report writer and a report generator. IDM-X requires a dual-disk system with 64K bytes of memory. Price is \$399. **Micro Architect Inc.**, 96 Dothan St., Arlington, Mass. 02174.

**Circle No 442**

## Tool aids development of CP/M programs

The Programmer's Apprentice, a program-development tool for CP/M-based 8080 and Z80  $\mu$ cs, uses a macro-like language to define standard routines that its code generator accepts to create fully debugged programs in the MBASIC language, providing screen-prompted data input, database management, file

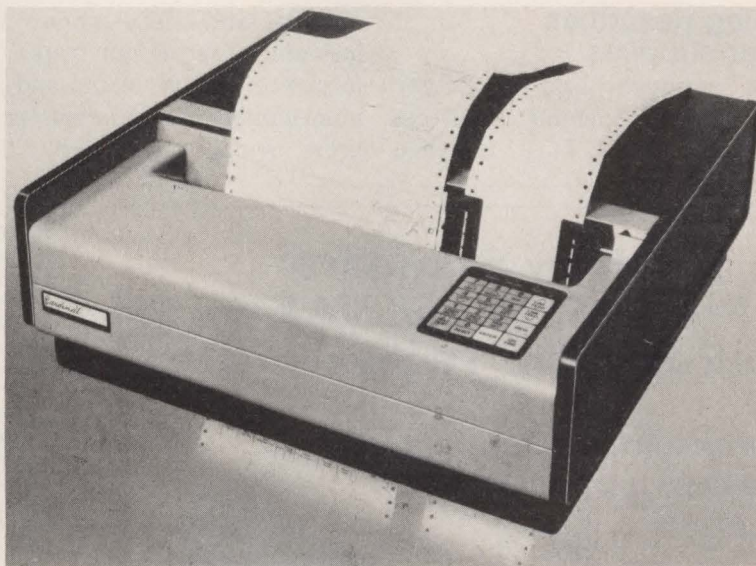
maintenance and report generation. To generate a program, a user first specifies the screen or report template on the CRT via Apprentice's built-in screen editor. Then the definition modules use the screen/report template to define the

attributes of each field and to select the fields to be the record-control keys. Finally, the MBASIC source code is generated. **The Software Group**, 10471 Brookhurst St., Anaheim, Calif. 92804.

**Circle No 443**

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High Speed Dot Matrix Data Printer



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# New Literature

## Pro-Log guide features PROM selection

A selection of programmable devices is featured in this guide. It lists 420 devices from 21 manufacturers, including bipolar fusible link PROMs, MOS EPROMs, PALS and  $\mu$ ps containing programmable memory. Information is organized alphabetically by manufacturer and numerically by array size. The guide provides part numbers, number of pins, output types, erased states for EPROMs and initial states for fusible-link PROMs. The vendor's personality modules that support each device are identified. **Pro-Log Corp.**, 2411 Garden Rd., Monterey, Calif. 93940. **Circle No 432**

## Catalog describes power supplies

The vendor's line of power supplies, power systems and accessories is detailed in a 128-page

catalog. The catalog contains detailed specifications, outline drawings and prices. Also listed in the catalog are 43 five-year-guaranteed switching power supplies and nine new models in the one-year-guaranteed commercial-grade LY series. **Lambda Electronics**, 515 Broad Hollow Rd., Melville, N.Y. 11747. **Circle No 433**

## Literature features superminicomputer line

A family of superminicomputers are featured in a brochure. The 10-page, illustrated brochure contains sections on each of the vendor's virtual-memory computer systems—from the H80 to the H800. A chart provides an overview of the models and data about each, including throughput rates, performance measurements and maximum number of interactive terminal users supported. **Harris Corp.**,

**Computer Systems Division**, 2010 W. Cypress Creek Rd., Fort Lauderdale, Fla. 33309.

**Circle No 434**

## Leasametric data products described in catalog

The vendor's data products are featured in a catalog. The publication covers data terminals,  $\mu$ p test-and-development systems and telecommunications equipment. Data-processing products include acoustic coupler/modems, graphic and interactive CRT terminals, KSR and RO printers, store-and-forward devices and desk-top computers. The catalog also features  $\mu$ p test-and-development systems from Advanced Micro Computer, Hewlett-Packard, Intel, Millennium, Motorola, Tektronix and Zilog. The 64-page catalog's analyzer section includes products from Biomation, Dolch Logic Instru-

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## New Literature

ments, Fluke, Hewlett-Packard and Tektronix. Leasametric, 1164 Triton Dr., Foster City, Calif. 94404.

Circle No 428

### Brochure describes $\mu$ c and software lines

Software and  $\mu$ c product lines are described in five color brochures. The eight-page brochures are: "Commodore Personal Computer," describing the vendor's four levels of  $\mu$ cs; "The Educational Experience;" "Shopping for Software," which surveys word-processing, financial and information-management systems and systems for specific industries; and "VIC 20-The Friendly Computer." Also available is a 16-page corporate overview brochure. Commodore Business Machines, Inc., Computer Systems Division, 681 Moore Rd., King of Prussia, Pa. 19406.

Circle No 429

### Catalog includes data sheets

Data sheets and price lists for available standard products for the MIL-STD-1553 are featured in a 44-page catalog. The publication includes specifications for the MTI-110, BCU-11LA, data link coupler, BCS/IEEE 488, a bus activity simulator and a multiplexed data bus system. SCI Systems, Inc., 8600 S. Memories Parkway, P.O. Box 4000, Huntsville, Ala. 35802.

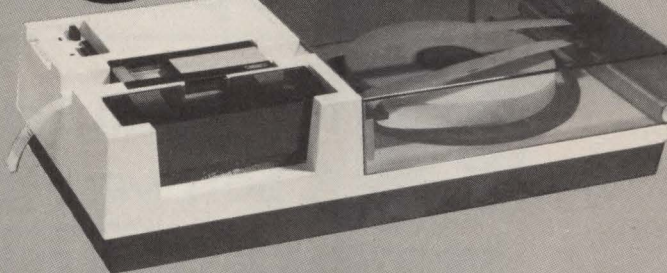
Circle No 430

### Multitasking concepts featured in a brochure

Multitasking concepts and considerations for writing tasks in a multi-tasking environment are featured in a four-page brochure. The leaflet outlines a series of multitasking kernels for five  $\mu$ ps, including the 8085, Z80, 6502, 6800 and 6809. U S Software, 5470 N.W. Innisbrook Place, Portland, Ore. 97229.

Circle No 431

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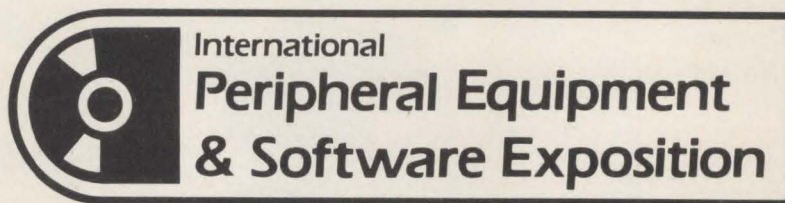
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# Endpoints

**Wet Ink Dept.** **New World Computer Co.**, Irvine, Calif., has entered a five-year second-sourcing agreement with West German printer/computer house **Olympia Werke AG** to manufacture Micro-Disk 5¼-in. fixed and removable Winchester. The contract is worth \$9.5 million for 1982 alone... **Kennedy Co.**, Monrovia, Calif., has netted two contracts totaling \$100,000 for its tape transports and Winchester. A two-year \$800,000 contract has been signed with Western Electric of Denver for Kennedy's model 9800 tape transports for use in the Dimension telephone system. A one-year \$200,000 contract with IBC, Chatsworth, Calif., will integrate Kennedy's model 5300 Winchester-disk drives into the Ensign multi-user Z80-based  $\mu$ c systems... **Intel Corp.**'s Software Distribution Operation, Santa Clara, Calif., has made agreements with two companies to distribute Intel's 16-bit operating systems. SDO will integrate MS-DOS single-user operating systems from Microsoft, Inc., Bellevue, Wash., and CP/M and CP/M-86 single-user and MP/M-86 multi-user operating systems using Intel hardware and software components... **Durango Systems**, San Jose, Calif., has agreed to supply its series of Colt desk-top computers to Money Concepts International, Inc., a Miami, Fla., insurance company. Money Concepts will sell the hardware through its network of more than 30 planning centers, and will use life-insurance software developed by Disc Systems, Philadelphia. Shipments have begun, and Durango plans to ship more than 100 in 1982... **Vector Graphic** continues to penetrate the government market via a one-year contract with the General Services Administration for Vector 2600, 3105 and Multi-Share 5005  $\mu$ c systems, and the 7700 letter-quality printer. Vector government revenues exceeded \$110,000 in fiscal year 1981, and \$70,000 in the first month of fiscal year 1982... **Micropolis Corp.**, Chatsworth, Calif. has landed a \$4-million one-year contract with Litton Industries subsidiary Monroe Systems for Business, for Micropolis's model 1015 5¼-in. 328K-byte floppy-disk drive. The drive will be incorporated into Monroe's OC 8000 occupational computer and its EC 8000 educational computers. Delivery of 5000 drive units has been accepted, and delivery will continue monthly.

**Ground-Breaking.** **International Business Machines Corp.** has opened its fifth and sixth retail-product centers selling office products, supplies, services and the new personal computer in Los Angeles and Beverly Hills, Calif. IBM has centers in Philadelphia, Baltimore, Washington, D.C., and San Francisco, and is planning others in Sunnyvale, Calif., Seattle and Chicago... **Commodore Business Machines Corp.**, which opened its 589,000-sq.-ft., \$5.25-million facility in Lansdale, Pa., last December, plans to put another \$15 million into



**Vector Graphic's new headquarters** in Thousand Oaks, Calif., is four times the size of the company's previous facility.

renovation and equipment for the new building. With a \$4-million loan from the Pennsylvania Industrial Development Authority, the expansion project will result in some 2000 new jobs over a three-year period... **Tandem Computers, Inc.** will construct a 140,000-sq.-ft. building in Cupertino, Calif., that the company says will house 400 employees in December. The 16th Tandem facility will contain product development, new product marketing and manufacturing operations... **Vector Graphic, Inc.**, has moved into its \$2.2-million 120,000-sq.-ft. headquarters in Thousand Oaks, Calif. Manufacturing will claim 60,000 sq.ft.

**Money talk.** **General Dynamics Communication Co.**, St. Louis, Mo., has acquired telecommunications equipment distributor Telephone Installation and Maintenance Co., which will become part of GDCC's field and operations group... **Shell Canada Ltd.** has purchased a majority interest in its affiliate, Silicon Valley office-automation-equipment company **Artelonics, Inc.**, making Artelonics a full subsidiary of the parent company... **Measurement Systems and Controls, Inc.**, a division of Systems Group, Orange, Calif., has announced a 20 percent price reduction on its DM6400 series of dynamic memory boards, resulting from increased demand. The DM6400 sells for \$660, the DM4800 is \$615, and the DM3200 is \$575.

**Randomly Speaking.** **Vector Graphic** has set up a dealer advisory council whose members will represent the company's retail, office-equipment and systems-house dealers. Among the topics under discussion are equipment and software evaluation, marketing feedback and customer-relations problems... **Systems Group** has increased speed 400 percent in its new implementation of CP/M. Systems' version uses 1024-byte sectors, increasing throughput speed as much as four times and using one-eighth the number of disk bytes needed for sector-ID information.

—Nancy Love



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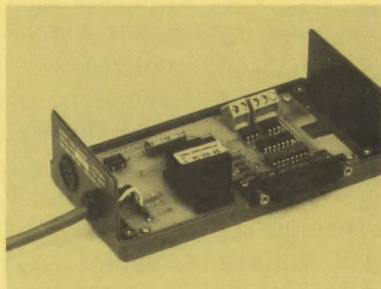
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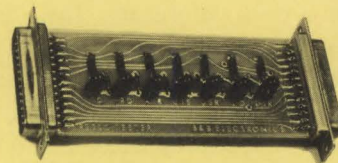


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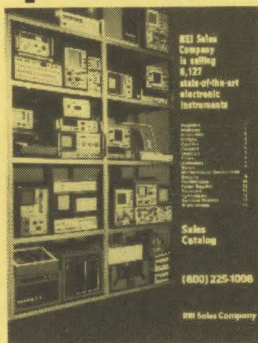
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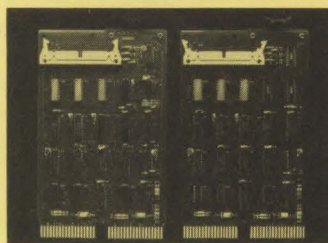


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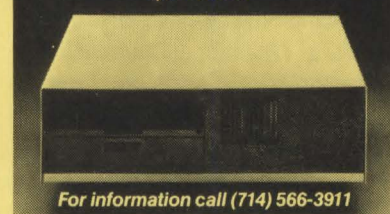
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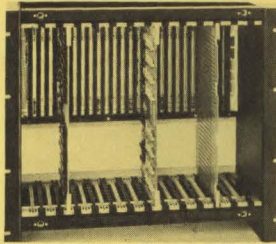
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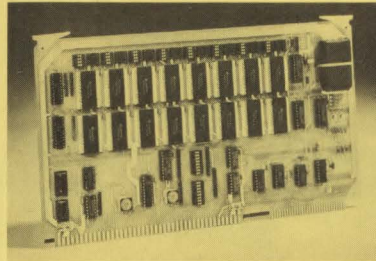


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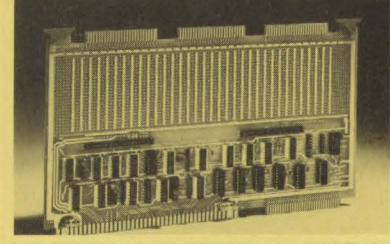
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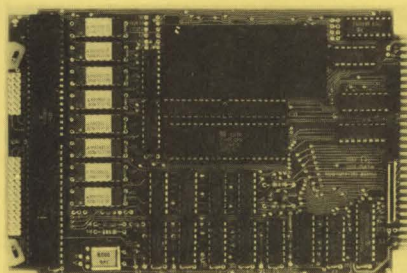
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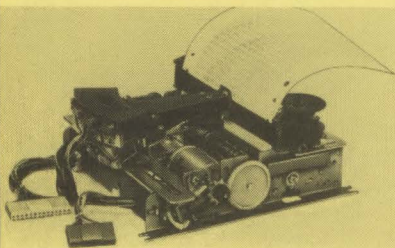
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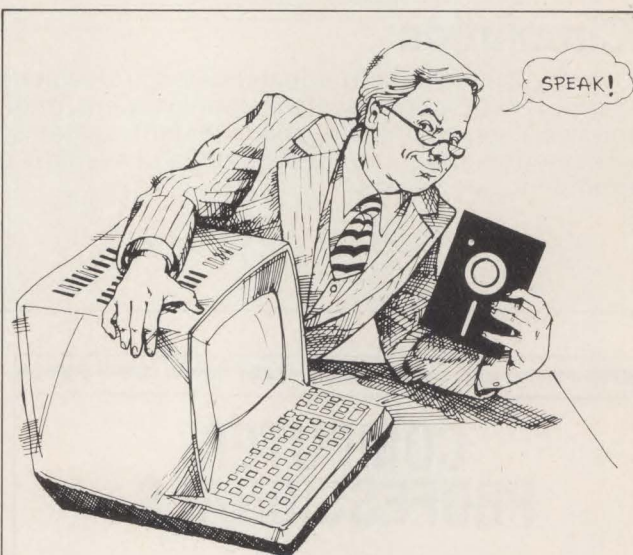
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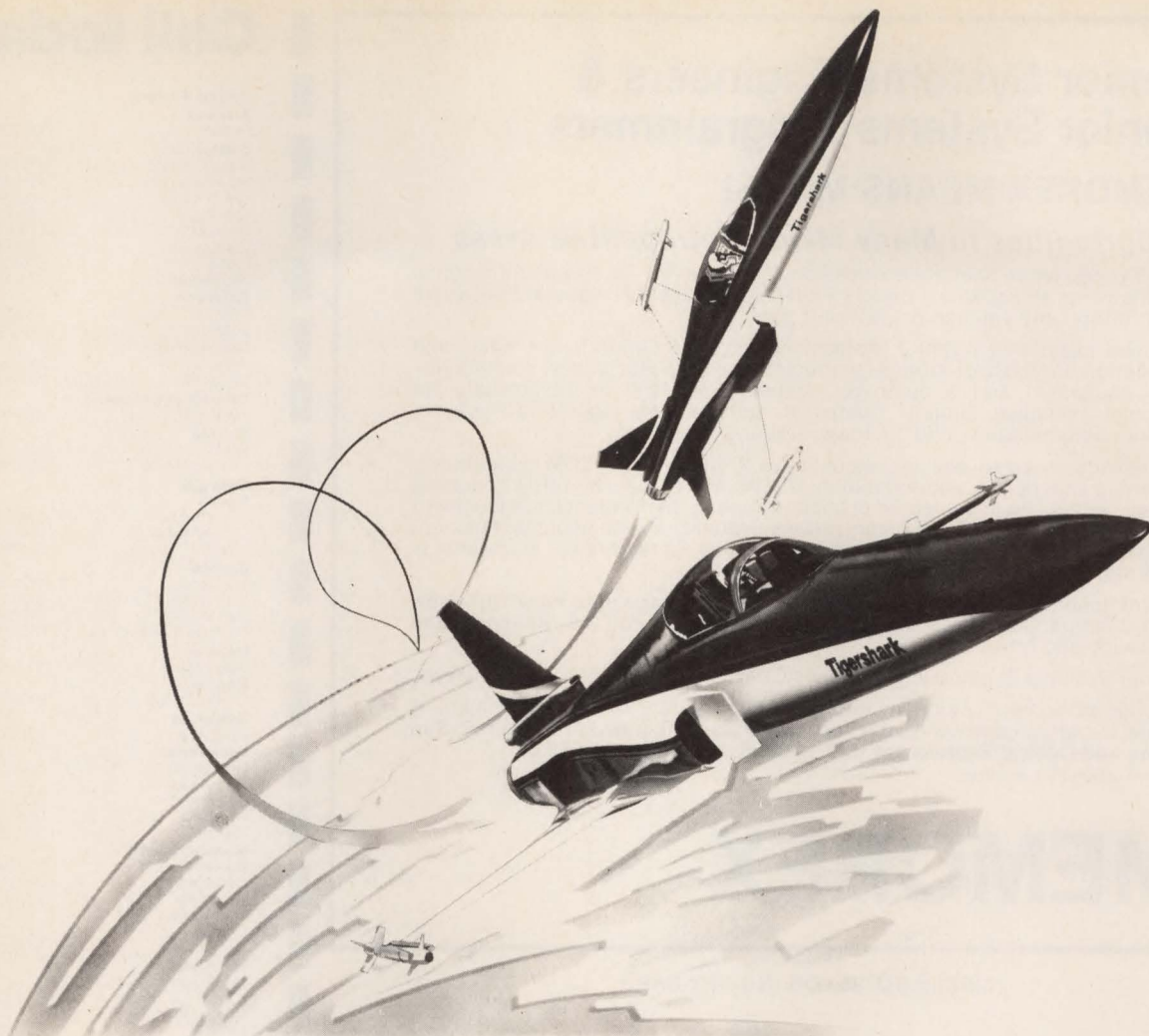
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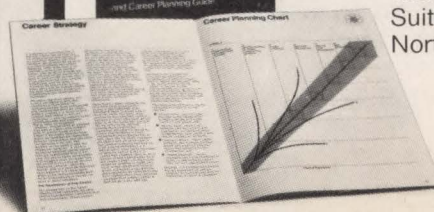
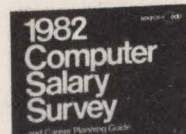
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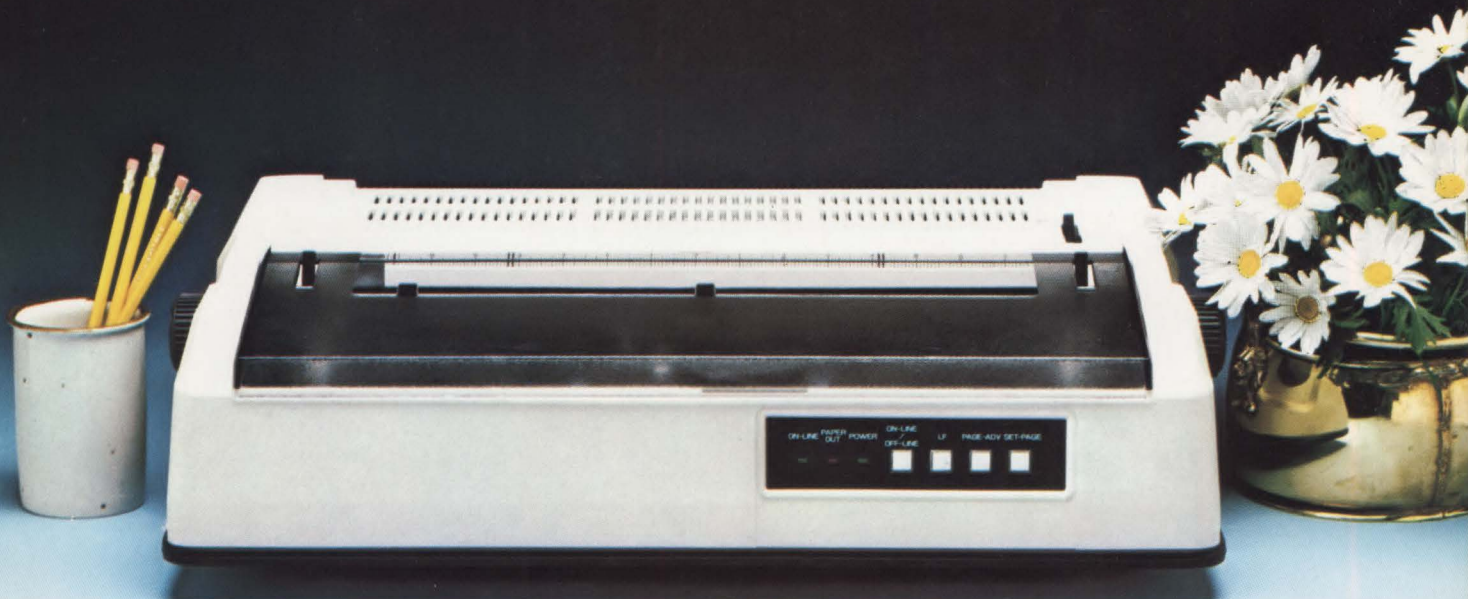
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