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DECEMBER 1985

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Minis gain on supers with vector processors

Electronic publishing lands on the desktop

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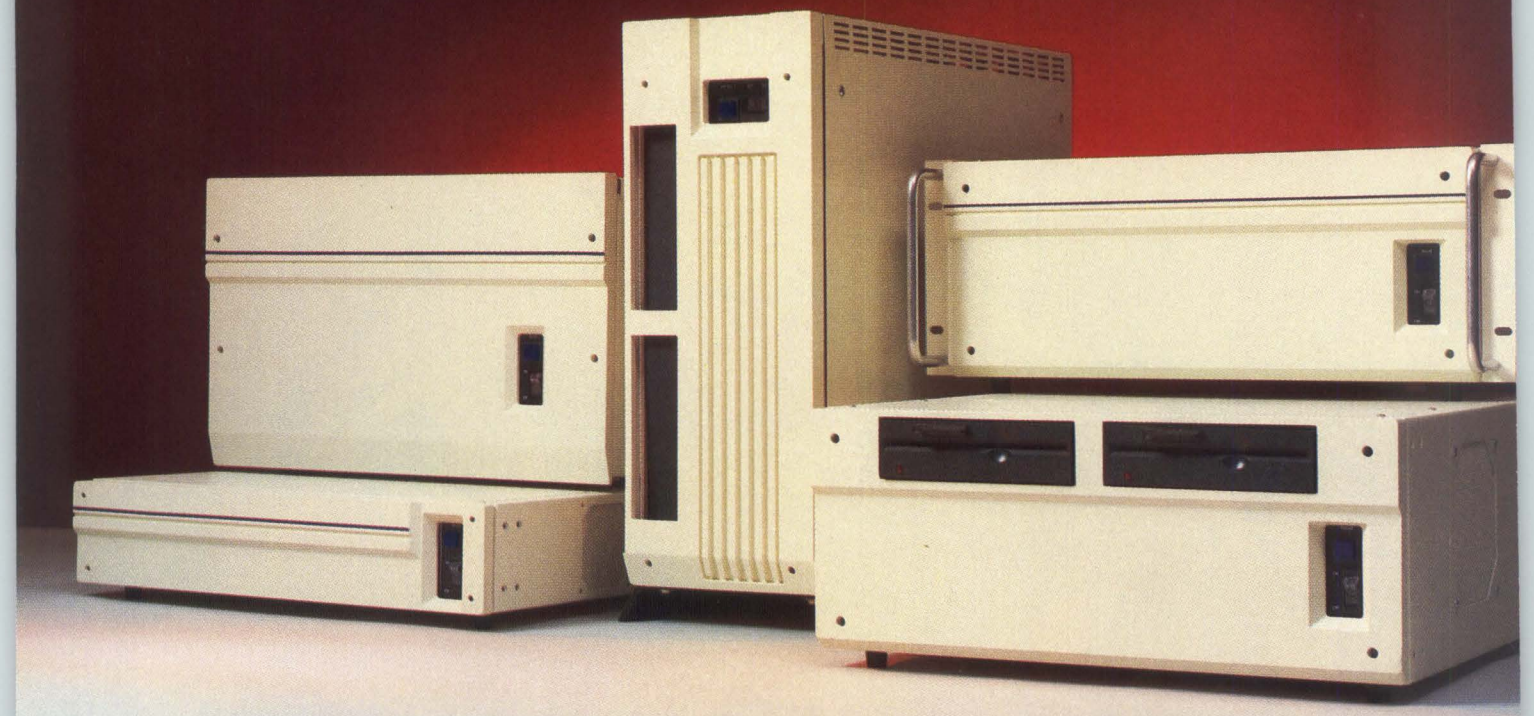

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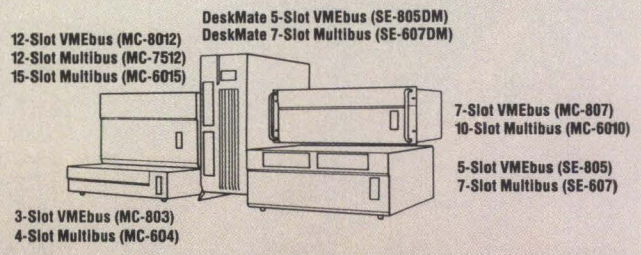

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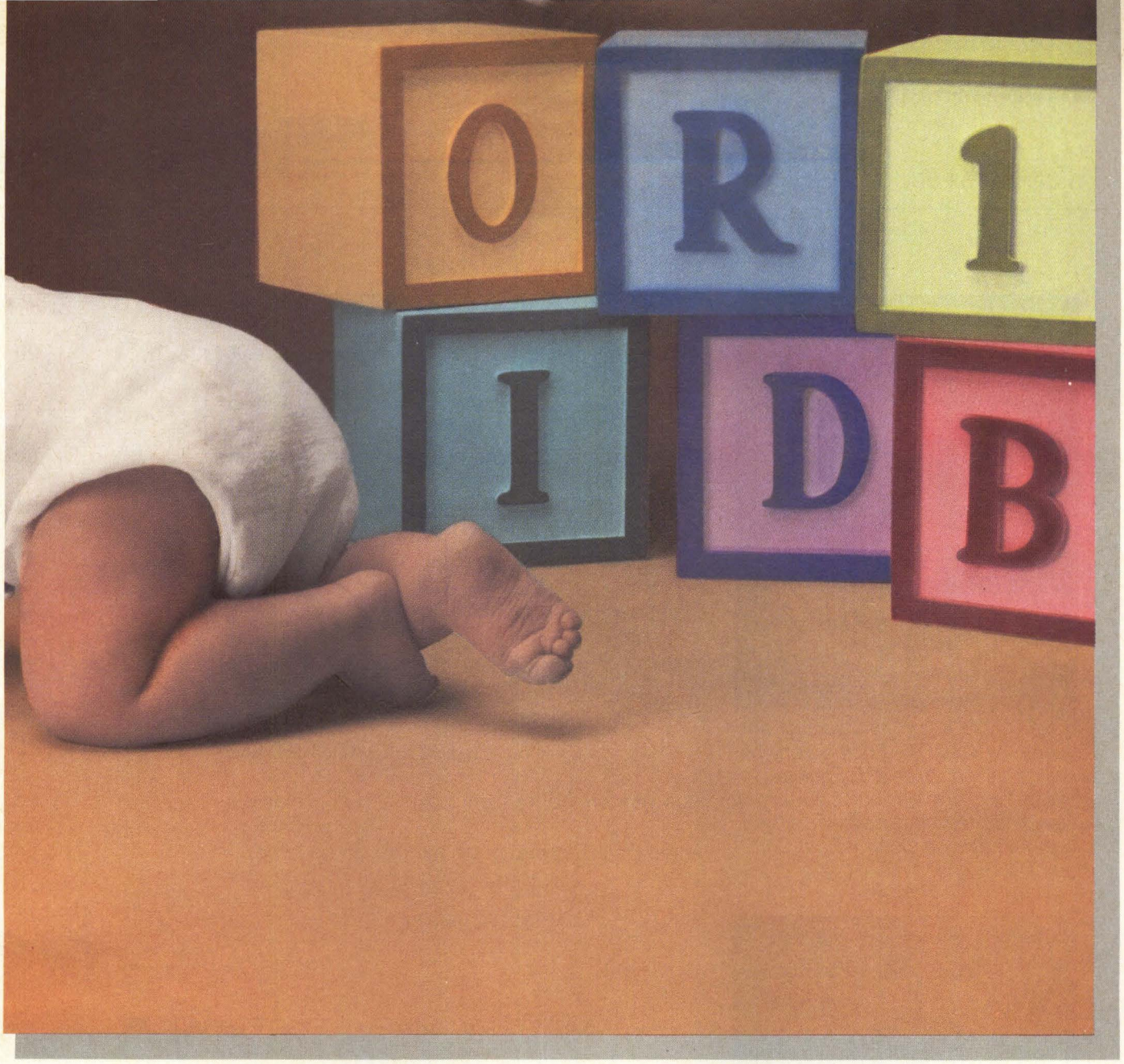

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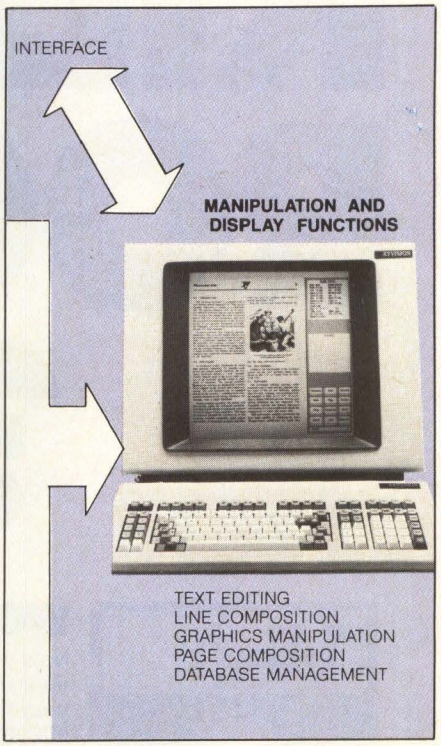

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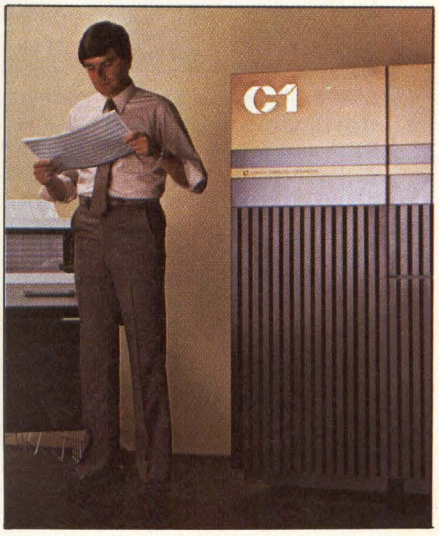

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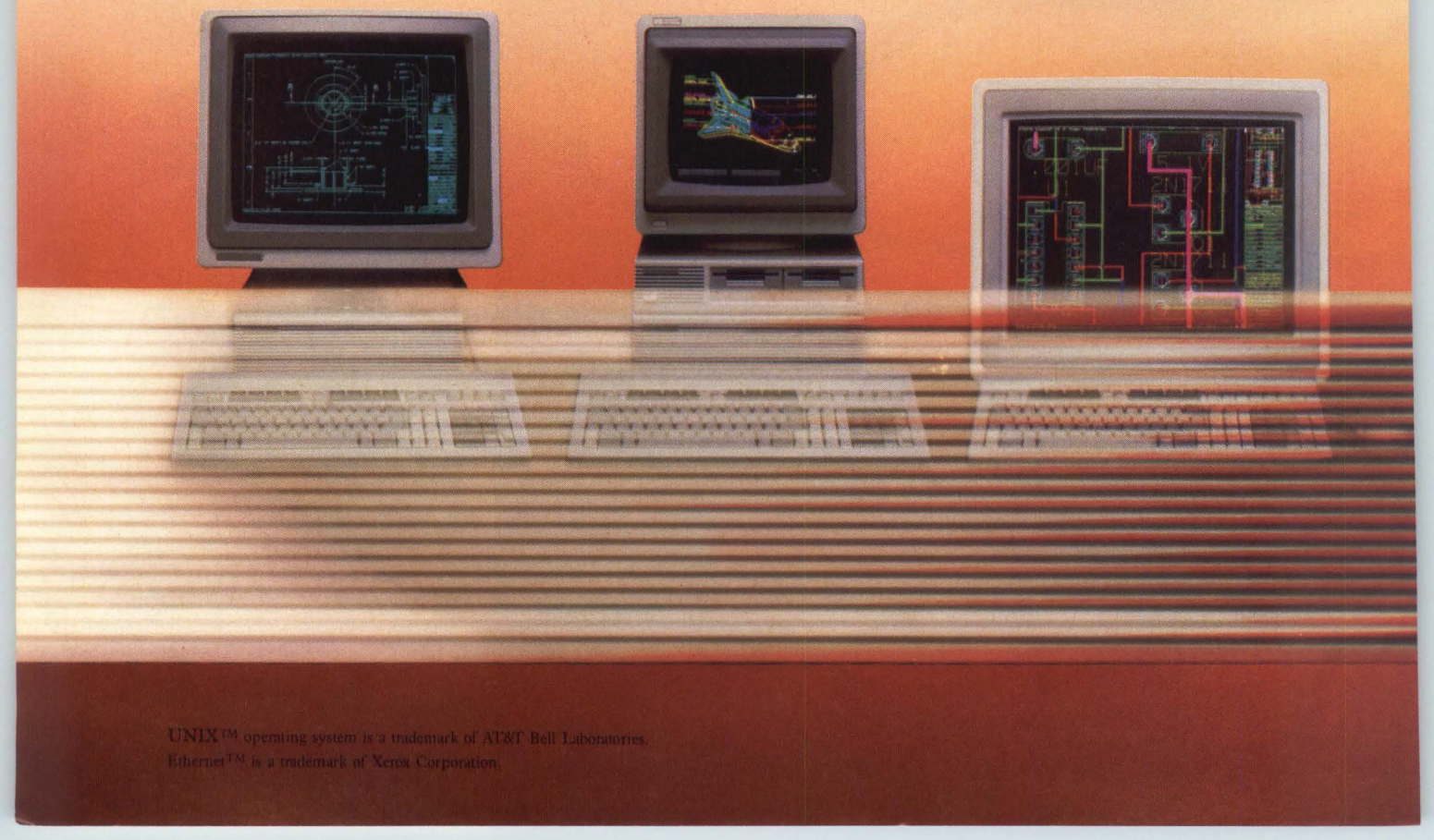

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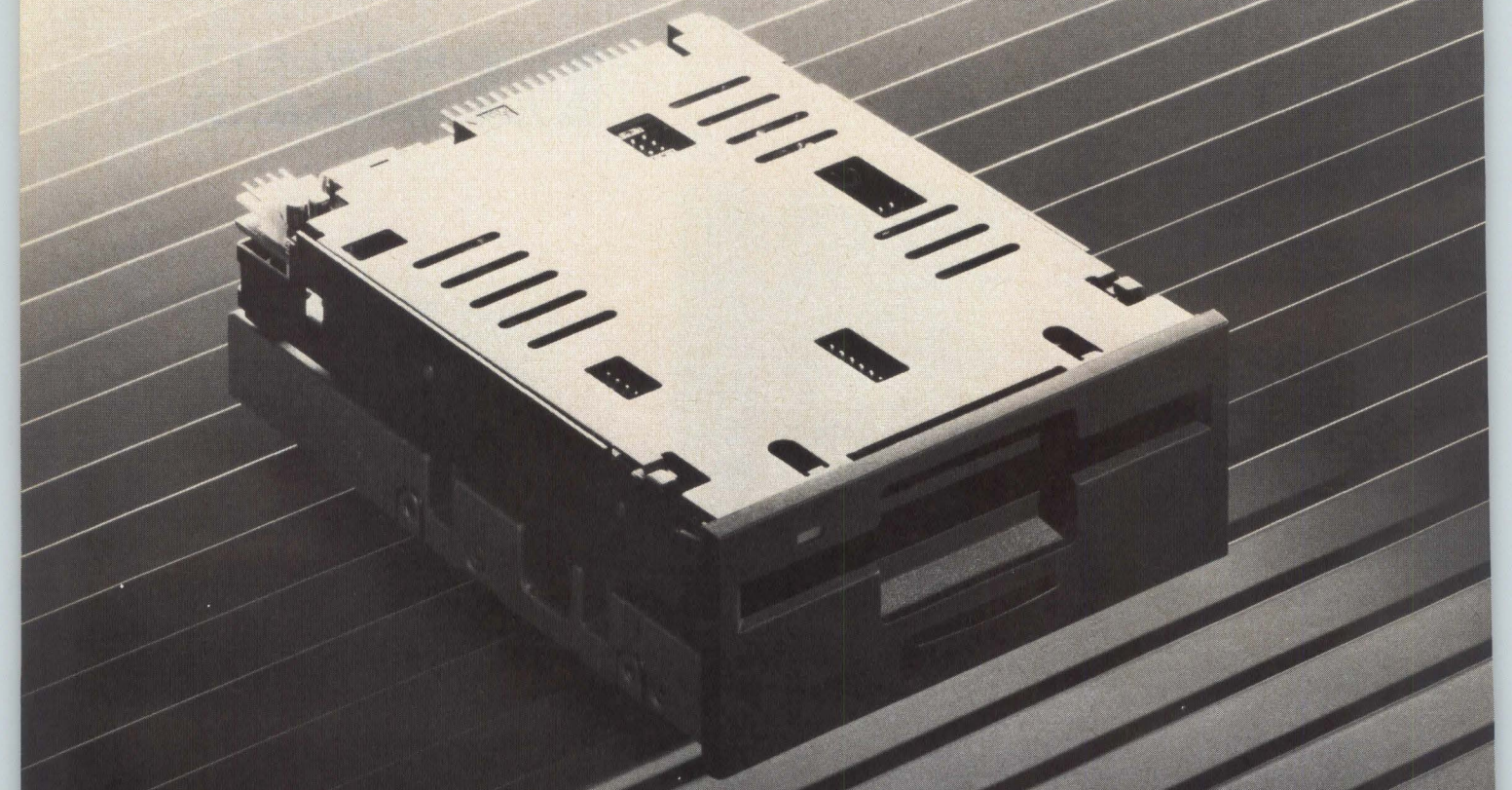

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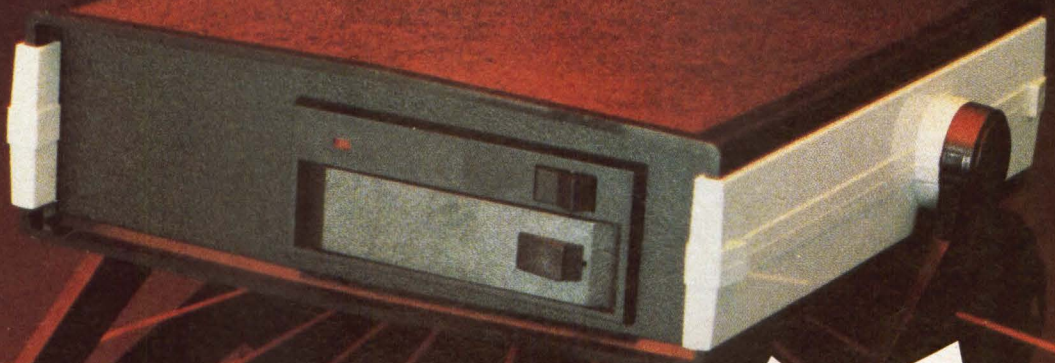

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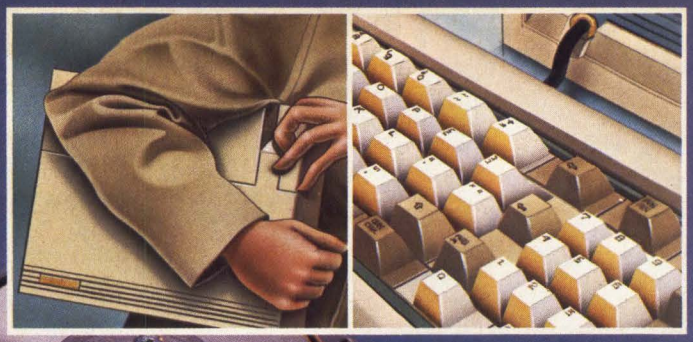

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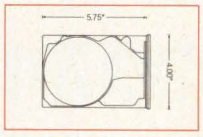

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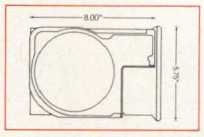

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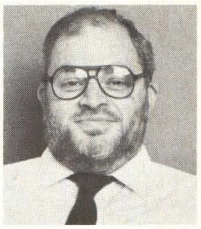

LOOK AT THE JAPANESE FROM THE CORNER OF YOUR EYE

There are stars that are so faint you can see them only out of the corner of your eye. When you look straight at one, it vanishes. Look at a piece of space beside the star, and it reappears. There is a physiological explanation for the phenomenon: We have more rods—the cells we use for light perception—at the periphery of our retinas. So, we see light better out of the corner of our eye.

It would be better for us if we looked at the Japanese out of the corner of our eye, too. The Japanese don't give off much light. On purpose. They believe in putting their light under a bushel. On a recent trip to Japan, I tried to look at the people out of the corner of my eye. And I think I may have figured something out.

More than anything else, the Japanese believe in control—of themselves, of their total environment. Example, street scene: we American computer people are in a bus stuck in a massive grid lock in Tokyo. Suddenly, just across the street, a woman leaps from her car, loudly berates her husband for being so stupid as to get stuck in traffic and flounces off. Our Japanese guide and the driver look at this scene in open-mouthed horror. Finally, the guide, surprise still in her voice, says, "It is unusual for a Japanese to make such a scene. She must be a Japanese-American."

She is not trying to be funny. To the Japanese, control is what sets them off from the rest of the world—from Americans in particular.

But there's a catch. The Japanese practice what psychologist Fred Rothman of Tufts University calls secondary control. Primary control is what John Wayne did to the Indians. Secondary control is what the Indians did with nature. It's going with the flow.

For example, Americans control their home market against imports directly, like John Wayne would, with tariffs, restrictions, agreements, rules. The Japanese do it indirectly by making distribution so complicated that no foreigner can figure it out.

The flap over trade restrictions with Japan is not an argument over controls. Nobody thinks Japan should surrender control of its borders. The argument is over the kind of controls her trading partners want her to use. We want Japan to use direct controls because we understand them and know how to live with them. We want Japan to drop indirect controls. They drive us crazy.

Do you see the problem? We're not asking the Japanese just to let in more imports. We're asking them to change their entire way of thinking about the business of imports. We're asking them to change something with roots deep in their souls.

Of course, we'll keep pushing and the Japanese will keep resisting, passively, with a smile, because that's the nature of secondary control. Nothing too bad will happen. There won't be a war. Neither side will break off diplomatic relations. The Japanese need the West, and we need the Japanese.

But you can count on this: It's going to continue to be much, much, much easier for you and your companies to buy computers and peripherals in Japan than it will be to sell them there. The Japanese trade imbalance—like death, taxes, communism and the Middle East —will not disappear in our lifetimes.

James F Donohue

James F. Donohue
Managing Editor

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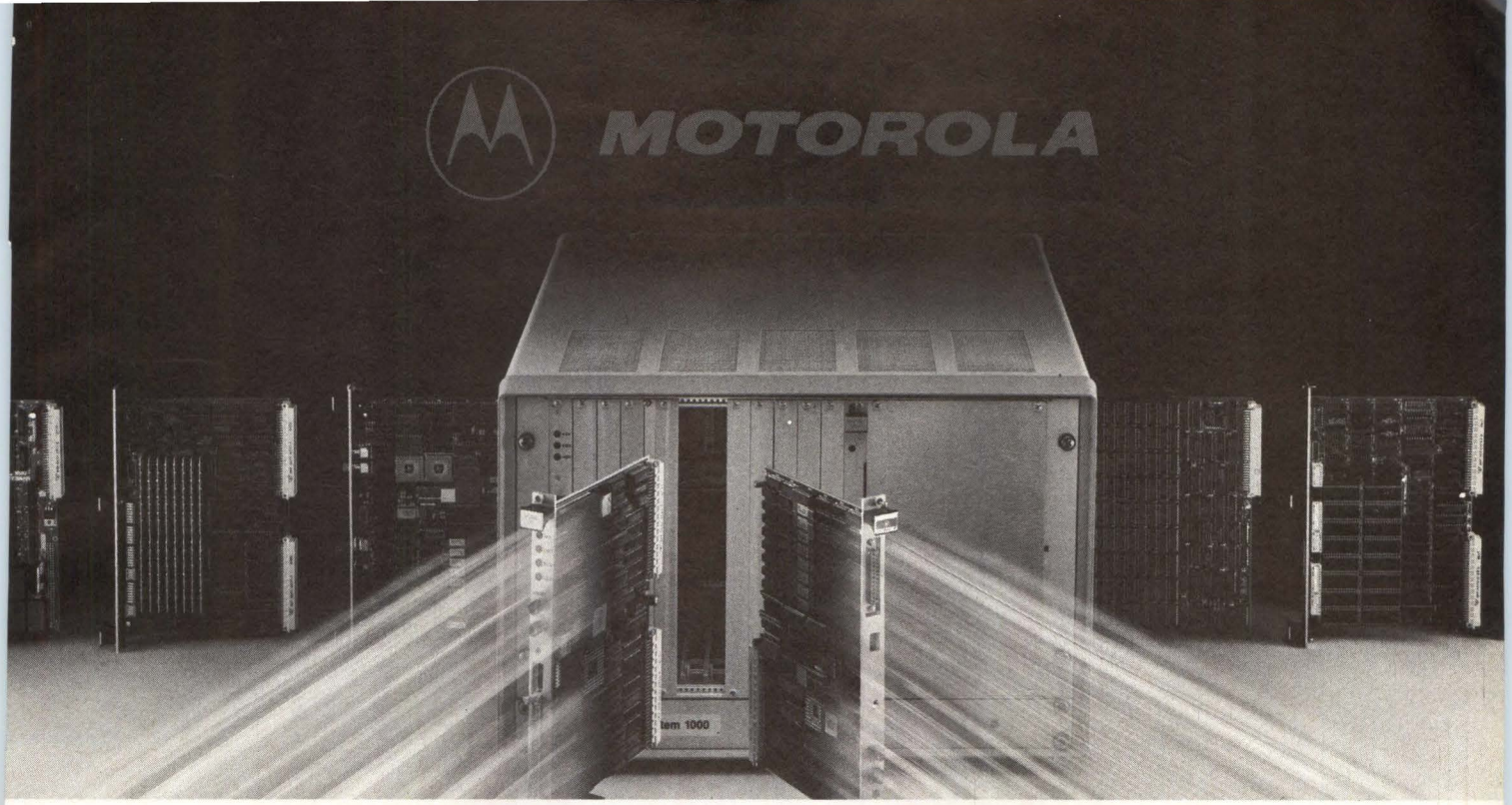

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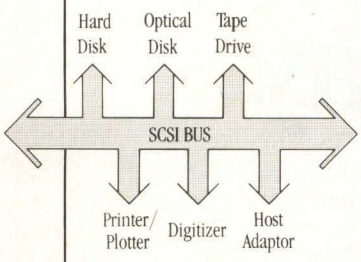

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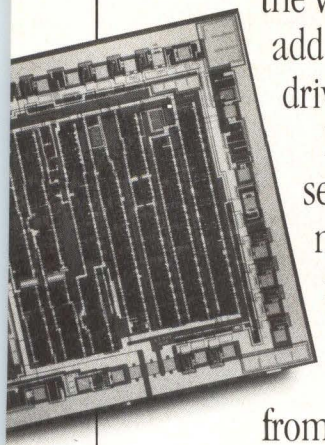

Either way, four MB per second transfer rates, combination commands that minimize host intervention, and a *Translate Address* command that switches from logical to physical address make our SCSI controller the highest performance, space-saving single-chip solution you've been looking for.

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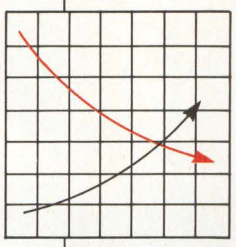

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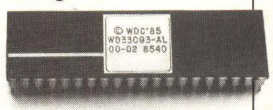

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Computers

CIRCLE NO. 13 ON INQUIRY CARD

BREAKPOINTS

THE MAP DOESN'T STOP AT AUTOFACT

Manufacturing Automation Protocol (MAP) and Technical and Office Protocol (TOP) activity is gaining momentum following MAP/TOP's demonstration at November's Autofact '85 in Detroit. Starting in March, a host of companies will begin the implementation of OSI Net, connecting MAP/TOP systems at various sites in the United States and abroad to test protocols and exchange messages and files. Those companies include Amdahl Corp., Boeing Computer Services Co., Charles River Data Systems Inc., Digital Equipment Corp., General Motors Corp., Hewlett-Packard Co., IBM Corp., ICL Plc., NCR Comten Inc., Olivetti SpA, Software Decisions Inc., Tandem Computers Inc. and Wang Laboratories Inc. The project will develop testing techniques for MAP/TOP products and demonstrate network capability on AT&T Communications' Accunet or Wang's WangPac X.25 packet-switching links.—*Jesse Victor*

REED-SOLOMON ERROR-CORRECTION CHIP COULD SET NEW STANDARD

One by-product of the work being done on the enhanced small device interface for optical write-once, read-many disks may be a new standard for error-correction codes. A chip that implements a Reed-Solomon code providing better than 10^{12} performance from media, with a raw error rate as low as 10^{4}, is expected shortly from a partnership of Data Systems Technology, Broomfield, Colo., and SMS/OMTI, Mountain View, Calif. The NG-8510 chip supports an interleave of three, each interleave with up to 669 bytes. Multiple chips can be ganged together to obtain more interleaves for block lengths greater than 2K bytes. —*Carl Warren*

AT&T PACT WITH VMARK PROMISES WIDER UNIX BASE

AT&T Information Systems has signed a reseller agreement with VMark Computer Inc., Natick, Mass., that ATTIS claims will increase the number of business-application software packages for UNIX-based computer systems from approximately 500 to potentially 3,000. Under the agreement, VMark will act as a master value-added reseller of ATTIS UNIX-based systems, including the UNIX PC and the 3B series. VMark will also supply UniVerse, an on-line database that supports applications developed for the PICK operating system. ATTIS says the agreement means PICK-based application software will now be able to run under UNIX.—*Stephen Shaw*

BUREAU OF STANDARDS EXAMINES OSI PROTOCOLS

The National Bureau of Standards (NBS) has established a research program to study the performance of open systems interconnection protocols. As part of the program, the NBS is compiling and maintaining a bibliography of papers and reports on the protocols. Researchers who submit relevant papers will be provided with an initial copy of the bibliography, along with periodic updates. Address research contributions to Kevin Mills, Manager of

Protocol Performance Laboratory, National Bureau of Standards, Room B217, Technology Building, Gaithersburg, Md. 20899.—*Bruce MacDonald*

GET READY FOR A NEW CAD/CAM GRAPHICS EXCHANGE STANDARD

If you're a computer aided design/computer aided manufacturing equipment vendor or user, take a look at what may be the successor to the ANSI-defined standard, Initial Graphics Exchange Specification. The International Standards Organization is now at work on STEP, the Standard for the Exchange of Product data, and ISO's Technical Committee, TC 184, has already published a 42-page initial-requirement definition of the standard. Jerry Weiff, the convenor of the STEP working group within TC 184, believes a draft international standard for STEP will be approved by the end of 1987, after which implementation by CAD/CAM system vendors can begin.—*Keith Jones*

CONTROL DATA'S HALF-HEIGHT WREN TAKES FLIGHT

Control Data Corp., Minneapolis, has begun shipping a half-height version of its Wren 5¼-inch drive to selected evaluation sites. The drive, dubbed the "Slim Envelope" Wren, has a formatted capacity of 51M bytes and a 28-msec access time. It uses an ST506/412 interface. Company officials were unwilling to disclose further details.—*Carl Warren*

UNDER-$2,000 VMEBUS GRAPHICS BOARD USES HITACHI CHIP

Basu Inc., San Jose, Calif., has broken the $2,000 barrier for VMEbus graphics boards. The low-end version of the company's newest boards, based on the Hitachi HD63484 CRT controller chip and loaded with 512K bytes of dual-ported memory, is $1,795. A version with 2M bytes of memory lists for $2,885. Basu is apparently one of the first board manufacturers to incorporate the Hitachi chip, which can be used to implement more than 120 firmware graphics commands.—*Mike Seither*

MICOM TIES PC/AT TO ETHERNET WITH PROCESSOR BOARD

Micom Systems Inc.'s NP600 Ethernet protocol processor board links IBM Corp.'s PC/AT to the Ethernet local area network. A single-board communications processor, the NP600 plugs into the PC/AT bus. When it is used with value-added software, says the Simi Valley, Calif., company, it allows PC/ATs to communicate with each other and with other devices on the network. Priced at $1,150, the NP600 comes with 128K bytes of memory and 16K bytes of electrically programmable ROM, expandable to 512K bytes and 64K bytes, respectively.—*Lynn Haber*

DATA GENERAL UNVEILS FAMILY OF HARDWARE, SOFTWARE

In one of its broadest product announcements to date, Data General Corp., Westboro, Mass., recently introduced the three-model Eclipse MV/20000 32-bit superminicomputer; the low-cost Eclipse MV/2000 DC 32-bit, single-board unit; and the DS/7500 and DS/7700 series of engineering workstations, based on the company's Eclipse MV architecture. Accompanying the machines are a distributed operating system that uses Ethernet, AOS/DVS and TEO, a common user interface that combines technical and office applications in one system. —*Bruce MacDonald*

The fastest Perkin-Elmer compatible disk controller you can buy.

Console configuration supports future SMDs without PROM changes.

Reads and writes P-E's IDC and MSM packs.

Install any size SMD drive without OS/32 software patches.

High speed formatting.

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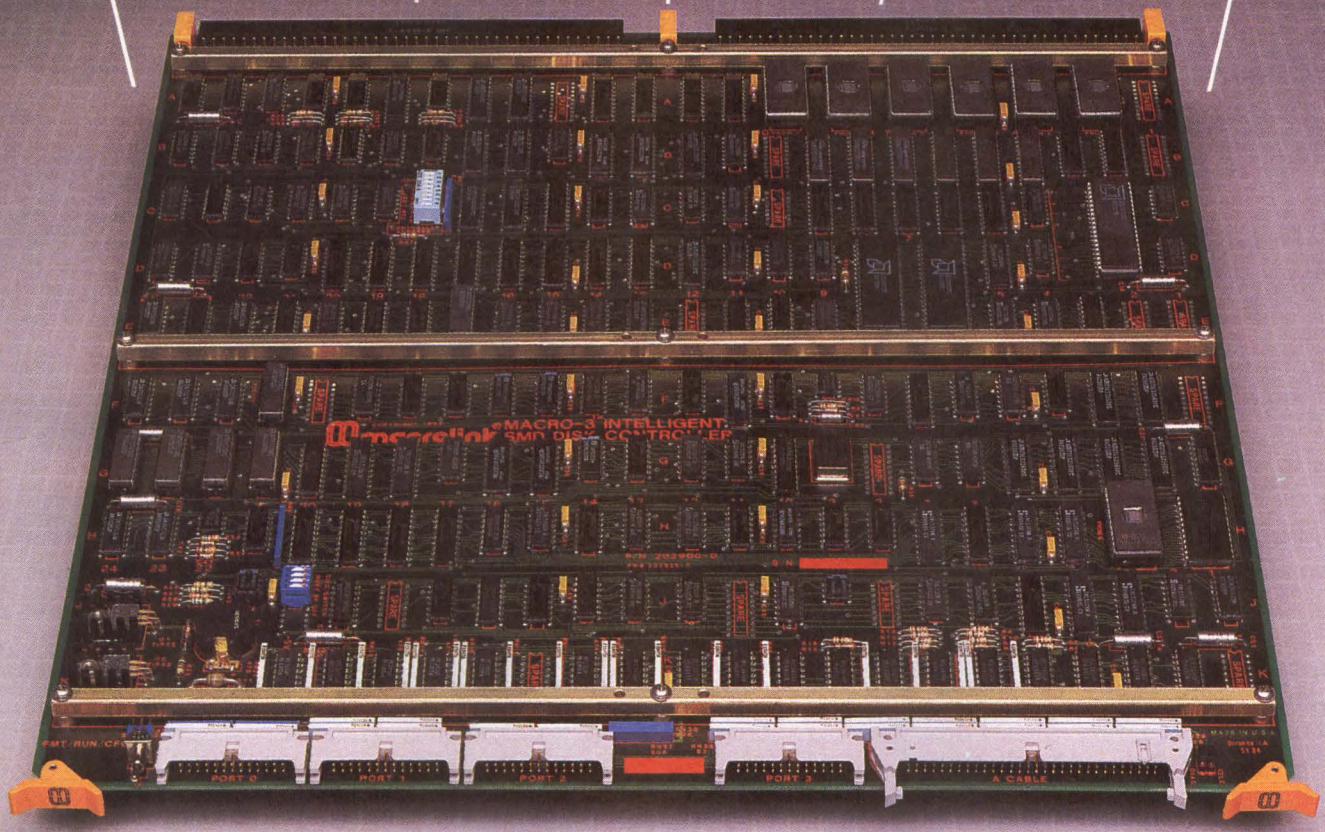

You're ready for the new generation of high performance SMD disk drives with the MACRO-3. High speed drives (over 2MB/Sec) are no problem. Only the MACRO-3 SMD controller offers full emulation of P-E disk systems, and supports advanced drives like the Eagle & CDC's FSD and XMD on any 3200 CPU. It can read both IDC and MSM packs at the same time, a feature that P-E just can't match. And it's /XELOS/proven.

MACRO-3 is shipped from stock with installation manual, cables and a one year warranty. Of course it comes with the high reliability, tested performance and attractive pricing you'd expect from Macrolink. After all, we invented the P-E emulating disk controller board.

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THE VT220 CONVERTIBLE

Ready for graphics when you are

The Facit A2000 Video Terminal is in all respects compatible with the VT220 concept.

But unlike a standard VT220 terminal, it can be easily converted into a very fast VT240 graphics terminal. Whenever you (and your software) are ready for it. Just plug a board into the terminal's cabinet. No extra box is required.

If you need the graphics immediately, you can have the A2000 already converted.

That's the version we call Facit G2000 – G for graphics.

Superfast Tektronix 4010 and DEC ReGIS graphics

The graphics board has two powerful on-board microprocessors which use highly advanced integral division for control of the graphics. The result is dramatically shorter drawing times. Furthermore the terminals emulate both the Tektronix 4010 (Plot 10) and DEC ReGIS command sets.

Besides the graphics features, there are also several other reasons for looking closer at the A2000 and G2000. In addition to the functions of a standard VT220 terminal, they have expanded set-up menus, extra status lines, operator programmable function keys and a compose key that doubles as escape key.

Nothing will impress you more than a "hands on" demonstration of the Facit A2000 and G2000.

The terminals are ready.

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FACIT

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TECHFILES: A QUICK LOOK AT NEW PRODUCTS AND TECHNOLOGY

Digital Equipment Corp., Maynard, Mass., has deepened its commitment to the emerging compact-disk ROM (CD-ROM) market with two readers, five databases and an Application Development Service. The desktop readers for the IBM Corp. PC, PC/XT and PC/AT and DEC's Rainbow 100 are priced less than $2,300. The databases, provided on DEC 600M-byte, 4.7-inch disks, include abstracts ranging from electrical engineering to environmental health and safety. The $1,150 to $1,195 annual subscriptions include quarterly updates and search-and-retrieval software. CD-ROM services available from the Application Development Service include database preparation, disk production, conversion programming and training.—*Jesse Victor*

Look for a reduced instruction set computer from **Point 4 Data Corp.** before the year-end. The superminicomputer from the Irvine, Calif., company will use a pipelined architecture, a 16-bit proprietary CPU and a 32-bit VME memory bus to achieve a maximum speed of 15 million instructions per second. An 84M-byte Winchester disk drive and 20M-byte streaming-tape drive will be standard on the eight- to 128-user machine. Prices range from $42,000 to $99,000.—*Mike Seither*

Keep your eye on the continuing battle between **Motorola Inc.** and **Intel Corp.,** both of which will introduce Manufacturing Automation Protocol (MAP) products that implement all seven layers of the MAP 2.1 protocol. Motorola's 10M-bit-per-second (bps), MC68020-based MVME372 Advanced Network Interface board has 640K bytes of RAM, runs MicroMAP software and utilizes the new MC68824 token bus controller chip. The VMEbus board, with an associated modem board, will be available in July 1986. Intel's new MAP-NET software/iSXM 554 MAP board combination for the Multibus, which also implements all seven MAP layers, will debut in April. Motorola has already gone head-to-head with Intel's iSXM 554 MAP board with a two-board set that, like the iSXM 554, implements the first four MAP layers. The Motorola MVME370SET comprises an Intel-80186-based controller board with VMEbus interface and 128K bytes of RAM, software in UNIX System V format and a 10M-bps modem board.—*Jesse Victor*

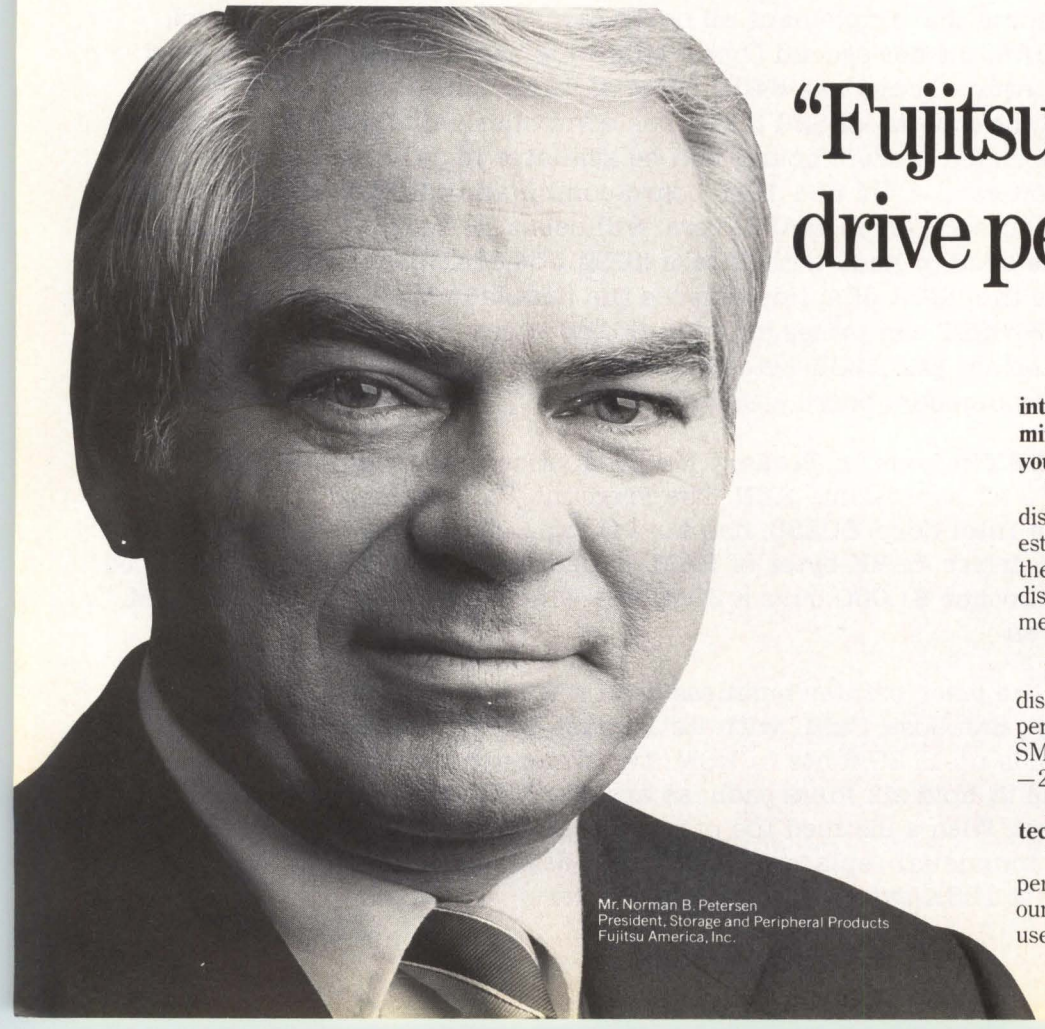
COMDEX/FALL '85 POST DATE: Look in January for production models of **Apricot Inc.'s** IBM Corp. PC/AT-compatible XEN. The Fremont, Calif., company's machine is based on the Intel Corp. 80286, has six I/O expansion slots, two 3½-inch flexible disk drives, 512K bytes of RAM, supports up to 16 users and is priced at $3,500. Another $1,000 buys a 20M-byte Winchester and 1M byte of RAM. —*Carl Warren*

Entering the laser printer business with a Hitachi America Ltd. engine is **Qume Corp.,** San Jose, Calif., with its 10 page-per-minute Laser 10. The machine holds up to 20 fonts in ROM; two fonts are resident. ROM cartridges are available to hold six fonts each, as are blank ROMs for downloading fonts from the host. With a claimed life of more than 300,000 pages, the Laser 10 also allows individual replacement of toner, developer and drum. The price is $2,799 with a 128K-byte buffer.—*Mike Seither*

Zilog Inc. has befriended AT&T Technologies Systems' WE32100 32-bit microprocessor. The CPU serves as the backbone of Zilog's new System 8000/32 family of multiuser computers. The model 110, to be priced at about $22,000, can handle up to 25 users and comes with 256M bytes of rigid disk storage. Model 130, a 58-user system with up to 1.3G bytes of storage, will be priced about $30,000. Both will run on UNIX Version 2. Zilog, of Campbell, Calif., plans to ship the units in March or April.—*Mike Seither*

New high-capacity, 5¼-inch Winchester disk drives from **Priam Corp.,** San Jose, Calif., include the 172M-byte model 617 and the 234M-byte model 623. Both have access times of 18 msec and use the enhanced small device interface. Prices are $1,495 and $1,795, respectively, in OEM quantities of 2,500. Priam also introduced its model 725, a 254.9M-byte unit with the small computer systems interface. The eight-platter drive has an average access time of 20 msec. Pricing is not available.—*Mike Seither*

JDL Inc., Westlake Village, Calif., is pitting its color dot-matrix printer against plotters for a share of the engineering market. The company has modified its JDL-750 printer to produce C-sized drawings (17 inches by 22 inches). By adding drivers for AutoCAD and DASH, two widely used computer



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"Fujitsu has done it drive performance,

Put these new 10½" and 8" Fujitsu drives into your existing design, and with only minor changes you'll significantly increase your system's performance and capacity.

With the introduction of the 10½" Eagle disk drive three years ago, Fujitsu established a new performance standard for the industry. The Eagle quickly became the disk drive against which others were measured. In both performance *and* quality.

And now we've done it again.

We've expanded both our 10½" and 8" disk drive lines with two new maximum-performance models. They set a high-speed SMD (HSMD) standard for data transfer —2.4 Megabytes per second!

And it's done using RLL encoding technology.

That means you get this new level of performance without sacrificing one bit of our world-proven reliability. These drives use the same basic head, media and

aided engineering programs, the JDL-750, priced at $1,850, can print color circuit-board designs, schematics and mechanical drawings.—*Mike Seither*

NOTES FROM OVERSEAS: Early 1986 should see U.S. availability of two new ink-jet printers from **Siemens AG,** Munich. The PT 88S and PT 89S are said to offer faster drying ink, a quieter paper-movement mechanism and higher speeds than Seimens' PT 88 and PT 89, as well as near-letter-quality (NLQ) printing and subscript and superscript characters. Speed ranges from 200 characters per second (cps) to 340 cps in draft mode, and 66 cps to 114 cps in NLQ. End-user prices are about $1,000 for the 80-column PT 88S and about $1,200 for the 132-column PT 89S.—*Keith Jones*

Another European entrant to the U.S. computer field "sometime in 1986" will be **Thomson Semiconducteurs,** Grenoble, France, with its new range of VMEbus boards. Thomson is aiming for a 10 percent share of the worldwide VME board market by 1989—a market which the company thinks will be worth $700 million annually by then. Look for four CPU boards based on Motorola Inc.'s MC68000 and MC68010 microprocessors, three memory boards and a variety of communications controllers, including one that supports X.25.—*Keith Jones*

again. We've set another standard in disk with a new, high-speed SMD interface."

actuator technology as our previous designs. Plus the same SMD interface.

Both models offer expanded storage capacity as well. The new M2361 Eagle provides 689 Megabytes and the new M2333 8" drive has 336 Megabytes. And you can stack four of the 8" units in a standard 19" rack, providing 1.3 Gigabytes of storage in the space of one 14" drive.

Both units offer fast access (18 and 20 milliseconds, respectively). Both use the same track capacity and controller. And both offer Fujitsu's field-proven quality, backed by a 20,000-hour MTBF specification.

And to top it all off, they offer you the lowest cost of ownership.

For more information or to arrange for evaluation units on the new 8" or Eagle disk drive, call (408) 946-8777 or write Fujitsu America, Inc., Storage Products Division, 3055 Orchard Drive, San Jose, CA 95134

Fujitsu Storage Products. Maximum Performance. Maximum Quality.

The M2361 10½" Eagle Disk Drive—689 MB

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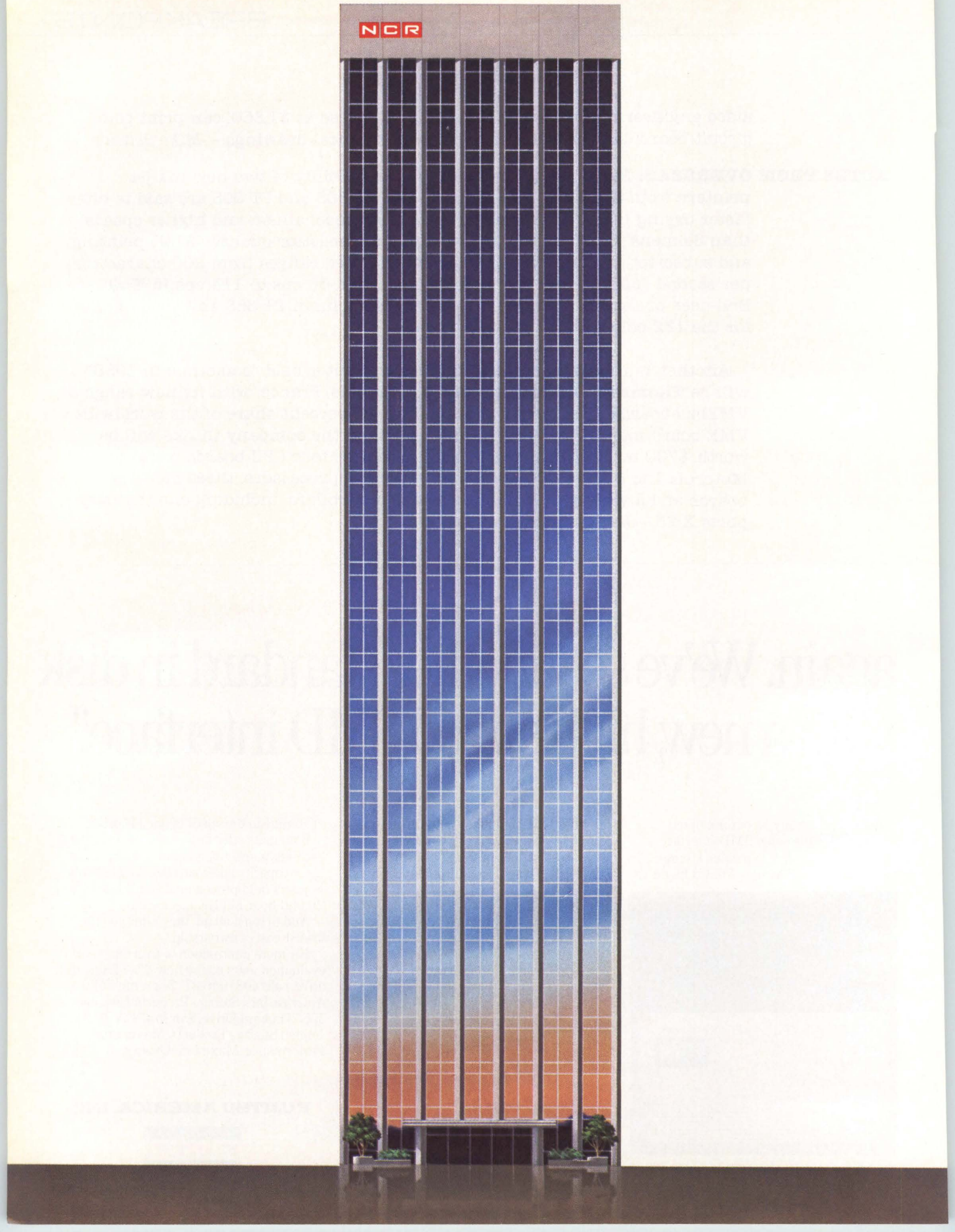
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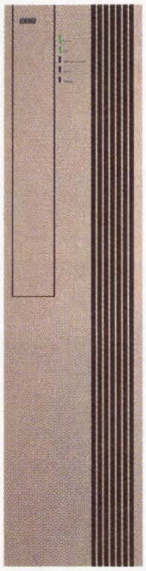

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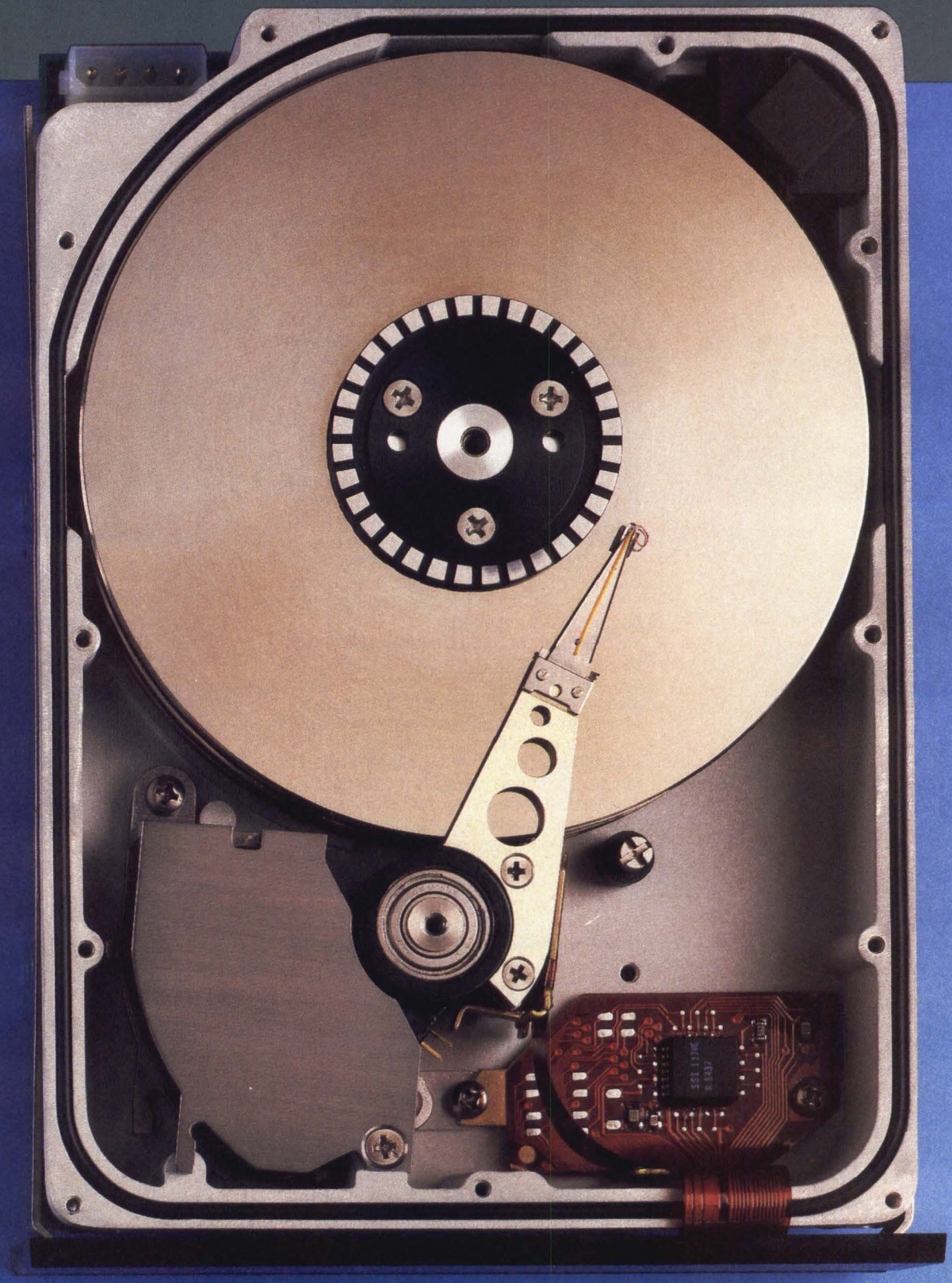

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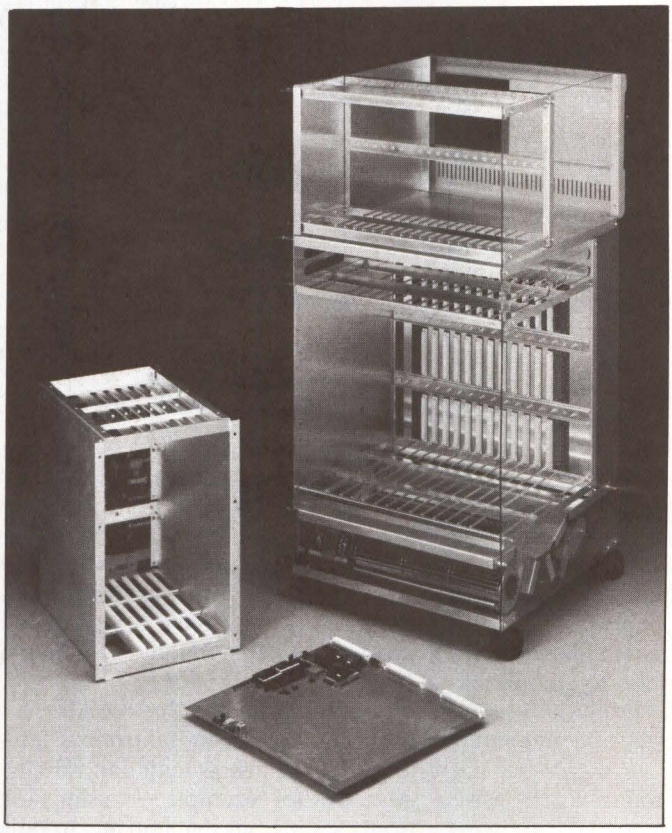
Tektronix places its bets on computer-based testing

Mike Seither
Associate Western Editor



Tektronix hopes its new instruments *on cards (foreground), which will be housed in VMEbus- based card cages (rear), will offer system builders an alternative to traditional IEEE-488 rack-and-stack instrumentation.*

The time has come for a new generation of test and measurement equipment, according to Tektronix Inc. And what's the shape of things to come? "Computer-based instrumentation (CBI)," proclaims the Beaverton, Ore., company.

That's the name Tektronix has given to its new, closely coupled system of intelligent instrument boards that are built around the VMEbus. In an attempt to establish a new industry standard, Tektronix is encouraging other manufacturers to produce their own board-level instruments around the open architecture of CBI. Company officials claim that, compared with instrument clusters tied together with the IEEE-488 bus, CBI significantly cuts software development costs and increases performance at least tenfold.

The IEEE-488 bus, known also as the GPIB (general-purpose instrument bus) or the HPIB (Hewlett-Packard instrument bus, after Tektronix's prime competitor that pioneered the standard), is the dominant way to connect individual "rack-and-stack" instruments for use in design, test and service.

Prime Data, a San Jose, Calif., market research concern, estimates that last year's worldwide instrument sales of $6.66 billion will nearly double by 1990. Tektronix is wagering that its new CBI architecture will grab a good part of that growth.

Arnold Frisch, manager of the Tektronix strategic unit that brought CBI to market, concedes that the IEEE-488 bus will still be the leading interface between computers and instruments through the beginning of the next decade. "But alternatives [like CBI] will grow at the expense of GPIB in some markets," Frisch says.

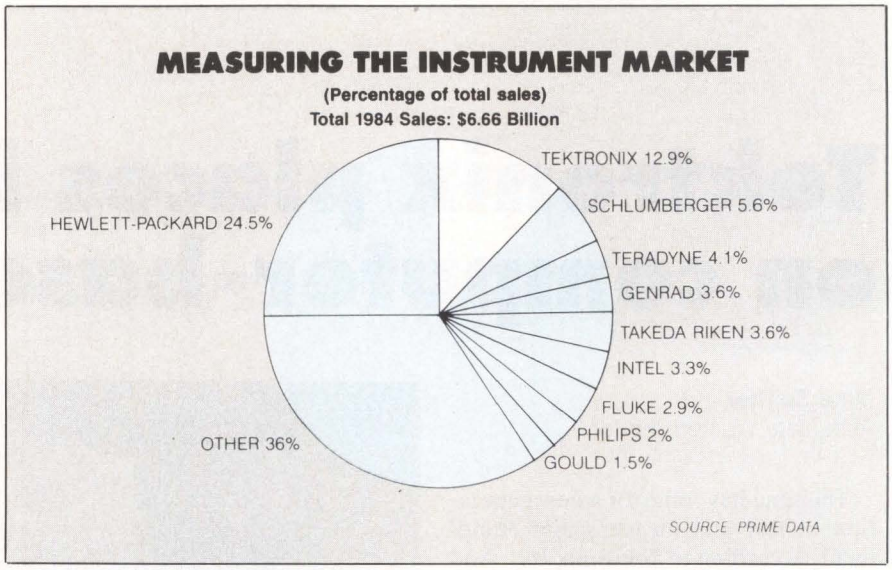
Predicts military support

Tektronix expects CBI to receive immediate support from prime contractors building military test equipment. Frisch says that two major aviation test-equipment programs for the Air Force and Navy have gone to contractors who have opted for computer-based instrumentation instead of GPIB systems. The reason is dissatisfaction with GPIB on the part of the Department of Defense, says Frisch. "It's at the point now where the cost of GPIB test-equipment support is larger than the cost of some of the weapon systems themselves," he says. "That's unacceptable."

What's the problem with GPIB? The complex programming that's required when a new instrument is added to the system, says Gary Gallager of Hughes Aircraft Co. Gallager is head of microprocessor programming at Hughes' ground systems group in Fullerton, Calif.

Under GPIB systems, similar instruments from a single manufacturer may

often have radically different command sets. That requires extensive low-level software to be written for each instrument, he says. In the life cycle of a major weapons system, Gallager adds, newer and better instruments replace older ones, adding to the programming headache. The result is that software can account for more than half the cost of a contract for an automated test-equipment system.



GPIB called sluggish

Another problem with GPIB, says Galen Wampler, president of Prime Data, is the relatively slow speed of the bus: The fastest GPIB can run is 1M byte per second. "In fact, a good implementation will run at about 300K bytes per second," says Wampler. The slowdown stems from overhead caused by so much protocol traffic on GPIB's 8-bit bus. By comparison, the 32-bit VMEbus can transfer data at 10M bytes per second. Says Wampler, "Bus speed is a very real issue for people who want to run instruments concurrently in real time."

Tektronix is offering two basic products in its CBI line. One, the Delta series, is a turnkey system to verify functions and timing in VLSI chips. That system, to be priced less than $100,000, is targeted at department-level design engineers, to whom Tektronix believes the responsibility for testing application-specific integrated circuits is shifting.

A second CBI product line consists of off-the-shelf components, or what Tektronix calls "building blocks"—backplanes, cabinets, power supplies and card cages. Other standard hardware includes a single-board control processor based on the Motorola Inc. MC68010 CPU and various communications interfaces, such as Ethernet, RS232 and IEEE-488.

In all, the Tektronix CBI system can hold up to a dozen instrument cards. Each card has built-in intelligence by way of an on-board 68010 processor. Also available is a trigger time-base controller that uses a 50-MHz bus to sequence and synchronize tests among different instruments that require precise timing. Tektronix claims the trigger time-base controller, priced under $5,000, can coordinate events within 100 picoseconds.

Three initial cards offered

Tektronix has made available for evaluation three instrument cards: a digitizer ($20,000), an arbitrary waveform generator ($15,000) and a pattern generator-word recognizer ($25,000). All three come with the Delta series. Full production for the components is expected to begin in the second half of 1986.

So far, a number of OEMs have taken an interest in Tektronix's latest approach to instrumentation. Hughes Aircraft, for example, is using Tektronix's VMEbus components to build a portable analog system to test boards for the military. Says Bob Krogman, marketing manager for the program, "We chose Tek's VMEbus in order to reduce what would normally be a rack-and-stack system. That was the primary goal."

Krogman says Hughes also was attracted by the difference in speed between GPIB and the VMEbus and by Tektronix's commitment to an open architecture. "When other manufacturers begin making instruments for the same [VME]bus, that will give us flexibility that we really don't have with the IEEE-488," says Krogman.

One instrument manufacturer that plans to ride Tektronix's coattails is Colorado Data Systems (CDS), which builds production test equipment. Louis Klahn, marketing manager for the Englewood, Colo., company, says, "From our point of view, we don't care whether our instruments run on the VMEbus, the Multibus or the Swahili bus. If the IEEE-488 performed up to its 1M bytes, it would be OK. The point is, a major player in this business has decided on a standard and opened up the architecture. No one will have to license this architecture like they had to in the early days of HPIB."

Klahn says his company is developing an optimized VMEbus interface under the Tektronix architecture that will allow CDS to attach its own set of instrumentation to the system.

Despite the praise Tektronix has received for its new approach to instrumentation, no one in the industry is yet ready to play taps for the IEEE-488. In fact, says Gallager of Hughes, an IEEE committee (P981) is developing a new software standard that defines a common protocol for message exchanges among different instruments on the bus. Gallager says that, although some committee members believe the future of GPIB is limited, the bus will be around for a while. "It's so embedded in test systems that I'd be surprised to see its demise within the next decade," Gallager says. □

Has binary compatibility come to UNIX?

Michael Tucker, Associate Editor

Some UNIX applications may be about to get a shot of binary compatibility. Certain experts are saying that UNIX ports to the Intel Corp. 32-bit 80286 and 80386 chips, and their use in the popular IBM Corp. PC/AT may rewrite the rules for UNIX.

The UNIX market has long suffered from the fact that not only is UNIX, itself, divided into competing variants but even those individual variants sometimes perform differently from processor to processor. Where, for example, software based on MS-DOS from Microsoft Corp., Bellevue, Wash., could generally be expected to run on any MS-DOS- or PC-DOS-compatible machine, UNIX lacked this "binary compatiblity." An application designed to run under UNIX System V on a machine from one vendor might or might not (indeed, almost certainly wouldn't) work on another vendor's machine even though it too ran on UNIX System V.

That could now change, at least on desktop UNIX machines, because of the microprocessor chips from Intel of Santa Clara, Calif. Unlike similar chips, these have their memory management unit (MMU) located on the chip itself. "A computer designer would tell you that's not particularly smart," notes Charles Hickey, president of porting house Microport Systems, Soquel, Calif., "but for UNIX, it solved a particular problem. A [software application] developer can assume that MMU will never change. That means you can get binary compatability. You could take a binary application off one 286-based machine, like an AT&T [Information Systems] 6300, and run it on another, say an IBM PC/AT."

Not everyone is so hopeful. Jim Isaak, director of product marketing for Charles River Data Systems, Cambridge, Mass., and chairman of the IEEE P10003 operating systems committee, strongly disagrees: "That's a half-truth. The 286 has been no end of frustration to the UNIX community. It is simply nasty.

"Let's say we all agree to use it. The MMU affects you just a little bit. What does affect you a lot is the method you use to get into the operating system. The 386 doesn't limit the way you do that...so you could easily lose binary compatability that way."

Still, the 80286 and 80386 are bound to have a lasting effect on what UNIX is, and what it's used for, for the simple reason that they are the chips selected for the PC/AT, its compatibles and its most ambitious rival, the AT&T 6300 Plus. Douglas Michels, vice president of XENIX's second source, the Santa Cruz Organization, Santa Cruz, Calif., is confident enough of the chip to say, "My personal view is that the Intel-family XENIXes are going to dominate the UNIX world very fast. Clearly, in the one-to-eight-user market, you're going to see the 286 pretty well run the market. If you're an applications developer for the small multiuser market, and you're not writing XENIX applications, you're not going to be in business in a year." □

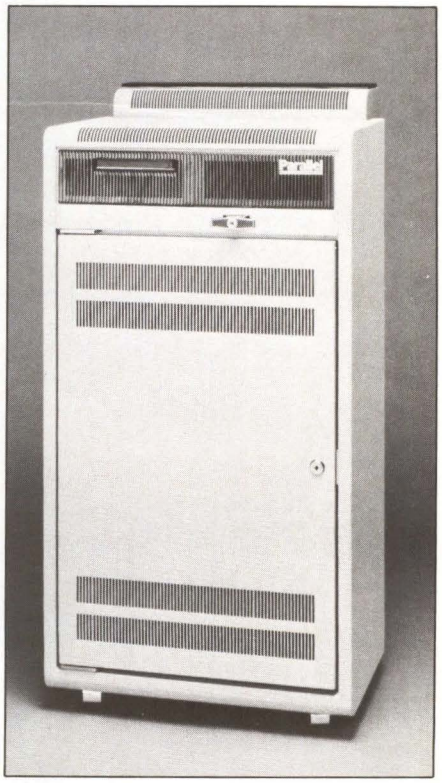
Fault-tolerant computing tries to get less expensive

Lynn Haber, Associate Editor

The image of fault-tolerant computing has fallen. The handful of start-up companies—which analysts say have been bankrolled by venture capitalists at $150 million to $250 million over the past few years—have largely failed in their promise of low-cost products. Still, the niche remains for continuous-processing systems for under $100,000. Which companies are prepared to deliver the goods? According to industry analysts, such systems are most likely to come from the fault-tolerant computer manufacturing leaders, Tandem Computers Inc., Cupertino, Calif., and Stratus Computer Inc., Marlboro, Mass.

Peter Lowber, director of information systems with the market research company the Yankee Group, Boston, contends that opportunities for start-ups in low-end fault-tolerant systems are bleak. "Eighteen months ago the market environment for start-ups to build a low-cost, fault-tolerant machine had potential," says Lowber. "But, now, the credibility of these companies has been badly damaged."

Fault tolerance is a computer feature of paramount importance to the on-line transaction-processing market,



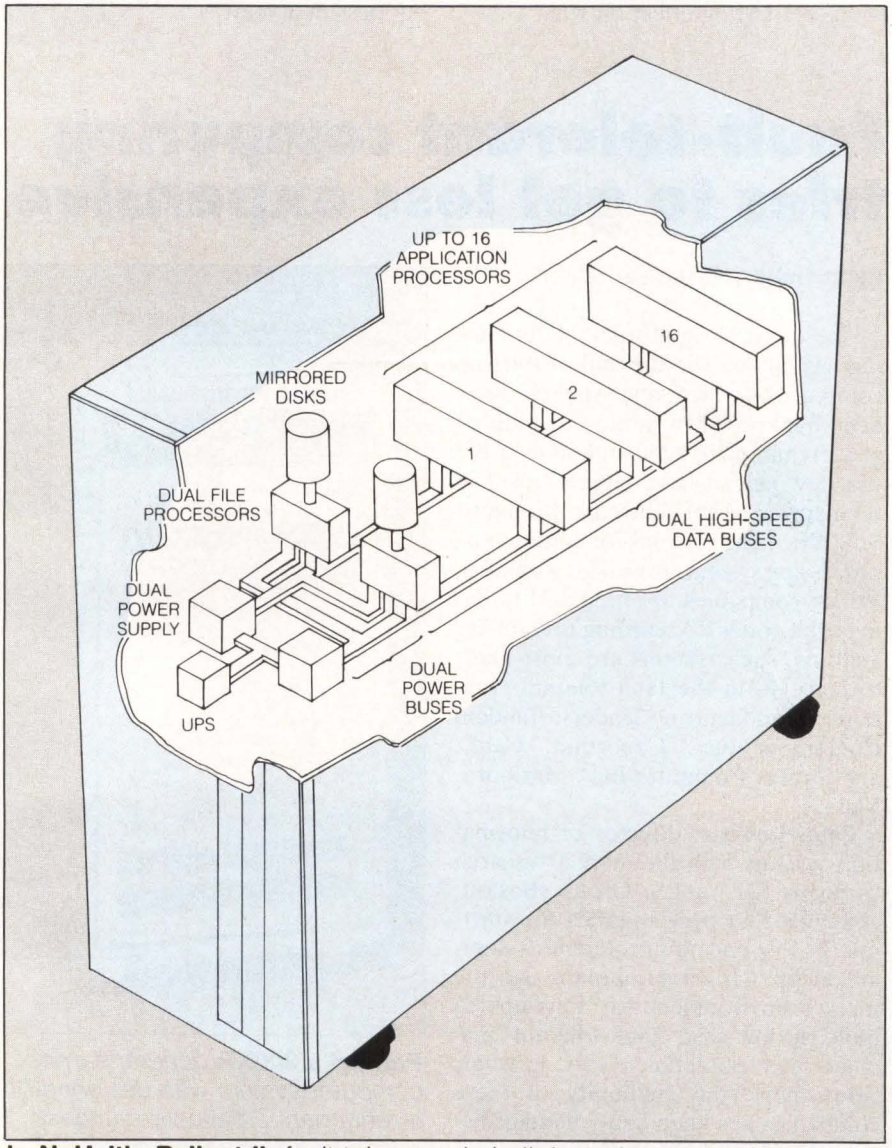
Parallel's 300XR *general-purpose computer system was designed on a redundant architecture and is based on the standards of the UNIX operating system and the IEEE-796 Multibus.*

whose customers include banks, airlines and brokerage houses. Here, computer downtime can mean million-dollar losses. In 1984, this market reached $16.6 billion dollars and is projected to increase 30 percent annually, according to Lowber. While fault-tolerant systems only account for a fraction of those revenue dollars, a growing market remains for vendors who can bring fault tolerance or even "high-availability" (nearly total uptime) to smaller businesses.

These lower cost, fault-tolerant systems would meet the needs of the branch office or distributed applications, or any businesses requiring up-to-date database information, such as hotels and mail-order houses.

Both Tandem and Stratus, whose systems usually begin at about $200,000, recognize the need for lower cost systems. "If you walked into our laboratories today," says a spokesman from Stratus, "you'd see activity going on for low-end products. I'd say you'll probably see smaller fault-tolerant systems from both Stratus and Tandem in the near future."

When low-cost, industry-standard, off-the-shelf computer components came about, they were expected to fuel the low-end of this market by allowing fault tolerance to be added as an inexpensive feature. But system developers ran into major problems involving attempts to rewrite UNIX—the chosen operating system—to accommodate fault tolerance, says Lowber. These UNIX implementations were supposed to have been a quick-fix answer for many users; significantly, though, Tandem and Stratus developed proprietary operating systems.



In NoHalt's Reliant II, *fault tolerance is built in at the system level via redundant disks, file processors, data buses and power supplies. A special monitoring subsystem scans to detect faults.*

By 1985, says market analyst Sandra Gant of InfoCorp, Cupertino, Calif., lower hardware and technology costs meant fault-tolerance capabilities would no longer add significantly to the overall price of a computer. That, at least, was the idea. "Manufacturers could now use lower cost of ownership and the importance of uptime as an argument for selling such systems," she says.

But, development difficulties, product delays and cash shortages eventually jaded industry watchers and potential customers alike. A few start-ups—Auragen Systems Corp., Fair Lawn, N.J., and Synapse Computer Corp., Milpitas, Calif., for instance —closed up shop before opening.

The cost of Tandem and Stratus entry-level systems—the Nonstop series EXT model and the model FT 250, respectively—each cost over $100,000. Only a few new systems, from other manufacturers, cost less. NoHalt Computers, Farmindale, N.Y., offers the Reliant II, a 50M-byte, dual-disk computer system with an entry-level price of $30,000. According to Jerry Ottieri, vice president of sales for NoHalt, the Reliant II ties two processors together (expandable to eight pairs) and relies on redundant databases and power supplies.

In addition, Parallel Computers Inc., Santa Cruz, Calif., markets the 300XR, a fault-tolerant system featuring redundant architecture based on Motorola Inc.'s MC68010 microprocessor and the Berkeley UNIX Version 4.2 operating system. It is equipped with the IEEE-796 Multibus. Parallel's systems range in price from $50,000 to $100,000.

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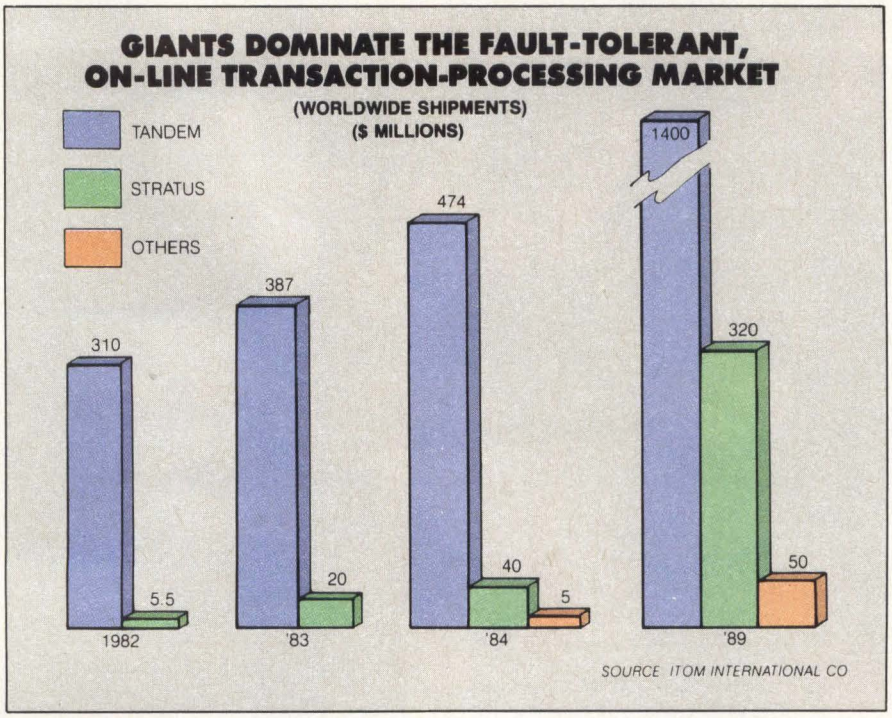

Originally, the low-end start-ups were out to beat Tandem and Stratus with lower priced, equal-performance machines. But, according to Omri Serlin, consultant and president of market research concern ITOM International, Los Altos, Calif., the Reliant II and 300XR, while respectable in their own right, simply do not match the functionality or performance of the more expensive Tandem and Stratus products—therefore posing no threat to them. Combined, NoHalt and Parallel have installed only 60 units.

Competition comes from above

For Tandem and Stratus, the greater threat comes from mainframe manufacturers such as IBM Corp. and Burroughs Corp. According to the Yankee Group's Lowber, two-thirds of the on-line transaction-processing market is dominated by IBM and he says their mainframe computers have developed a reputation for high reliability and uptime.

While traditional methods of achieving high computing availability have been through hardware (redundant components), high availability is also attainable via software. IBM, for example, will offer in the third quarter of 1986 the XRF (Extended Recovery Facility), a Multiple Virtual Storage/Extended Architecture (MVS/XA) system and Systems Network Architecture enhancement. Basically, XRF enables users to rewrite or recover an application on-line, should a processor running IMS go down.

The viability of availability

A likely system configuration for businesses requiring high availability, then, might be a non-fault-tolerant mainframe running a database program, thereby serving as the backend to a low-cost, fault-tolerant front end.

Other computing schemes are also giving users high availability—for instance, the multiprocessor and multiuser technologies afforded by Digital Equipment Corp.'s clustering ability.

It is for this reason that industry analysts say low-end fault-tolerant system manufacturers will eventually be competing with multiuser microcomputer manufacturers. □

FCC reversal on AT&T separation rankles VARs

Stephen J. Shaw
Washington Editor

The Federal Communications Commission's recent decision to remove the requirement that AT&T Co. sell its computers, terminals and interconnection equipment through a separate subsidiary could mean long-term trouble for third-party dealers and value-added resellers. The decision allows AT&T's unregulated equipment arm, AT&T Information Systems, to be partially melded back into AT&T.

AT&T predictably welcomed the FCC decision, while both equipment and service competitors accused the FCC of caving in to pressure from AT&T. Among the most vociferous of the opponents was the North American Telecommunications Association (NATA) of Washington, a trade group of vendors of private branch exchanges and other network-interconnection equipment.

The decision reverses a 1980 ruling in which the FCC imposed on AT&T a "structural separation" requirement in what was known as the Computer II Inquiry. Its purpose was to prevent AT&T from subsidizing customer-premises equipment (CPE) with revenues from network services offered by AT&T Communications.

FCC issues four safeguards

In voiding the separation requirements, the FCC ordered AT&T to adopt certain non-structural safeguards to prevent abuses of AT&T's still-dominant position in the provision of long-distance network services. Specifically, the FCC ordered that AT&T provide its equipment competitors, six months in advance, with information on planned changes in the telephone network that would affect equipment interconnection; to submit an accounting plan, before final implementation of the order, demonstrating the lack of

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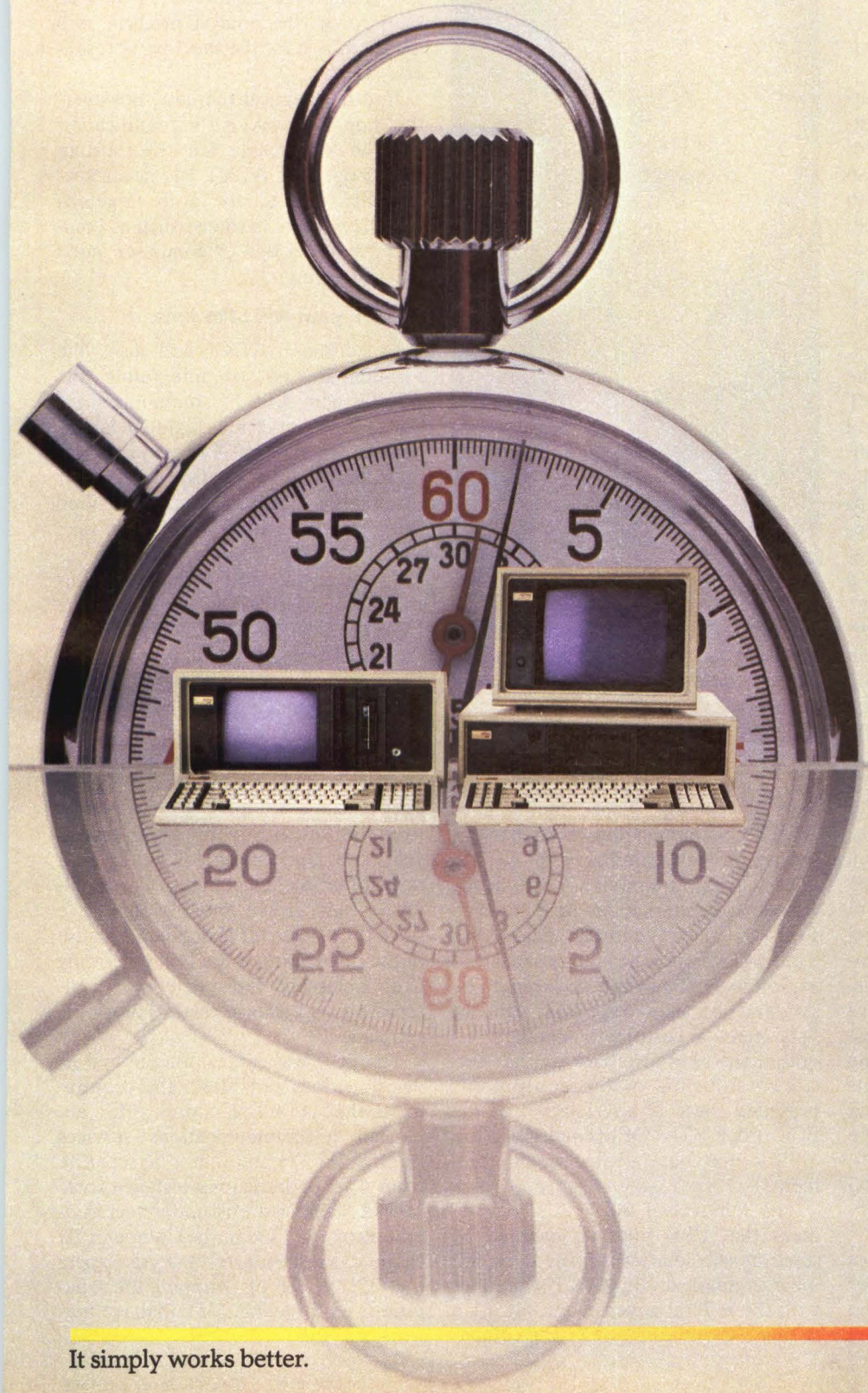

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any cross-subsidization between equipment and network-service offerings; to provide network service to competitors' customers equally with its own CPE customers; and, at a customer's request, to refrain from divulging any information on the customer's networking to ATTIS.

NATA termed the four non-structural safeguards "ambiguous, open-ended" and as having "more holes than substance." A NATA spokesman said the decision will allow AT&T to implement its own marketing plans before the public and the telecommunications industry have a chance to comment on the AT&T-designed accounting plan that will, supposedly, prevent cross-subsidization abuses. According to a staff attorney in the policy branch of the FCC, the AT&T accounting plan will be first subjected to a limited review by the commission. If the plan is found to be generally acceptable, AT&T will be allowed to proceed with joint marketing of equipment and services. But only after that initial review will the public have a chance to comment on AT&T's plan.

AT&T executive vice president Charles Marshall says the decision means better service for customers and urges that remaining restrictions on the provision of enhanced services be dropped. The decision, he adds, would enable AT&T to manage its costs more effectively, and lead ultimately to lower prices.

In a prepared statement, Marshall said AT&T will test a joint marketing arrangement. Ten integrated account teams will be formed by personnel from ATTIS and AT&T Communications to separately serve business customers. Each of the two organizations will manage five of the account teams. "We'll use this experience to plan the management of other large accounts by early 1986," he said. AT&T will also immediately consolidate its three marketing groups (two from ATTIS, one from AT&T Communications) that sell to the federal government into one organization.

The merging of AT&T's sales forces could also squeeze VARs and other third-party equipment vendors who have been selling ATTIS equipment in

Charles Marshall, *AT&T executive vice president, says the FCC's latest decision will lead to lower prices for customers.*

vertical markets. Large numbers of AT&T Communications sales personnel are already familiar with ATTIS' line of CPE equipment, notes Katie Klosterman, market research supervisor with Yates Ventures, Palo Alto, Calif. AT&T now has the go-ahead to exploit its communications strength by sending one sales force that can not only meet a customer's network requirements, but also back up that network solution with equipment, provided there is no violation of the FCC order. "The OEMs and VARs are a little nervous," Klosterman comments.

The removal of the FCC's requirement that CPE sales be handled by separate subsidiaries is likely to be felt most dramatically in AT&T's dealings with the federal government, always a strong segment for AT&T. The company's efforts had been hampered by the need to maintain three sales teams, in addition to maintaining relationships with several VARs to meet specific government applications. A unified sales force, the analyst predicts, will mean trouble for the third-party resellers.

In other vertical markets, however, the impact of AT&T's reunification may be less keenly felt. Klosterman points out that AT&T has never successfully sold to (or even targeted) specific vertical markets, such as computer aided design or computer aided manufacturing.

AT&T's plan will take time

In addition, AT&T still faces the formidable task of integrating the ATTIS and AT&T Communications sales forces, until now highly independent. Although AT&T certainly has more personnel at its disposal now for integrated equipment and service sales, the transition will likely take some time, Klosterman says.

So, it seems, did formulating this ruling, for which AT&T petitioned the FCC in mid-1984. AT&T argued that the duplication of personnel and facilities was costing it more than $1 billion per year. Removing the structural separation requirement, AT&T claimed, would enable the company to offer equipment and long-distance service as one package to meet its customers' needs more effectively. More than a year later, the commission has agreed, noting that the telecommunications industry has grown more competitive since the Computer II decision because of the divestiture of the Bell Operating Companies and the emergence of alternate long-distance carriers and CPE suppliers.

The FCC was careful to note that its decision does not affect the requirement that AT&T can only offer enhanced telecommunications services through ATTIS and that it be separate from AT&T's basic long-distance voice service. That issue is under reconsideration by the FCC in the Computer III Inquiry. Most industry analysts expect the FCC to end up dropping the separation requirements for enhanced network services. □

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Masscomp responds to slump with multiprocessing machines

Bruce J. MacDonald
Assistant Managing Editor

While many computer companies trim budgets and staffs in tactical moves against the downturn, Massachusetts Computer Corp. has opted for a more strategic decision: applying supercomputer technology to minicomputers to create an extended family of new multiprocessing machines.

The move is reshaping the Westford, Mass., company's image as a one-product, high-performance workstation vendor. More importantly for Masscomp, analysts expect the new family to turn the company around after a string of quarterly losses, which began last winter after more than two years of dynamic growth.

The company's strategy highlights the five-member 5000 family, a Motorola Inc. MC68020-based line of 32-bit multiprocessing machines. The machines range from a $15,000 engineering workstation to a $250,000 superminicomputer that can be configured with up to four processors; Masscomp claims it provides 11 times the Whetstone performance of a Digital Equipment Corp. VAX 11/780 for less money. Indeed, it is price/performance that Masscomp believes will distinguish its "microsupercomputers" in the highly competitive scientific/technical market.

To achieve high processing speeds for relatively low cost, the machines incorporate a triple-bus architecture. Also, four of the five machines have two-way associative cache memory and supercomputer-like elements such as floating-point and array processors.

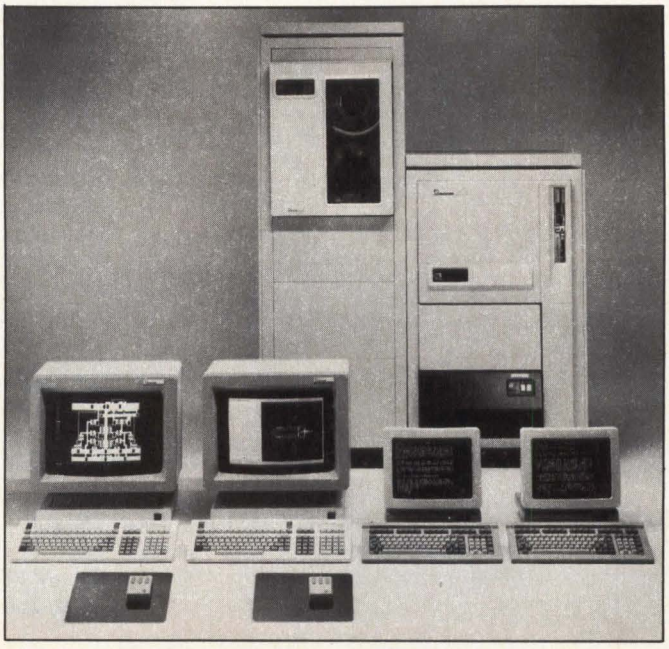
The introductions reflect a steady sales shift for Masscomp, which made its name and much of its revenue in the real-time data-acquisition business. When shipments of the MC-500 (renamed the 5500 and upgraded from an MC68010 CPU to the 68020) first began in late 1982, 70 percent of the company's single-model sales were for data acquisition. Data acquisition now accounts for only about 40 percent of Masscomp's annual sales and the company does not anticipate the share will increase. Sales of machines for scientific and technical applications make up the balance.

"They're capitalizing on a definite trend within their customer base—a move away from the real-time area to more scientific or technical computing," says Jeffrey Canin of Hambrecht & Quist Inc., a San Francisco investment banking company. The market potential is much greater, too, he adds, estimating that hardware sales alone for scientific, FORTRAN-intense applications will total $5 billion to $6 billion this year. Real-time data acquisition, on the other hand, "is limited and tends to be very much a replacement market." He estimates that of the $3 billion to $4 billion annual data-acquisition market, approximately $2.5 billion is controlled by DEC and Hewlett-Packard Co.

The new products are also timely. In March, Masscomp suffered its first quarterly loss ($506,000) after two years of steady growth in which revenues had jumped from $2.6 million to $45.2 million. A $1.7 million loss followed in June, chased by a $3.29 million loss in September, the first quarter of the company's 1986 fiscal year. In August the company cut salaries by 6 percent to 12 percent for all 550 employees; in late October it laid off 12 percent of the staff.

According to both analyst Canin and Masscomp vice president for marketing, Douglas Rowan, the company was hit particularly hard by its dependence on OEMs, to which 50 percent of sales —slightly more than 1,500 units to date—are made. "That's impacted the company significantly in terms of the profit levels and the revenue growth," says Canin. Adds Rowan: "We were totally dependent upon essentially a single product [the MC-500], based upon the 68010, and we had very good customers who were waiting for the new round of 68020 machines and that also really hurt us for a couple of quarters."

In the rush to get product to market and improve its fortunes, Masscomp reportedly had models of its machines in beta test within two weeks of receiving the new chips from Motorola. But



Masscomp's 5700, *the largest and fastest of the company's new multiprocessing, MC68020-based 5000 family, can be configured with up to four CPUs to reportedly provide 2½ times the performance of a DEC VAX 8600 for a third of the cost.*

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introduction was delayed, says Rowan, until "we had customers experienced with it—until we had a major product-shift capability."

Redefining a workstation image

That shift has turned the essentially one-product company, positioned against such workstation vendors as Apollo Computer Inc., DEC, HP and Sun Microsystems Inc., to one that now draws competitive comparisions all the way up to Cray Research Inc. supercomputers. At the low end is the 5300 for workstation applications and data acquisition and control, with an entry-level price of $15,000. It is the only system to use the 12.5-MHz 68020; all other models incorporate the 16.7-MHz version of the chip.

The next machine is the 5400, priced from $20,000, which can be configured with Masscomp's optional "Lightning" floating-point accelerator and is designed for standalone or networked technical applications or data acquisition.

The 5500 is optimized for multitasking, multiuser applications, and available with optional floating-point and array processors, for a starting price of $23,500.

The 5600, priced from $34,000, has been designed for technical computing requiring high-bandwidth data transfer and is also available with floating-point and array processors and the Lightning floating-point accelerator. Like the 5500, it can be configured with dual processors.

The top-of-the-line 5700, for I/O-intensive tasks, is available with up to four CPUs and four system I/O paths for a reported floating-point performance of more than 12 million Whetstones per second. Prices begin at $71,000 and range as high as $250,000.

While the 5300 and 5400 will target the workstation market that Sun addresses with models such as the 2/130 and 3/160 and Apollo with its DN 560-2, the price/performance of Masscomp's larger models moves the company squarely into minisupercomputer turf. The 5700 is said to run at up to 10 million instructions per second, and provide up to 1 million samples per second for data-acquisition purposes. Masscomp also claims that for a third of the cost, the 5700 offers 2½ times the Whetstone performance of a VAX 8600—the machine by which minisupercomputer makers like Alliant Computer Systems Corp., Convex Computer Corp. and Floating Point Systems Inc. tend to measure their systems. By comparison, Alliant's FX/1 and FX/8 range in price from $270,000 to $1 million.

At least one analyst feels the move is key to the company's health. "Masscomp is probably not going to be able to effectively compete as a supplier of what's going to become the standard work-system," surmises analyst Adam Zais of International Data Corp., Framingham, Mass., who anticipates that the price for single-user workstations will drop to $6,000 to $7,000 by the end of the decade. "They have to position themselves against people [minisupercomputer makers] like Floating Point, Alliant, Convex and ELXSI....My initial take is that they're trying to change their market strategy from being considered Apollo-Sun-Masscomp to be more like Alliant - Convex - Floating Point-Masscomp. If you consider the marketplace, there are a lot fewer of those guys than there are in the workstation business."

To keep system speed up and cost down, Masscomp has incorporated a number of innovative techniques in its multiprocessing architecture, several of which draw directly from mainframe technology. The triple-bus architecture allows the systems to keep up with the speed of the 68020 processor—about three times faster than the 68010. The architecture comprises a proprietary memory bus for the CPU(s) and memory; a standard system bus, Multibus, for the data-acquisition and control processors, peripherals, graphics and networking; and a data-acquisition bus, STD+bus, for digital I/O, digital/analog converters and clocks. All the systems except the 5300 employ the two-way associative cache memory to speed up computation and reduce bus contention.

Masscomp's Lightning floating-point accelerator, available on all models except the 5300, is said to process floating-point calculations at rates of between 3 million and 12 million Whetstones per second, depending on the number of CPUs. Speed is boosted further by Masscomp's array processor, the VA-1 Vector Accelerator, which provides high-speed, single-precision vector arithmetic such as fast Fourier transforms on the 5500, 5600 and 5700. By pipelining mathematical operations and overlapping data transfers with computation, it reportedly offers as many as 13 million floating point operations per second on the 5600 and 5700.

The new family runs Masscomp's version of real-time UNIX, RTU, to provide the response characteristics necessary for real-time work—something that UNIX, originally developed for timesharing, was not designed to do. Masscomp's version, which is compatible with both UNIX System V and Berkeley UNIX Version 4.2, incorporates fixed priority scheduling, prioritized asynchronous system traps, high-speed pipes and shared memory.

The 'thousand-chicken approach'

But while analyst Zais believes Masscomp has indeed redefined its market, he questions whether such multiprocessing can be fairly compared with the parallel-processing architectures provided by the Alliants and the Floating Points. "If you consider a minisupercomputer or microsupercomputer market," he explains, "you've got to have some true parallelism start creeping in—multiple-instruction, multiple-data stream stuff. In this case they're working on the microprocessor using what someone calls the 'thousand-chicken approach.' In other words, it's low-granularity—small-grain as opposed to large-grain. And it's also more loosely coupled than tightly coupled....It's not true parallelism. It's more like supercomputer stuff—array, vector, matrix stuff."

Regardless of how the company achieves its competitive price points, analysts concur that the new range should broaden OEM and third-party opportunities. Says Canin: "One can look at the products and perceive Masscomp as a workstation company,

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but that would be ignoring the fact that the company has provided such added value through their triple-bus architecture and their proprietary array processor and floating-point accelerators. The 68020 is only one component of a very high-performance architecture. And it's now been clearly proved that the architecture, even as announced in the original box [the 500], was very flexible in enabling future extensions."

That optimism is shared by Masscomp, which expects to do as much as 40 percent to 50 percent of its business this quarter with its new machines, with the balance made up by the renamed 5500.

The company also anticipates that its ratio of sales to OEMs and end-users will remain about equal for the foreseeable future. Masscomp numbers approximately 70 OEMs in its list of customers, among them Gerber Scientific Inc., Graftek Inc., Harris Corp. and the National Aeronautics and Space Administration, which it serves both directly and through three different OEMs for as much as 8 percent of its annual business.

Despite a difficult 1985, the picture for Masscomp is soon to get brighter, say analysts. Based on the expectations of its current OEMs, predicts Canin, the company should see a strong second half to its fiscal 1986 year, which ends in June. Canin cites the company's reputation for product reliability, which stems from Masscomp's background in real-time data acquisition (the company says there is a mean time between failures of one year on its machines), adding, "They're very well-endowed with cash. They're clearly going to be able to get through the current malaise." □

GSS adds raster capability to its virtual device interface

Mike Seither
Associate Western Editor

In a move to better penetrate business and engineering markets, Graphic Software Systems Inc., Wilsonville, Ore., has added raster graphics capability to its latest implementation of the virtual device interface (VDI).

The new version of the VDI, called GSS CGI for computer graphics interface, will allow programmers to use bit-mapped graphics to create applications with higher quality text, pop-up menus and windows, the company says. The name of the product, too, signals an expected change in the nomenclature of CDI, according to officials in the company.

ANSI, which has proposed the VDI standard, is apparently considering changing its designation to computer graphics interface, or CGI. By using the acronym, CGI, for its newest product, GSS hopes to better identify itself with the emerging graphics standard. That standard provides a functional interface between application programs and a wide range of graphics input and output devices, such as printers, plotters, scanners, cameras and terminals.

GSS president Tom Clarkson says that the company's latest release will "further establish GSS as the industry leader in microcomputer graphics software...GSS CGI solidifies our position as the de facto virtual device interface standard."

However, some industry analysts question that line of reasoning. One of them is Robert Lefkowits, director of software services at Infocorp., the Cupertino, Calif., market research outfit. "There is no single industry standard, and in my view there won't be one for a good long while," says Lefkowits.

Although AT&T Co. and IBM Corp. adopted GSS' earlier version of the VDI interface, Lefkowits says that the company "is still struggling for recognition" against competitors like Digital Research Inc. and Microsoft Corp., both of whom also have raster-based graphics products.

Deme Clainos, vice president of marketing for GSS, says the company has designed the bit-mapped management directly into the device drivers, and not into the application. As a result, programmers using GSS CGI do not have to modify an application every time a driver is added for another input or output device, he says.

To date, the company has developed more than 50 separate device drivers for its previous implementation of VDI, all of which will run on the new version. With the introduction of GSS CGI, an additional 17 drivers have been made available, among them ones for IBM's adapters for color and enhanced graphics as well Big Blue's PC printers for color and graphics. Also available are drivers for Microsoft's serial and parallel mice; Epson America Inc.'s MX80, FX80 and FX100; Hercules Computer Technology's monochrome graphics card and Hewlett-Packard Co.'s 7470 and 7475 plotters. GSS says it plans to write more raster-based drivers later, adding that it has agreements to write a driver for a Ricoh Corp. scanner and port GSS CGI for use in Convergent Technology Inc.'s UNIX and proprietary operating systems.

GSS is positioning the software for a number of applications, including desktop publishing, business graphics presentations, architecture, engineering and construction, where quality and quantity of type fonts are important features.

In that regard, GSS CGI provides Helvetica currently, and the company expects to ship Times and Century in the first quarter of 1986. GSS CGI pixel arrays are read, written and saved in ASCII, binary or metafile formats.

Analyst Lefkowits adds that the importance of raster graphics is its ability to "fill" characters, no matter what size, with individually addressable pixels on the screen. That degree of precision allows a wider latitude in the choice of type designs. The OEM price for GSS CGI is $200. □

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*Source: Newton-Evans Research Co.
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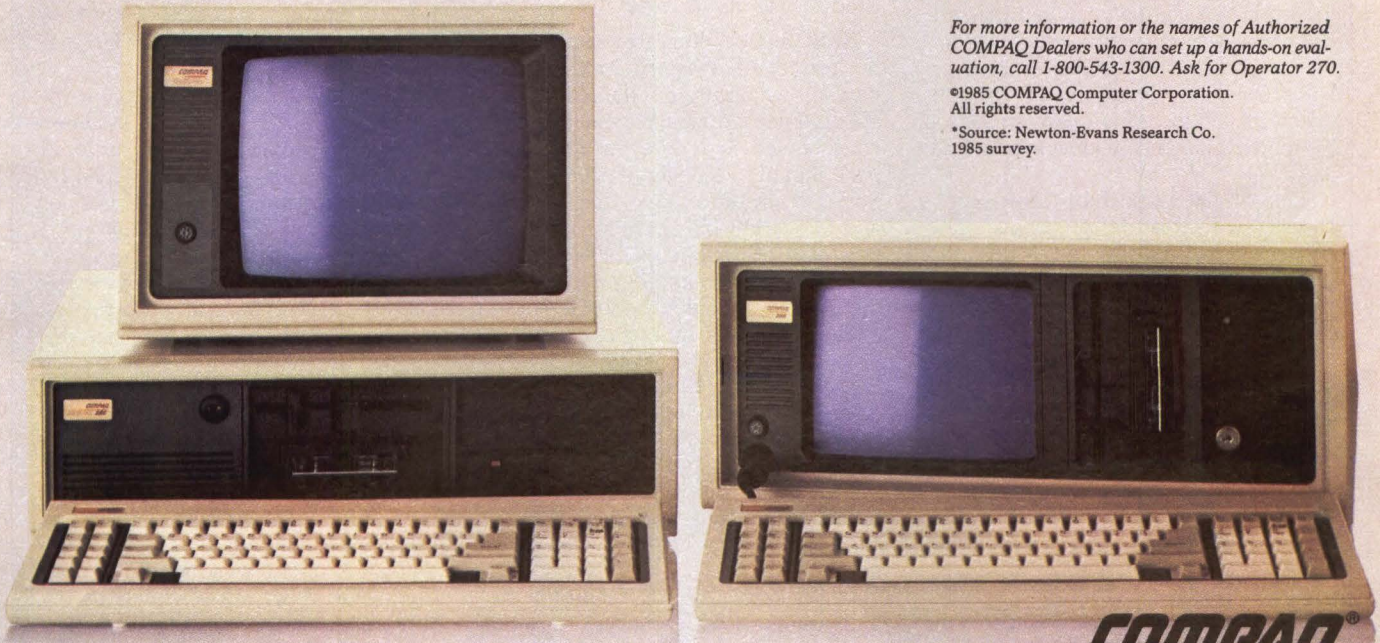

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HEARD ON THE HILL

U.S. microelectronics top Soviet shopping lists

Stephen J. Shaw
Washington Editor

Like housewives planning family meals, Soviet military strategists routinely prepare lists of restricted high-technology items for their foreign operatives to acquire from the United States and its Western allies.

According to a recent report prepared by the CIA and released by defense secretary Caspar Weinberger, the latest shopping spree has left Soviet shelves well-stocked. In fact, during the past 10 years, thousands of Western high-technology products have been obtained through both legal and illegal means. Billions of rubles and hundreds of thousands of man-hours have been saved in research and development efforts by the Soviet military by this infusion of existing Western technology into the Soviet military-industrial base.

"Each year Moscow receives thousands of pieces of unclassified, classified and proprietary documents as part of this campaign," summarizes the report. "Virtually every Soviet military research project—well over 4,000 each year in the late 1970s and over 5,000 in the early 1980s—benefits from these technical documents and hardware."

The Soviet acquisition effort comprises two separate programs. The first is managed by the VPK, the Military Industrial Council that forms the defense-production arm of the Presidium's Council of Ministers.

Working mainly through Soviet and Eastern Bloc intelligence services, the VPK program seeks military hardware, blueprints, product samples and test equipment. After the acquired documents are studied or the equipment is subjected to reverse-engineering, the technology learned is incorporated into Soviet military manufacturing.

The second program, managed by the Ministry of Foreign Trade and several Soviet intelligence services, obtains great quantities of manufacturing and test equipment to incorporate directly into production lines. Largely through subterfuge, this program targets export-controlled microelectronics, computers, communications, robotics and other equipment to increase the productivity of Soviet weapons industries.

In the mid 1970s, the VPK program succeeded in acquiring the architecture of the IBM Corp. 360 and 370 computer systems and using it as the model for the country's Ryad computer series. In the late 1970s, VPK requested and got a Fairchild Instrument Corp./Xincom semiconductor memory tester. With it, a Soviet counterpart was developed. The original tester, according to the report, could also be used to copy or reverse-engineer Western integrated circuits. The tester and its design components saved several hundred man-years of Soviet development, the CIA estimates.

Silicon trail leads West

Most Soviet integrated circuits can be traced to Western origins. The best-known example is the Intel Corp. 8080A microprocessor, which the Soviets copied and gave an equivalent part number, KRS80 IK80A. Other Soviet microprocessors, the Logika-2 and Series 133/155, were attributed to the Texas Instruments 5400/7400 IC.

Other U.S. technology secured by the Soviets includes bubble-memory systems for use in tactical missiles, disk drives for the Ryad computers and documents on digital signal-processing for a Soviet version on the NAVSTAR satellite navigation system. "Soviet requirement data also includes the firms and sometimes the names of persons who have the desired hardware and documents," the report adds.

In response to VPK requirements, approximately 30,000 pieces of Western hardware and 400,000 technical documents were collected between 1976 and 1980. The report estimates that one-third of all the VPK's annual requests are fulfilled, and that VPK requests grow 15 percent a year.

The Soviet Ministry of Foreign Trade is largely responsible for managing most covert diversions of export-controlled Western technology. Various techniques are employed, from deceptively describing equipment and falsifying identities of end users to illegal purchases, creating dummy companies and using unscrupulous Western traders.

Of particular interest to the Soviets are microelectronics fabrication equipment and computers. In this area, the Soviet trade-diversion program is credited with shaving the Western lead of from 10 to 12 years in the mid-1970s to four to six years today. Now the Soviets are after large quantities of test equipment for VLSI circuits, according to the report.

The Ministry of Foreign Trade's diversion program is characterized by volume purchases, both lawful and unlawful. For instance, before 1980 the Soviets bought hundreds of tons of electronics-grade silicon. In 1980, sales to the Soviet Union were restricted, but Soviet acquisitions continued through shipment diversions from the United States, West Germany and Japan.

Integrated circuits intended for direct use in Soviet computer systems, states the report, are usually ordered from the United States and Japan by trading companies in various parts of the world, then shipped through third parties in huge quantities to the Soviet Union or other East European destinations. The report estimates that as many as 100 million circuits may be shipped annually in this fashion.

The CIA report implies that understanding the scope of Soviet methods of getting hold of Western technology is a critical first step in preventing that technology from being turned against the United States and its allies.

"The assimilation of Western technology is so broad that the United States and other Western nations are thus subsidizing the Soviet military buildup," the report concludes.

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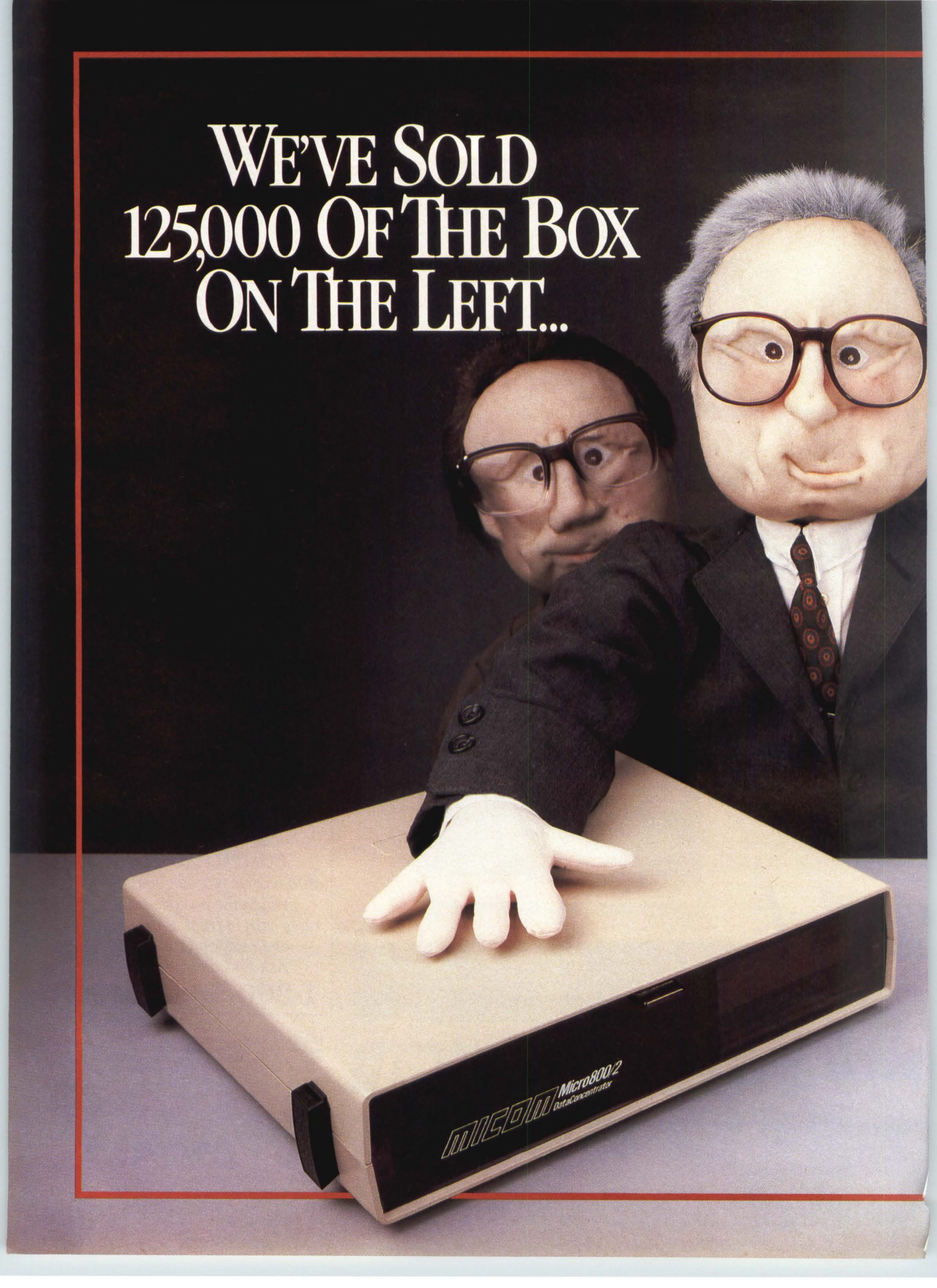
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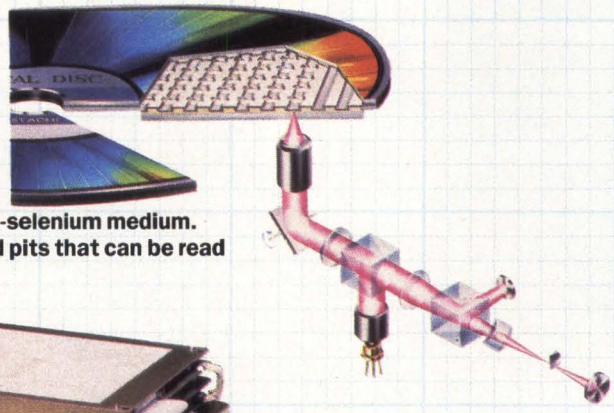
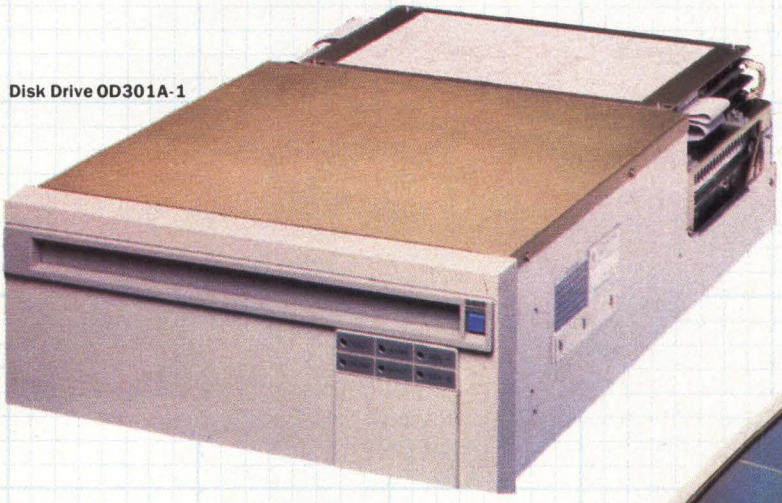


Disk Drive OD301A-1



The 301 Series drive automatically checks each data bit after it is written and also records error-correcting bits. The combined use of read-after-write checking and error-correction codes reduces expected read errors to 10^{-12}, allowing storage of both image and encoded data.

Disk Cartridge OC301

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■ The 301's formatter/controller implements either the industry-standard SCSI interface or a GP-IB (IEEE-488) interface, which enables the disk subsystem to be used with a wide range of computers. The unit includes its own memory buffer to speed data transfer between a host computer and the disk drive, which has a 250 millisecond average access time.

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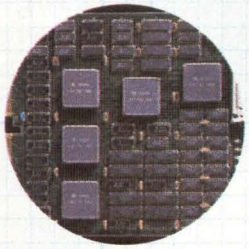

Hitachi Developed
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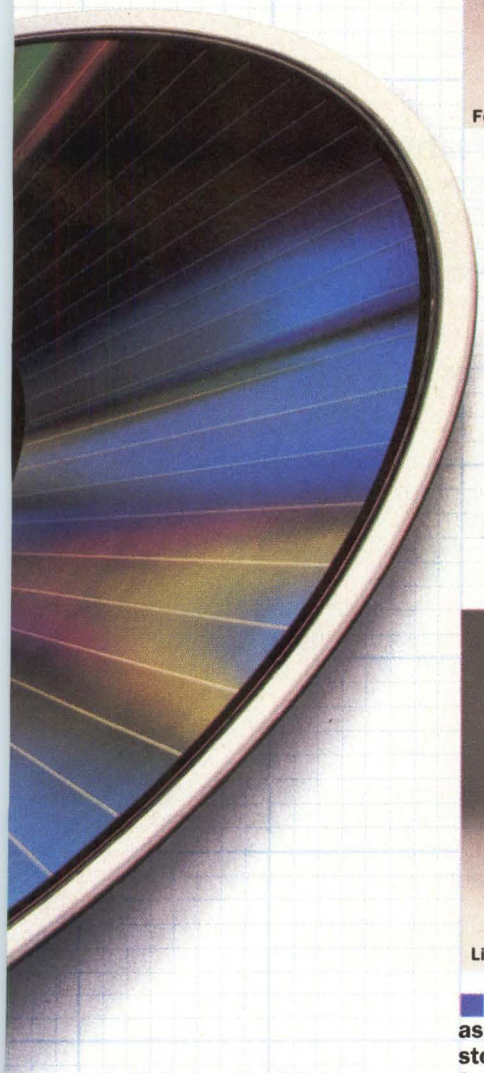

This 12-inch optical disk can store 2.6 gigabytes of images or encoded data.

Library Unit OL301S-11

■ The 301 Series library unit provides as much as 83 gigabytes of on-line storage capacity. It incorporates a formatter/controller, one or two disk units, and an automatic changer for as many as 32 disk cartridges.

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The ability to record so much information so compactly opens vast new applications for on-line information storage and retrieval. For example, with the 301 Series, it becomes economically feasible to create extremely compact electronic archives for storing and retireving copies of medical records, engineering drawings, and other documents, much faster than with conventional microfilm or magnetic tape storage. Other applications include electronic publishing and backup of volatile databases in large-scale information processing systems. For more information, contact:

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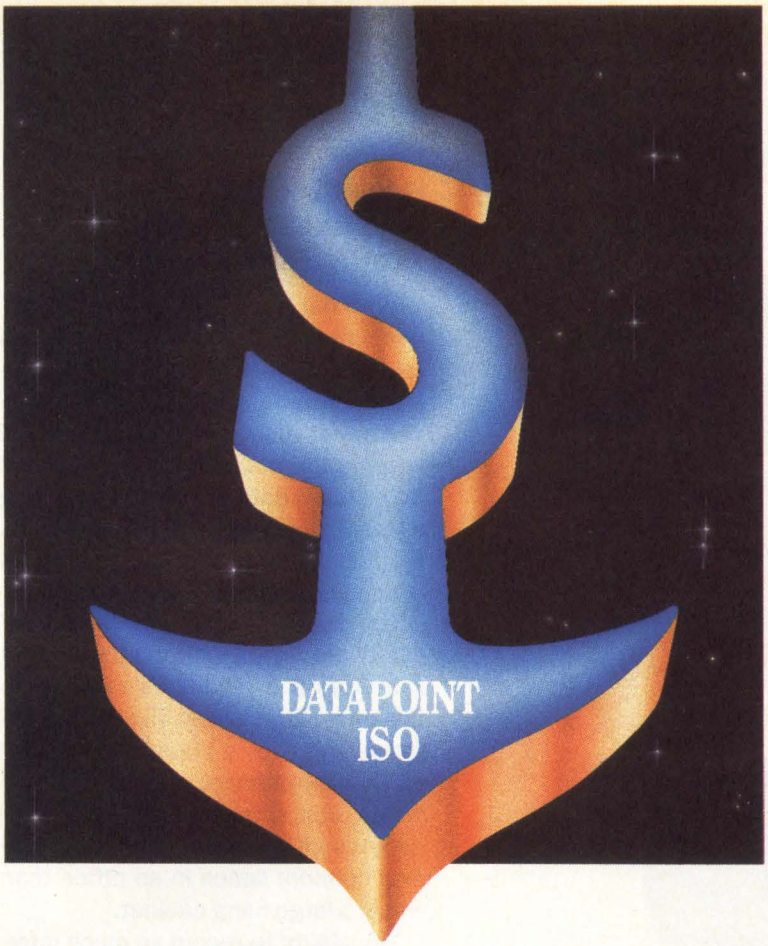
CIRCLE NO. 20 ON INQUIRY CARD



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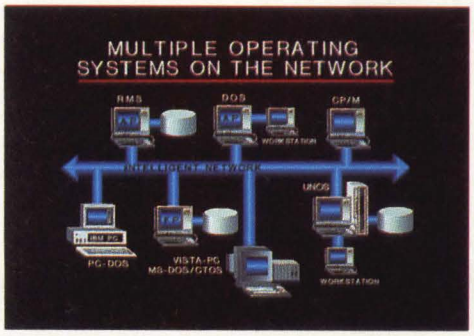

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CIRCLE NO. 21 ON INQUIRY CARD

LAN TIGHTENS FACTORY FLOOR CONTROL

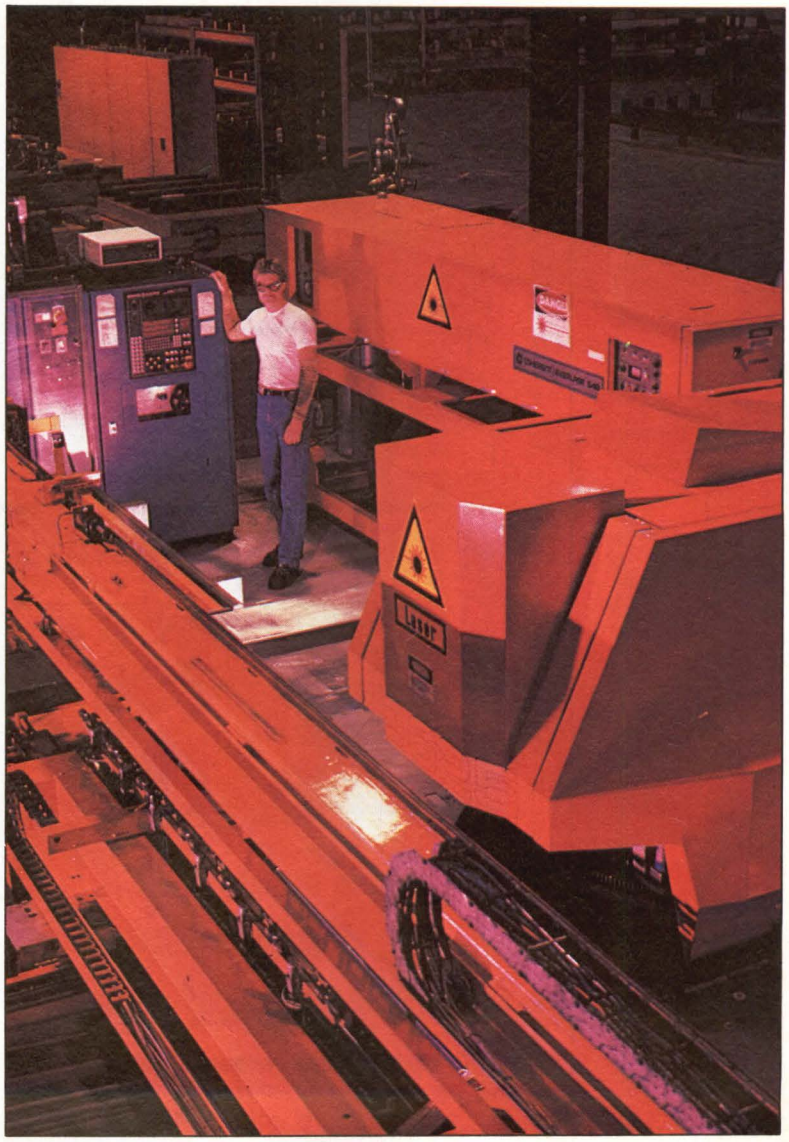
The John Deere Harvester Works uses a MAP-compatible LAN to optimize parts production and speed information between computer room and factory floor

John Mizlo, John Deere Harvester Works

At a more-than-260-acre site in East Moline, Ill., the sheet-metal facility of the John Deere Harvester Works designs and produces farm combines. The facility handles all aspects of production—from punching and welding sheet metal to assembly and final inspection. Recently the company optimized its manufacturing operations by installing the Token/Net local area network from Concord Data Systems Inc., Waltham, Mass.

Deere Harvester uses numerical controllers (NCs) to feed cutting and tooling instructions to machine tools on the shop floor. By 1984, more than 30 machine tools were managed by numerical control. To improve parts quality and implement just-in-time techniques, however, it estimated that it would need 30 more NC machines by 1988. In addition, the number of software programs needed for these machine tools would increase accordingly—from 2,500 in 1984 to more than 12,000 by 1988. Faced with such growth, the company decided to develop a more efficient method of handling parts programs.

Previously, engineers custom-designed programs for each part and created punched mylar tape with a flexible disk copy for backup. The employees then hand-delivered the tapes to the shop floor—a quarter of a mile away—for loading onto the NC systems. The punched mylar tape fed information to the NCs, which in turn sent cutting and tooling instructions to machine



A Behrens laser press *automatically punches sheet metal using instructions downloaded from the DNC in Deere Harvester's computer room.*

tools. If a program contained errors, an engineer would have to create a new tape in the computer room and hand-carry it back to the shop floor. These procedures took an average of half a day to complete.

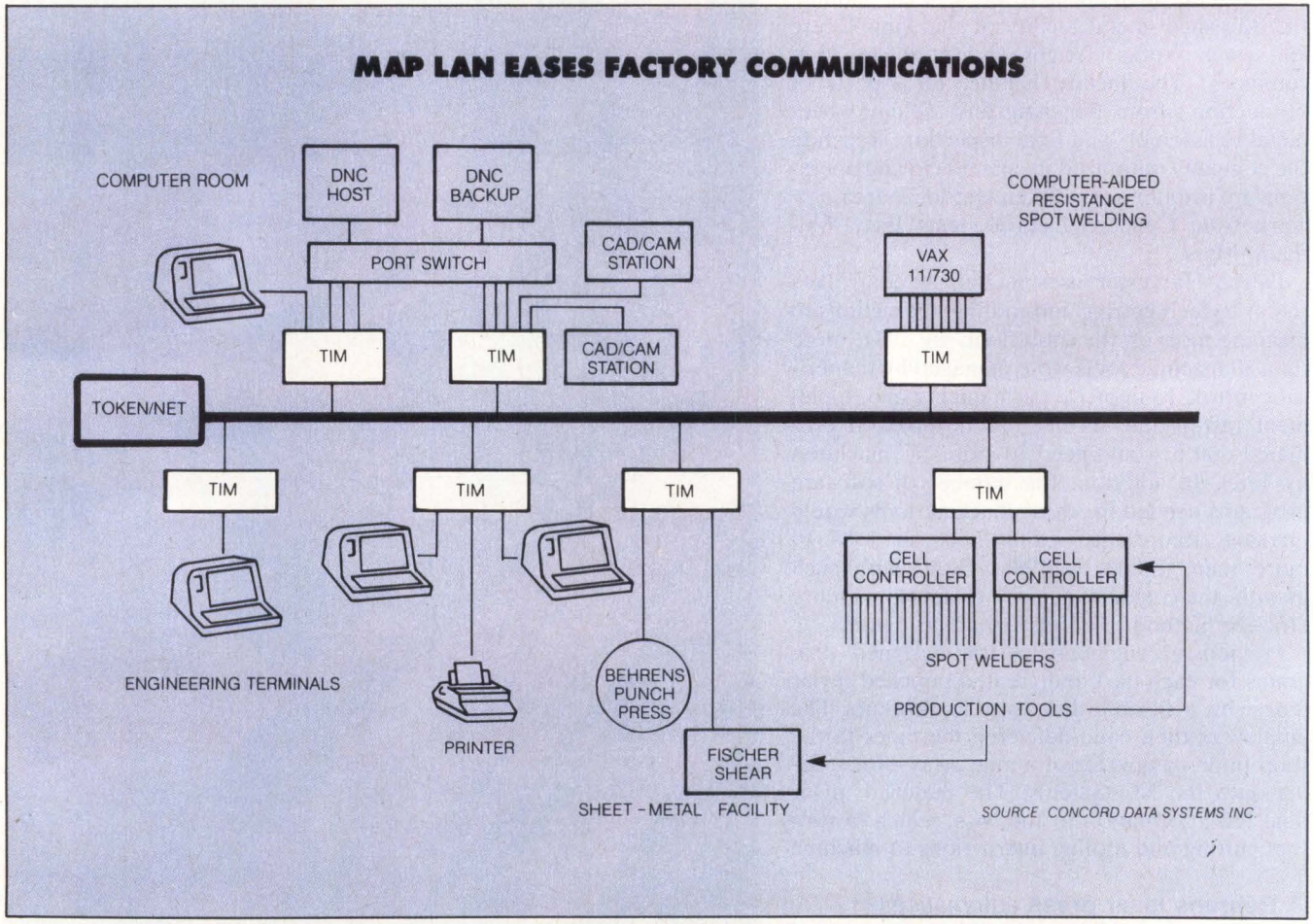
DNC handles data flow

To optimize its operations, the Harvester Works installed a distributed numerical-control (DNC) system in its computer room. It planned to use the DNC system to store parts programs in a central location and to download them to the appropriate shop-floor computerized numerical-control (CNC) system. But this solution required an efficient method of transferring information. The company vetoed using point-to-point links from the DNC system to each CNC machine because the factory environment dictated large distances between links, making them impractical and expensive to install. Instead, with the advent of General Motors Corp.'s Manufacturing Automation Protocol (MAP), which defines factory-floor communications, Deere Harvester decided to install a local area network. The LAN would be a pilot project for the company to determine if networking was feasible.

In August 1984, Deere Harvester formed a task force comprised of members from three departments—computer systems, plant engineering and production engineering systems—to evaluate various LANs and to develop and implement a network solution. The task force named two criteria for the LAN: compatibility with industry standards and broadband communications, allowing both asynchronous and synchronous communications.

MAP compatibility was essential

A very important criterion for the LAN was compliance with industry standards, specifically, MAP. This strategy was risky, however, because MAP was still developing. To ensure compatibil-



Token/Net provides factory communications *via the Token/Net interface module (TIM), a three-board, four- to 12-port, microprocessor-based communications controller that links production machine tools, engineering terminals and the computer room.*

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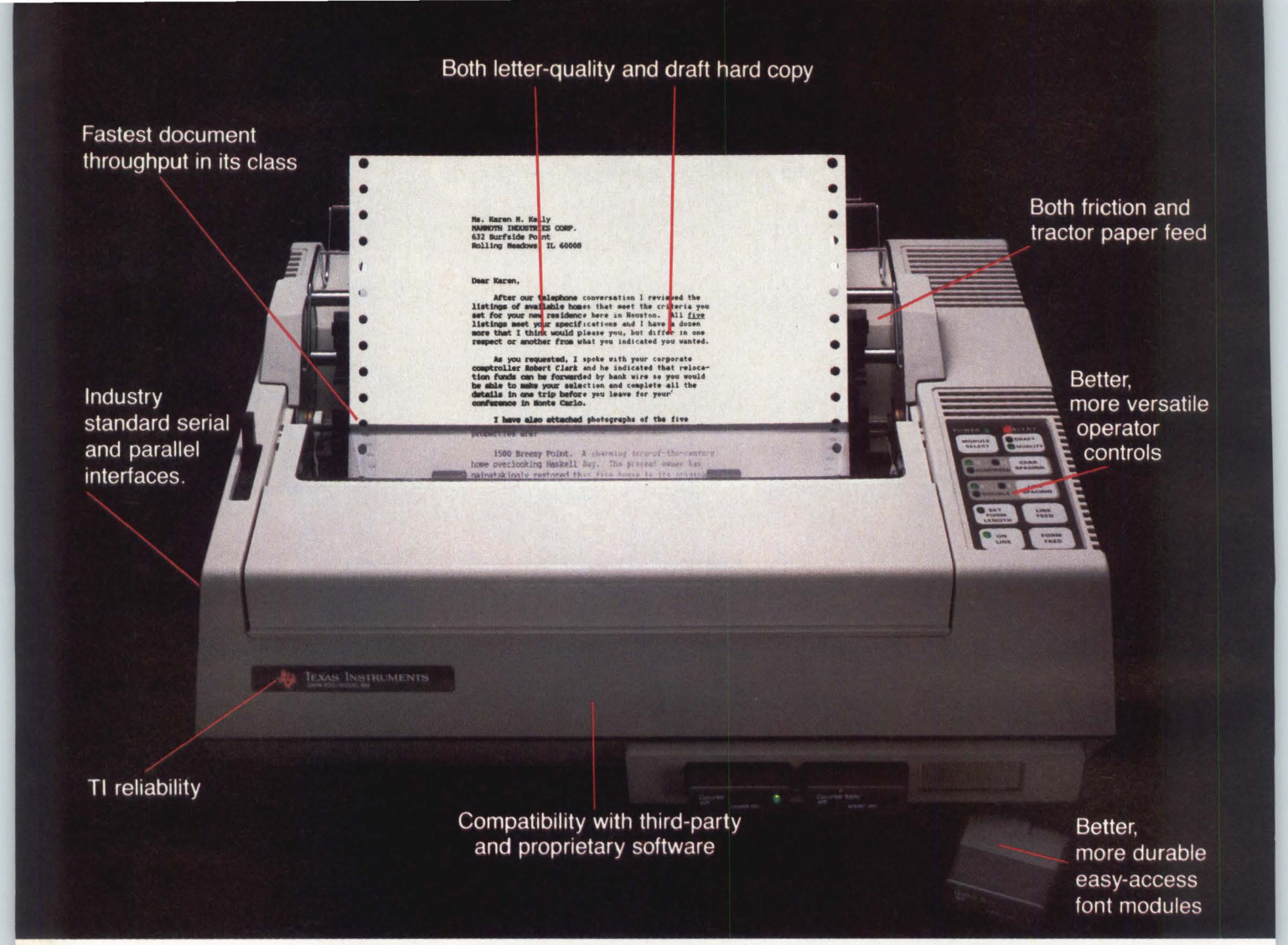

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CIRCLE NO. 23 ON INQUIRY CARD

ity, Deere Harvester specified an IEEE 802.4 token-bus solution, which implements the first two levels—the Physical and Data-Link layers—of MAP. The LAN required high-level software that implemented the International Standards Organization's seven-level model for open systems interconnection. This would ensure upward compatibility as MAP became more clearly defined.

Along with standards compatibility, the LAN had to include broadband communications because broadband can handle voice and video communications as well as data transmission. As a result, it could support a variety of applications, helping to justify the expense of installing coaxial cable throughout the factory. In addition, broadband signals resist dirt and noise and are thus better suited to industrial environments than are other communications signals. What's more, the extensive use of broadband by cable television companies ensures a stable, reliable product at a relatively low price.

Finally, the task force stipulated that the LAN have both asynchronous and synchronous terminal communications ability because the network could be used for several applications, requiring both kinds of communications. For example, the network could connect CRTs for production inquiries, programming and machine monitoring.

Deere sent out a request for proposal and, after evaluating several MAP-compatible LANs, selected Concord's Token/Net. Deere Harvester felt Token/Net was the only solution that met its sophisticated technological requirements.

LAN yields productivity gains

The DNC system allows NC programs to be downloaded to machine tools on the factory floor over the LAN. If a program requires an update, an engineer simply accesses and corrects the program on the DNC system. The system then downloads the corrected software to the shop floor, and parts production continues.

Deere Harvester can now develop parts programs on a computer aided design/computer aided manufacturing system from Computervision Corp. and transfer the programs across the LAN to the DNC system for storage. Asynchronous terminals on the network allow users to access either the DNC or the CAD/CAM system from a single terminal.

Token/Net provides factory communications via the Token/Net interface module (TIM), a

Harvester's more-than-260-acre sheet-metal facility *handles all aspects of production—from punching and welding sheet metal to assembly and final inspection.*

Broadband can handle voice and video communications as well as data transmission.

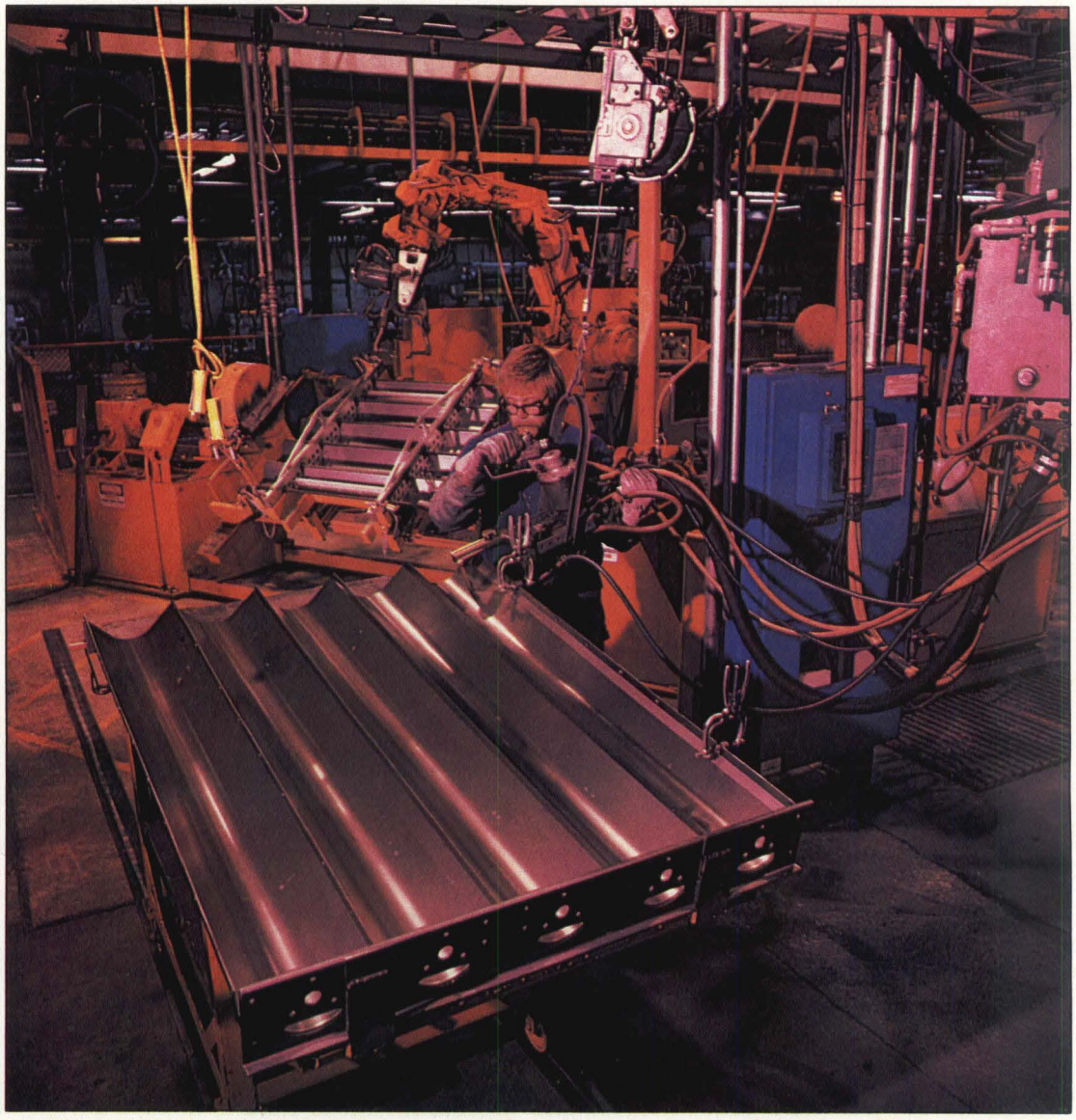
three-board, four- to 12-port, microprocessor-based communications controller that links production machine tools, terminals and the computer room. For example, a TIM connects a Behrens laser punch press and a Fischer metal-cutting shear on the factory floor to the DNC system in the computer room. Other TIMs connect the CAD/CAM system, several engineering terminals and a printer to the network.

The TIM includes a high-speed radio-frequency modem, an access board that implements the token-passing protocol and a network-control unit that generates statistics and provides network-management functions. Each TIM uses Concord's terminal-server software, which implements the higher layers of the ISO model and provides RS232 and RS449 switching.

The biggest problem in getting the network up and running was the lack of application software for communications since MAP standards are not yet developed. As a result, it was impossible for the DNC system to communicate with the CNC systems controlling the laser punch press and the shear. To solve the problem, software interfaces had to be developed.

The Harvester Works Token/Net LAN instal-

At each spot-welding station, *a robot performs preliminary welding, and an operator adds the finishing touches. The equipment is managed by controllers connected to the network via Concord's Token/Net interface modules (TIMs).*



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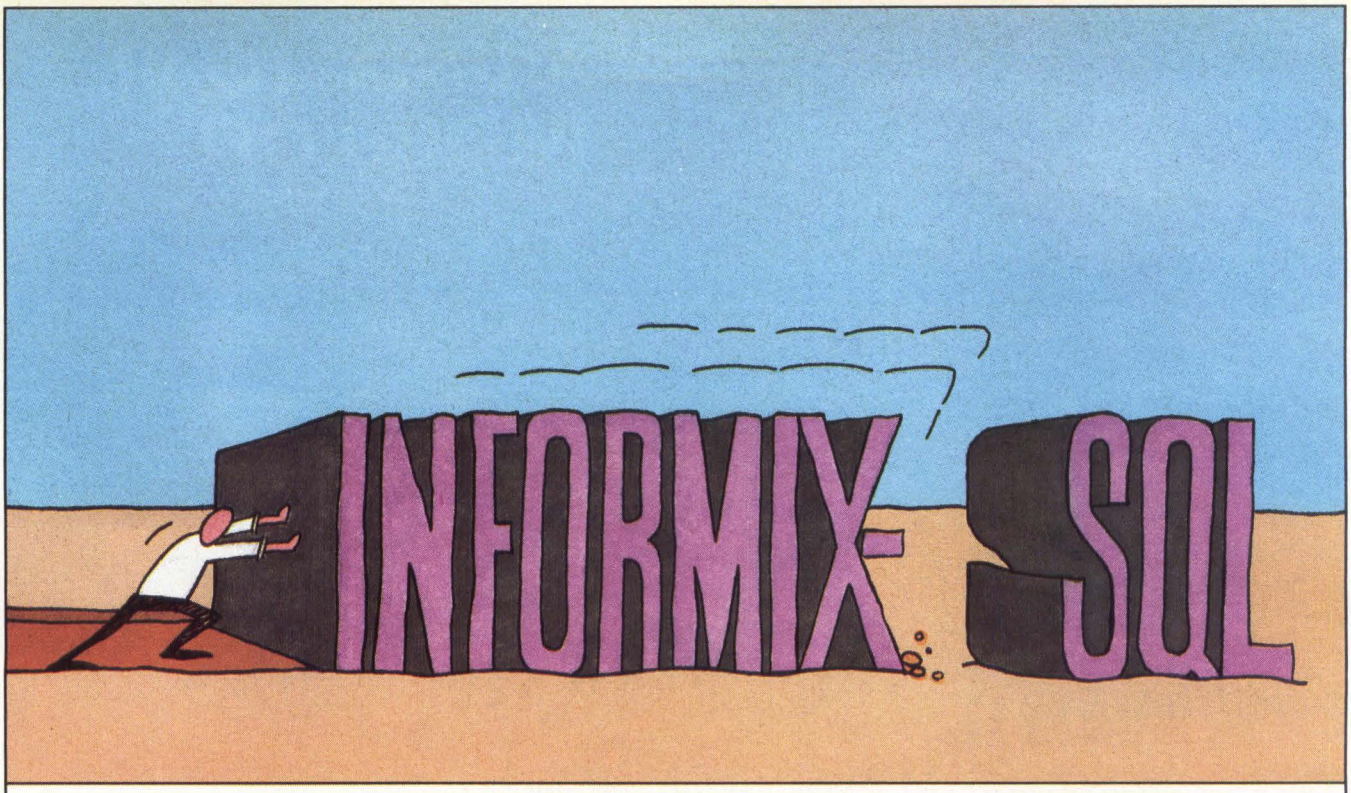

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lation continues to expand. For example, Deere Harvester is installing a computer aided resistance spot-welding system to improve welding quality. When installation is complete, Concord's TIMs will connect three cell controllers on the factory floor to a Digital Equipment Corp. VAX 11/730 minicomputer in the computer room. Each cell controller will in turn manage as many as 16 spot welders. The network will allow engineers to enhance production quality through monitoring and controlling the power and duration of welding along with other parameters.

Network increases flexibility

Deere Harvester also sees other possible benefits through linking DEC VT100 terminals that distribute job instructions to the factory's paint areas. Workers use these terminals to receive instructions and to report production. Each terminal currently connects to a dedicated VAX 11/750 minicomputer via twisted-pair wire and modems. The 11/750 schedules workers' tasks and instructs automated guided vehicles in the paint areas.

The company sees increased flexibility through the ability to access all systems from any location, as the greatest benefit in networking the factory's terminals. Because terminals could automatically log onto either the production or backup VAX system, the current backup bus switch would no longer be needed should the production VAX fail.

Deere Harvester sees other possible applications for the Token/Net LAN. Those under consideration include teleconferencing large meetings, using video cameras for security monitoring of remote areas and providing interactive video service for job training. □

John Mizlo is a system analyst at the John Deere Harvester Works, East Moline, Ill. He was responsible for installing the division's network.

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The biggest problem in getting the network up and running was the lack of application software.

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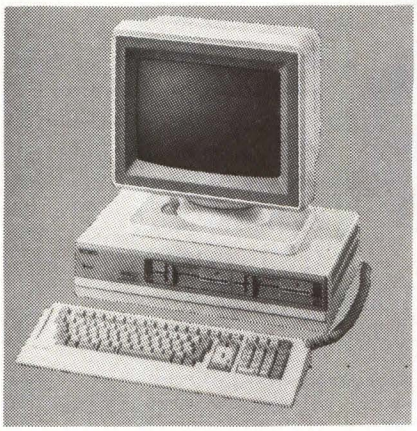

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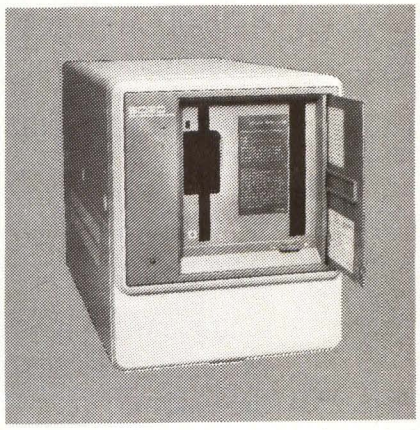

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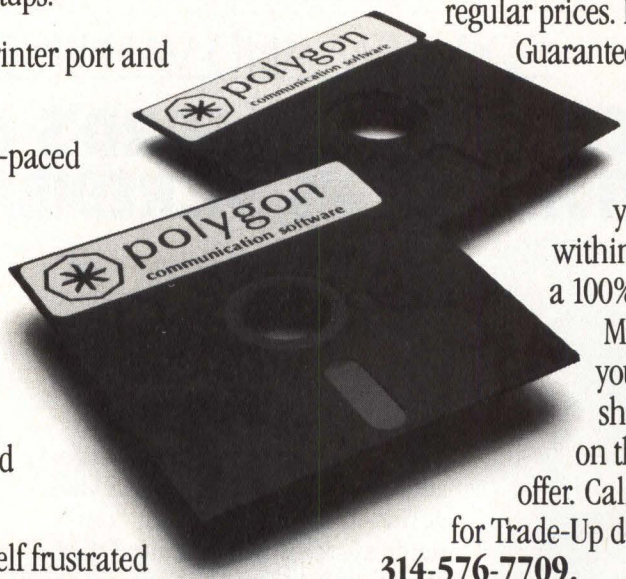

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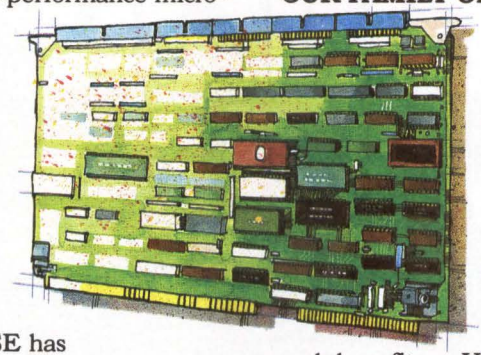

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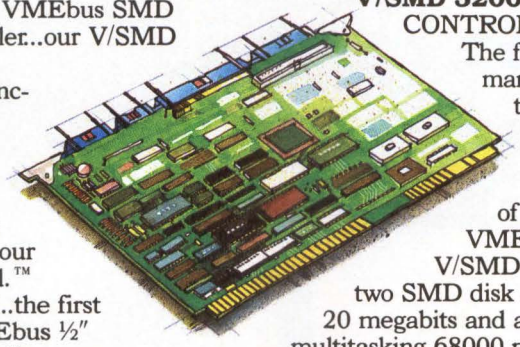

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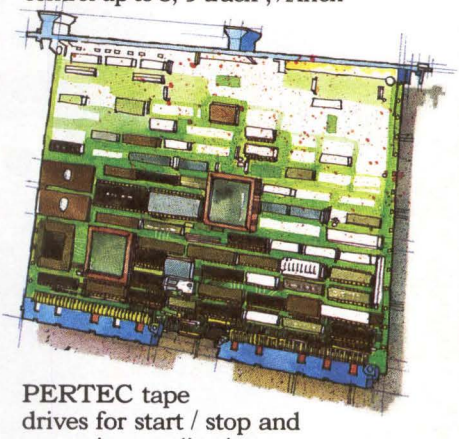
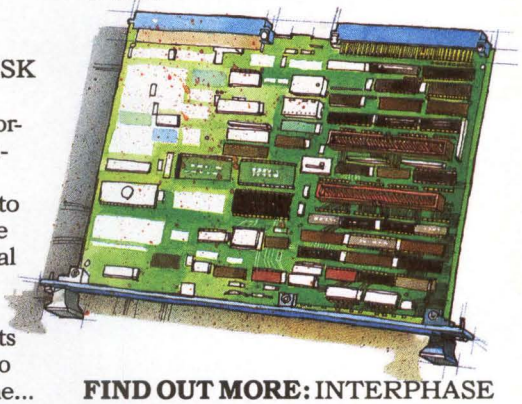
INTERPHASE's latest VMEbus product is a companion to the V/SMD 3200, and opens new VMEbus design options for you. The V/Tape will control up to 8, 9 track , ½ inch



PERTEC tape drives for start / stop and streaming applications. The V/Tape also supports GCR as well as 1600 bpi operations and has ultra fast bus transfer rates at up to 200 ips. Advanced features like 128KB Tape Cache and an on-board 68000 family processor mean it can communicate directly with the INTERPHASE V/SMD 3200 disk controller...cutting your BUS usage in half.



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The C2600 offers OEM's superior capacity and superior performance combined with proven Century Data Systems reliability. For more information contact: Century Data Systems, Product Marketing, 1270 N. Kraemer Blvd., Anaheim, CA 92806 (714) 632-7500.

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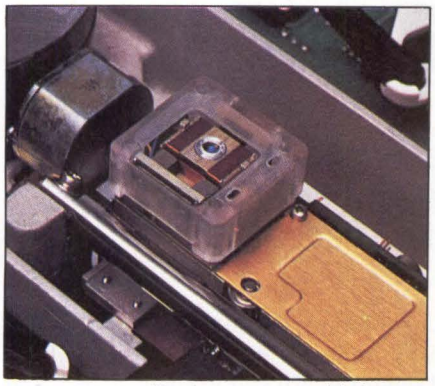
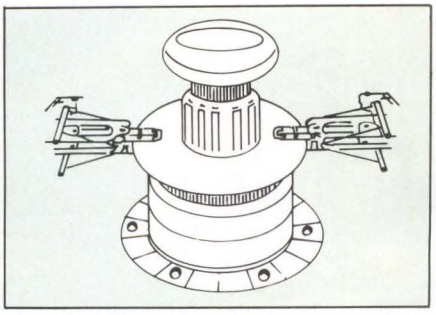
FEATURE HIGHLIGHTS



p. 68 . . . . . *Optic storage shining on*

p. 85 . . . . . *EP on the fast track*



p. 95 . . . . . *Thin film vs. oxide media*

OPTICAL STORAGE SHINES ON THE HORIZON 68
Optical storage technology has finally progressed from promise to product with over 25 companies competing. Our special report looks at the advantages of this new technology, as well as at the hurdles that remain in its way. The article examines the three dominant classes of optical disk drives—OROM, WORM and erasable—and includes a complete list of optical drive manufacturers, products and key specs.

ELECTRONIC PUBLISHING LANDS ON THE DESKTOP 85
This was a boom year for electronic publishing systems, and analysts are predicting a 35 percent annual growth rate over the next few years. One of the most exciting areas of EP is the emergence of low-cost (i.e., under $10,000) systems that combine a microcomputer, a page scanner, a laser printer and EP software on a compact, desktop unit. These systems enable users to combine text, line art and graphics without resorting to a corporate art department or photo-offset printing. Our feature includes a complete list of EP manufacturers.

THIN FILM CHALLENGES OXIDE MEDIA 95
Improvements in magnetic media lie at the heart of advances in disk-drive performance. Standard oxide media, long the mainstay of the hard disk industry, is now being challenged by thin-film media, which includes plated, sputtered and plated with sputtered overcoat versions. The advantages and disadvantages of the various types are critical concerns to manufacturers of disk drives and to system integrators.

MINIS GAIN ON SUPERS WITH VECTOR PROCESSORS 107
The high end of the mini-micro market is getting crowded with an array of new machines called superminicomputers, minisupercomputers and near-supercomputers. One company that claims a Cray-like architecture but superminicomputer prices is Convex Computer Corp. A close look at the architecture reveals a virtual-memory processor with 64-bit data paths and vector accumulators, 128M bytes of main memory and a 60-megaflop speed rating.

OPTICAL STORAGE SHINES ON THE HORIZON

Read-only, write-once and erasable optical disk drives promise voluminous economical data storage, but lack of media standards and software hinders market acceptance

Carl Warren, Western Editor

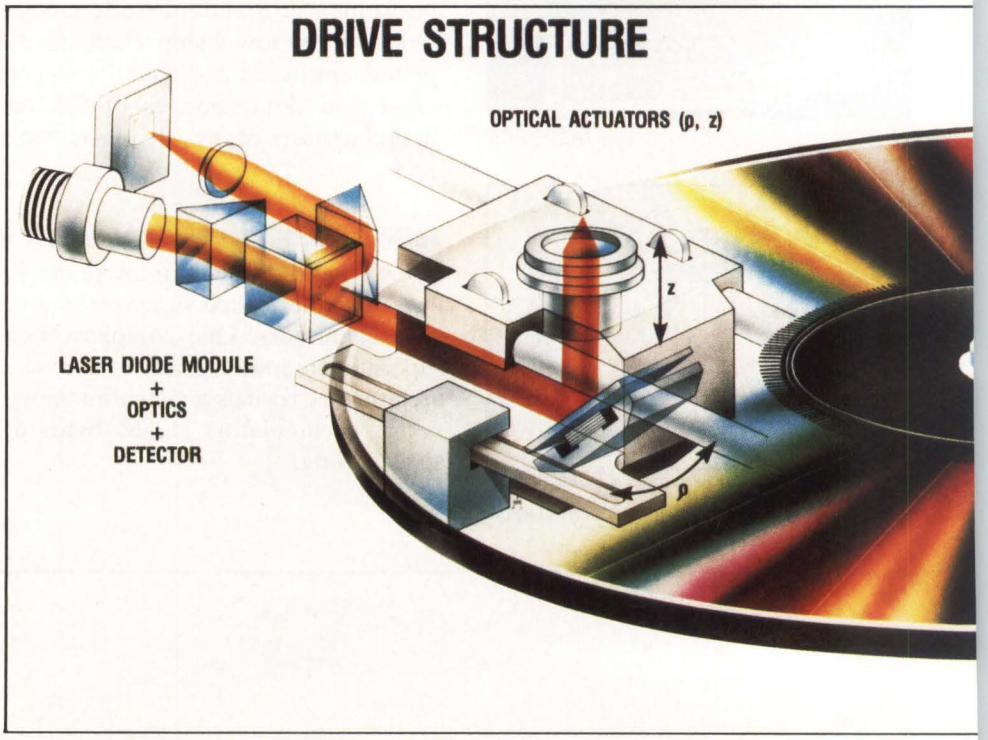
Using special galium arsenide diode lasers, no bigger than a pencil eraser, on exotic rare-earth-based recording surfaces, optical disk drives promise to store from 40M bytes of data on 3½-inch disks to over 2G bytes on double-sided 12-inch disks.

Currently, three distinct classes of optical drives exist:

- Optical ROM (OROM)
- Write once, read many (WORM)
- Write many, read always (WMRA), erasable.

For the near future, OROM devices promise to be the most prominent. WORM drives, available in limited quantity, are still in their infancy and are about 18 to 24 months away from reaching full production. Erasable optical drives are at least four to five years away from full-scale production and market acceptability.

Both WORM and erasable optical disk drives suffer from similar problems. Specifically, even though the basic technology is developed, reliable media is still not available. Several questions regarding the interface and data format remain, and major uncertainties regarding control and



To read and write up to 2G bytes *of data on a 12-inch, double-sided disk, the Alcatel Thomson Gigadisc uses a laser diode with focusing optics mounted on an optical actuator.*

data-handling software exist.

Furthermore, no standards currently exist for data interchange. Interestingly, manufacturers of 12-inch optical products argue that standards aren't needed because their products are being used in niche markets that establish their own standards.

However, that doesn't appear to be the case with 5¼-inch WORM and erasable disk drives. Already, ANSI members are near agreement on a cartridge standard and are looking into the interchange problems as well. Many industry observers concur that 5¼-inch drives will probably enjoy standards well before 12-inch products. This is primarily because 5¼-inch products will be more pervasive than 12-inch drives due to lower cost.

Read only is here today

OROM devices contain prewritten data that can't be written over, much like a phonograph record. The data is mastered from video tape and is written with a laser beam onto a master disk, which in turn is used to press copies. Once pressed, the platters are covered with metal and put in a protective coating to minimize water absorption. The resulting disk contains anywhere from 500M bytes to 2G bytes of data—depending on diameter and number of data surfaces used.

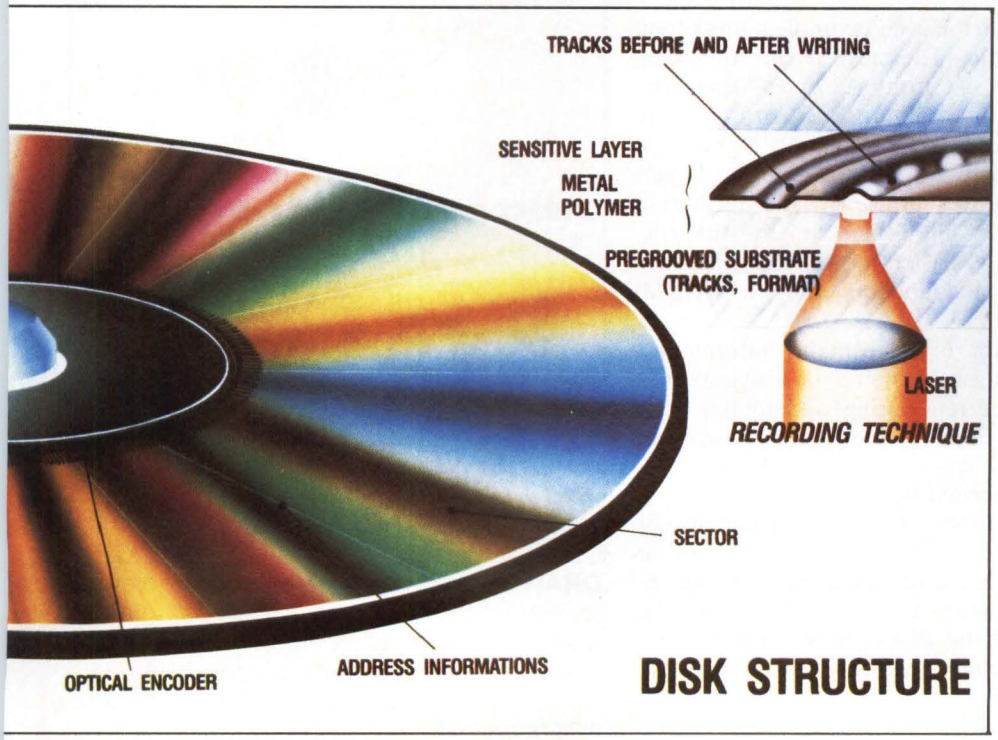
One company, Reference Technology Inc., has developed a 12-inch, 2G-byte OROM system, called the DataDrive Series 2000, for publishing archive information. In addition, the company is an OEM to Hitachi America Ltd. for a 5¼-inch drive that it bundles in the DataDrive 500, a 550M-byte system.

Reference Technology has also developed the necessary software including a keyed information-retrieval package to assist in writing application software, a full text-retrieval package and a complete file-management system. In addition, the company provides a data-preparation service to prepare data for etching onto the optical disks.

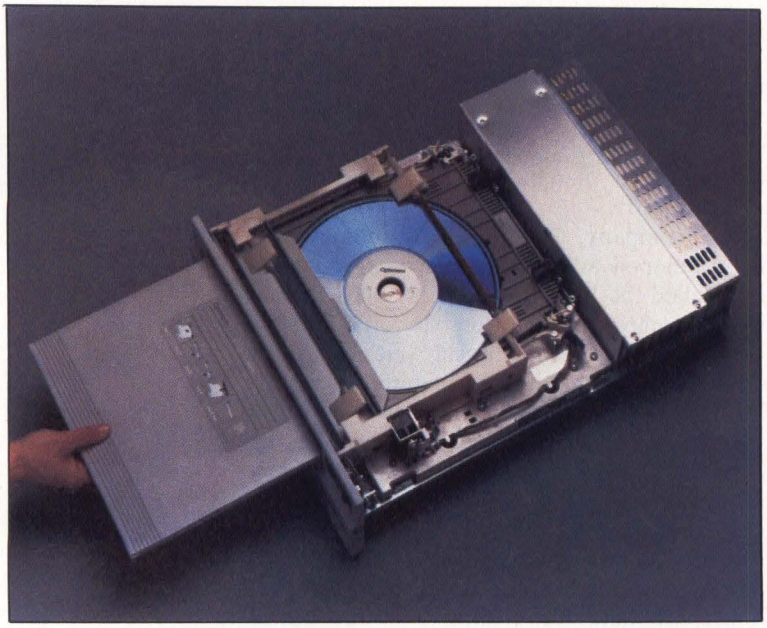
Other companies entering the OROM and data-preparation arena include Hitachi, Sony Corp., Toshiba America Ltd. and Victor Co. of Japan (JVC Brand).

WORM blocks need protection

Even though OROM drives do offer publishers a low-cost method of distributing information (typically about $20,000 for mastering a disk and



Most optical disk media, *such as Alcatel Thomson's Gigadisc, store data in the form of bubbles on the medium's pregrooved surface. A write pulse from the 20-mW laser is absorbed by the sensitive recording layer, and the heat generated decomposes a small part of the adjacent polymer. The resulting gas pressure deforms the recording layer into a bubble, which appears more reflective than the adjacent area and is thus able to be read by a 1-mW laser.*



Storing 1G byte *—or about 100,000 pages of typewritten information—on a single platter, the Optimem 1000 WORM drive uses a 12-inch cartridge and a SCSI interface.*

$6 per copy), optical disk drive manufacturers see the need for WORM and, eventually, erasable capability.

WORM drives are similar in some respects to OROM devices in that, once written, the data can't be changed. However, several complications exist with WORM drives.

For example, data areas have to be protected. As a result, data blocks are provided with a write-protect block that signals the drive electronics to not turn the laser on until an unwritten block is available. The next block, the data block, ranges in size from 512 bytes—the standard sector size used on an IBM Corp. PC—to 1,024 bytes.

Some manufacturers believe that the larger sector size improves efficiency and facilitates error correction, while others contend that the 512-byte sector is easier to work with. Thus, both sizes can be found on different WORM drives.

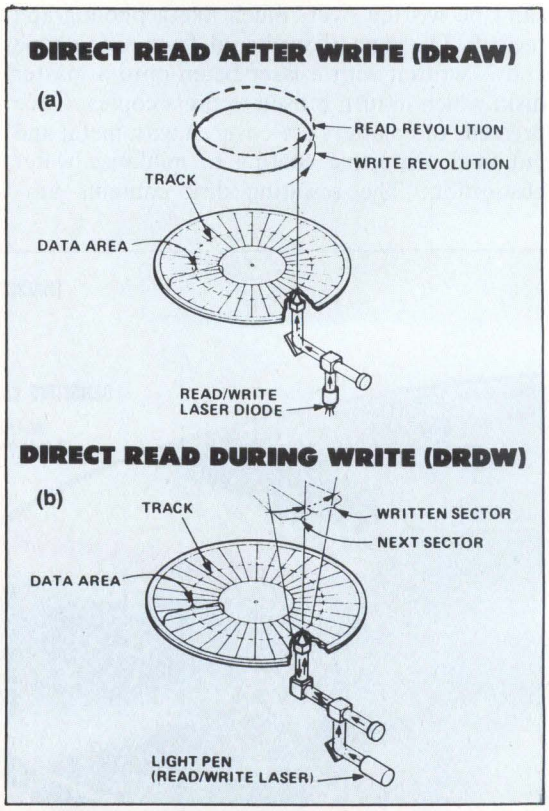
The final data block contains information about the previously written data. For example, if an error occurred during a write cycle, a pointer to the next usable block is written. Additionally, 16 bytes are used to point to new data that is associated with the record.

Further complicating the drive is the choice of media format. Manufacturers use either a spiral track, which is similar to tape format, or concentric ring tracks, which more closely resemble the layout on magnetic disks. Most optical drive manufacturers claim that their drives can use either format.

Laserdrive Ltd., a manufacturer of 5¼-inch WORM drives, uses the spiral tracking method. The company targets low-end applications, such as storage for computers like the Apple Computer Inc. Macintosh, the Atari Inc. ST series and Commodore Business Machines Inc.'s Amiga. Thus, speedy access times aren't a primary consideration.

Designers can use either constant linear velocity (CLV) or constant angular velocity (CAV) technology to maximize drive performance. In the former, the recording density remains constant over the entire disk; thus the disk spins slower at the outside tracks than at the inner. In contrast, a CAV drive maintains a constant revolutions-per-minute rate but the densities are higher at the inner tracks. The CLV method yields high capacities but is expensive because of hardware and software overheads. The CAV method comes closer to the price/performance ratio that most system integrators expect.

The lack of available media is causing drive manufacturers difficulty. Although companies such as 3M, Maxell Corp. of America and Plasmon Data Systems are manufacturing



DRAW recording *(a) requires a full rotation to inspect the previously written data. In contrast, DRDW recording (b) immediately checks to see if the data is correct, thus removing the necessity of an extra rotation, which speeds write operations.*

Introducing The Gold Quadboard®. "The hardware equivalent of 1-2-3®."

Computer Buyer's Guide and Handbook, September, 1985

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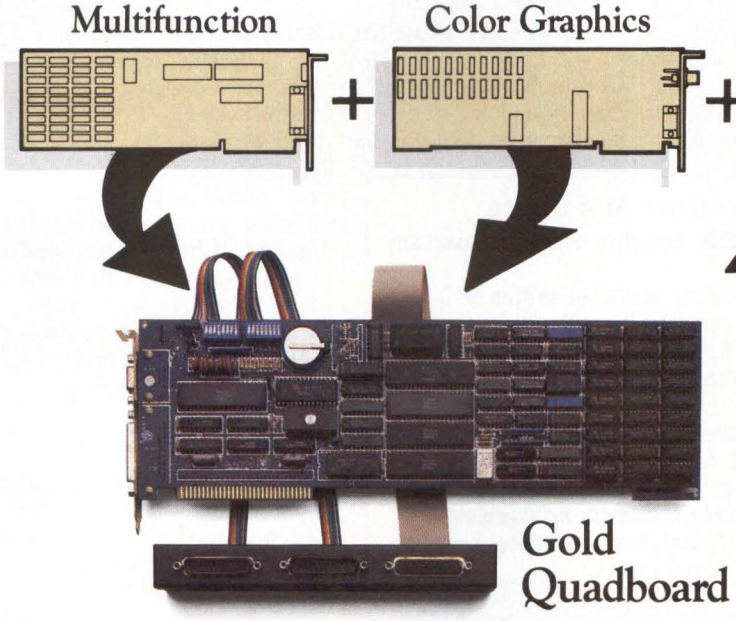

Use Keysaver to protect your data from power outages or misstruck keys, or create keyboard macros to help automate your work. Keysaver even comes with a special security feature that protects your system from unauthorized access.

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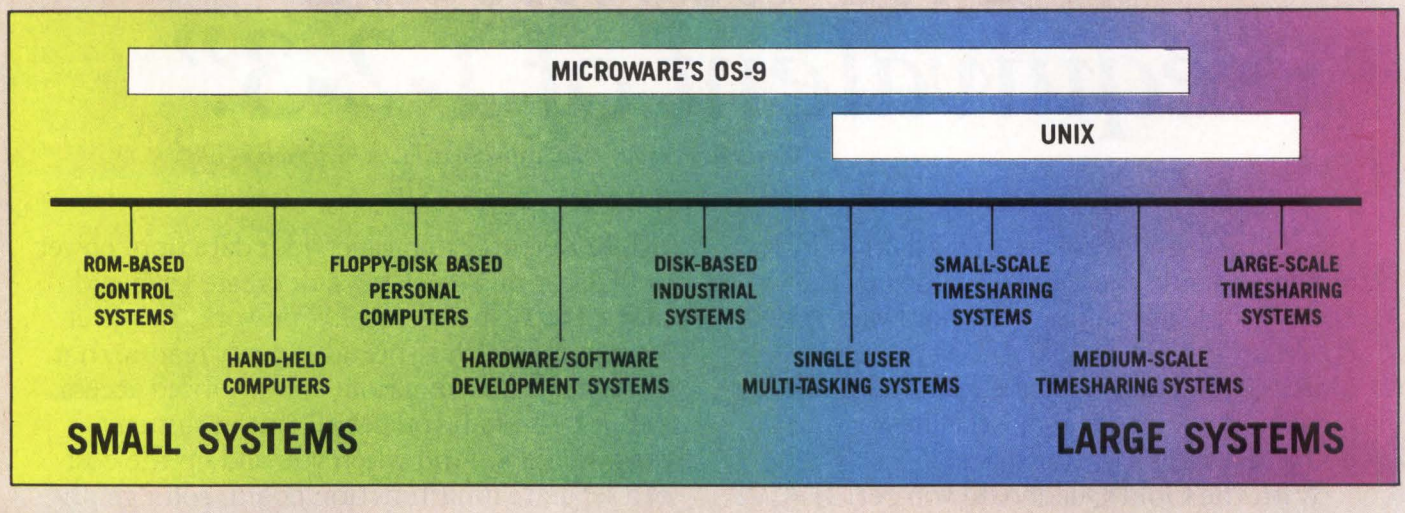
CIRCLE NO. 31 ON INQUIRY CARD

Only Microware's OS-9 Operating System Covers the Entire 68000 Spectrum



Is complicated software and expensive hardware keeping you back from Unix? Look into OS-9, the operating system from Microware that gives 68000 systems a Unix-style environment with much less overhead and complexity.

OS-9 is versatile, inexpensive, and delivers outstanding performance on any size system. The OS-9 executive is much smaller and far more efficient than Unix because it's written in fast, compact assembly language, making it ideal for critical real-time applications. OS-9 can run on a broad range of 8 to 32 bit systems based on the 68000 or 6809 family MPUs from ROM-based industrial controllers up to large multiuser systems.

OS-9'S OUTSTANDING C COMPILER IS YOUR BRIDGE TO UNIX

Microware's C compiler technology is another OS-9 advantage. The compiler produces extremely fast, compact, and ROMable code. You can easily develop and port system or application software back and forth to standard Unix systems. Cross-compiler versions for VAX and PDP-11 make coordinated Unix/OS-9 software development a pleasure.

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Comprehensive support for modular software puts OS-9 a generation ahead of other operating systems. It multiplies programmer productivity and memory efficiency. Application software can be built from individually testable software modules including standard "library" modules. The modular structure lets you customize and reconfigure OS-9 for specific hardware easily and quickly.

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Once an underground classic, OS-9 is now a solid hit. Since 1980 OS-9 has been ported to over a hundred 6809 and 68000 systems under license to some of the biggest names in the business. OS-9 has been imbedded in numerous consumer, industrial, and OEM products, and is supported by many independent software suppliers.

Key OS-9 Features At A Glance

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CIRCLE NO. 32 ON INQUIRY CARD

WORM, OROM and, to a limited degree, erasable media, supplies aren't large and bit-error rates are still in the 10^{-4} range (which, however, can be corrected using error-correction code schemes). Additionally, WORM media can be preformatted and scanned to map defect areas. This map is a list of bad, or unusable, sectors. The controller uses the map information to avoid bad sectors and tracks.

Typically, optical recording uses a precisely focused laser beam to burn tiny pits on a recording platter. The presence or absence of pits, when they rapidly pass under a light beam in playback mode, triggers a photoelectric receptor that translates that presence or absence to electrical signals, which are then transformed into digital data. This technique is used by WORM drive manufacturers.

However, this technology does have drawbacks. Specifically, the pits don't always have precise edges, thus fouling the readback system and presenting non-correctable errors. Moreover, the ragged edges cause a poor carrier-to-noise ratio (CNR).

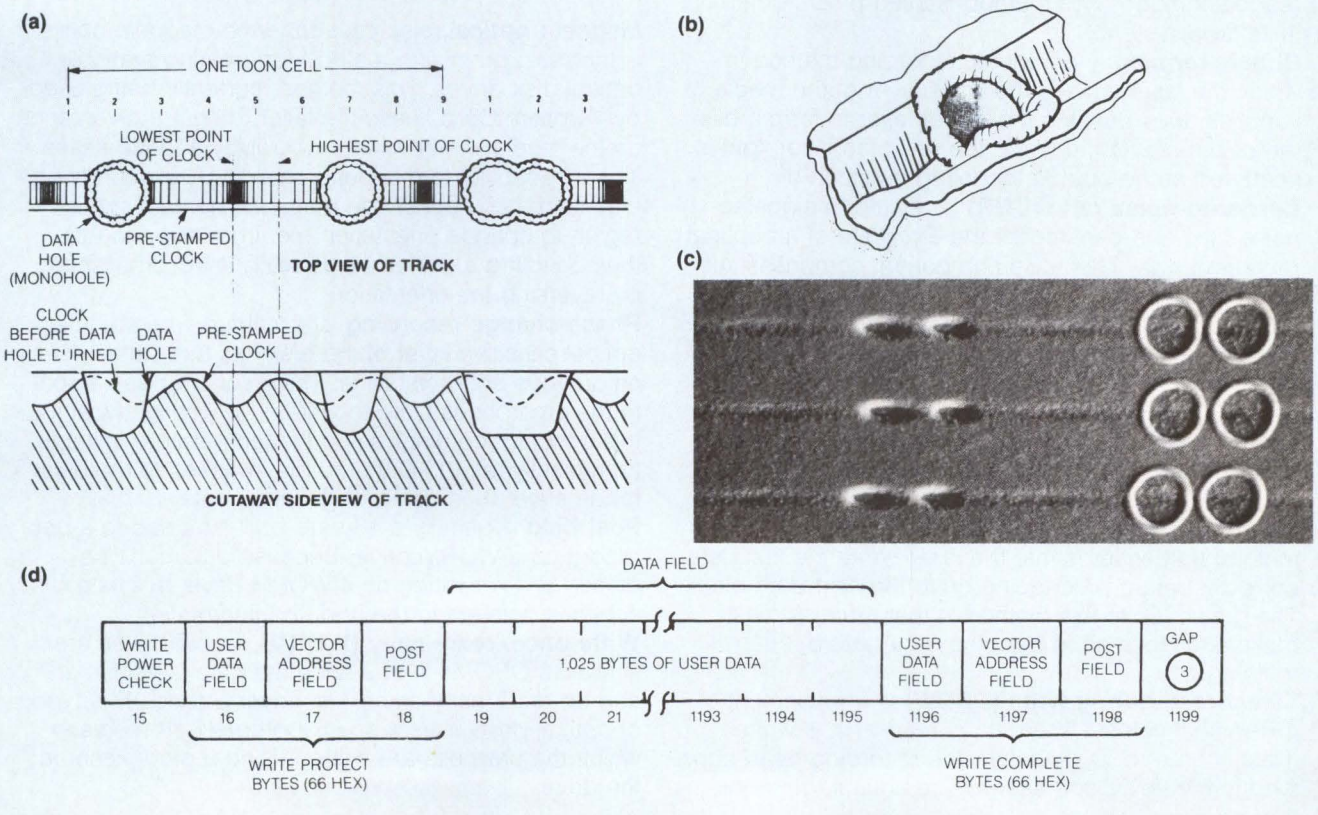
One method of manufacturing media, developed by 3M, that improves reliability is a blistering or bubble-forming technique. With this method, the laser burst raises the temperature of a spot on the media to about 2,000 C, causing the lower layer to vaporize and forcing the covering layer up into a bubble, or blister. The blister has no ragged edges to contribute to surface noise. The readback system senses scattered light from the bubble, which denotes a written bit.

Companies such as Eastman Kodak Co. are also developing optical media. Kodak puts a

Stages in creating WORM media

In a write-once, read-many (WORM) drive that uses an ablative-pit recording method, the media is pregrooved and formatted with clock information (a), and then is burned in, appearing as a hole (b). As shown (c), clock information appears as a series of bubbles (left) and the data as fringed holes (right).

The data is arranged in sectors (d)—much like magnetic disks—except that each sector begins with a write-protect field to prevent overwriting and destroying existing data. The write-protect fields are followed by the user-data field and the write-complete field. The latter points to either a new sector if an error was encountered during writing, or to a new data record if the record was updated.



protective polymer coating over the sensitive recording layer. And, like 3M, the company is exploring a variey of recording methods such as ablative, blister and phase change.

Phase-change recording uses a technique whereby the physical state of the material is changed from a crystalline to an amorphous state to denote a written bit. Reversing the process to change back to crystalline erases the data. Although Sony has more than 10 years of experimentation with phase-change technology, reliable data on media life is still sketchy. It is believed that it is somewhere between three to five years, and possibly 10, depending on how the media is stored. One disadvantage to phase-change media is that it is temperature sensitive and reverts back to a crystalline state at about 100 C.

Magneto-optical media is currently viewed with favor by erasable drive manufacturers. With this media, no physical change takes place in the crystal structure. Rather, magneto-optical disks use high-coercivity media (2,000 to 3,000 Oe) with the magnetic domains in vertical orientation. The laser heats a spot, which lowers the media's coercivity and makes it susceptible to

Glossary of key optical technology terms

Ablative-pit forming is an optical recording method in which the data bit is written by forming a pit, or depression, in the sensitive recording layer of the disk by removing, or ablating, surface material. This is achieved by the laser literally burning a pit in the surface. The difference in surface reflectivity caused by the pitted area is then read as a data bit in readback mode.

Alloying is an optical recording method in which two chemically compatible film layers are heated at specific points by a laser to create an alloyed layer. The difference in reflectivity is then registered as a bit in readback mode. This method is used by DOCdata NV in its tape system.

Bubble forming is an optical recording method in which the laser causes the underlayer of the media to vaporize, thus pushing the upper layer to form a blister, or bubble. On reading, the reflected laser light is scattered at the bubble, denoting a written bit.

Carrier-to-noise ratio (CNR) is related to signal-to-noise ratio and can impact the error rate of an optical recording disk. The noise component comprises substrate inconsistencies, as well as amplifier and laser noise. Typically, for 100 kHz bandwidth of carrier, noise of about 70 microvolts magnitude is read. Thus the optimal solution to CNR problems is to pick a bandwidth somewhere above the associated noise bandwidth that is wide enough to accommodate the data stream, yet narrow enough to avoid generating its own noise.

Direct read after write (DRAW) is an error-detection method that ensures that the laser wrote the last data correctly before proceeding on to the next data block. The drawback to this method is that the disk must make a full rotation to read the data before it can write again.

Direct read during write (DRDW) is a refinement of DRAW technology. The data is read as it is written. Thus, if an error is detected, the recording head can skip to the next good sector. The advantage to this error-detection method is speed because it doesn't require a full disk rotation, as does the DRAW method. The disadvantage is that it requires more sophisticated and expensive light-path technology than that used on DRAW devices.

Optical ROM (OROM) is a type of optical disk technology in which the information (digital data and images) is laser-etched onto the surface of a master disk that is used to press copies. A laser optical system within the drive reads the data. This method of optical storage is currently the most pervasive and is used with digital music in the form of compact disks (CD).

Magneto optical, also called thermo-magneto optic, is the most promising method for creating erasable optical disk drives. This method, currently being used by Verbatim Corp., uses the laser to heat a given spot on the media, which lowers coercivity and increases its susceptibility to magnetic change. A surrounding bias field then causes the magnetic domain in this region to change orientation (i.e. from down to up), thus denoting a written bit. Erasing is accomplished by reversing the orientation.

Phase-change recording is a method whereby the optical sensitive layer of the disk has two states: amorphous and crystalline. The laser changes a spot to the amorphous state to write a bit. The drawback to this optical recording method is temperature instability: typically, at 100 C the media switches to the crystalline state, thus destroying written data.

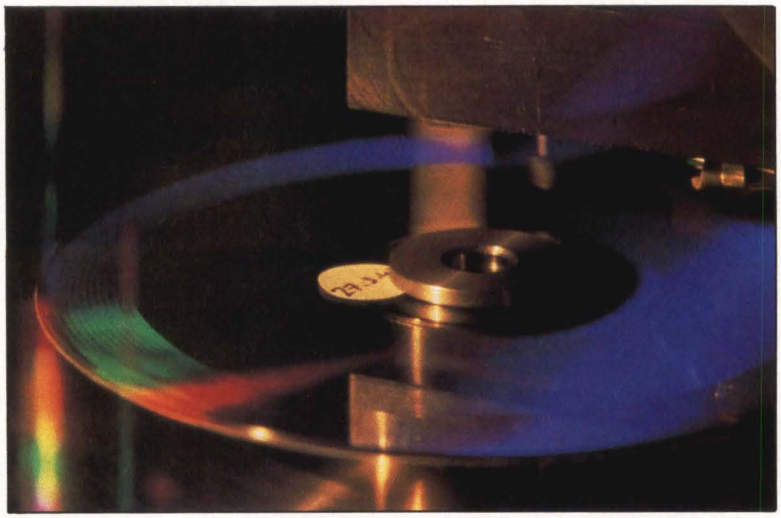
Post field is usually a 16-byte field attached to a data record on a WORM drive. Because data can't be erased or overwritten on a WORM drive, this field contains pointers to the updated information.

Write-once, read-many (WORM) optical drives are similar to OROMs in that once the data is written, it can be read many times, but never erased. This type of optical drive uses a special pregrooved media in which the data bits are written using a diode laser in the drive.

OPTICAL DRIVE MANUFACTURERS

Manufacturer	Model	Type: OROM, WORM, erasable	Capacity (G bytes)	Interface	Surfaces	Data rate	Disk size (inches)	Notes
Alcatel Thomson Gigadisc Inc.	GM 1001	WORM	2	SCSI	2	1.5M BPS at 480 rpm	12	shipping
Cherokee Data Systems	Pathfinder	WORM	.3	ESDI	1	N/A	5¼	samples early '86
Daisar Corp.	unnamed	erasable	.7	ESDI/SCSI	1	N/A	8	plan models by late '86; media developed by Kerdix and Nakamichi
Fujitsu Ltd.	F6441A1	WORM	1.3	SCSI	1	N/A	12	drive available in Japan
	F6441B1	WORM	1.3	similar to ESMD	1	783K BPS	12	drive available only in Japan
Hitachi America Inc.	OC301-1	WORM	1.3	IEEE-488	1	400K BPS at 600 rpm	12	shipping
	OC302-2	WORM	1.3	IEEE-488	2	400K BPS at 600 rpm	12	shipping
	CDR-1502	OROM	.552	8-bit parallel	1	176K BPS	5¼	shipping
Information Storage Inc.	525 WC	WORM	.1	ESDI	1	2.5M bps at 1,800 rpm; can read OROM disks	5¼	shipping
Laserdrive Ltd.	LD33	WORM	.23	ESDI/SCSI	1	1.25M bps at 900 rpm	5¼	under development, due mid '86; spiral track format without sectors; aimed at low-end systems; may move to 1.6 micron track pitch
Nippon Columbia Co. Ltd.	Denon CD-ROM	OROM	.6	8-bit parallel	1	153K BPS	5¼	shipping
Nissei Sangyo America	OD-301	WORM	2.6	SCSI	2	N/A	12	sample quantities
	CDR-2500S	OROM	.552	SCSI	1	N/A	5¼	sample quantities; WORM version in mid '86
North American Philips Corp.	CM-100	OROM	.6	8-bit parallel	1	1.41M bps	5¼	shipping
Optical Storage International	Laserdrive 1200	WORM	2	SCSI	2	1.5M BPS at 480 rpm	12	shipping
Optimen	Model 1000	WORM	1	SCSI	1	5M bps	12	shipping; 5¼-inch model by mid '86
Optotech Inc.	Model 5984	WORM	.488	proprietary; ESDI/SCSI	2	2.2M bps at 1,200 rpm	5¼	shipping; provides development software for file management
Reference Technology Inc.	Datadrive 500	OROM	.55	IBM PC parallel	1	150K BPS	5¼	shipping
	Datadrive 2000	OROM	2	SCSI	2	247K bps	12	shipping
Sony Corp. of America	CDU-1	OROM	.54	8-bit parallel SCSI	1	150K BPS	5¼	uses CLV; 200 to 530 rpm
	WDA-2000	WORM	1	SCSI	2	N/A	8	shipping in small quantities
	WDA-3000	WORM	2/3.2	SCSI	2	N/A	12	shipping in small quantities
Toshiba America Inc.	DF-050	WORM	.5	SCSI	2	2.5M bps at 900 rpm	5¼	shipping in Japan
	DF-0450	WORM	3.6	IEEE-488	2	2.5M bps at 900 rpm	12	shipping in Japan
Verbatim Corp.	prototype	erasable	.04	undefined	1	N/A	3½	prototype planned for '87
Victor Co. of Japan	JVC brand model	OROM	.7	N/A	1	N/A	5¼	expected to ship early '86

Key:
OROM = optical read only memory WORM = write once, read many BPS = bytes per second bps = bits per second



To produce optical media, *Plasmon Data Systems uses a two-stage process. The first is to create the "moth eye" structure, the grooves and the preformat information. The subsequent step is replication, including molding and metallizing the substrate disk.*

magnetic reorientation by a surrounding bias field. Bits are erased using the same process.

Magneto-optical media is easier to make because manufacturers can borrow from methods used in creating sputtered vertical media, as well as processes developed for WORM media. Moreover, bit-error rates are closer to those of magnetic media.

One company currently developing magneto-optical drives is Verbatim Corp., which this past summer demonstrated a 3½-inch, 40M-byte model. Similarly, start-up Daisar Corp. is developing an 8-inch, 700M-byte version that it plans to begin sampling by the end of 1986. The Daisar drive uses media developed by sister company Kerdix Inc., who is borrowing technology developed by Nakamichi U.S.A. Corp. The media was originally designed for erasable-media audio systems.

ECC improves reliability

Of great concern to drive manufacturers and system integrators is the error and defect handling on optical drives. The method used by Optical Storage International (OSI) centers on a direct-read-during-write (DRDW) approach to detect errors. This technique reads back the data the moment it is written and compares it to the data in the write buffer. If an error exists, a new section of disk is chosen. This approach differs from so-called direct-read-after-write (DRAW) drives, which read after the writing is performed, thus necessitating a full rotation of the drive before a new area can be written.

But most drives perform error handling after the fact—on read back. When an error is detected, the system attempts to correct it using a polynomial factor that is set to correct a given number of errors over a specified burst period. In addition, the ECC circuitry and associated firmware must account for the interleave factor, or staggering of sectors, as well as loss of signal synchronization.

Reed-Solomon codes are capable of correcting single or multiple errors. An implementation of this in silicon has been developed by Data Systems Technology. The chip uses an interleaved Reed-Solomon code that can handle up to three interleaves, or, by using several chips in parallel, an interleave factor of 3^N, where N is the number of chips used. Moreover, the chip can accommodate up to 669 bytes per physical sector, or 669^N with additional chips.

Depending on the microprocessor used and the number of errors encountered, error-correction times vary. For a 12-MHz, 8-bit processor encountering eight errors, the typical correction time is 7.6 msec. Implemented with full buffer management and an enhanced small device interface controller or a small computer systems interface, error-correction times drop, and raw bit error rates decrease from 10^{-4} to an acceptable 10^{-12} on optical drives. Although the correction time may appear excessive, using an intelligent interface hides the operation from the user; thus corrected data is delivered in about the same time as is non-corrected data.

Interface is critical

Regardless of the type of optical drive, interfacing is the prime concern to system integrators.

Drive manufacturers are considering using either ESDI or SCSI. There is some thought given to an ESDI/SCSI combination. This latter possibility has merit because ESDI is a device interface and SCSI is a system interface.

The intended goal of an interface is to make the drive characteristics transparent to the system and to the user. Thus, all interface approaches remove most integration burdens from the system integrator. For example, it is expected that with ESDI, existing Winchester controllers can be used in an optical system by changing the ROM code. SCSI can be similarly employed.

Several manufacturers, as shown in the accompanying table, are already using SCSI. On the other hand, some manufacturers, such as Information Storage Inc. (ISI), opt for ESDI.

The advantage of SCSI over ESDI is that the drive can be easily matched to a system via a host adapter rather than a complete controller. Optimem, for one, uses a SCSI controller with bit-slice processors. Included on the controller is an interleaved Reed-Solomon code for error detection and correction. The Optimem SCSI controller also implements a 4K-byte buffer (four sectors), which allows a continuous flow of data.

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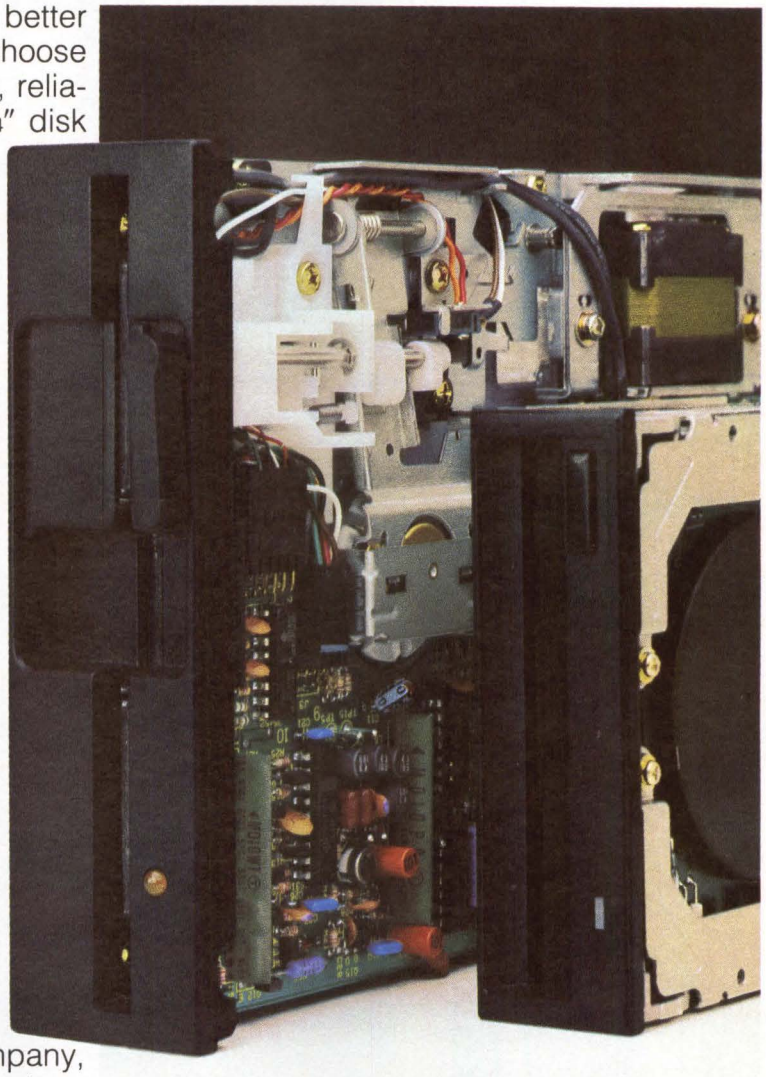

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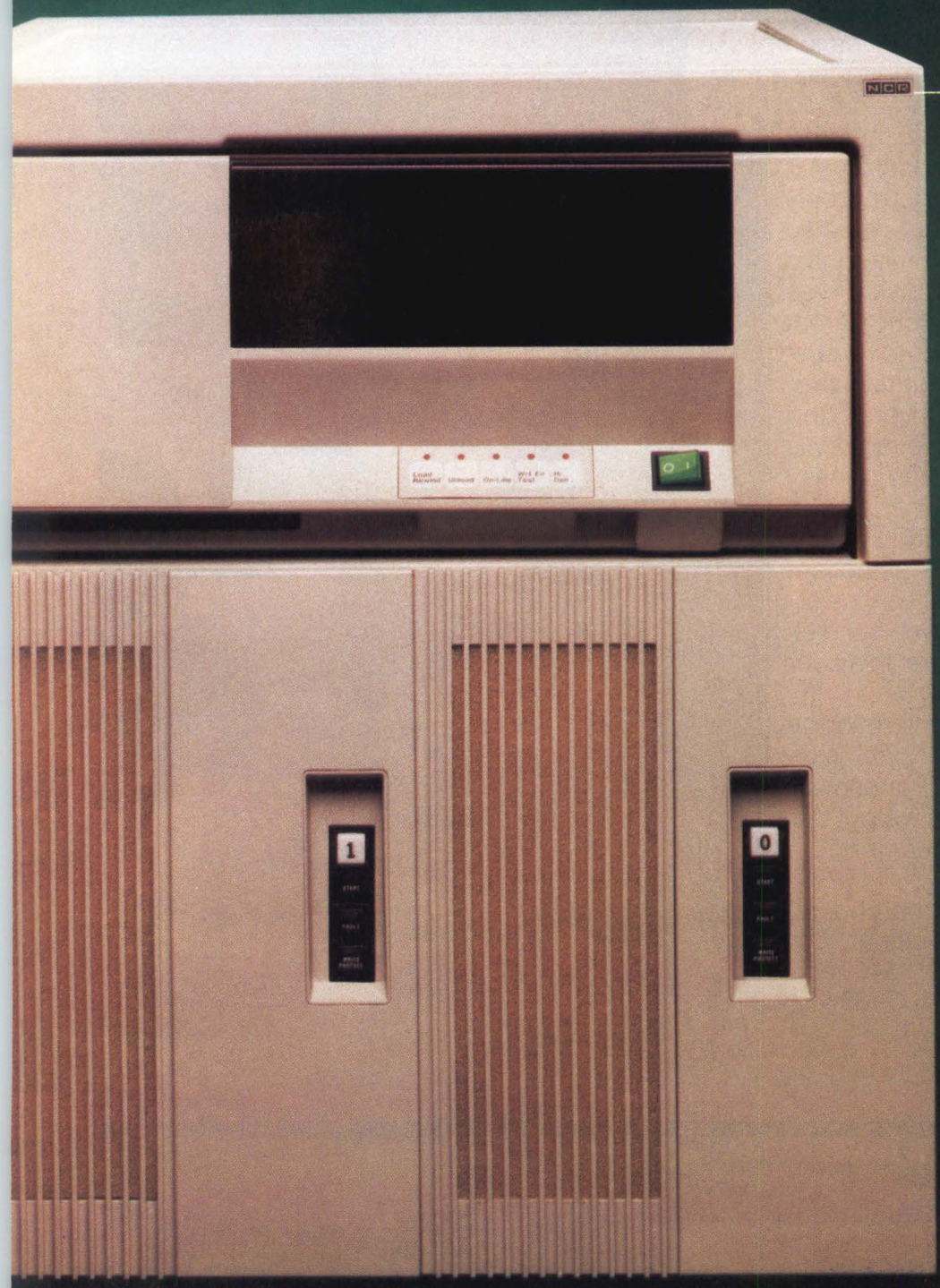

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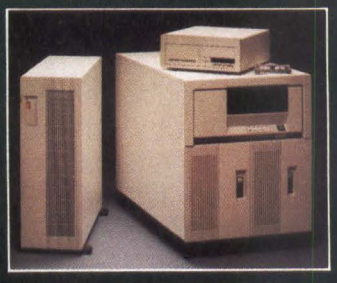

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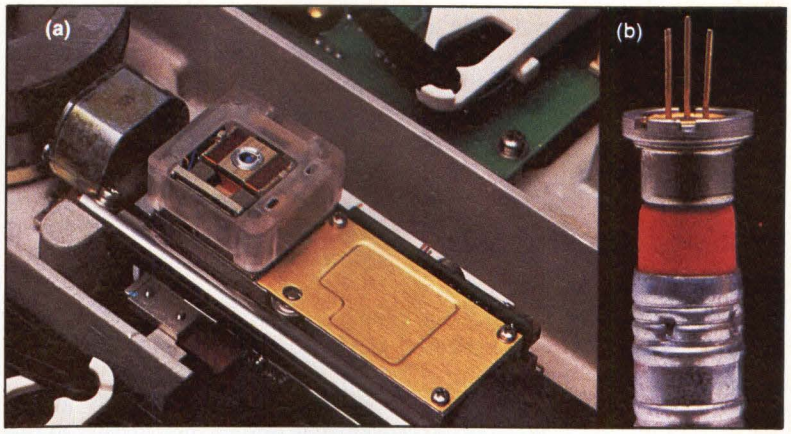
ESDI advantages are similar to those of SCSI, but it isn't as well defined for optical implementations as is SCSI. It is expected that by mid-1986 the specification will be fully defined and numerous semiconductor companies will be making ESDI chip sets.

An important aspect of the SCSI approach, as opposed to device- and host-specific controllers, is that many of the tough technical details of the drive are transparent to the user/integrator. The system integrator thus has to deal only with the data-transfer rate, which can be configured either for 5M bits per second or 10M bps.

Software remains a problem

Most operating systems don't recognize devices with 15,000 tracks per inch and the need to turn lasers on and off in critical time patterns. For OROM devices, the problem isn't as critical as in WORM or erasable devices. The latter two require precise timing and control over the laser and the spindle speed. In addition, WORM drive



Encased in a light-path housing *that mounts on the head actuator (a), the semiconductor diode laser used in the OSI LaserDrive is no bigger than a pencil eraser (b), but is capable of generating 20 mW of laser power to create pits in the medium surface.*

Companies mentioned in this article

Alcatel Thomson Gigadisc Inc.
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Franklin, Mass. 02038
(617) 528-8890
Circle 370

Cherokee Data Systems
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Daisar Corp.
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BA Venlo, Netherlands
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(408) 496-3236
Circle 385

Optimem
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Santa Clara, Calif.
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Verbatim Corp.
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Victor Co. of Japan (JVC Brand)
4-1 Nihon Bashi-Honcho
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Circle 394

Currently, none of the software houses that develop operating systems are providing optical disk support.

software must detect that a region has been previously written, and recognize post fields to locate pointers to new data. Furthermore, full file management and information retrieval have to be built in.

Because companies like Information Storage and Optotech Inc. are offering 5¼-inch WORM drives for the IBM PC/XT, they have developed supporting software that operates with MS-DOS.

ISI, for example, has ISDOS, which is a sophisticated device driver that installs in the Configure system file (CONFIG.SYS) on the PC. This file is used by MS-DOS to attach foreign devices such as optical disk drivers to the system.

One function of ISDOS allows mounting of the data file. This is necessary due to the limitations of MS-DOS, which cannot request data beyond a 32M-byte limit. Moreover, the MOUNT function also recognizes most recent versions of files, thus removing the need for the user to specify which files are new.

Similarly, Optotech offers an IBM PC support package that provides such disk I/O primitives as open, close, read, write and seek. In addition, it allows for error- or fault-reporting of the optical system. This package assists system integrators in developing software that uses the optical disk.

OSI is also taking the full system approach, offering a complete range of system-level and application-development software. Additionally, because the OSI LaserDrive 1200 employs a SCSI interface/controller, the company has implemented a rich set of SCSI commands, including message system, reserve and release, and logical unit and block address functions. The OSI system is the first full implementation of the SCSI intelligent interface and command set.

Currently, none of the software houses that develop operating systems are providing optical disk support. However, companies such as start-up Guaranteed Software, along with the previously mentioned manufacturers, are developing file-handling products for, in most cases, the IBM PC. □

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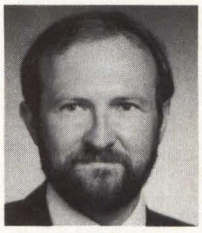

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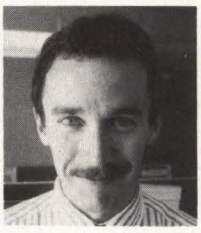

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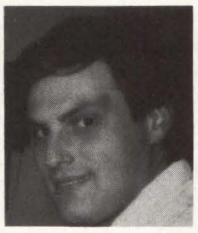

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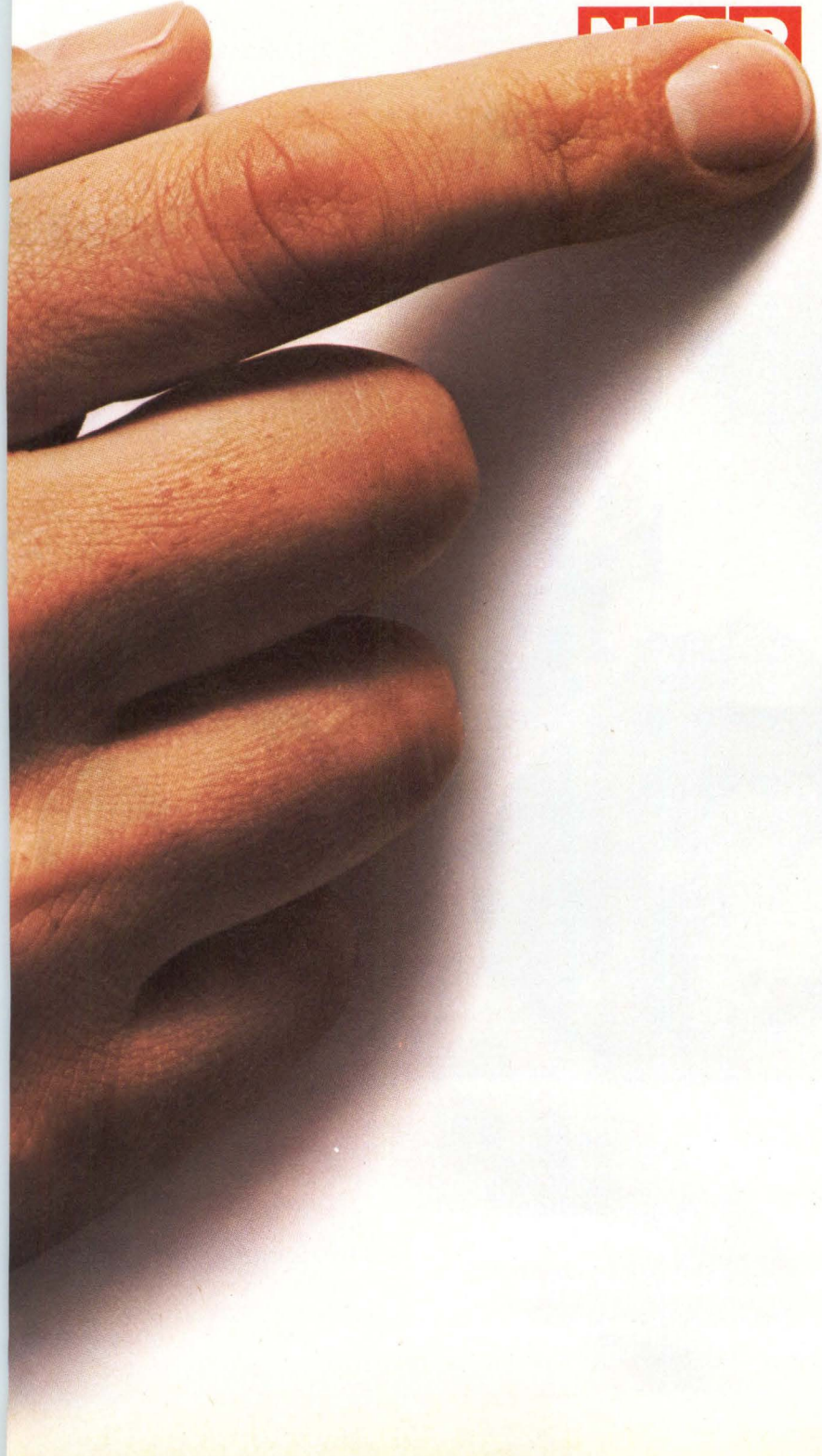

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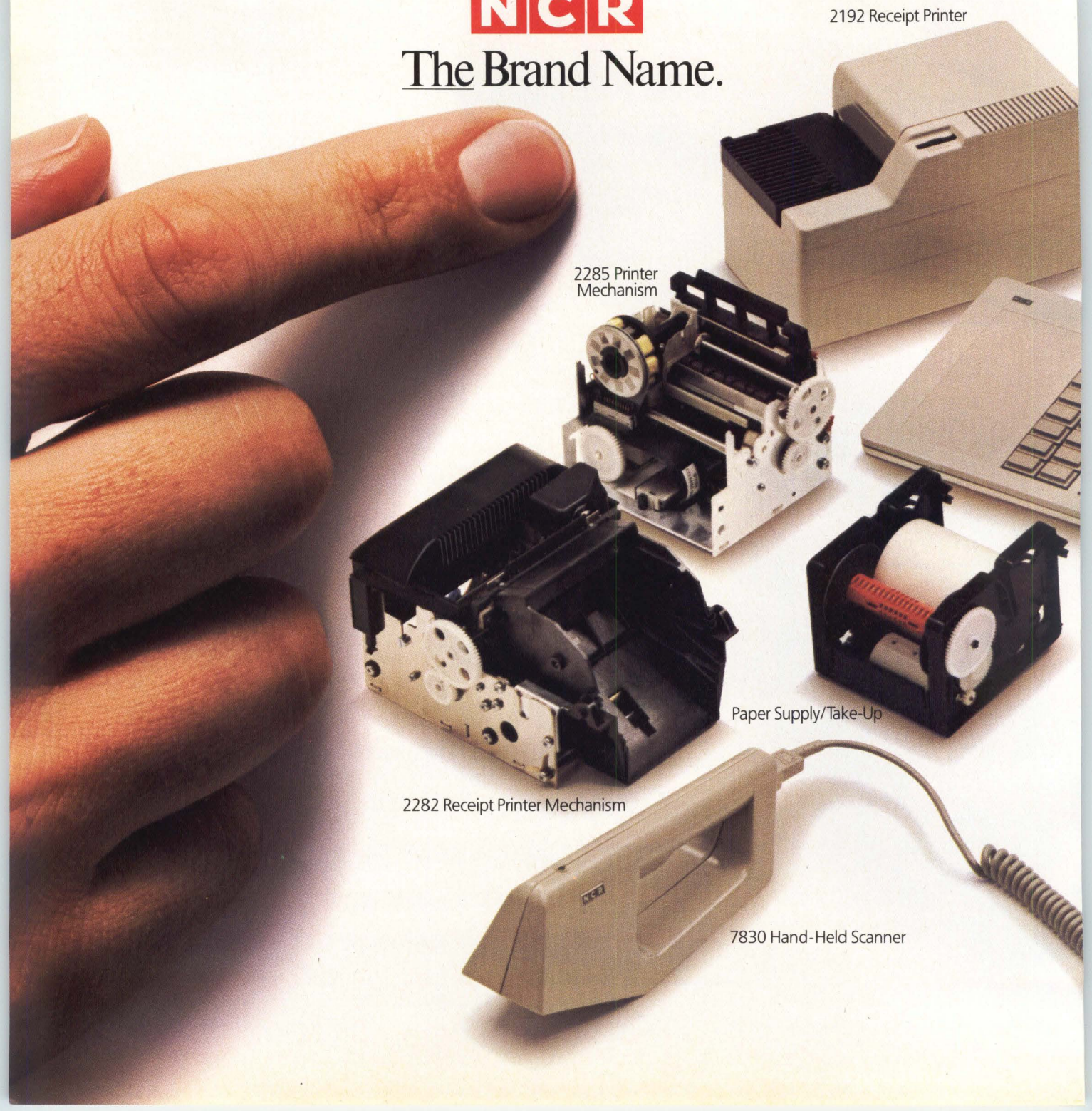

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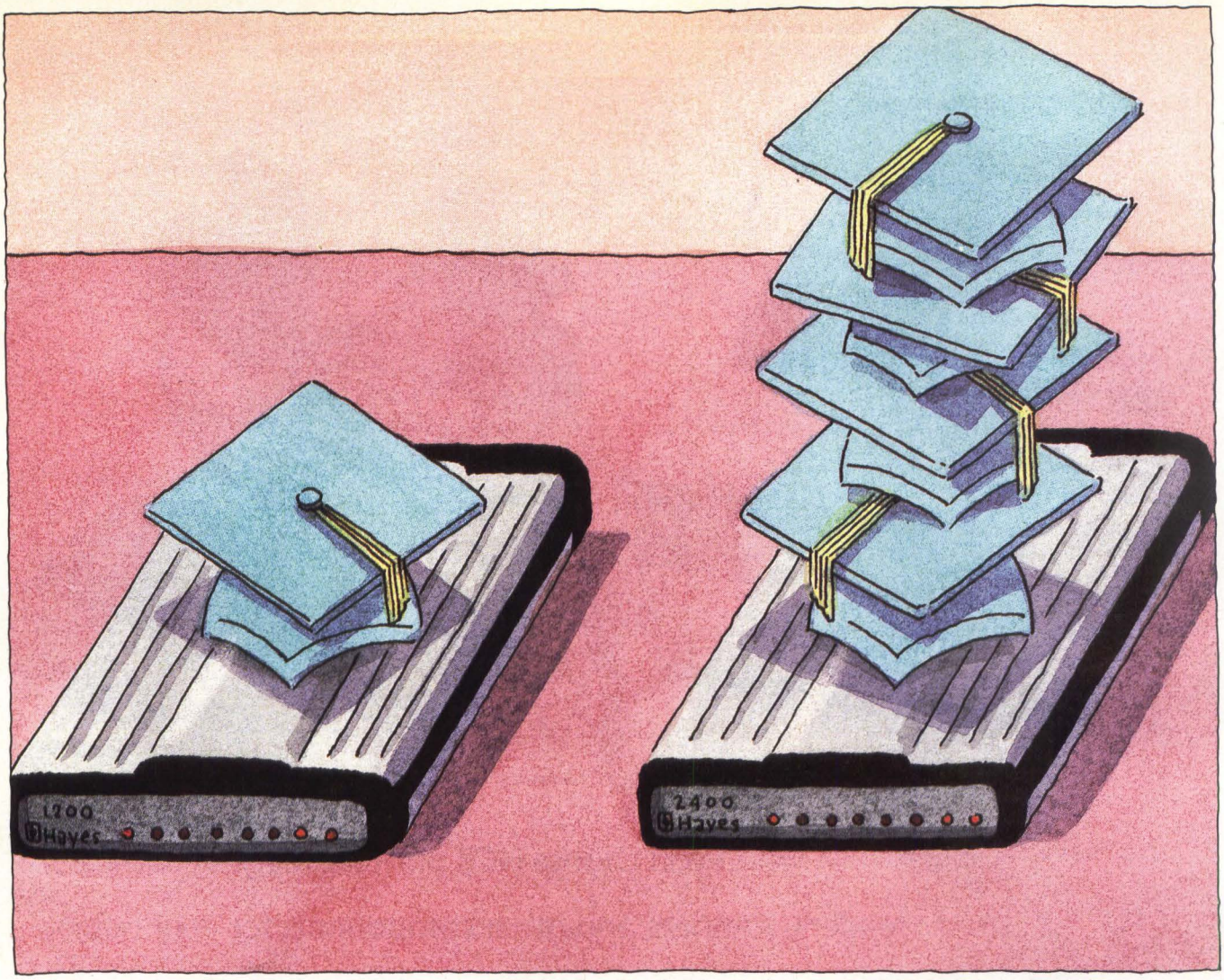

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ELECTRONIC PUBLISHING LANDS ON THE DESKTOP

By combining microcomputers, page scanners and laser printers with specialized software, electronic publishing challenges traditional printing methods

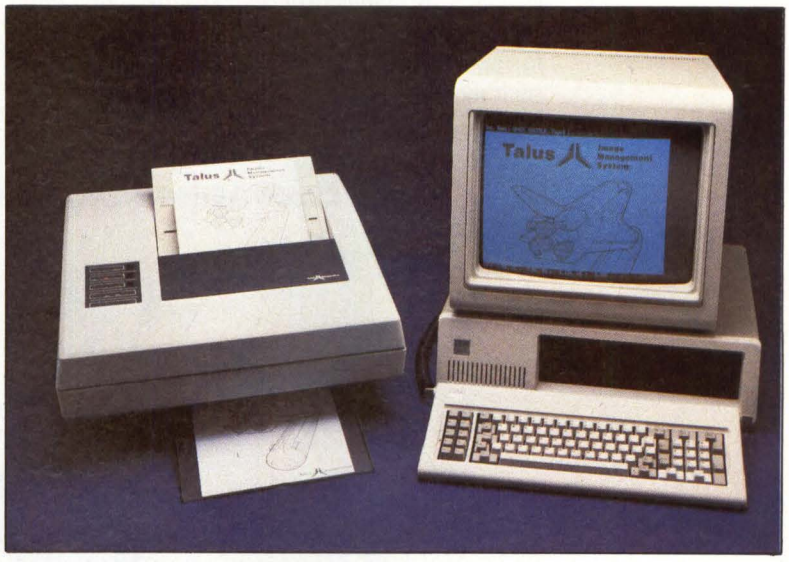
Jerry Borrell
Senior Western Editor

Microcomputer-based electronic publishing (EP) systems produce output that rivals traditional printing technologies in quality. Costing less than $10,000, low-end systems—integrating a microcomputer, a page scanner, a laser printer and EP software—enable users to combine text, line art and graphics without resorting to a corporate art department or photo-offset printing. High-end systems—in the $100,000 range—integrate high-quality photographic reproduction and typesetter-ready output.

The potential market for EP systems is vast—a significant slice of the 7 percent to 10 percent of corporate revenues devoted to publishing activities, contends Bruce Blumberg, manager of printers and networking at Apple Computer Inc. Whatever the future, today's EP market is already on a fast growth track. Ajit Kapoor, director of EP at Dataquest Inc., San Jose, Calif., foresees 35 percent annual growth for the market through 1988. He estimates total sales rising from $233 million in 1984 to $1 billion in 1988.

Jay Prakash, vice president for computer aided design/computer aided manufacturing at Strategic Inc., Cupertino, Calif., predicts 37 percent total annual market growth through 1989. Prakash breaks the market into three segments and sees the highest annual growth rate, 51 percent, for a CAD technical-illustration segment. Sales of mid-range EP systems, such as Interleaf Inc.'s OPS-2000 (MMS, November 1984, Page 137) will exhibit 24 percent annual growth, with low-end, business-application systems showing 12 percent annual growth.

The market success of EP systems hinges on developments in four areas: hardware and software for text and graphics input, interface software, packages that manipulate text and graphics, and laser printers capable of both alphanumeric and graphics output. EP hardware and software can be further categorized as serving desktop/personal-publishing systems or in-plant systems. Defined by user needs, the systems differ in amount and quality of output, graphics-handling capabilities and type of documents they handle (including technical documents, proposals and memos.)



A desktop EP system *from Corporate Data Sciences integrates Talus' 200-dpi facsimile-based page scanner with image-processing software.*

An EP system must accept data files from word processors or terminals; hard copy comprising text, line art and graphics; and documents created on other EP systems. EP users

"want to integrate multiauthor, multisystem documents to the input stream of publication," explains Bob Baynor, vice president of Xerox Corp.'s Electronic Publishing Group.

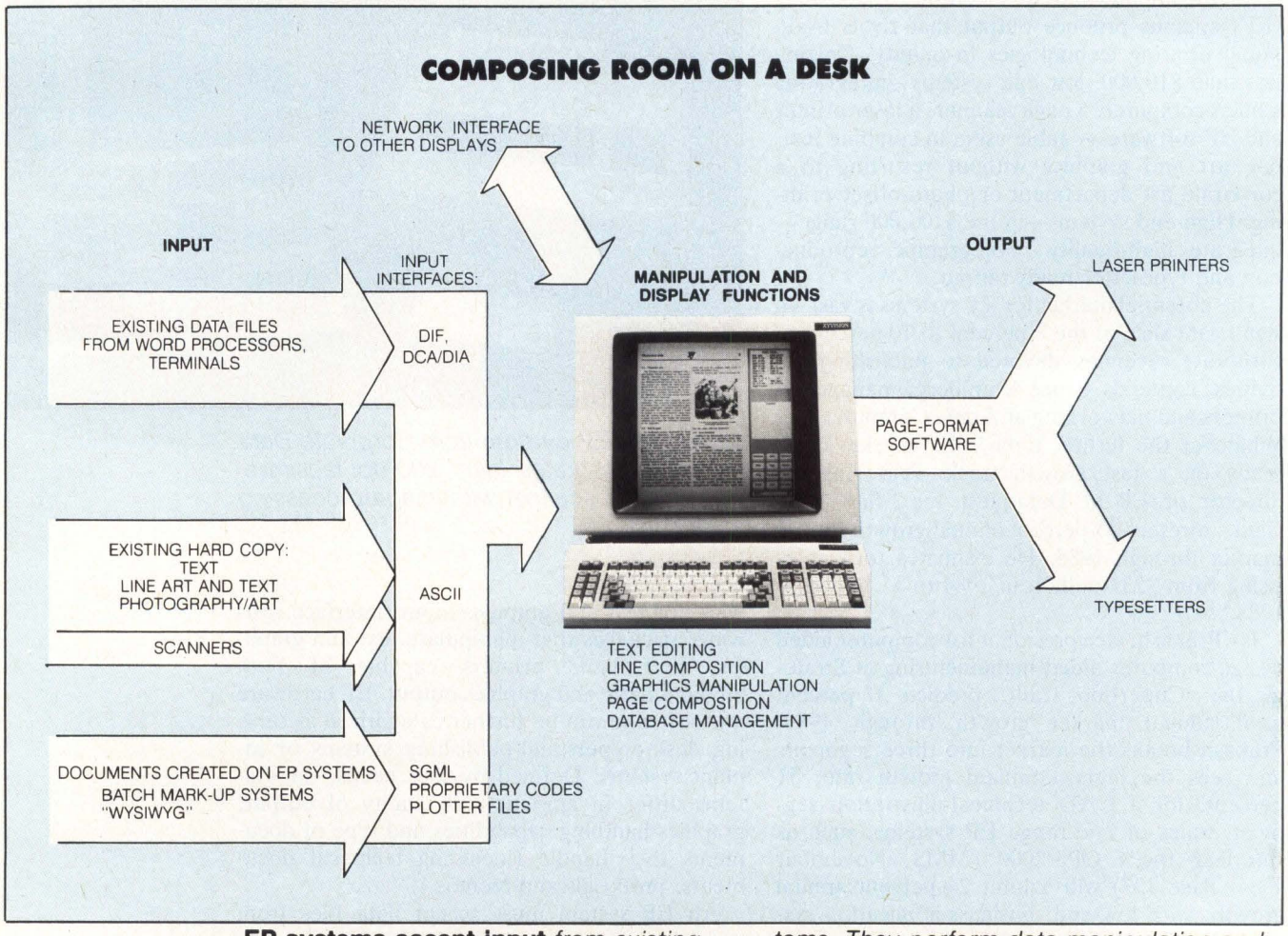
But this input variety presents barriers to system integrators. For example, no EP system provides access to all types of data files. Compugraphic Corp.'s new file translator is the exception to this rule, contends James Klauber, senior product manager for EP systems, in that it does provide universal file acceptance. Other EP system vendors develop interfaces as required by customers.

The problem of incompatible file formats has prompted the promulgation of standards proposals. Proposed by the Graphics Communications Association, standard generic mark-up language (SGML) provides generic codes by which typesetters automatically recognize the content and format of files. Document-format standards, such as IBM Corp.'s Document Content Architecture (DCA) or the Navy's Document Interchange Format (DIF), similarly provide codes that identify the content and format of electronic documents. The standards permit communications between different types of word-processing equipment.

Digitizing takes two approaches

EP users working with text, line art and graphics require digitizing hardware. EP systems take two approaches to this problem: optical character recognition (OCR) devices for text entry and optical scanners for graphics. Both benefit from low-cost charge coupled devices (CCD)—semiconductor sensors that have displaced higher cost tube-based image-capture systems.

CCDs are implemented as linear arrays in drum or flatbed scanners. Scanner vendors Datacopy Inc. and Ricoh Corp. use a flatbed approach, requiring the optics subsystem to move over the copy, as in commercial photocopiers.



EP systems accept input *from existing data files; hardcopy, including text and art; and documents created on other EP systems. They perform data-manipulation and display functions and send formatted pages to a laser printer or typesetter.*

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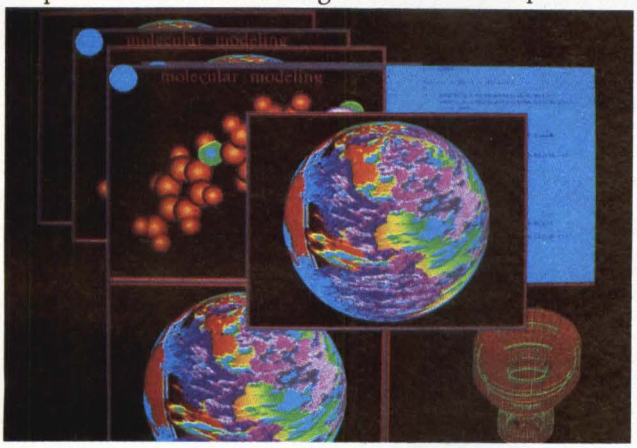

LEX 90's exclusive Virtual Windows functionality allows real-time *color* window management of up to eight user-defined windows.

And its cost-effectiveness excites executives. Which makes it look very good indeed. For example:

Every model in the LEX 90 family has the same basic components which use the latest bit-slice technology for rapid execution of complex graphics calculations.

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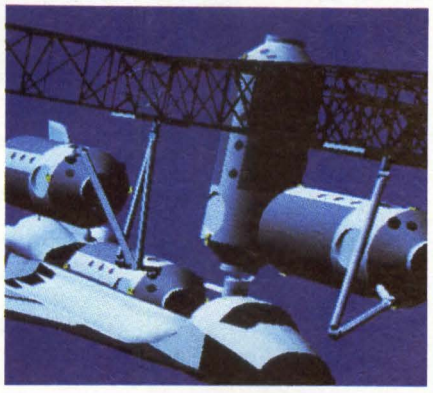

This space station model, courtesy of Martin Marietta, was created with Lexidata's SOLIDVIEW display technology, and GEOMOD™ application software from SDRC.

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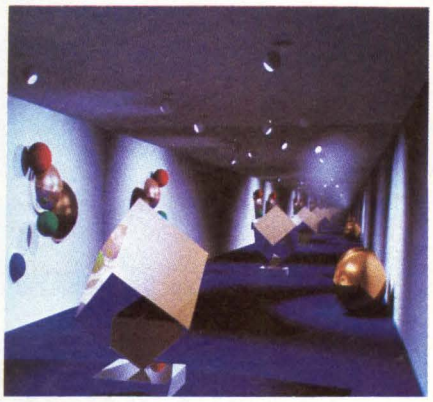

This gallery "exhibits" LEX 90's true color capability and appears courtesy of Cornell University's Program of Computer Graphics.

For a good look at the LEX 90 family and its expanding capabilities, call us at 1-800-472-4747. In Massachusetts, call 617-663-8550. Or write Lexidata Corporation, 755 Middlesex Turnpike, Billerica, Massachusetts USA 01865. TWX: 710-347-1574.

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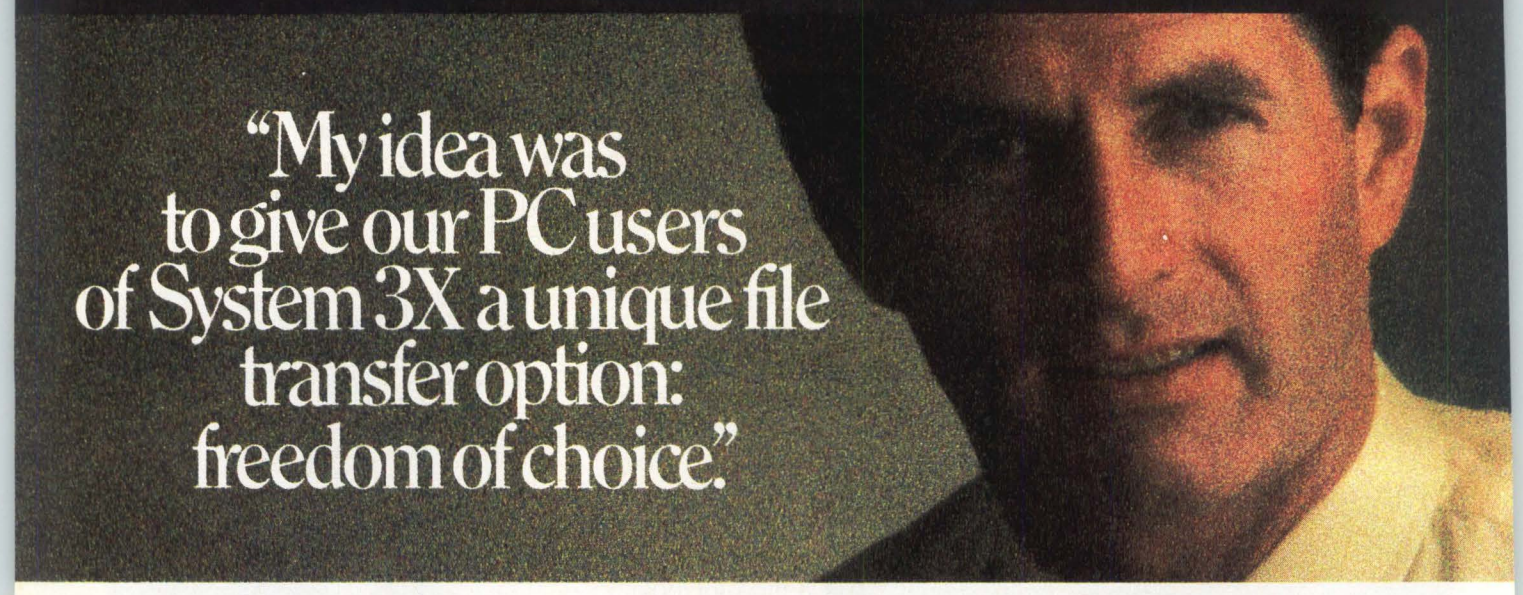

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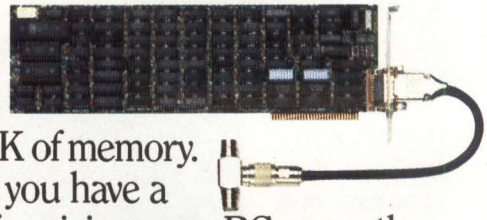

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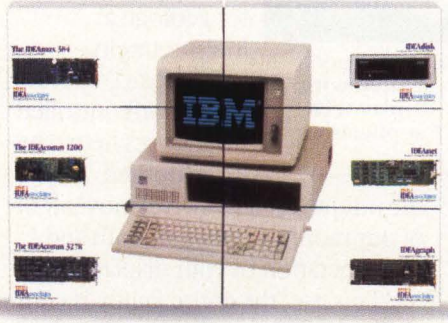

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Talus Corp. and Dest Corp., however, borrow the drum approach from facsimile equipment, moving documents over the CCDs. Another scanner vendor, Thunderware Inc., produces a $240 machine based on Apple's Imagewriter printer that captures text and graphics for the Macintosh.

OCR devices scan documents line-by-line using pattern-matching algorithms to identify the scanned characters. The fact that most office documents use a few "standard" fonts, such as Times Roman, Courier and Elite, lessens computational requirements. In reality, however, the same fonts are implemented differently by different manufacturers, making recognition a problem. As a result, OCR applications have been limited.

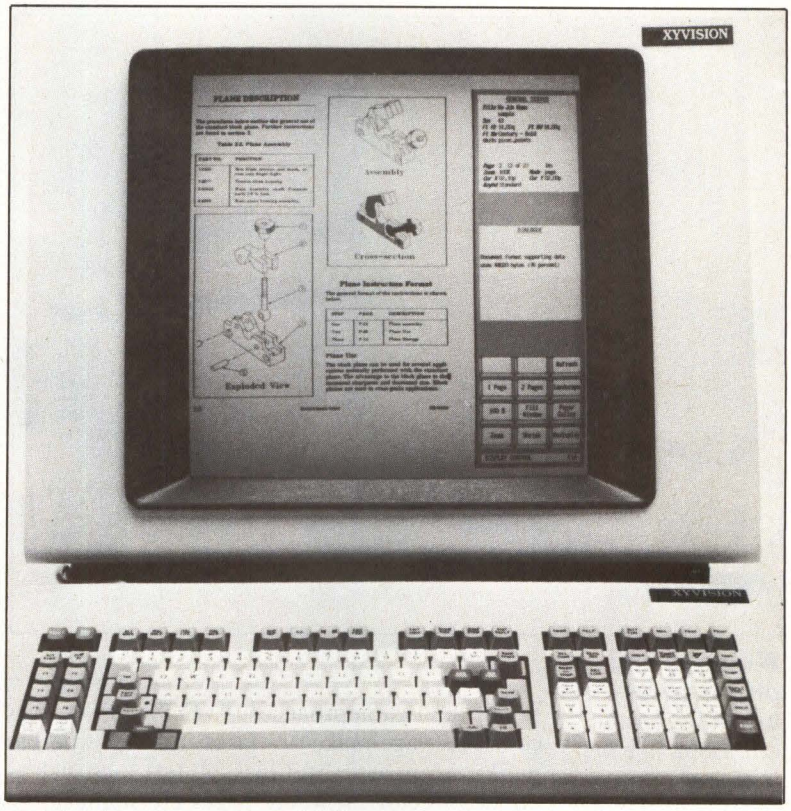
Optical scanning of graphics also presents problems. Digitizing line art is more practical than handling halftone or continuous-tone photography. But if users want to do more than "edit" pixels, then the system must recognize geometric shapes—points, lines, arcs—within the bit map. This recognition requires a raster-to-vector conversion, extremely troublesome to integrators, even in CAD systems. AutoDesk Inc.'s CAD/Camera and Optigraphics Corp. E-size-document scanner provide this capability for inputting drawings to CAD systems—at opposite ends of the cost/performance spectrum.

High-resolution photographic capture requires enormous amounts of memory and thus is impractical for all but high-end EP systems. Gary Mayerick, vice president of engineering at scanner vendor Imagitex Inc., points out that an 8-inch-by-11-inch page scanned at 300 dots per inch (dpi) requires 1M byte of storage. Increasing gray scale to 256 (8 bits per pixel) for an 8-inch-by-11-inch image requires 8M bytes. Bruce Mann, product planning manager at scanner supplier Information International Inc., asserts that photographs must be scanned at 1,200 dpi to meet prevailing publishing standards.

Desktop EP market burgeons

The market for single-user desktop EP systems, manipulating text, page layout and art, and producing less than 5,000 pages a year, has blossomed in 1985. The market has been driven by low-cost, powerful, easy-to-use packages running on Apple's Macintosh computer, such as Aldus Corp.'s Pagemaker and Manhattan Graphics Corp.'s ReadySetGo. Systems based on the IBM PC include DataCopy's Word Image Processing System and Corporate Data Sciences Inc.'s Data Center.

Interleaf, Xerox, Caddex Corp., Intran Corp., Prescience Inc., Texet Corp. and Xyvision Inc.



Interactively integrating *art, text and tables is the job of the Xyvision EP system.*

address in-plant production demands, focusing on systems that allow several writers and artists to work on a single document. Xyvision president Larry Liebson defines this EP configuration as one capable of producing 5,000 to 10,000 pages per year. Prescience bases its Hieroglyph package on Sun Microsystems Inc. workstations. The package runs as a concurrent application under UNIX and offers interactive data exchange between EP and other programs.

Vendors offering EP systems for technical illustration include Auto-trol Corp., Computervision Corp., Information International Inc., InterCAD Corp., Intergraph Corp., Qubix Graphics Systems Inc. and Versatec Inc.

Interactive input vs. mark-up languages

Creating pages on EP systems follows two different approaches—mark-up languages or interactive "What You See Is What You Get" (WYSIWYG) systems. Mark-up languages such as TEX, TROFF and SCRIBE require an imbedded command syntax, similar to that used by typesetters, to format a page of text. And, like typesetters, they have little graphics capability. Xerox's Baynor characterizes the difference be-

A charge-coupled devices-based scanner *captures line art, text and photographs for Datacopy's Word Image Processing System.*

tween the two approaches: "WYSIWYG serves complex page-make-up tasks better, whereas mark-up languages suit massive text jobs such as phone directories, where pages are similar."

Mark-up-language-based systems target scientific and technical applications. Talaris Systems Inc. integrates laser printers from QMS Inc. with software to allow graphics produced by ISSCO's DISSPLA, Megatek Corp.'s Template or Tektronix Inc.'s 4010/14 to merge with text. Mark Skiba, vice president of the American Programmers Guild Ltd. (APG), developed INSET to serve engineering users of word-processing software. INSET runs as a concurrent application tool, allowing PC-based graphics generated by packages such as BrightBill Roberts and Co. Ltd.'s Graphix Partner to be merged with documents and transmitted to a graphics printer.

WYSIWYG systems are characterized by interactive manipulation of text and graphics for page make-up on a CRT. Despite these systems' promise, however, most have limited text, graphics and text/graphics-merging capability.

Displays quality documents

EP systems' manipulation of text and graphics requires high-quality displays. Displaying black text on a white background is an accepted standard—especially in light of the high cost and technical limitations of higher resolution color displays. Display quality reflects several factors: user preference, system cost and display format. The norm is 19-inch monitors that display a full 8-inch-by-11-inch page at actual size, useful in WYSIWYG applications.

Conversion of analog type to a bit map presents special demands, "a mixture of technology and visual perception," comments Mike Parker, president of Bitstream Inc. Representing type accurately requires large character matrixes and huge memories. "Matrixes 20 to 30 pixels on a side are needed to form the more elaborate fonts," notes David Boucher, president of Interleaf. This size matrix also lends itself to more efficient rasterization, he adds.

Most EP systems store the bit map and "tune" each font to their unique display resolution, i.e., the Macintosh's 72 dpi, the Sun workstations' 81 dpi and the Xyvision system's 100 dpi. Most ASCII terminals, by comparison, display only 20

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to 30 dpi. The Macintosh sacrifices some type quality in whole-page displays, but Apple's goal, insists John Scull, desktop publishing market manager at Apple, is to provide the "most functionality at the lowest cost." Ken Andrews, vice president of software engineering at Texet believes quality type representation requires 120 or 150 dpi. Other observers see this level of resolution as overkill, because CRTs will never match the quality of hard copy.

Whether to store fonts in individual bit maps or to store one description for each font, which is then sized and manipulated, is an issue that divides suppliers. John Warnock, president of Adobe Systems Inc., explains that problems with bit maps, other than storage size, are not apparent at 1,000 dpi, but become obvious at lower resolutions when the typeface becomes distorted.

RIP units process images

Raster image processors (RIP), developed by laser-printer manufacturers, control print engines via a page-description language. The RIP processes a page description stored in its memory, as sent from the host computer.

The issues faced by RIP developers are numerous. For one, a RIP must have memory to store a bit map for a page of text and graphics. Some RIPs (from Hewlett-Packard Co. and

Companies mentioned in this article

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(617) 938-8095
Circle 441

Most EP systems store the bit map and 'tune' each font to their unique display resolution.

Tegra Inc., for example) have less than a full page of memory. This method saves memory, but requires a complex RIP architecture to process the page "on the fly." For another thing, the reading of data from RAM and onto a moving printing drum presents design challenges involving high bandwidth and precise synchronization.

The technique chosen to draw type represents a third group of issues. HP stores fonts in hardware ROM cartridges, providing speed but limiting the number of fonts, styles and point sizes available. Postscript, from Adobe, stores a single model for all fonts, scaled or modified as needed—a flexible approach but requiring additional processing by the RIP. Imagen Inc.'s Impress language borrows from both approaches. The RIP scales fonts in ROM but, unlike Postscript, it drives only Imagen printers.

Lasers make it possible

Once created on an EP system, a document must be sent to a printer. Traditionally, a chronic incompatability exists between typesetters and text-entry devices. Each typesetter has unique interface hardware and software. An entire subindustry sells black boxes or "shaftstall" equipment to convert data among terminals, typesetters and host computers from different manufacturers.

Similarly, vendors of laser printers develop unique languages to drive their devices. "Drivers are more complex because printers have changed from dumb peripherals to intelligent systems," declares Jerry Ervin, senior product manager at Dataproducts Corp. This means further problems for integrators who must interface EP systems to a variety of output devices.

Concept Technologies Inc. resolves this problem with Graphic Software Systems Inc.'s (GSS) virtual device interface (VDI), easing driver development. The need for system integrators to supply software interfaces is changing, due in part to the increasing complexity of printer controllers.

Laser printers rival expensive typesetters in terms of cost, speed and size. However, the great quandary for laser-printer integrators begins with their choice of RIP architecture and page format. Some vendors avoid the issue by supporting multiple printer-interfacing standards. QMS, for example, supports Postscript, Interpress and its proprietary standard QUIC.

As these issues are resolved, manufacturers must still address the question of printer resolution. Data Recording Systems Inc. already offers an 800-line-per-inch laser printer. Tom Fay, executive vice president at Tegra contends that its 1,000-dpi Genesis laser printer, driven by Canon U.S.A.'s LBP-5 print engine, competes with digital typesetters.

In 1986, 400- to 500-dpi laser printers, based on the Canon LX engine, will appear. Some of these products will remain in the price range of today's 300-dpi printers. Luis Trabb Prado, vice president and founder of Imagen, cautions that above 480 dpi, design issues beyond resolution, such as paper handling and registration, come into play. This will keep printer costs high. But typical EP system users will continue to demand —and get—higher resolution laser printers.

EP system integrators will face competition in 1986 from traditional printing-industry vendors such as Compugraphic, Allied/Linotype Co. and Eastman Kodak Co. For example, Kodak owns Atex Inc., Iconix Inc. and Verbatim Inc. and holds substantive investments in Interleaf and Sun Microsystems, positioning it as a dominant force in EP systems. □

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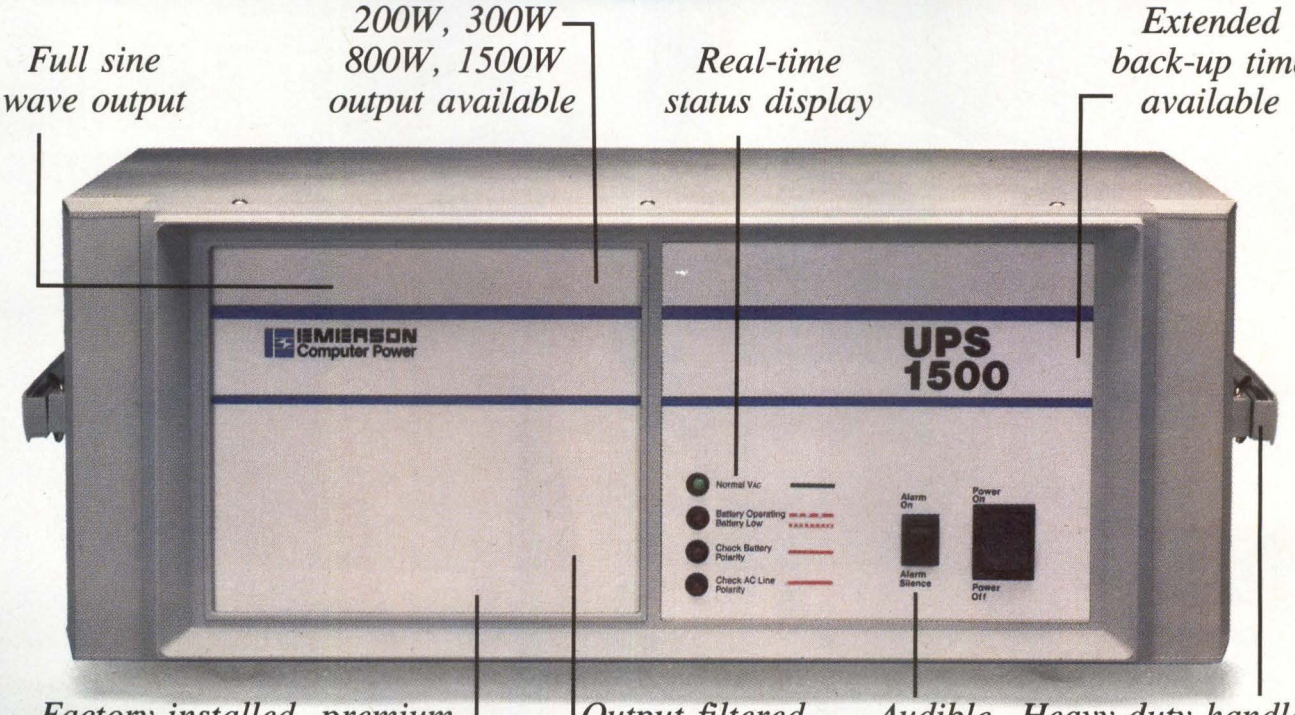

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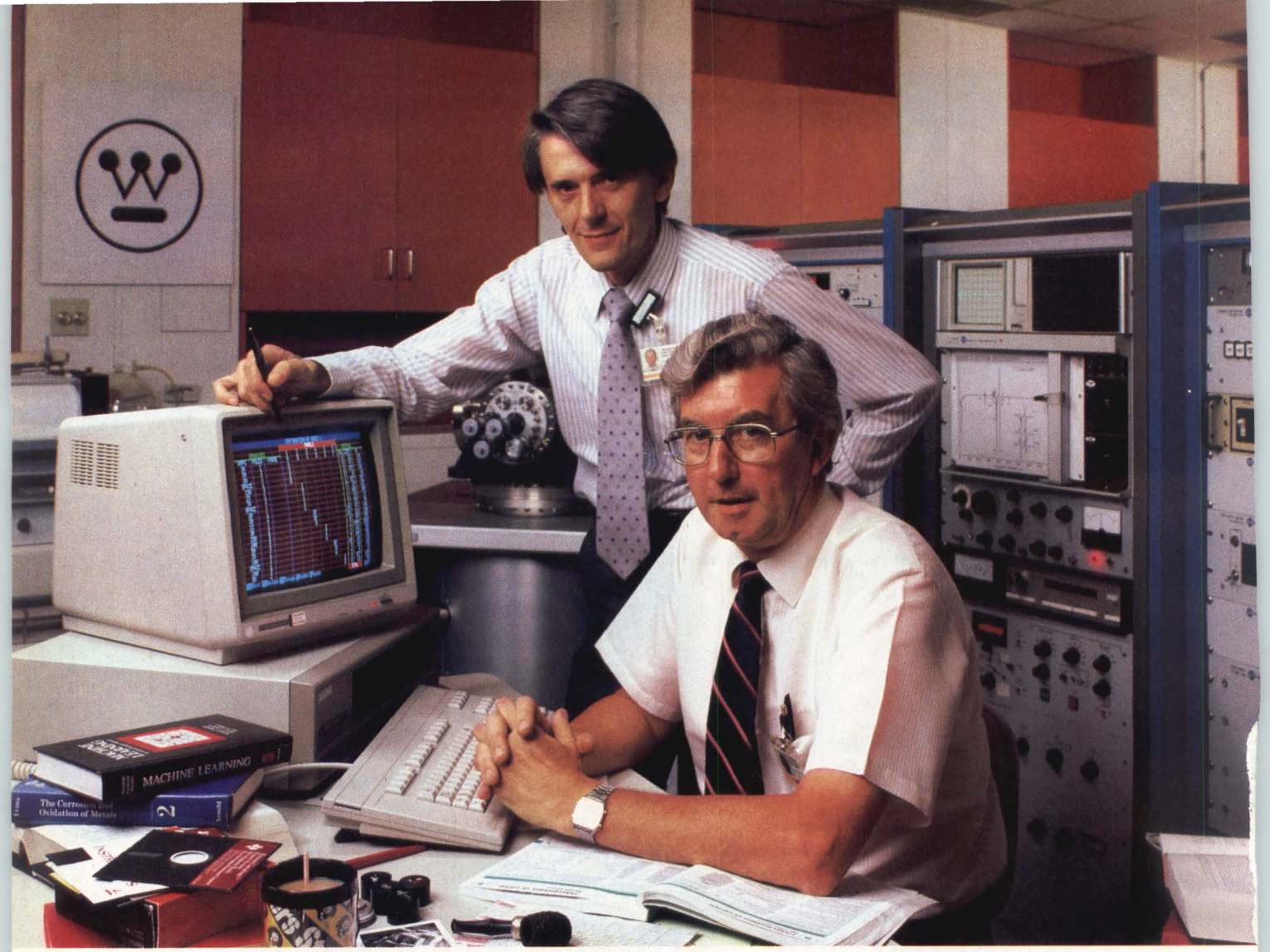

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THIN FILM CHALLENGES OXIDE MEDIA

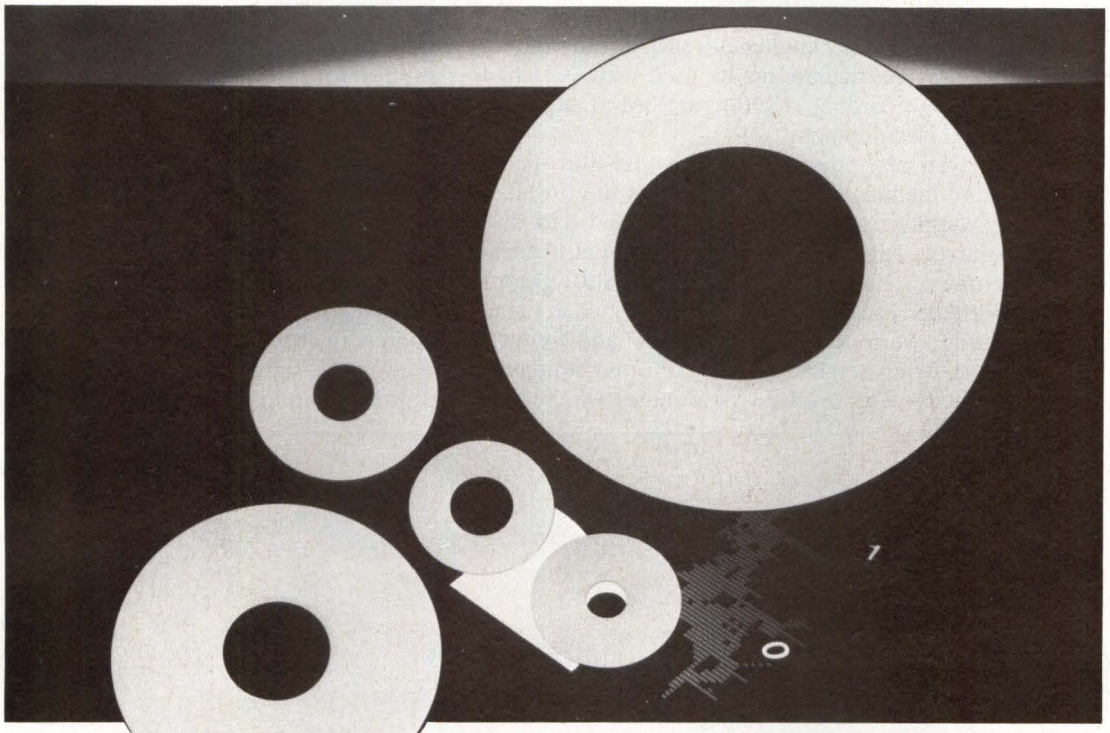


Photo: Courtesy of Ampex Corp.

A new breed of smaller, higher capacity rigid disks is thinning the herd of oxide-disk makers, but it's still not clear which species will reign

Dennis D. Waid, Peripheral Research Corp. and **Don Mann,** Don Mann Magnetics Inc.

Disk drive capacities increased approximately fivefold from 1973 to 1981 and are expected to double again by 1986 or 1987. This second growth spurt will result primarily from improved media performance. Although recording-head technology has changed over the years, magnetic media coating technology remained relatively stable from 1962 to 1981. The coating was typically 330-oersted (Oe), 35-μin, gamma ferrous-oxide on an aluminum substrate.

Thin-film media—the "new" alternative—has actually existed for more than 20 years. But in the past it was produced only by a few companies, and its market appeal was limited because standard oxide media performed adequately. But since 1982—because of an influx of venture capital and increasing demands of disk drive manufacturers—about 15 companies have become involved in thin-film-media production. Disk media now divides into two basic categories: oxides (standard and high-coercivity) and thin film (plated, sputtered and plated with sputtered overcoat).

Storage demands accelerate

Demand for small-diameter disks is expected to continue through the late 1980s because of the popularity of the microcomputer and the mandate for additional on-line storage. According to the *1984 Disk/Trend Report*, Mountain View, Calif., shipments of 5¼- and 3½-inch disks will increase from about 7.7 million in 1984 to around 22.9 million in 1987.

Drive manufacturers continue to demand higher capacity, lower cost per megabyte, greater reliability and smaller size. Three rigid disk drives introduced in 1984 exemplify this trend: a 51.4M-byte, 3½-inch model from Newbury Data Recording Ltd., Staines, England; a 306M-byte, 5¼-inch drive by the Memory Products Division of Siemens Communications Systems Inc., Westlake Village, Calif.; and a 760M-byte, 5¼-inch drive from Maxtor Corp., Santa Clara, Calif.

Those higher capacity products require perfor-

mance not available with today's oxide-disk technology. Different forms of plated media are being used to fill the current need, and radically different disk technologies—such as the random-oriented particulate media used with stretched-surface-recording (SSR) at 3M Corp.—are under development.

Even after deciding to use thin-film media, drive manufacturers must address the problems of supply, production yields, second and third sources, ruggedness and price competitiveness. However, media manufacturers also grapple with the issues of second-sourcing, industry standards, performance consistency and reduced head-flying heights. How these often-conflicting concerns are resolved determines the relative strengths and weaknesses of the media choice.

High bit density is a pre-eminent concern among users of disk media. Technical considerations include flying height, resolution requirements for modified frequency modulation (MFM) data encoding, coercivity, output and on- and off-track overwrite. Unfortunately, improving one specification sometimes involves a trade-off in another area.

The limitations of standard 330-Oe oxide relate to the magnetic coating's relatively low coercivity, which results in demagnetization losses that are proportionate to bit density. Low coercivity also causes poor resolution and inadequate head-signal output.

Resolution and head-signal output can be im-

REPRESENTATIVE RIGID DISK

	Standard oxide	High-coercivity oxide	Plated	Sputtered
Akashic Memories Corp. 3570 Ryder St. Santa Clara, Calif. 95051 **Circle 335**				•
Ampex Corp. Disk Media Operations 960 Rincon Circle San Jose, Calif. 95131 **Circle 336**			•	
Anelva Corp. 121 E. Brokaw Road San Jose, Calif. 95112 **Circle 337**				•
Applied Information Memories 776 Sycamore Drive Milpitas, Calif. 95035 **Circle 338**				•
BASF Systems Corp. 35 Crosby Drive Bedford, Mass. 01730 **Circle 339**	•			
Brown Disk Manufacturing Inc. 1110 Chapel Hills Drive Colorado Springs, Colo. 80918 **Circle 340**	•	•		
Burton Magnekote 11334 Playa St. Culver City, Calif. 90230 **Circle 341**			•	
Charlton Associates Inc. 1 Marconi Irvine, Calif. 92718 **Circle 342**	•	•		
Control Data Corp. 8100 34th Ave. S. Minneapolis, Minn. 55440 **Circle 343**	•			

	Standard oxide	High-coercivity oxide	Plated	Sputtered
Cyberdisk Inc. 1531 S. Sinclair St. Anaheim, Calif. 92806 **Circle 345**				•
Datapoint Corp. 9725 Datapoint Drive San Antonio, Texas 78284 **Circle 346**			•	
Domain Technology 304 Turquoise St. Milpitas, Calif. 95035 **Circle 347**			•	
Dysan Corp. 5201 Patrick Henry Drive Santa Clara, Calif. 95050 **Circle 348**	•	•		
Eikon Inc. 69 Moreland Road Simi Valley, Calif. 93065 **Circle 349**			•	
Fujitsu Ltd. 36 Kita-Owaribe Nagano, 380, Japan **Circle 350**				•
Grenex Inc. 47050 Kato Road Sunnyvale, Calif. 94538 **Circle 351**				•
Hewlett-Packard Co. P.O. Box 15 Boise, Idaho 83707 **Circle 352**				•
Ibis Systems Inc. 1850 Evergreen Drive Duarte, Calif. 91010 **Circle 353**			•	

proved through high-energy and high-coercivity oxide coatings, but overwrite then becomes a problem, particularly when the head resides reliably at a 19-μin flying height. The higher coercivity surface causes serious cross-read residuals from adjacent tracks, so even measuring overwrite while the head is on track is deceiving —off-track overwrite becomes critical. Another problem is that the cobalt used in higher coercivity coating contributes to peak shifts—a crossing of frequency curves—and distortion.

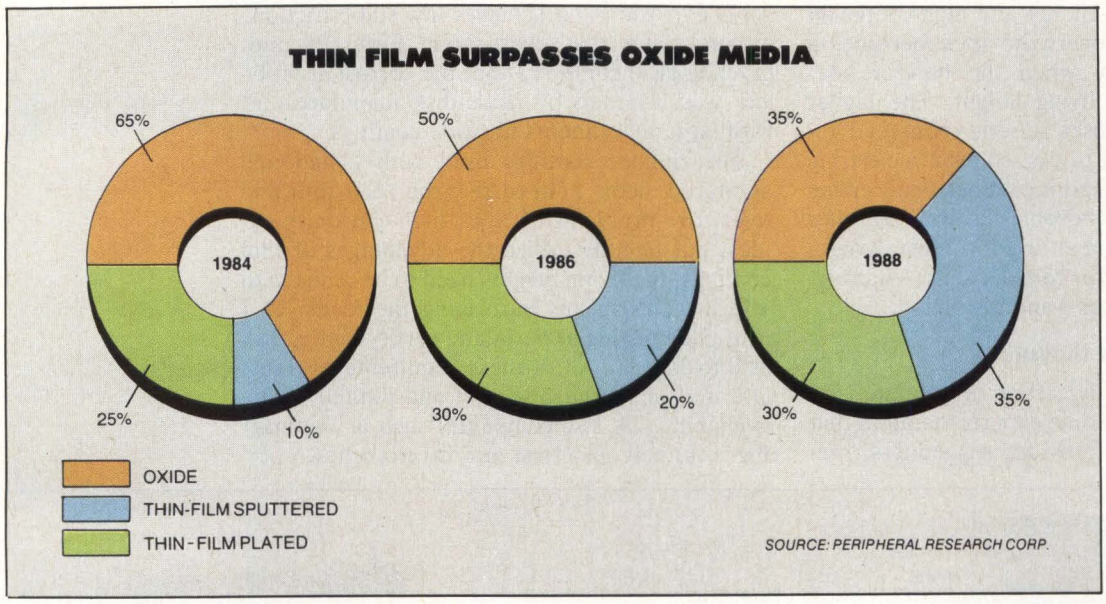
Overcoating: fact or fiction?

Overcoating—usually carbon or graphite—remains controversial. Some experts maintain that a sputtered overcoat provides ruggedness, prevents corrosion and achieves low static friction. Others claim that overcoating furnishes only psychological comfort—that the corrosion problem was invented by oxide-disk manufacturers with large investments in oxide coatings.

The thinner coatings used with plated and sputtered media help correct the peak-shift and overwrite problems of thick high-coercivity oxides, but to fully utilize the advantages of thin coatings, the flying heights need to be reduced to 10 μin. This means burnishing the media at 4 μin, glide testing at 6 μin and certifying the disk at 8 to 10 μin. All of these requirements translate into increased disk cost and limited media availability. A few companies such as Komag Inc. routinely glide test at 5 microinches.

MEDIA MANUFACTURERS

	Standard oxide	High-coercivity oxide	Plated	Sputtered
IBM Corp. 5600 Cottle Road San Jose, Calif. 95193 **Circle 354**	•			
Information Memories Corp. 2875 N. Western Pkwy. Santa Clara, Calif. 95051 **Circle 355**			•	
Kearney Magnetics Inc. 150 Charcot Ave. San Jose, Calif. 95131 **Circle 356**		•		
Komag Inc. 591 Yosemite Drive Milpitas, Calif. 95035 **Circle 357**				•
KSI Systems 14055 Larchwood Place Chino, Calif. 91710 **Circle 358**			•	
Lanx Corp. 1750 Junction Ave. San Jose, Calif. 95112 **Circle 359**				•
Lin Data Corp. 2005 De La Cruze Blvd. Santa Clara, Calif. 95050 **Circle 360**				•
Media Technology Corp. (STC) 575 Dado St. Mountain View, Calif. 95131 **Circle 361**			•	
Megastor (Tandon) 5102 Calle Del Sol Santa Clara, Calif. 95054 **Circle 362**			•	
Microdisk (SyQuest Tech.) 47923 Warm Springs Blvd. Fremont, Calif. 94539 **Circle 363**			•	
Nashua Corp. 44 Franklin St. Nashua, N.H. 03061 **Circle 364**	•	•		
Oktel Corp. (Xidex) 1220 Page Ave. Fremont, Calif. 94538 **Circle 365**				•
SAEmag International Inc. 350 Martin Ave. Santa Clara, Calif. 95050 **Circle 366**			•	
3M Corp. Data Recording Div. 3M Center St. Paul, Minn. 55101 **Circle 367**	•	•		
TriMedia Corp. 47730 Westinghouse Drive Fremont, Calif. 94539 **Circle 368**				•
Ultra-Disc Corp. (CCT) 690 Gilbraltor Drive Milpitas, Calif. 95035 **Circle 369**			•	
Zwan Magnetics 1607 16th St. Santa Monica, Calif. 90404 **Circle 370**				•



Sputtered and plated *media will encroach significantly on the standard oxide market share.*

It's generally thought that perpendicular recording on flexible disks will materialize within the next few years, primarily from Japanese manufacturers. Perpendicular recording on rigid disks—currently done by only a few manufacturers—will be a niche market. It will not be widely accepted due to media-durability problems and data rates that are too high for current system architectures. However, less expensive, more flexible controllers and acceptability of higher data rates could bring perpendicular recording to the forefront of media technology. To date, only Lanx Corp. has concentrated on this technology.

Reversible optical recording is on the horizon and will offer much lower cost per megabyte than thin-film or perpendicular recording. The cost per megabyte for reversible optical recording is expected to be as low as $1.50 for end users. (Today's Winchester technology costs $12 to $18 a megabyte.) But currently, optical disks offer write-only capability. Getting to reuse the disk in a read/write/erase application will require advances in magneto-optical recording techniques. If the technical hurdles can be leaped, a plentitude of problems associated with other media would be solved, giving optical recording a decided boost. Optical disks will most likely appear in larger minicomputer and microcomputer applications (i.e., more demanding jobs than portable and desktop systems can now handle). Optical disk drives may not be economically practical at capacities of under 100M bytes per spindle.

Oxide-disk manufacturers will see more cost

Comparing the four *most popular media demonstrates liabilities of each.*

HIGH BIT DENSITY HAS ITS PRICE

	Media type			
	Standard oxide	**High coercivity oxide**	**Plated**	**Sputtered**
Drawbacks in order of severity	record demagnetization	high flying height	low flying height vs. cost	availability
	low resolution	overwrite	availability	low flying height vs. cost
	head output	peak shift	overwrite	overwrite

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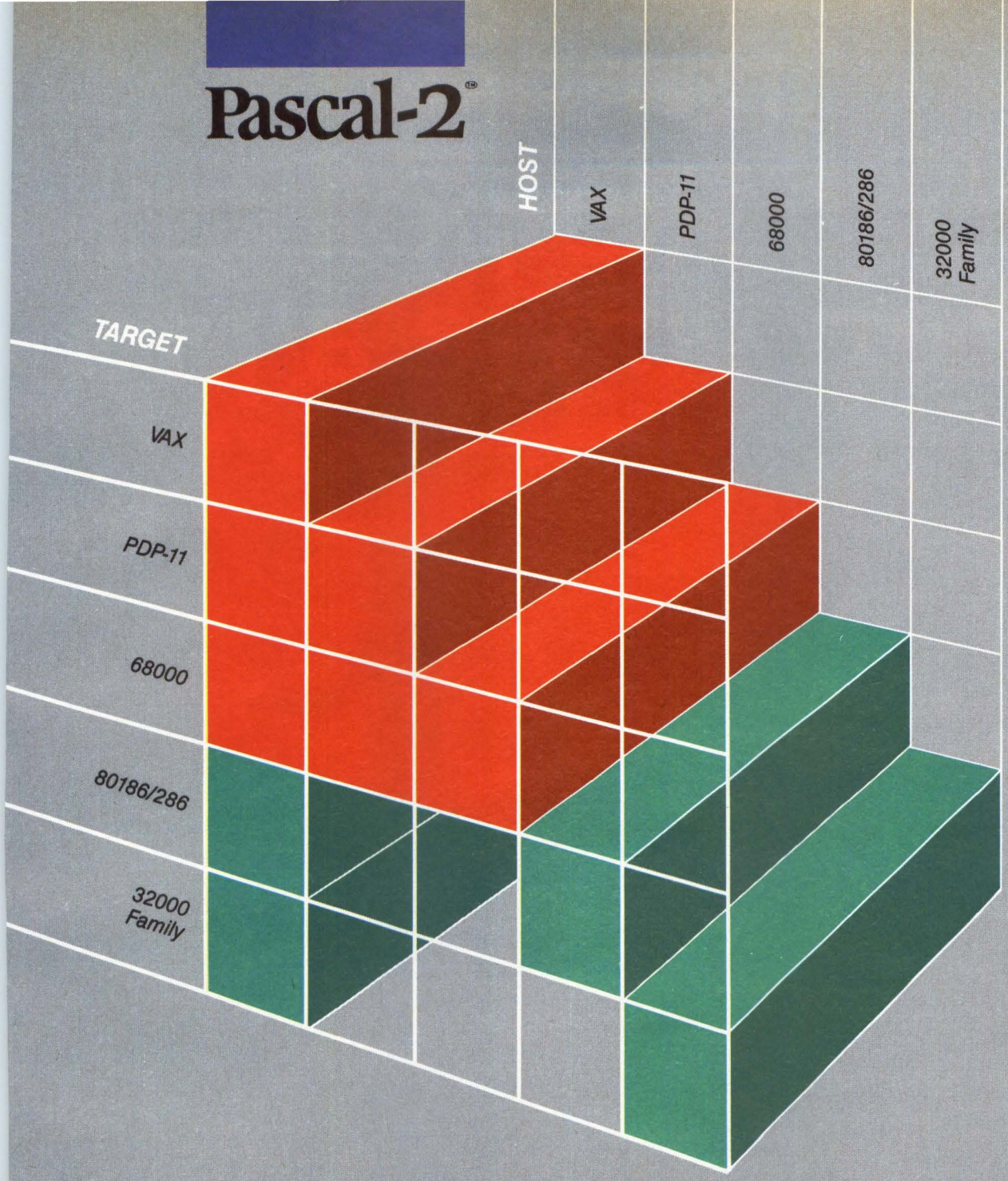

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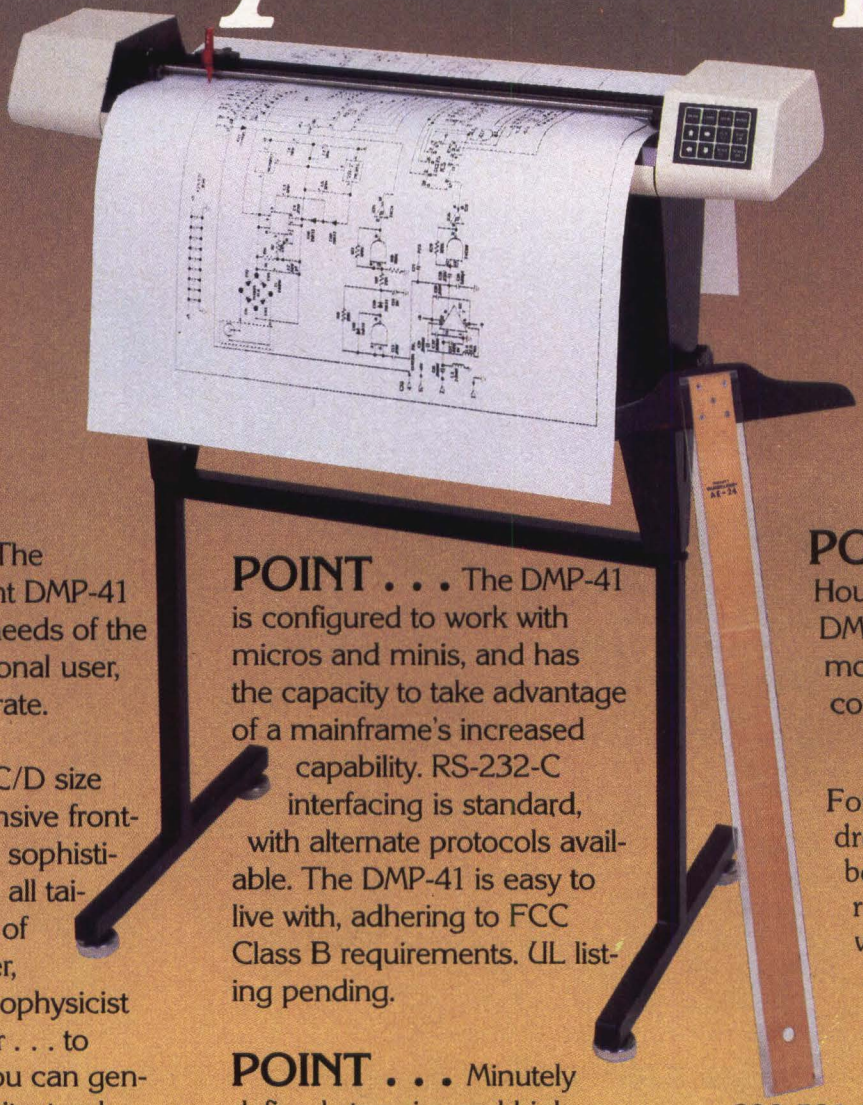

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SPUTTERED SPECS PROMISE PERFORMANCE

	High BPI goal	Standard oxide	High coercivity oxide	Plated with overcoat	Plated without overcoat	Sputtered
Flying height (μin.)	≤ 10	19	14	12	13	**10**
Head output (μV)	≥ 400	300	**600**	**500**	**450**	**600**
Resolution (%)	≥ 75	65	70	**75**	72	**80**
Signal/noise (dBa)	≥ 30	28	29	**32**	**30**	**34**
Overwrite (dBa)	≤ −30	**−38**	−26	**−30**	−29	**−31**

Sputtered media meets *or exceeds all the specifications required to achieve the typical manufacturer's bit-per-inch goals. Plated media, with or without an overcoat, stacks up well.*

competition from thin-film-media producers over the next few years. However, the oxide-media market will probably be more stable than the thin-film market because the number of manufacturers of oxide disks is small. Also, few companies are entering the field, companies producing low-capacity Winchester disk drives have no reason to change media, and new oxide-disk manufacturing techniques should reduce production costs.

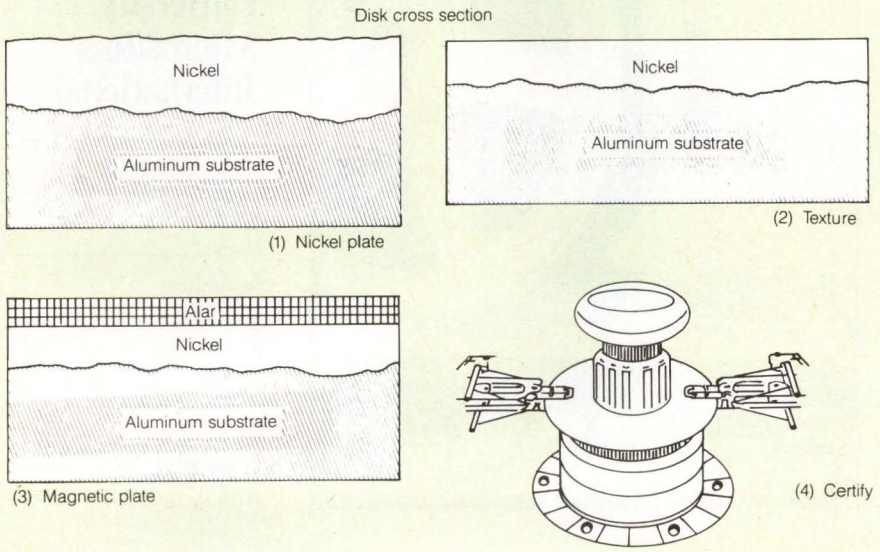
Thin-film companies, though, will compete fiercely among themselves, due to the large number of manufacturers making thin-film media. The market will be segmented by cost, performance and, possibly, disk size. Companies requiring either rugged drives, removable media or slightly higher performance will choose plated media with or without a sputtered overcoat. It is anticipated that plated media will be the most plentiful and least expensive of the thin-film media. High-capacity, high-performance disk manufacturers will most likely opt for either sputtered disks or plated disks with sputtered overcoats.

What, then, should determine the decision between sputtered or plated media? The advantages of sputtered media are:

- Better disk yield for drive applications requiring low cost and low flying height, such as that required on the inner tracks of a 3½-inch Winchester.
- The ability to sputter magnetic material on

Plated thin-film media *is produced in four stages. (1) A layer of non-magnetic nickel is plated 800 μin thick onto an aluminum substrate. (2) The nickel surface is polished flat by a very fine abrasive material. (3) A 3-μin magnetic layer is plated onto the nickel. (4) The disk is tested for defects and rated for commercial use.*

PRODUCING PLATED MEDIA TAKES FOUR STEPS



Source: Ampex Corp.

It is anticipated that plated media will be the most plentiful and least expensive of the thin-film media.

a variety of materials other than aluminum potentially provides low cost, smooth surfaces and lighter disks.

Usually, the pursuit of smooth surfaces—which enables lower flying heights—means lower production yields. However, yields are better in the manufacture of sputtered media because sputtering avoids the chemical process that creates problems for makers of plated and oxide-coated media. Instead of coating aluminum with nickel and polishing it smooth, manufacturers are making sputtered disks with glass, mylar and plastic, which are smoother to start with and do not require secondary coatings.

Lighter disks are particularly appealing to manufacturers of portable and transportable computers; supplying power to the spindle motor that turns the disk is significantly easier. The 3M SSR disk, for instance, has half the mass of other disks. That reduces by fourfold the torque requirements of the motor.

In short, as thin-film-disk technology matures, the industry will probably settle on two or three media coatings, each with a well-defined market: high-coercivity oxide, thin-film plated with sputtered overcoat and thin-film sputtered disks.

Within the last few months, many plated-media companies have either withdrawn from the market or decided to convert to a sputtering process. For example, Poly-Disc Systems Inc. has ceased operations; Ampex Corp. and Ultra-Disc Corp. are converting to sputtering; Burroughs Disk Memory Inc. has been discontinued and SAEmag International Inc. has subleased its space to a sputtering company. □

Dennis D. Waid is president of Peripheral Research Corp., Santa Barbara, Calif., and was a market researcher for Freeman Associates. **Don Mann**, president of the consulting company Don Mann Magnetics Inc., Newbury Park, Calif., has 22 years' experience in magnetic product development.

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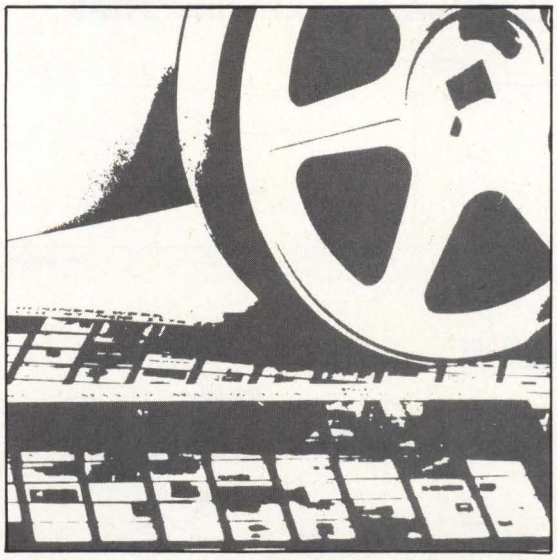

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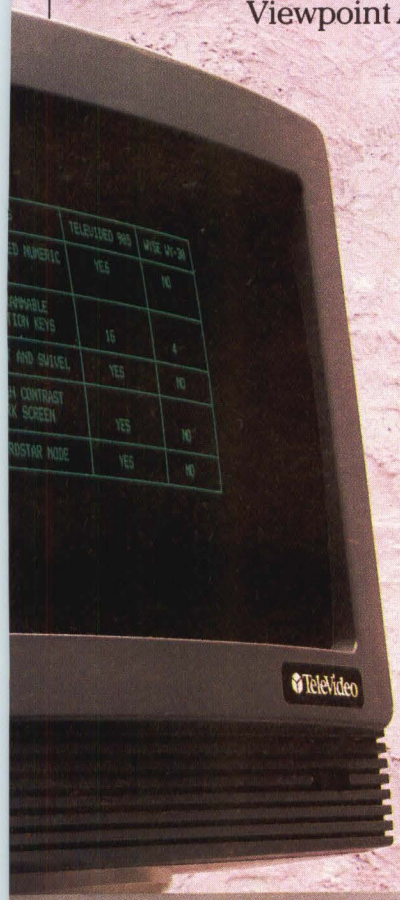

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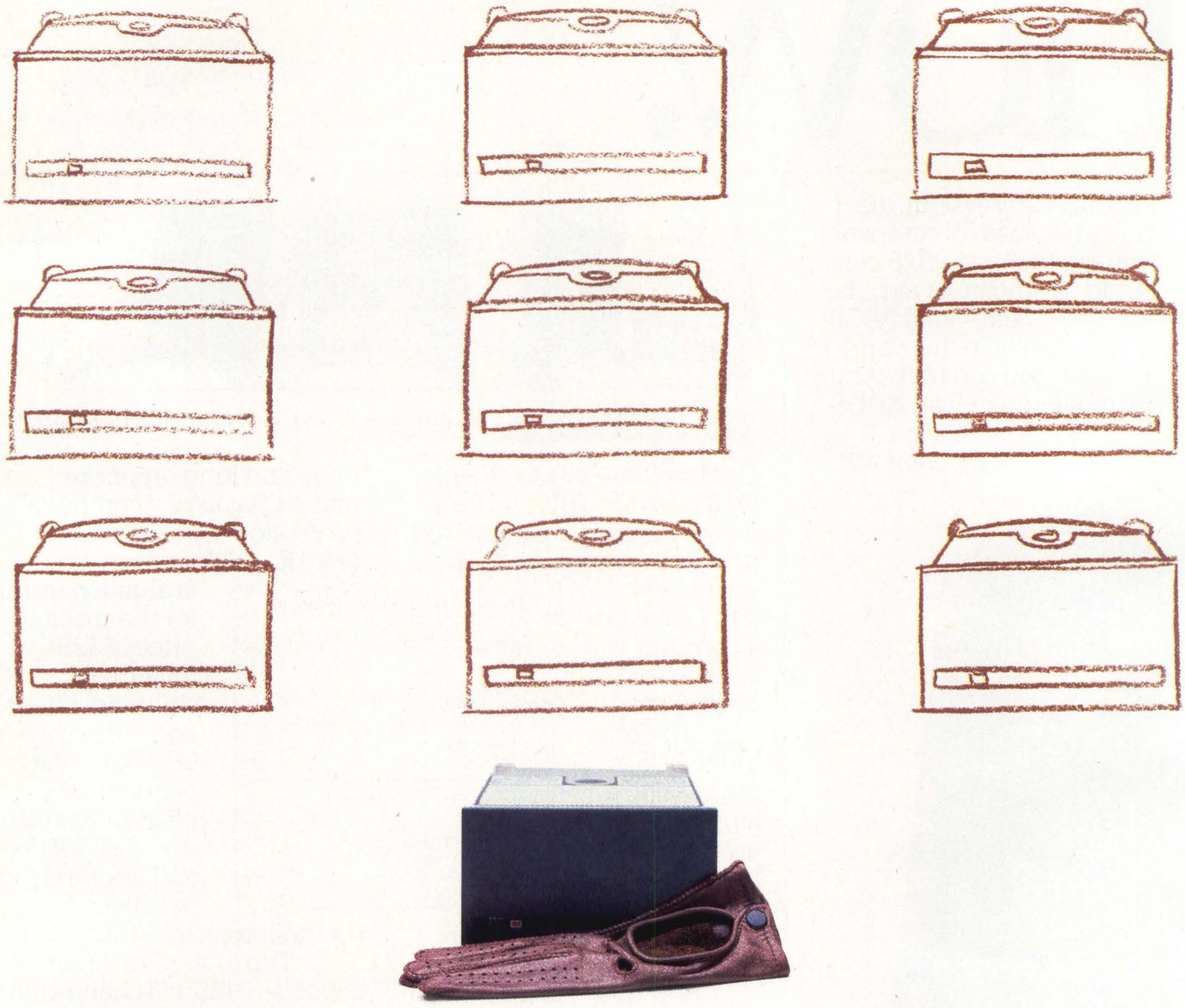

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MINIS GAIN ON SUPERS WITH VECTOR PROCESSORS

With architectures similar to the Cray 1, systems can perform like supercomputers in demanding applications at supermini prices

Frank Marshall, Steve Wallach and **Harold Dozier,** Convex Computer Corp.

Seymour Cray founded Cray Research Inc. in 1972 and introduced the Cray 1 in 1976. It and other supercomputers have been powerful additions in the computer lineup. But they also have been extremely expensive. As a result, there has been considerable interest among designers in developing a system that would possess supercomputer-like architecture, yet cost in the range of superminicomputers. Such a system would establish a new category of computer—one bridging the gap between traditional supercomputers and superminicomputers. These machines perform like supercomputers in such demanding applications as computer-aided design, simulation and verification. Morever, they would be powerful associates of both smaller and larger computers. For example, instead of using a scalar processor as a front end for a Cray, users could employ a relatively inexpensive Cray-like system. Instead of offloading computation from a superminicomputer to a Cray, users might send them to a "bridge" machine.

With an architecture that closely models *that of the Cray 1, the Convex C-1 creates a new category of machine: one fitting between superminicomputers and supercomputers.*

Architecture defines differences

The truly distinguishing characteristics between supercomputers and superminicomputers are architectural. Superminicomputers are 32-bit scalar machines, which means they can only process one arithmetic element—single-instruction, single data (SISD)—at a time. To process a set of four such elements would require four separate operations.

Supercomputers are capable of handling 64-bit vector processing, whereby four problems can be handled in a single operation—i.e., single-instruction, multiple data (SIMD).

Pipelining is another architectural aspect of supercomputers. Many computers execute instructions one at a time, completing all of the steps for each instruction before beginning to work on the next. A pipelined system, however, will handle the different steps of several sets of instructions simultaneously. The result is that it takes much less time to execute a set of instructions in a pipelined system than it does in a sequential type.

The C-1 posts a score of 60 megaflops, where the Cray 1 scores 140.

One machine which boasts supercomputer characteristics, but which is priced like a superminicomputer, is the C-1 from Convex Computer Corp., Richardson, Texas. The C-1 is a virtual-memory, Cray-like processor, including 64-bit data paths and vector accumulators. Because of its Cray-like architecture, all algorithms common to the Cray are directly applicable to the C-1. The Convex compiler performs integrated vector processing through a dual-pipe design and is highly pipelined for added scalar and vector processing speed. Moreover, like a Cray 1, it has a physical memory of 128M bytes.

Architecture resembles Cray machines

Using a dual-pipe design, the C-1 performs pipelined numerical operations on vectors, the same kind of operations characteristic of the Cray 1 and the similar Cyber from Control Data Corp., Minneapolis, Minn. The system includes a vectorizing FORTRAN 77 compiler. With it, users can take FORTRAN source code written for operation under the VMS operating system supplied with Digital Equipment Corp.'s VAX 32-bit minicomputer line, and recompile it immediately for execution. In addition, the compiler extracts any opportunities for vectorization (as in parallelism) and generates vector instructions for those portions. The more opportunities for vectorization, the faster a program will execute.

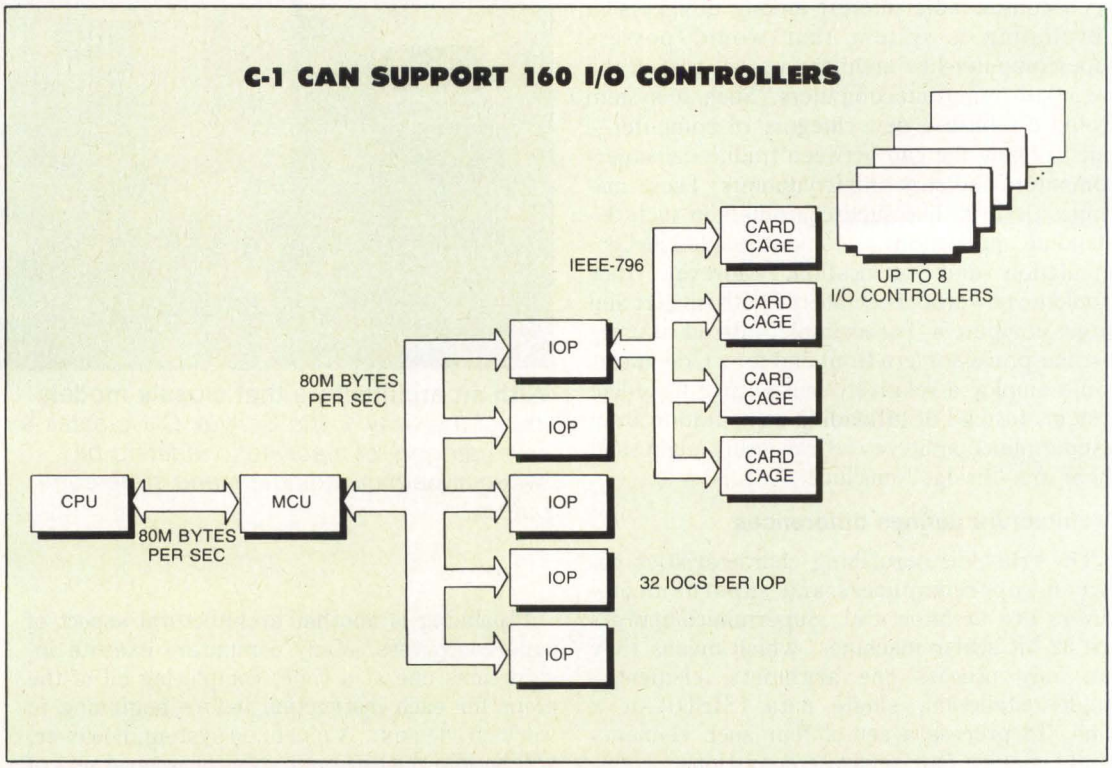
In addition, the compiler provides global optimizations through such techniques as constant folding and propagation, strength reduction, code motion, dead-code removal and instruction scheduling.

Vector optimizations, perhaps the most advanced features of the compiler, include vectorization for all nested loops, loop interchanges, generation of bit conditionals, recognition of reduction operators and partial vectorization. These attributes, along with the operating system development features, plus a symbolic debugger, provide a highly interactive development environment.

The C-1 in operation

One of the drawbacks to using supercomputers is the dearth of people with supercomputer experience. Thus, while prospective users go through their learning curve, an expensive system may remain under-utilized.

When designers have attempted to add vec-



The distributed-processing architecture *of the C-1 permits up to 160 I/O controllers to be attached to the system. The intelligent I/O processors (IOPs) can each control four card cages with up to eight I/O controllers, for a total of 32. The system will support up to five IOPs on its central bus.*

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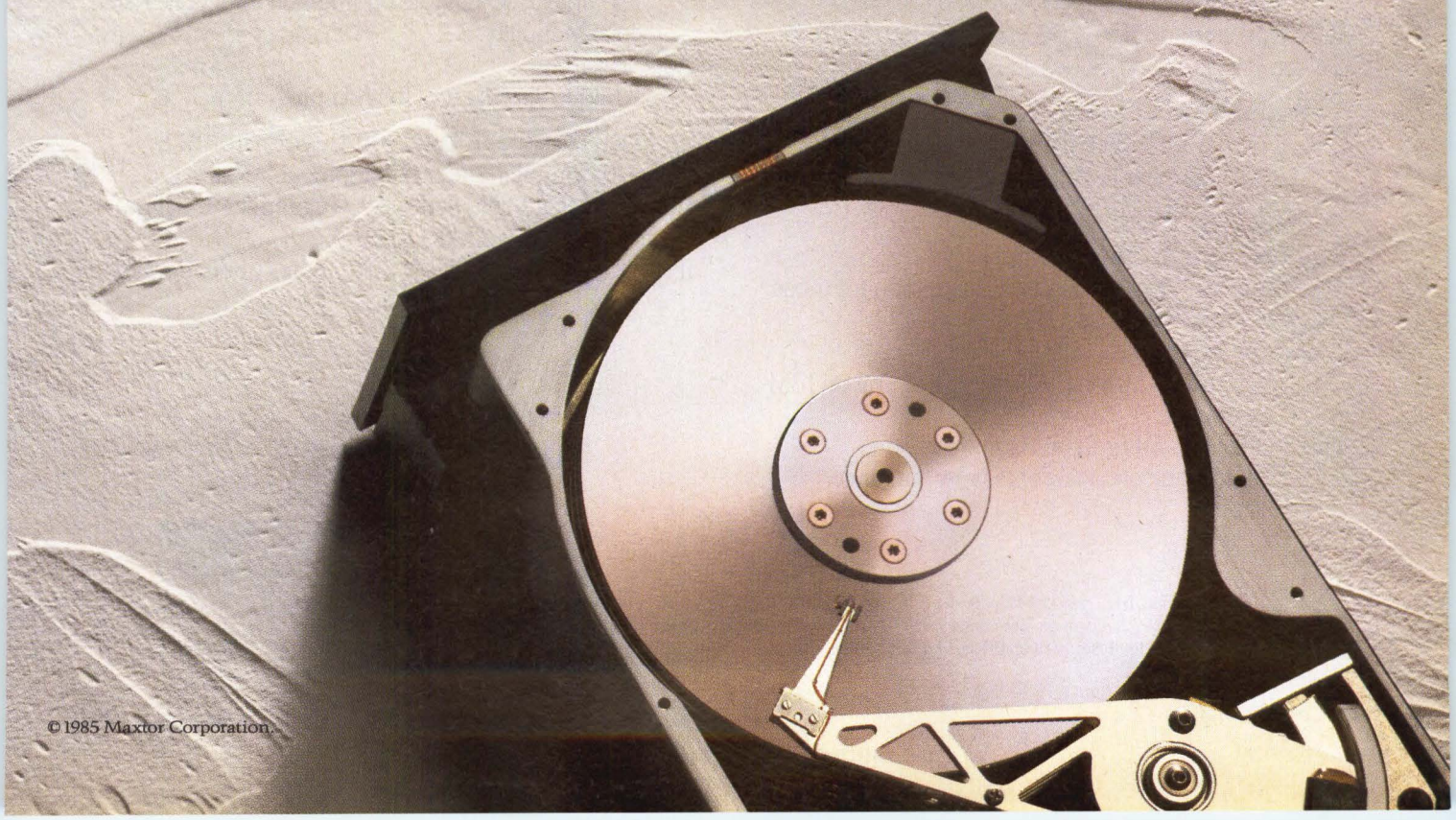

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tor processing capability to superminicomputers by linking them to attached array processors, they've often made that problem worse. The machines so produced were admittedly superior to an average superminicomputer in performance, but they were also far more complex. Where before, a user's time was sacrificed to learning one set of instructions, now it was lost on two.

With the C-1, however, users face a single, homogeneous interface. They deal with familar languages, operating systems and network and interface standards from the onset. The operating system is UNIX 4.2 Berkley version and users have their choice of programming languages, such as FORTRAN and C.

A single instruction set covers scalar and vector processing. A single FORTRAN compiler permits existing FORTRAN programs to run with varying levels of increased throughput. That same compiler extracts instances of parallelism and processes them vectorially.

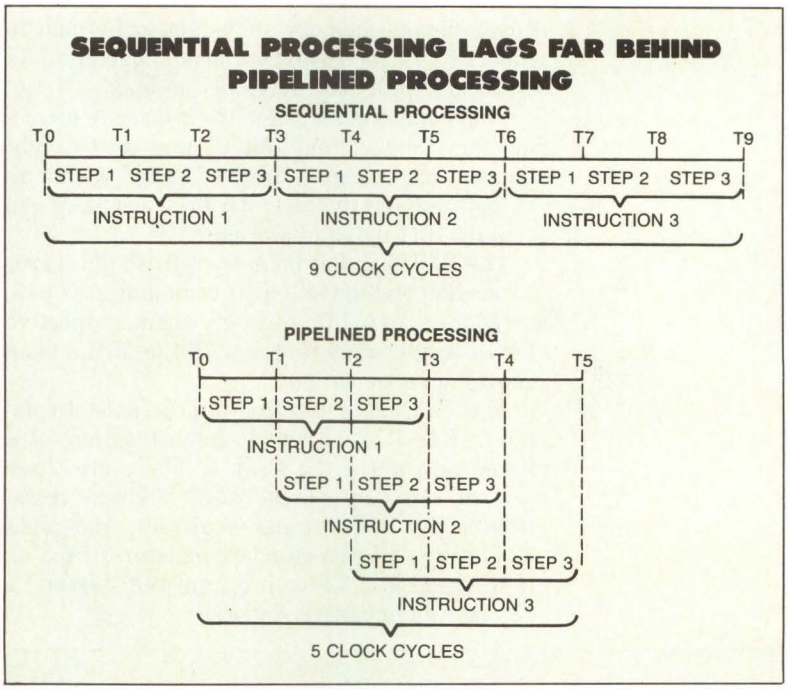
Even FORTRAN programs that do not have inherent parallelism will run on the C-1. Its scalar-processing capabilities are at least equal to, and often exceed, the fastest superminicomputer.

Indeed, a measure of supercomputer performance is the number of floating-point operations that can be done per second. For supercomputers, the scale starts in the millions of floating-point operations per second (megaflops). Superminicomputers do not even tip the scales at half a million, but the C-1 posts a score of 60 megaflops where the Cray 1 scores 140.

System I/O, meanwhile, involves intelligent distributed processing. That is, the CPU is relieved of mundane I/O overhead by a system of I/O processors (IOPs). Each has its own 32-bit microprocessor plus local cache memory. The processors accept high-level commands from the CPU and handle all of the underlying I/O tasks.

A C-1 may have as many as five IOPs connected to its 80M-byte-per-second central bus. Each can control up to four card cages, and each card cage may have up to eight I/O controllers. A fully-configured C-1 can thus support up to 160 I/O controllers. The I/O processors are packaged on IEEE-796-compatible printed-circuit boards. The card cages are Multibus 1 types so that users might have access to the scores of controllers sold by the many long-established Multibus-system vendors.

The system provides networking so that Convex systems can communicate with one another, or with other vendors' systems that subscribe to the same network protocols (TCP/IP).



In sequential-processing systems, *each instruction is completed before the next one is begun. In a pipelined system, there is overlapping of instructions. It takes five-ninths as long to execute the three instructions in the pipelined system as it does in the sequential type.*

The C-1 may thus support information and resource sharing, remote batch processing, computational servers and electronic messaging.

Finally, the C-1 contains a service processor unit (SPU) to handle system failures. The SPU is an independent unit with its own memory, tape and disk subsystems. It can perform serial scans on each system board, applying test patterns and then retrieving and analyzing results. It monitors parity checking of data paths, buses and CPU registers. By quickly identifying which board is at fault, the SPU greatly reduces the time needed to repair the system. Indeed, because the system allows boards to be removed or inserted while it is functioning, repairs can be done in minutes that might have otherwise taken hours.

Divided into three subsystems

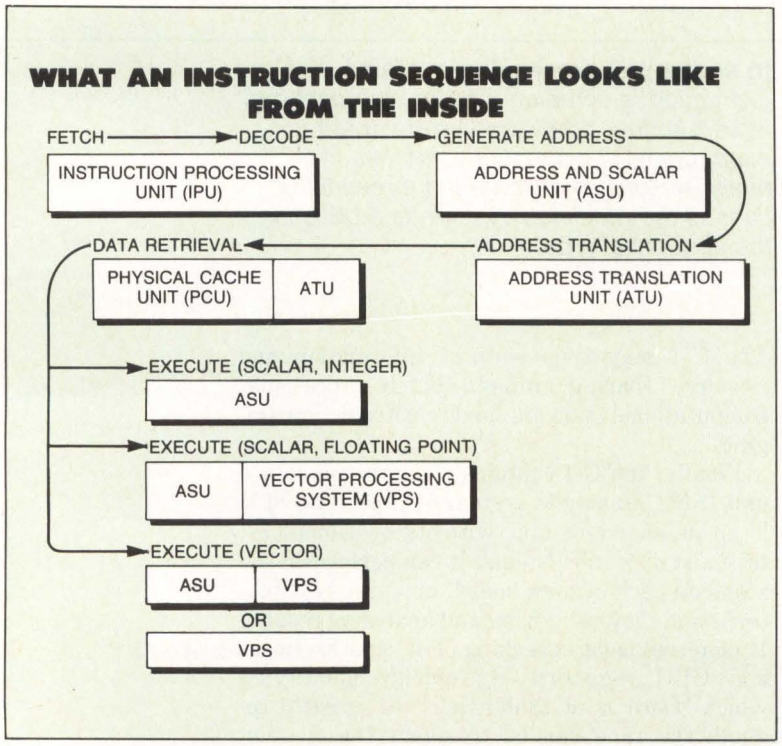
Three main subsystems make up the C-1's hardware: the CPU, I/O and memory. Memory is dual-ported. One port is for direct-memory access by the I/O subsystem; the other is for CPU/memory transfers. Separate high-speed

buses tie the memory subystem to I/O and to the CPU. Each is 64 bits wide and handles data traffic at up to 80M bytes per second.

The memory subsystem itself is made up of a memory control unit (MCU) and up to eight memory array units (MAUs). Loaded with individual 256K-bit dynamic RAMS, each MAU can contain 16M bytes of storage.

The MCU handles memory refresh plus error correction and detection. It communicates with the CPU and I/O through their respective buses, and communicates with the MAUs via a third bidirectional bus.

The C-1 has a reduced-instruction-set-computer (RISC) architecture. Its instruction set is based on that of the Cray 1. There are three sets of registers—eight 32-bit address registers; eight 64-bit scalar registers; and eight 128-bit-by-64-bit vector accumulators. In addition, there is a 32-bit program register and a 128-bit vector-merge register.



Beginning with a fetch, *the diagram shows a typical sequence of operations and the CPU areas that are involved. In some cases, execution may follow immediately after address generation (where the execution involves register-to-register processing). Execution involves just the ASU, or a combination of ASU and VPS, or just the VPS, depending on the data types to be processed.*

Register-to-register instructions are 16-bits long; those involving data memory references are either 32- or 48-bits long. Vector instructions are complete and orthogonal and support addition, subtraction, multiplication and division plus vector-compare logic.

The C-1's I/O subsystem supports both block-oriented transfers, such as disk reads and writes, plus character-oriented transfers, like those between systems and terminals. The I/O system is based on a virtual-channel abstraction which makes it easy to attach and integrate other I/O controllers to the C-1. The 68000-based I/O processors have their own software kernel whose utilities permit physical device-drivers on the processor to handle Multibus controllers in attached card cages. The kernel also supports communications among the system's virtual channels.

The C-1's CPU consists of five, asymmetric parallel processors: an instruction processing unit (IPU), an address and scalar unit (ASU), a vector processing system (VPS), an address translation unit (ATU) and a physical cache unit (PCU).

The IPU handles instruction fetch and decode. If the operation is simply register-to-register, then execution is handled by either the ASU or a combination of ASU and VPS, depending upon the nature of the data types. If the operation involves memory, then the ASU must generate the address after it has been decoded (by the IPU). The translation from logical to physical addresses is done by the ATU, then data is retrieved either from physical cache or memory.

These steps are done in a parallel/pipeline fashion. Thus, while the system is fetching the third instruction, it is decoding the second, and generating the address for the first, simultaneously. Up to eight instructions may be "in the pipe" at the same time. Regardless of whether the operation is scalar or vector, it gains a performance advantage via pipeline processing.

In vector operations, not only are the instructions processed in pipeline fashion, but also are carried out on a modified-data-flow, execute-when-ready basis called "chaining." For example, where a program calls for two vectors to be loaded to two vector registers, and then added, the add operation begins as soon as each vector element is ready, instead of waiting until all elements have been loaded. The concept is similar to pipelining except that it happens on an operand rather than an instruction basis.

The VPS consists of three independent, microprogrammed processors. One handles load/store/vector edit execution, the second does

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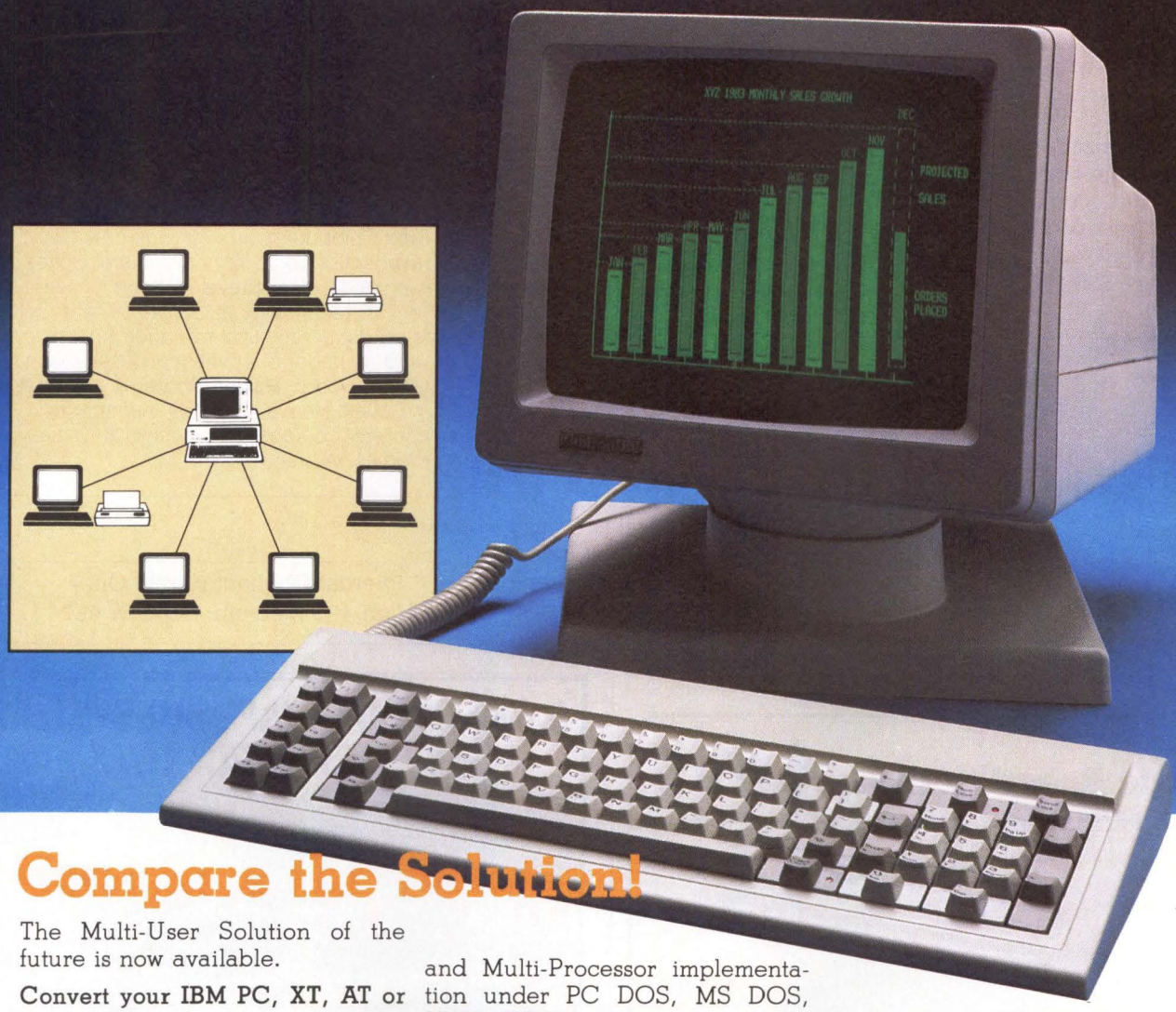

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CIRCLE NO. 49 ON INQUIRY CARD

Spec summary

- **Company:** Convex Computer Corp., Suite 151, 1819 Firman, Richardson, Texas 75081
- **Model:** C-1
- **Word size:** 64 bits
- **Real memory:** 128M bytes
- **Virtual memory:** 4G bytes
- **I/O bandwidth:** 80M bytes per second
- **Size:** 24 cubic feet
- **Cost:** $500,000

vector additions and subtractions, and the last performs vector multiplication and division. Chaining can take place even in mixed operations involving all three VPS processors.

The VPS can attain execution levels up to 60 million operations per second for 32-bit data and 30 million operations per second for 64-bit data. Concurrently with VPS execution, the C-1 also executes integer operations and branches. The VPS also offers a rich set of vector primitives. All arithmetic functions apply to integer and floating-point calculations.

A complete set of vector edit instructions—mask, merge and compress plus gather/scatter and vector-compare instructions permit vector conditional operations, sorts and merges and operations on spare matrices. □

Frank Marshall is vice president of development at Convex Computer Corp. He was previously vice president of computer products at United Technologies Mostek. **Steve Wallach** is vice president for technology at Convex. Prior to this, he was product marketing manager at Rolm Corp. and manager of advanced development at Data General Corp. **Harold Dozier** is manager of VLSI at Covex. He was formerly manager of microcomputer components design at United Technologies Mostek.

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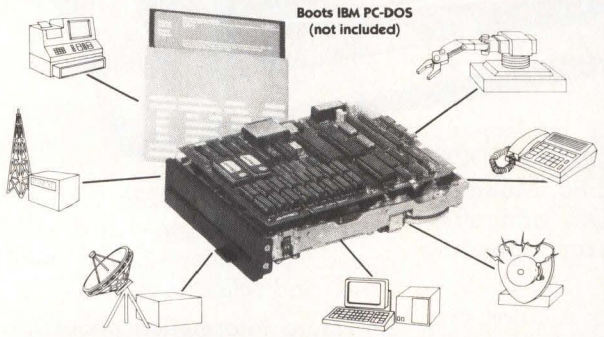

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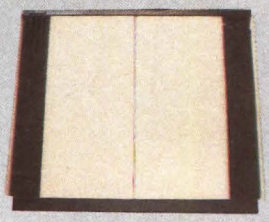

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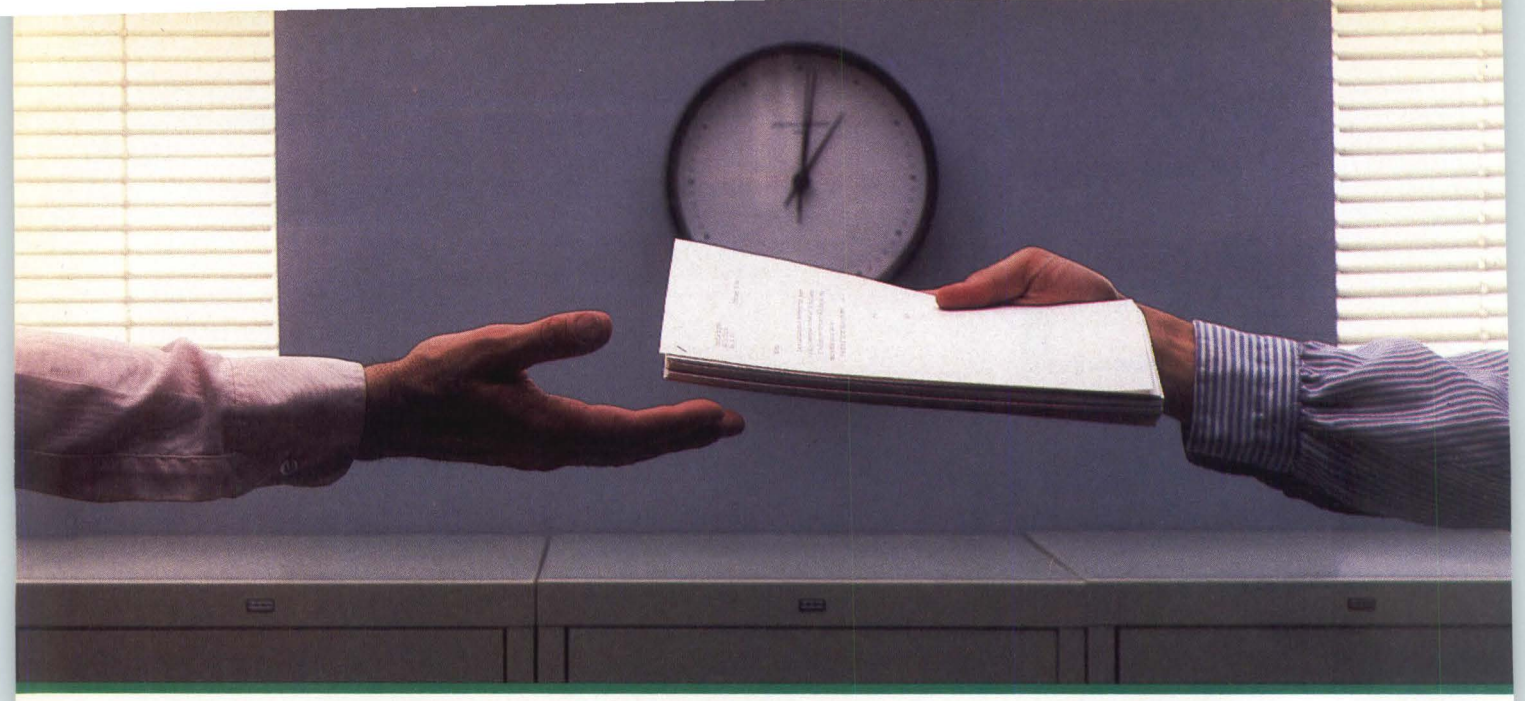

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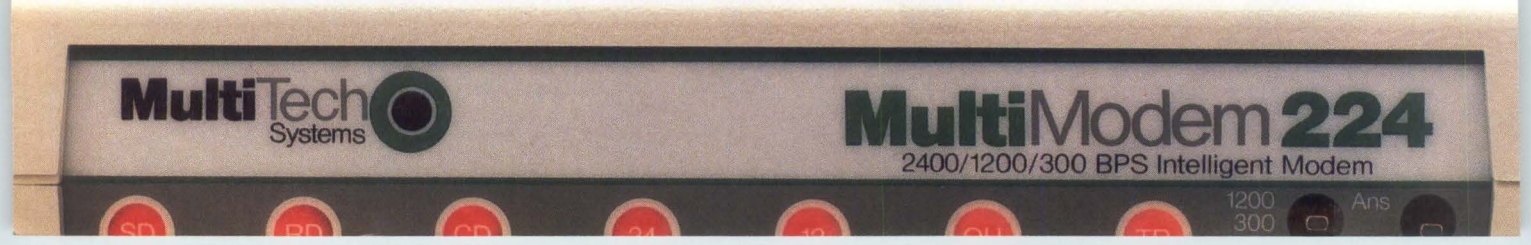

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Eileen Milauskas, Assistant Editor

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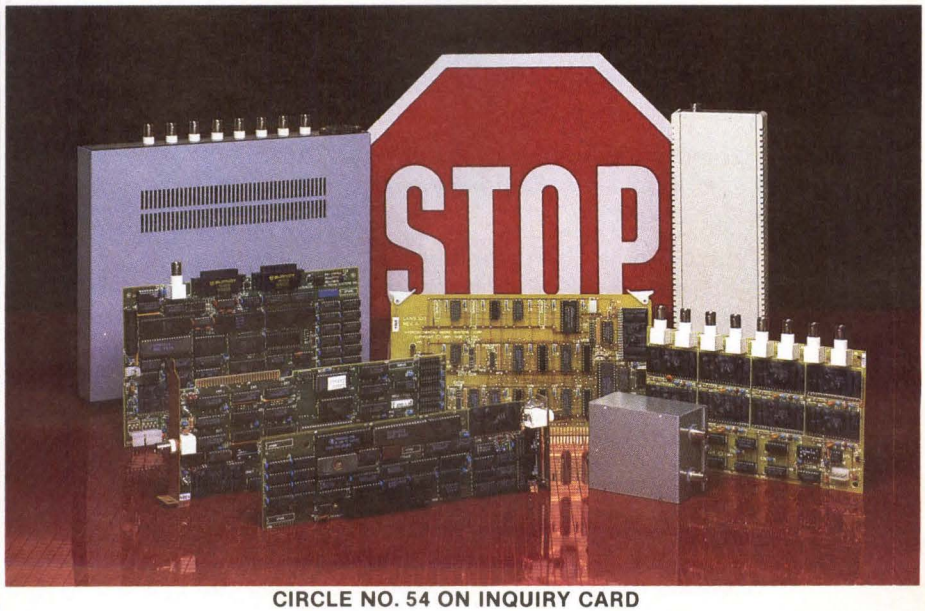

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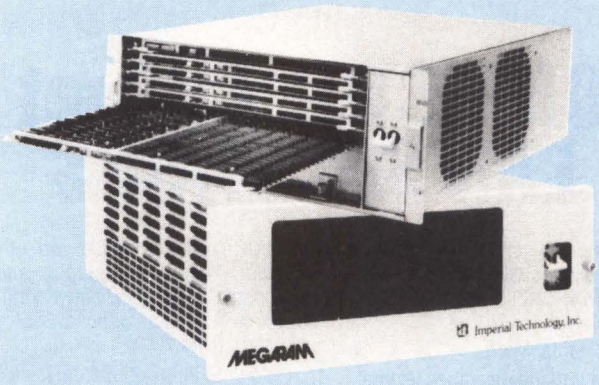

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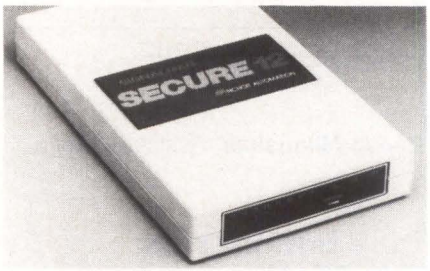
CIRCLE NO. 55 ON INQUIRY CARD



Modem includes security callback

- 1,200 bps
- Auto-dial, auto-answer
- Hayes compatible

An intelligent modem for personal computer applications requiring secure access from a remote location, the Signalman Secure 12 transmits data asynchronously at 1,200 bps. The auto-dial/auto-answer modem operates as a secure or a standard modem. Secure access is ensured by a password callback procedure. User-configurable security levels are password plus callback or password, callback and secondary password. The security callback system stores an average of 64 password and callback combinations, based on a seven-digit telephone number and an eight-character password stored in 1.2K bytes of dynamic memory. The modem conforms to the Hayes-compatible modem command structure and is compatible with the Bell 212A standard for operation with two-wire, full-duplex direct connect. $499. **Anchor Automation Inc.,** 6913 Valjean Ave., Van Nuys, Calif. 91406, (818) 997-7758.

Circle 301

Backup unit restores network communications

- Multipoint line
- Bypass mode
- Self-test

The DBU 368 dial backup unit remotely restores communications in a data network by automatically bridging multipoint circuits and extending private lines beyond a failed hub site. Should a master modem fail or in the event that a multiplexed modem downspeeds and drops a multipoint tail circuit, the single-card unit restores an entire multipoint line, including the drops. It establishes dial connections using a speed-dialing feature that permanently stores up to 10 sets of

Actual unretouched photo

PC Imaging... $1995.00

- 512 x 512 x 8 frame buffer (PIP-512)
- 1024 x 1024 x 8 frame buffer (PIP-1024)
- 256 colors/gray shades
- 16.7 million color output lut
- Real-time 8-bit frame grab
- DMA image transfer — 1M pixels/sec.

Matrox now offers two new image processing boards, the PIP-512 and PIP-1024. The PIP series of boards provides complete 8-bit image acquisition, frame buffering, and display capability for the IBM PC. A PIP board upgrades the PC, XT or AT into a LOW COST, PROFESSIONAL image processing workstation.

The PIP boards have all the high performance features characteristic of top-of-the-line image processing systems, with one exception: price.

The PIP-512 sells for only $1995.00 in single quantity.

For more info on MATROX PC imaging; CALL TOLL FREE 1-800-361-4903.

matrox

1055 St-Regis Blvd
Dorval, Québec, Canada
H9P 2T4
Tel.: (514) 685-2630
Tlx: 05-822798

IBM PC, IBM PC XT, IBM PC AT ARE TRADEMARKS OF INTERNATIONAL BUSINESS MACHINES.

CIRCLE NO. 56 ON INQUIRY CARD

22-digit numbers. Automatically bridging private-line signals with a dial-up connection, the unit reduces dial charges because the bridge can be located anywhere in the network to reduce dial distances. A bypass mode allows circuit extension over the dial-up network. Diagnostic features include self-test and soft straps. $995. **Infinet Inc.,** 6 Shattuck Road, Andover, Mass. 01810, (617) 681-0600.

Circle 302

Data switch suits 19.2K-bps devices

- Six to 192-line support
- Rate conversion
- Port contention

Supporting from six to 192 lines, the Distributed Data Switch connects devices that send or receive data at rates up to 19.2K bps. The switch can be divided in two sections, each 1½ miles apart, connected via twisted-pair wires. Standard features include rate conversion; port connection by name, number or class; port contention; priority queuing; auto baud; password-controlled protection; help menu; and toggling, which allows users to connect two separate ports and alternate between them. A system control feature enables the switch to disconnect a port, monitor activity on another port or broadcast messages to any or all of a switch's ports. Each port has a configurable switch, attention sequence of one to three characters. $800, basic unit; $450, each card. **Sequel Data Communications Inc.,** P.O. Box 4069, Cary, N.C. 27511, (919) 469-9510.

Circle 303

Gateway, servers conform to TCP/IP protocols

- 14 asynch device support
- IBM SNA host connection
- Leased, dial-up lines

The GS/3-IP network gateway interconnects up to eight physically isolated transmission control protocol and internet protocol (TCP/IP)-based Ethernets over multiple point-to-point connection media, including leased or dial-up lines, fiber-optic and microwave links. Line speeds range from 1,200 to 64K bps. Data transfers between Ethernets run at 175K bps. The CS/1-SNA-TCP/IP server provides TCP/IP hosts access to the IBM SNA environment over Ethernet. It combines LAN connectivity and services with protocol conversion to IBM SNA hosts, allowing foreign terminals or PCs connected to proprietary servers to look like IBM 3278 terminals. The CS/100-TCP/IP is a terminal or host server that allows four, 10 or 14 asynchronous devices to access TCP/IP-based host computers and the CS/1-SNA-TCP/IP attached to an Ethernet. $10,500, GS/3-IP, plus $250 annual software fee; $13,000, CS/1-SNA-TCP/IP, plus $1,000 software fee; $5,400, CS/100-TCP/IP, plus $250 annual software fee. **Bridge Communications Inc.,** 1345 Shorebird Way, Mountain View, Calif. 94043, (415) 969-4400.

Circle 304

Ethernet
TCP/IP for VAX/VMS™
Off the Shelf!

Complete package
for $8,795

Excelan offers a complete high-performance communications package including hardware, software, transceiver and all cables. Everything you need to perform high speed file transfers or do remote logins via Ethernet from a VAX running VMS or UNIX System V to UNIX 4.2 BSD machines and vice versa. Software includes TCP/IP protocols, and standard FTP (file transfer) and Telnet (virtual terminal) applications.

The entire VAX/VMS package is only $8,795, including the EXOS 204 Ethernet controller (quad-size Unibus board), EXOS 8040 TCP/IP software, EXOS 1100 transceiver and cables. And the entire UNIX System V package is only $7,295.

Excelan also offers similar packages for DEC PDPs, UNIX supermicros, and the IBM PC, XT and AT.

EXCELAN

2180 Fortune Dr. San Jose, CA 95131
Phone (408) 434-2300 Telex 176610

UNIX is a trademark of AT&T Bell Laboratories.
Unibus, VAX, VMS, and PDP are trademarks of Digital Equipment Corporation.

CIRCLE NO. 57 ON INQUIRY CARD

Introducing high performance switching at a low cost.

The IDX750™ Data PBX.

IDX750 is a trademark of M/A-COM, Inc.

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M/A-COM's IDX750™ is, quite simply, the best data PBX on the market today. Through high capacity switching, your users can access computers, printers and other peripherals from any location in your network. The IDX750 is compact, powerful and can be upgraded to larger capacity IDX models as your network grows. Yet the IDX750 is remarkably low in cost—and includes more standard features than any other data PBX.

- **Expandable**- modular growth from 24 to 768 lines with no system downtime.
- **User-Friendly**- menu-driven software with extensive "help" and information commands.
- **Cost-Effective**- multiplexes 24 asynchronous lines onto two twisted pairs at distances up to one mile.
- **Non-Blocking Design**- all full-duplex connections can run at speeds up to 19.2 Kbps simultaneously.
- **Network Control**- system configuration, management and diagnostics easily performed.
- **Reliable**- automatic switchover to optional redundant components.

M/A-COM is a leader in the development and manufacture of state-of-the-art communications equipment, providing complete support services. If you would like more information on the IDX750, call toll free (800)626-6640 or (619)457-2340; or write M/A-COM Telecommunications Division, 3033 Science Park Road, San Diego, California 92121.

M/A-COM
Telecommunications Division

CIRCLE NO. 58 ON INQUIRY CARD

Introducing a start-up systems company that wasn't born yesterday.

We're Hamilton Standard Digital Systems, Inc. And although we may be a new name to you, we're not new to the systems business. In fact, Hamilton Standard has been a major supplier of systems products for nearly thirty years.

And now, we've taken over the Mostek Systems Technology you've come to trust from our sister UTC company. And in the process, created a start-up systems company with a head start in the business.

For example, we're the world's largest supplier of 8-bit, Z80®-based, CP/M®-compatible STD BUS boards. Like our newest intelligent STD BUS family including the 68010-based processor card, and our user-configurable intelligent I/O VMEbus products, we offer a range of more than 30 other STD and VMEbus boards that help you build flexible, high-performance systems.

We're also a major supplier of add-in products for DEC®, Data General, Perkin-Elmer and MultiBus systems. And a pioneer of surface mount technologies, which allow a reduction of 40-60% in board sizes. We offer full-service CAD and automated manufacturing facilities. And a custom-build-to-print service to produce your own design, or vary one of ours.

So whatever your systems needs, start up a conversation with your nearest Hamilton Standard Digital Systems representative. In the Northeast, call 203/531-1146 or 609/596-9200. In Central areas, 214/466-7921 or 312/577-9870. In the West, 714/250-0455 or 408/287-5080. Or write 1419 Dunn Drive, Carrollton, Texas 75011, 214/446-2664.

See us at Dexpo West Booth #282

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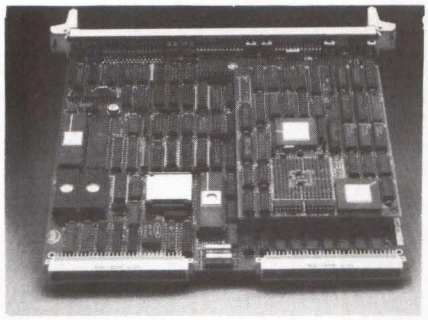
CIRCLE NO. 59 ON INQUIRY CARD

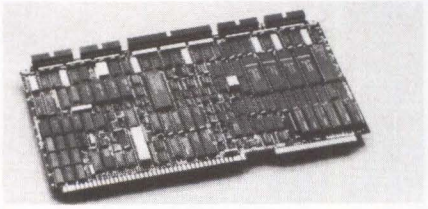


SBC controls multiple peripherals

- 80186 CPU
- Handles 12 drives
- 128K-byte RAM

The iSBC 186/224 single-board computer, a multiperipheral controller subsystem, supports up to four ST506/412-compatible, Winchester disk drives, up to four 5¼-inch, flexible disk drives (SA450/460-compatible) and up to four QIC-02 streaming-tape drives. The board, based on the 80186 microprocessor, includes diagnostics with built-in self-testing, the ability to configure software via interconnect space and the use of virtual interrupts. Performing multiple operations concurrently, the unit contains 128K bytes of dynamic RAM for multiple track-caching, boosting performance by supplying data to the CPU without incremental access to the Winchester disk. A driver for the iRMX 86 real-time operating system is available for the board. $1,995. **Intel Corp.,** 5200 N.E. Elam Young Parkway Hillsboro, Ore. 97123, (503) 640-7147.

Circle 305



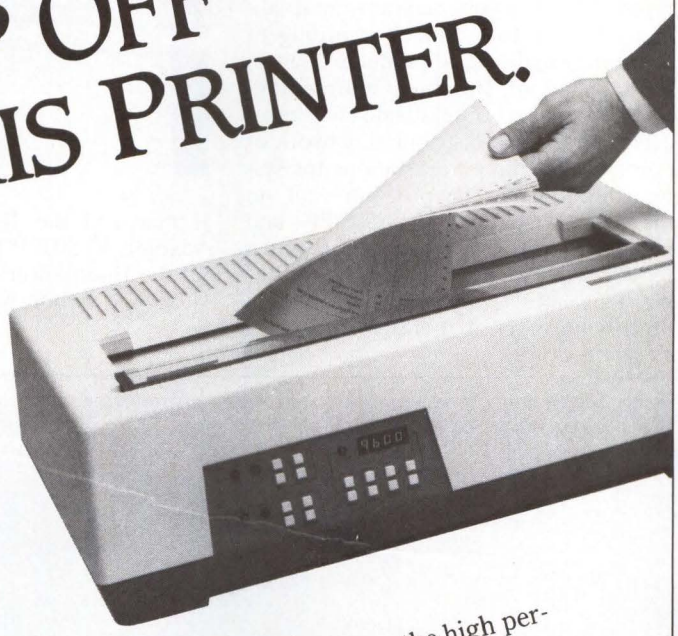
Controller supports four SMD disk drives

- iSBC 220-compatible
- Multibus-compatible
- Defective-track handling

A standard Multibus printed-circuit board, the MB-SMD contains a microprocessor, an interface and control logic to be software-compatible with the Intel iSBC 220 disk controller. Installed directly into the Multibus computer or expansion chassis, the controller provides the interface for a disk system of up to four large-capacity, removable or fixed media SMD disk drives operating at a 2.4M-byte-per-second data transfer rate. A defective-track handling feature reformats the track, assigns it a defective-track code and enters the address of the next alternate track. A self-test feature includes four LEDs to identify faults. Addressing capability is 16-, 20- or 24-bit selectable. Automatic error recovery and retry allow non-fatal errors to be recovered and/or retried up to 27 times. $2,100. **Wespercorp,** 14511 New Myford Road, Tustin, Calif. 92680, (714) 730-6250.

Circle 306

RIP OFF THIS PRINTER.



Stop wasting forms.
Get the new Datasouth 180DD–the high performance printer for true-to-form printing. It's fast, it's rugged, it's sophisticated and it prints legibly through six-part forms with ½ inch tear-off capability.
This makes the DS 180DD the ideal printer for hotels, motels, airlines, travel agencies–for any job that requires quality multipart form printing on demand.
Call your nearest Datasouth distributor today and ask about the new DS 180DD. When you consider all the money-saving advantages, it's really quite a steal.

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CIRCLE NO. 60 ON INQUIRY CARD

Software facilitates information-system design

- IBM PC/AT-compatible
- 256K-byte requirement
- DeMarco methodology

Automating the paper-intensive design methods of system developers, Structured Architect develops information systems on personal computers. Using the DeMarco method employed in the development of information-processing systems, the software tool graphically represents data-flow diagrams and validates the analyst's model according to structured analysis and produces analysis documentation. It allows information-system managers to subdivide large projects by creating a distributed network of personal computer workstations for system developers. The program runs on the IBM PC, PC/XT, 3270 PC and PC/AT with 256K bytes of memory and a fixed disk as well as on Compaq Portable, Plus and DeskPro models. Graphics boards supported include Hercules, Tecmar and the IBM Color Graphics Adapter. $3,500. **ISDOS Inc.,** Suite 103, 325 E. Eisenhower Parkway, P.O. Box 4179, Ann Arbor, Mich. 48106-4179.

Circle 307

Software executes presentation graphics

- 200 symbols
- Automatic spacing
- Chart editing

Freelance software combines graphics-presentation capability with chart editing, word-chart creation, symbol libraries and freehand drawing. Existing charts produced with Lotus 1-2-3 or the proprietary Graphwriter can be customized with comments, arrows, company logos or specialized symbols as well as resized and combined with other charts, images or text. Over 200 pre-drawn symbols are standard, grouped into sets ranging from arrows and borders to demographic and architectural symbols. When creating diagrams, illustrations or freehand images, objects can be moved, rotated, sized and edited with the help of custom grids, rulers and templates. Running on the IBM PC, PC/XT or PC/AT, the program requires 256K bytes of memory. Support is provided for the IBM Color Graphics

© 1985 Wyse Technology
3571 N. First Street, San Jose, CA 95134, (408) 433-1000

Adapter, the IBM Enhanced Graphics Adapter and the Hercules graphics card. $395. **Graphic Communications Inc.,** 200 Fifth Ave., Waltham, Mass. 02254, (617) 890-8778.

Circle 308

APL interpreter works with XENIX OS

- Concurrent file sharing
- Screen editing
- External process interface

The APL * PLUS UNX System is an enhanced APL interpreter and application-development system for the IBM PC/AT running under the XENIX operating system. The program's partial compilation of APL code results in no repeated syntactic analysis. Multiple function and variable full-screen editing allows simultaneous creating, viewing and editing of images. The system's concurrent file-sharing capability allows simultaneous updating of component files by different users. An external process interface facilitates a variety of non-APL programs such as database managers and graphics packages. The system requires 1M byte of memory. $995. **STSC Inc.,** a Contel company, 2115 E. Jefferson St., Rockville, Md. 20852, (301) 984-5000.

Circle 309

Software library aids image processing

- 80 modules
- LUT manipulation
- Line, area operations

A standalone library of board-level and image-processing routines for use with the proprietary PCVision Frame Grabber, ITEX/PC software speeds program development. The package contains over 80 routines that are callable from Microsoft Pascal, FORTRAN or C. Running on the IBM PC/XT, PC/AT and compatibles, the software reduces program memory requirements because only those routines used in the program are taken from the library after program linking. Included in the routines are initialization and register access, look-up table manipulation, image acquire and clear, image save and restore, pixel read and write, line and area operations and image geometry, processing and graphics. $1,595, single-use license. **Imaging Technology Inc.,** 600 W. Cummings Park, Woburn, Mass. 01801, (617) 938-8444.

Circle 310

ANSWER TO NOVEMBER'S PUZZLE

F	O	R	M	A	T		H	A	C	K	E	R
I	M		A	D	A	R		S	L	A	V	E
E	N		C	A	C	H	E		O	D	E	S
L	I	E	R			O			N	I		E
D		L	O	A	D		A	C	E		I	T
	M	E		M	E	D	I	A		S	T	
M	I	C	R	O	D	O	M	P	U	T	E	R
	C	T		L	A	S	E	R		A	M	
S	E		M	E	L		D	I	S	K		C
L		Z	O			W			H	E	R	O
U	S	E	D		M	E	R	G	E		O	B
M	I	R	E	S		B	A	S	E		D	O
P	R	O	M	P	T		M	A	T	T	E	L

DEC VT-220 compatibility, Wyse-style.

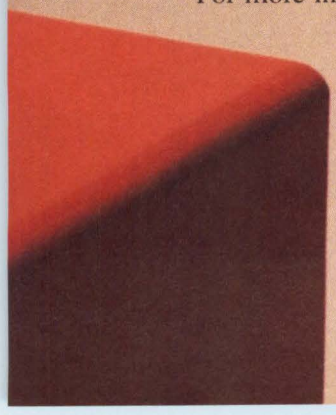
At $799 our WY-85 gives you complete DEC VT-220™ software compatibility in function and fit, plus a form that beats all, for a price that beats all.

Like all our terminals, the WY-85 packs all the ergonomic features you want into an unusually small footprint. The generous 14″ non-glare screen tilts, swivels, and handles a full 132-column format. Even the sculpted, low-profile keyboard adjusts for perfect fit and easier function.

So you get not just emulation, but the full operational compatibility you're looking for, including keyboard layout. For a lot less money, in a lot less space, with a lot more style.

No wonder Wyse terminals are now on more than 250,000 desktops worldwide.

For more information about our full line of computer display products, call toll-free, today.



WYSE

Call 800-GET-WYSE

CIRCLE NO. 61 ON INQUIRY CARD

VT-220 is a trademark of Digital Equipment Corporation. The "V" shaped design is a trademark of Wyse Technology.

Now you can take supercomputing power to the ends of the Earth.

And beyond.

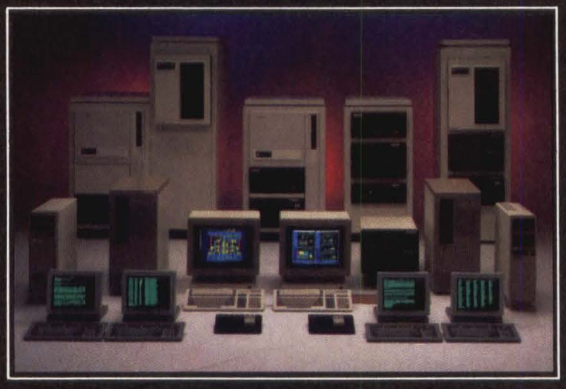
Introducing the first family of Micro Supercomputers.

Imagine supercomputing power you can take to the application. Today, MASSCOMP™ makes it a reality.

We've expanded the MC500 series to the MC5000 family by adding four new systems with faster 32-bit CPUs. Using our realtime version of the UNIX™ operating system (RTU™) and multiprocessing technology, they define a whole new class of computers. We call them micro supercomputers.

These new machines enable you to perform parallel data acquisition, computation, networking and graphics, without one task degrading another. They're designed to exploit concurrent operations while delivering powerful system performance in engineering, scientific and other computationally intensive applications.

MASSCOMP gets more performance at each level of technology than any other computer company. The ratio of whetstones or samples/second to the dollar proves it. No one else comes close.



They're in a class by themselves.

PRICE: $15,000 – $250,000

PERFORMANCE:
- .7 to10 MIPS
- 625K to over 12,000K Whetstones/second
- Up to 13 Mflops
- 1,000,000 samples/second—data acquisition
- 1–4 CPU multiprocessors

RELIABILITY:
- Less than 1 hardware failure per year average

UNIQUE FEATURES:
- Realtime UNIX™ operating system
- 68020 multiprocessing
- Triple Bus™ architecture
- Multiple graphics, networking options

Our micro supercomputers are transportable and dependable, whether you're studying the ocean floor through arctic ice or an oil field through desert sand. These are the kinds of places you can't take a computer that's going to break down. Relax. Our record of reliability sets the standard for the rest of the industry.

Choose from five systems you can tailor to your evolving needs. You'll realize the full advantage of the industry standard UNIX operating system coupled with our proprietary realtime enhancements. When you also consider the flexible applications software and powerful computational ability, it's easy to see why our micro supercomputers are in a class by themselves.

For more information, call us at 800-451-1824 or (617) 692-6200; or write MASSCOMP, One Technology Park, Westford, MA 01886.

You won't find a better system if you go to the ends of the Earth.

Or beyond.

MASSCOMP

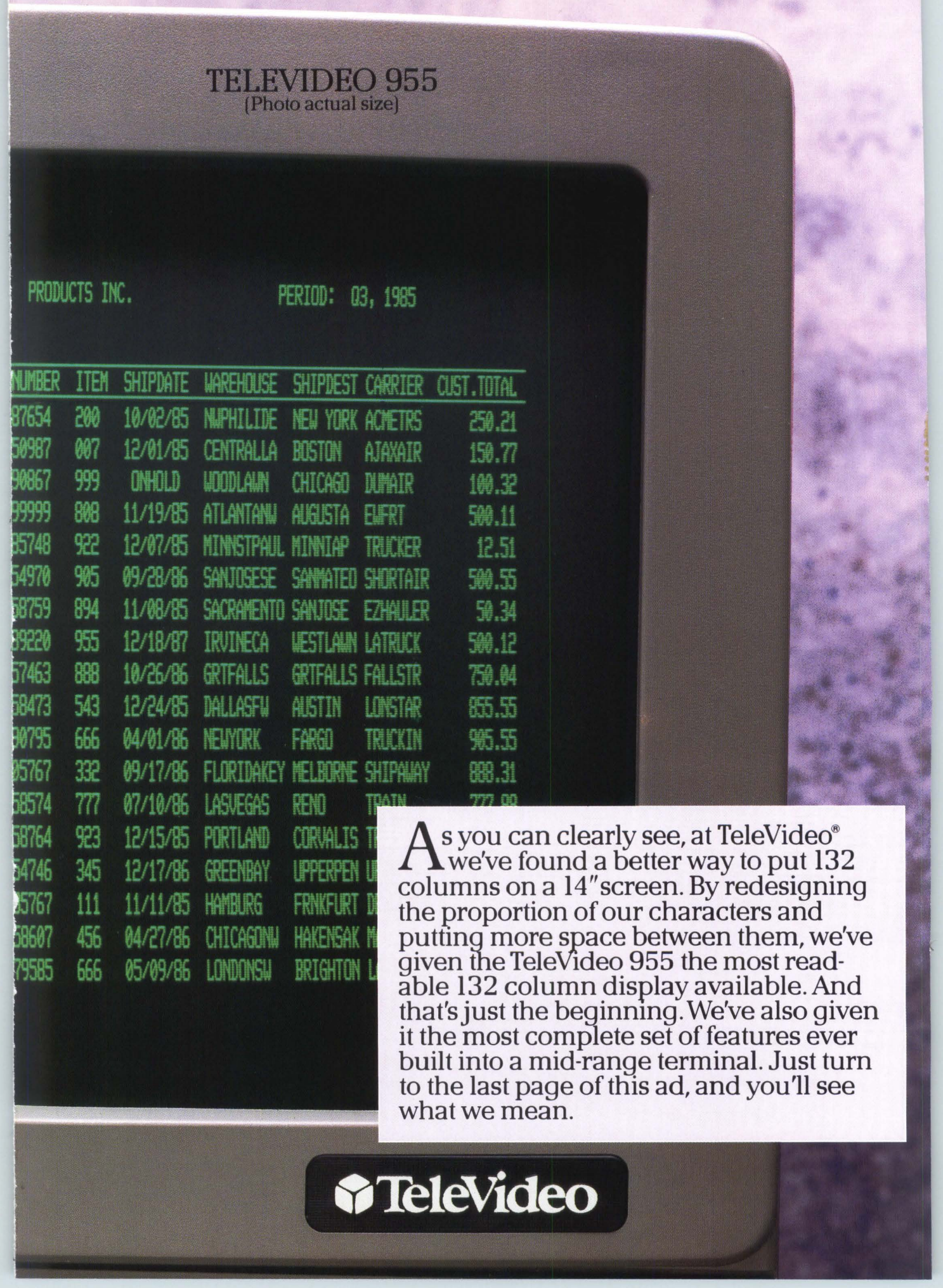
The Micro Supercomputer Company

800-451-1824

MASSCOMP, RTU and Triple Bus are trademarks of Massachusetts Computer Corporation. UNIX is a trademark of AT&T Bell Laboratories.

CIRCLE NO. 62 ON INQUIRY CARD

An eye-opening comparison between two $600 terminals.

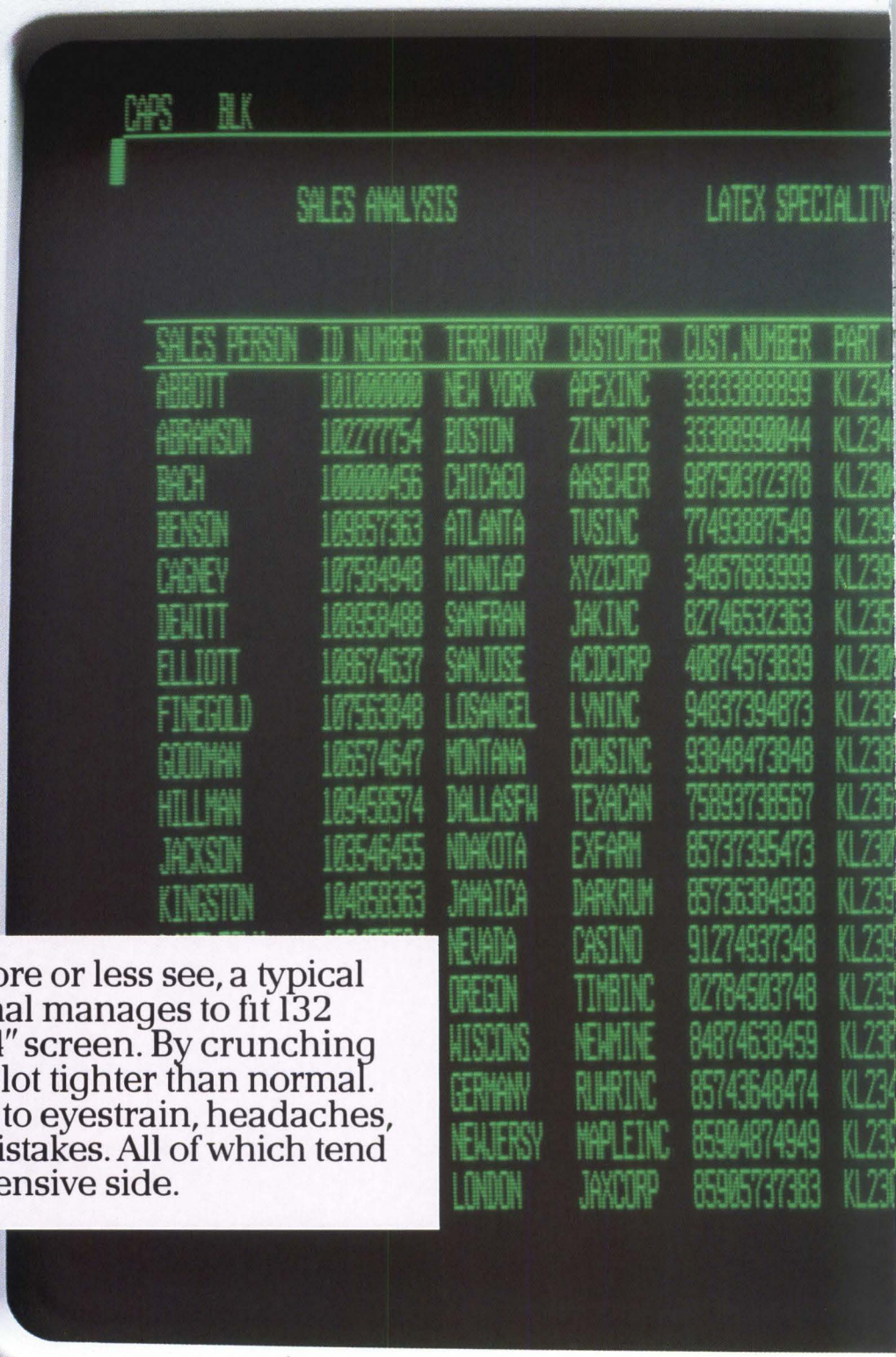


As you can clearly see, at TeleVideo® we've found a better way to put 132 columns on a 14" screen. By redesigning the proportion of our characters and putting more space between them, we've given the TeleVideo 955 the most readable 132 column display available. And that's just the beginning. We've also given it the most complete set of features ever built into a mid-range terminal. Just turn to the last page of this ad, and you'll see what we mean.

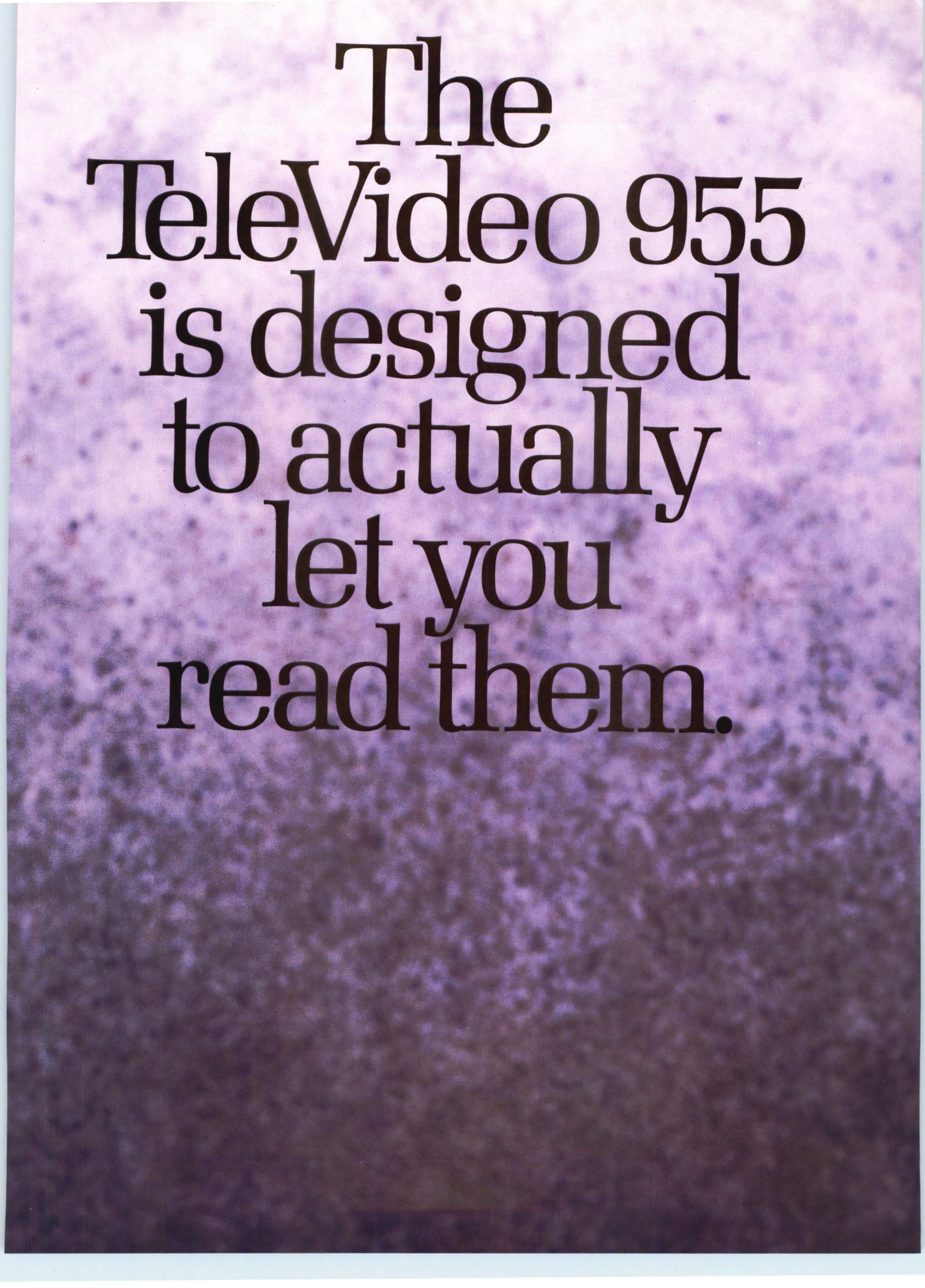
TeleVideo

Most 132 column terminals are designed to crunch a lot of numbers.

WYSE WY-50
(Photo actual size)



As you can more or less see, a typical $600 terminal manages to fit 132 columns on a 14" screen. By crunching them together a lot tighter than normal. Which can lead to eyestrain, headaches, and just plain mistakes. All of which tend to be on the expensive side.


The
TeleVideo 955
is designed
to actually
let you
read them.

Besides making the TeleVideo 955 a lot more readable, we gave it a whole list of features you won't find on any other 132 column terminal. Like 64 non-volatile programmable function keys. With 512 bytes of dynamically allocated variable memory. Your choice of green or amber screen. And ergonomics that, unlike Wyse's, meet the human factors standards recommended for adoption by the American National Standards Institute. And you get all this for only $629.

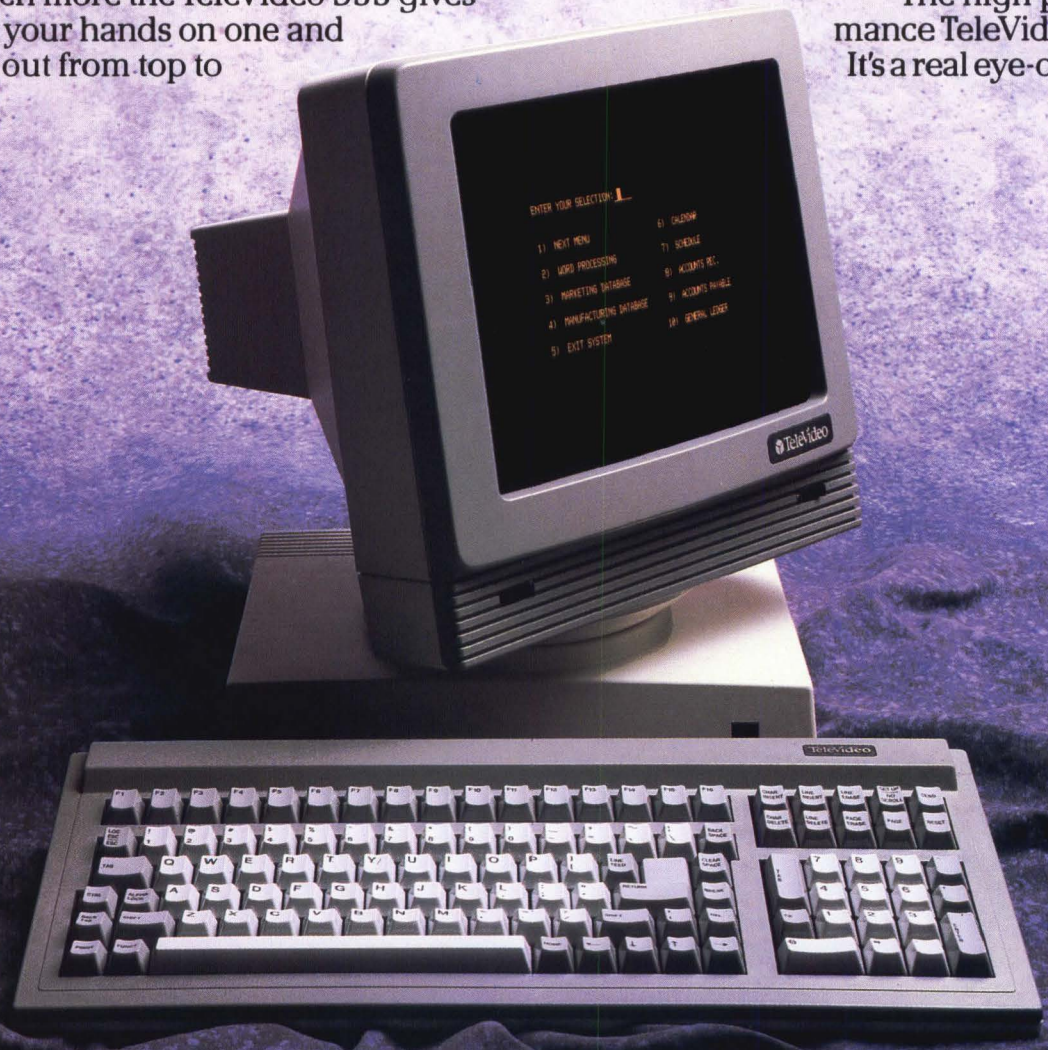
Available options include WY-50/50+ compatibility, graphics add-in board, and up to three additional pages of screen memory.

To see exactly how we compare feature for feature with the Wyse WY-50/50+, just look at the chart on this page.

Of course, there's an easy way to see how much more the TeleVideo 955 gives you. Get your hands on one and check it out from top to bottom. If you're a computer professional, MIS manager, or VAR, you've got until February 28, 1986 to order an evaluation unit for the special price of $400, including shipping. (U.S. and Canada only.) One per company, please. Just call 800-227-6703 and ask for Department 46. (In California, 800-632-7979.)

TELEVIDEO 955 VS. WYSE WY-50 AND WY-50+			
FEATURES	TVI 955	WY-50	WY-50+
Keyswitches tested to	100 million strokes	10 million strokes	10 million strokes
Screen color	Green or amber	Green only	Amber only
High contrast dark screen	Yes	No	No
Programmable function keys	16/64	16/32	16/32
Dynamically allocated function key memory	512 Bytes	128 Bytes	128 Bytes
Maximum bytes per function key	Unlimited	4	4
Graphics upgrade	Yes	No	No
User ROM Slot	Yes	No	No
List Price	$629	$599	$699

The high-performance TeleVideo 955. It's a real eye-opener.



TeleVideo®

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Directory provides printer specifications

The *1986 Printing Directory and Specification Guidebook Series* covers thermal, toner-based, color hard-copy and ink-jet printing in four volumes. Included are specifications of each printer, the manufacturer's actual product literature and print samples. A summary and overview section categorizes competitive products and groups them by selected specifications. $250, each volume. **Gorham International Inc.,** P.O. Box 8, Gorham, Maine 04038, (207) 892-2216.

Circle 311

Guide aids real-time design

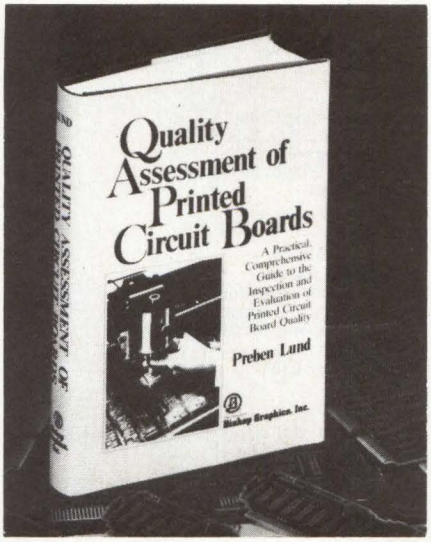
The eight-page brochure, "A guide to designing real-time in less time," offers advice in designing microprocessor-based systems using real-time, operating-system software. The guide includes a lexicon of real-time software terminology and provides a checklist of considerations such as program size, processor power and changing system requirements for selecting the appropriate software. Free of charge. **Hunter & Ready Inc.,** 445 Sherman Ave., P.O. Box 60803, Palo Alto, Calif. 94306, (415) 326-2950.

Circle 312

Survey presents word-processor specs

The 45-page, "Microcomputer Word Processors" survey gives specifications and pricing information on 107 word processors for microcomputers from 90 vendors. The directory begins with a reference, summary index that provides basic information on operating systems, supported hardware, memory requirements, program features, print features and price. The index is followed by descriptions of each product, arranged alphabetically by vendor. Each entry includes information on the product type, software and hardware environment, file-handling capabilities, printers supported, distribution channels and terms and support (price, license availability and protection information). $29. **Data Decisions,** 20 Brace Road, Cherry Hill, N.J. 08034, (609) 429-7100.

Circle 313



Volume assesses printed-circuit boards

Aiding printed-circuit board manufacturers, inspectors and designers, the illustrated and indexed *Quality Assessment of Printed Circuit Boards* provides information on establishing inspection criteria to identify board defects and their causes. Topics covered in the 530-page book include how to prepare for a cost-effective inspection, how to implement a sampling inspection method for reducing defects 90 percent to 95 percent, how to choose inspection equipment, how to evaluate inspection results and how to create and maintain an inspection record. The book contains 500 photos, graphs, tables and charts. $59.95. **Bishop Graphics Inc.,** 5388 Sterling Center Drive, Westlake Village, Calif. 91359, (818) 991-2600.

Circle 314

Catalog lists board products

A 90-page, 1985-1986 Gespac catalog provides system integrators with descriptions of the company's board-level products, software packages and development systems. Product listings include processors, memories, interfaces, controllers, transducers and subsystems. A quantity-one-to-99 pricing supplement is provided. Free of charge. **Gespac Inc.,** 100 W. Hoover Ave., Mesa, Ariz. 85202, (602) 962-5559.

Circle 315

Report highlights AI applications

"Artificial Intelligence Applications for Business Management" is a 240-page report on the use of expert systems and natural-language software as a tool for business management. Applications include financial planning, decision support, marketing, text understanding, advisory services, language translation, editing and office automation. A chapter on using the personal computer is included. $110. **SEAI Institute,** P.O. Box 590, Madison, Ga. 30650, (404) 342-9638.

Circle 316

Manual describes MC68020 CPU

The second edition of the *MC68020 32-bit Microprocessor User's Manual* aids design engineers, software architects and computer designers in the completion of hardware and software systems using the Motorola microprocessor. A definition of the CPU's instruction set is provided, as are complete timing diagrams and specifications. The manual's 11 chapters are Data Organization and Addressing Capabilities, Instruction Set Summary, Signal Description, Bus Operation, Processing States, On-Chip Cache Memory, Coprocessor Interface Description, Instruction Execution Timing, Ordering Information, Mechanical Data and Electrical Specifications. $5.20. **Motorola Inc.,** Literature Distribution Center, Broadway Building No. 1, 616 W. 24th St., Tempe, Ariz. 85282, (602) 994-6561.

Circle 317

Catalog details datacomm devices

A 160-page book listing over 500 datacommunications devices, the *Black Box Catalog* contains a 12-page, color insert highlighting 36 new products. It covers data switches, data cables, power managers, surge-protection devices, tools and networking hardware, test sets, multiplexers, modems, protocol converters, printer interfaces and reference books. Free of charge. **Black Box Corp.,** P.O. Box 12800, Pittsburgh, Pa. 15241, (412) 746-5500.

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Report emphasizes LAN strategies

In Section I of the 320-page, "Local Network Vendors' Strategies Report," 20 LAN companies are considered in terms of the fundamental technology and topological structure they employ, their level of correspondence to the OSI reference model and their marketing strategies. The section examines the stability of the various vendors and their ability to sustain a product line. Section II offers a closer look at individual products from key LAN vendors such as Nestar, Novell, Sytek and Ungermann-Bass. Special attention is paid to the LAN direction of IBM and AT&T. Descriptions of the hardware and software available include technical data, diagrams and pricing information. The report also includes three reference tables highlighting broadband, baseband and PBX system vendors and their addresses. $219. **Architecture Technology Corp.,** P.O. Box 24344, Minneapolis, Minn. 55424, (612) 935-2035.

Circle 319

Book examines PC technology

The 369-page *Insights Into Personal Computers* is coauthored by leading personal computer industry representatives who describe their companies' personal computer architectures, software and applications. The book discusses products in terms of general makeup, characteristics, hardware, software, industry, networks and history. Chapters include material on the anatomy of a portable computer, the role of communication technologies in the personal computer revolution, the function of venture capital in the industry and computer graphics. Personal computer architectures from the following companies are detailed: Apple, Data General, DEC, Hewlett-Packard, IBM, NEC, Texas Instruments and Wang, along with Intel's 80286 microprocessor. $29.50. **The Institute of Electrical and Electronics Engineers Service Center,** 445 Hoes Lane, Piscataway, N.J. 08854.

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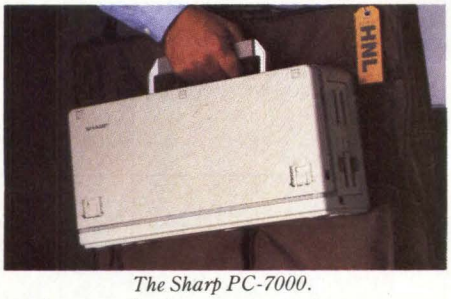

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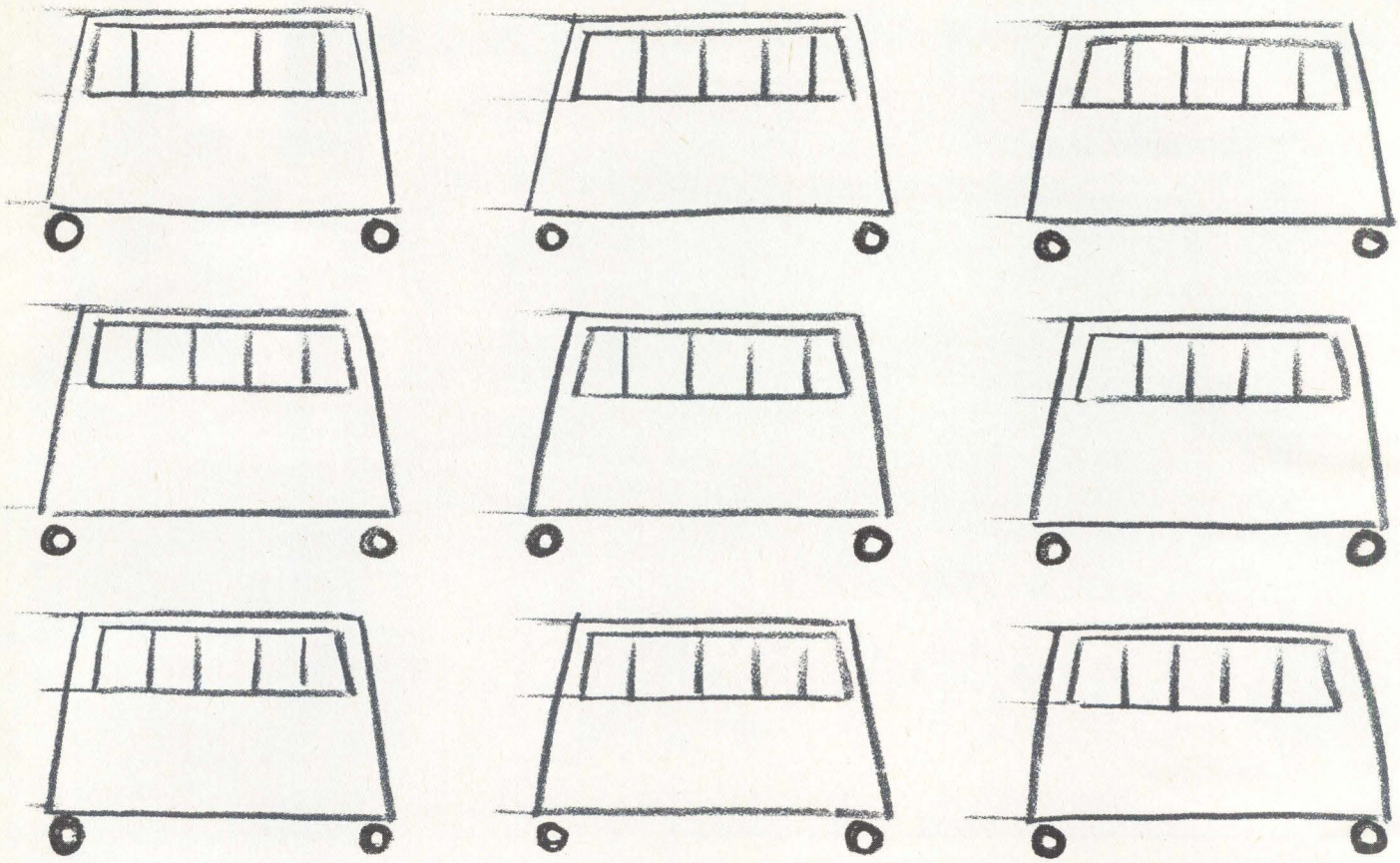

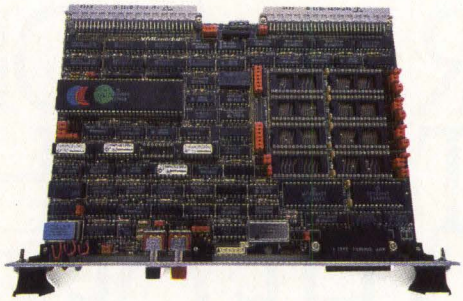

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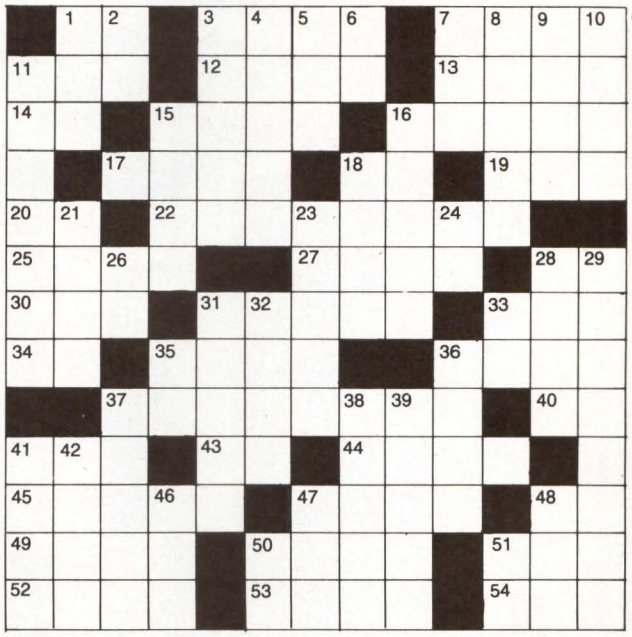
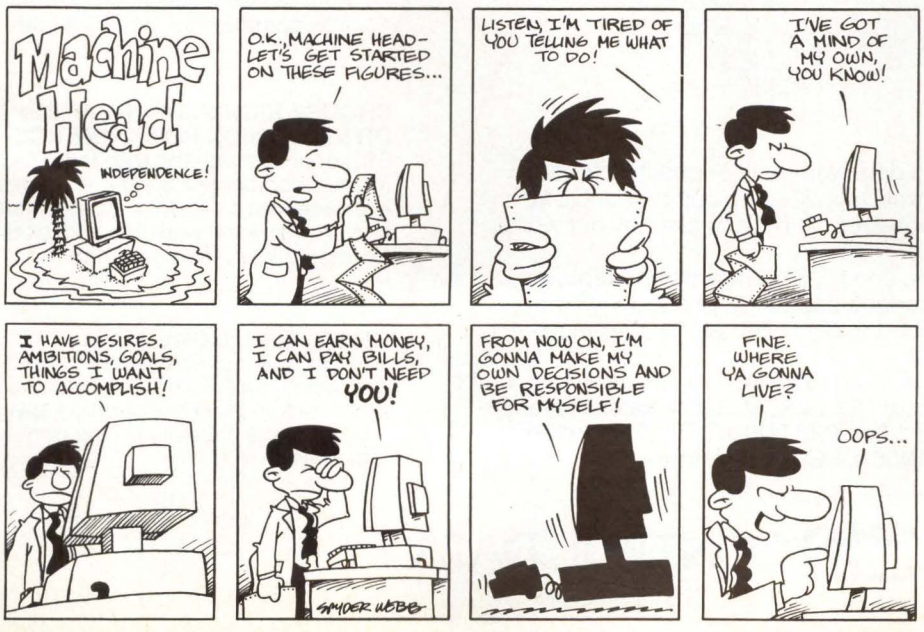


ACROSS

1 Special function
3 One's own welfare
7 Interpret
11 Function
12 Internal structure
13 Affectionate abbreviate for state in SE U.S.
14 Smaller "half" of Bible (Abb.)
15 Entry channel
16 See in business capacity
17 First marketed robot
18 French "the"
19 Historical time period
20 Alternating current (Abb.)
22 I/O device
25 Your "handle"
27 Avoid
28 Follow copy (Abb.)
30 Monitor (Abb.)
31 Systems of symbols
33 Spanish for "river"
34 His full name means "fortunate"
35 Author of poker program for Apple II
36 France's leading domestic computer maker
37 High-speed memory location
40 City's overhead railway
41 Function
43 For example
44 Metal-headed golf club
45 Type of printer
47 Metal bonded layer
48 What one gets paid for working Sunday (Abb.)
49 Computer owner
50 Binary data
51 Type of exploded chart
52 French "beast"
53 Radix in numbers scale
54 Logical operation

DOWN

1 __ matrix printer
2 Native to
3 Remember information
4 Mistake
5 Statement
6 Iron (Chem.)
7 Run batted in (Abb.)
8 Software language ties PCs to mainframes
9 Moslem ruler
10 Computer information
11 To improve
15 His full name means "rock"
16 DEC's model 8600 computer system
18 Type of printer
21 Printed-circuit board
23 Operating system
24 Hebrew eleventh month
26 Mount (Abb.)
28 Collection of related records
29 Gather together
31 Basketball player
32 Beginning (Abb.)
33 Ruthenium (Chem.)
35 Civil Engineer (Abb.)
36 Author of *Technostress: the Human Cost of the Computer Revolution*
37 Switch to release printer
38 Inclines produced by optical printer
39 Clear
41 Bungle
42 Level to the ground
46 Before
47 U.S. intelligence agency
48 CP/M command gives list of disk files
50 Air rifle pellet
51 River in N Italy



Solution will be printed next month.

Answers to November's puzzle can be found on Page 125.

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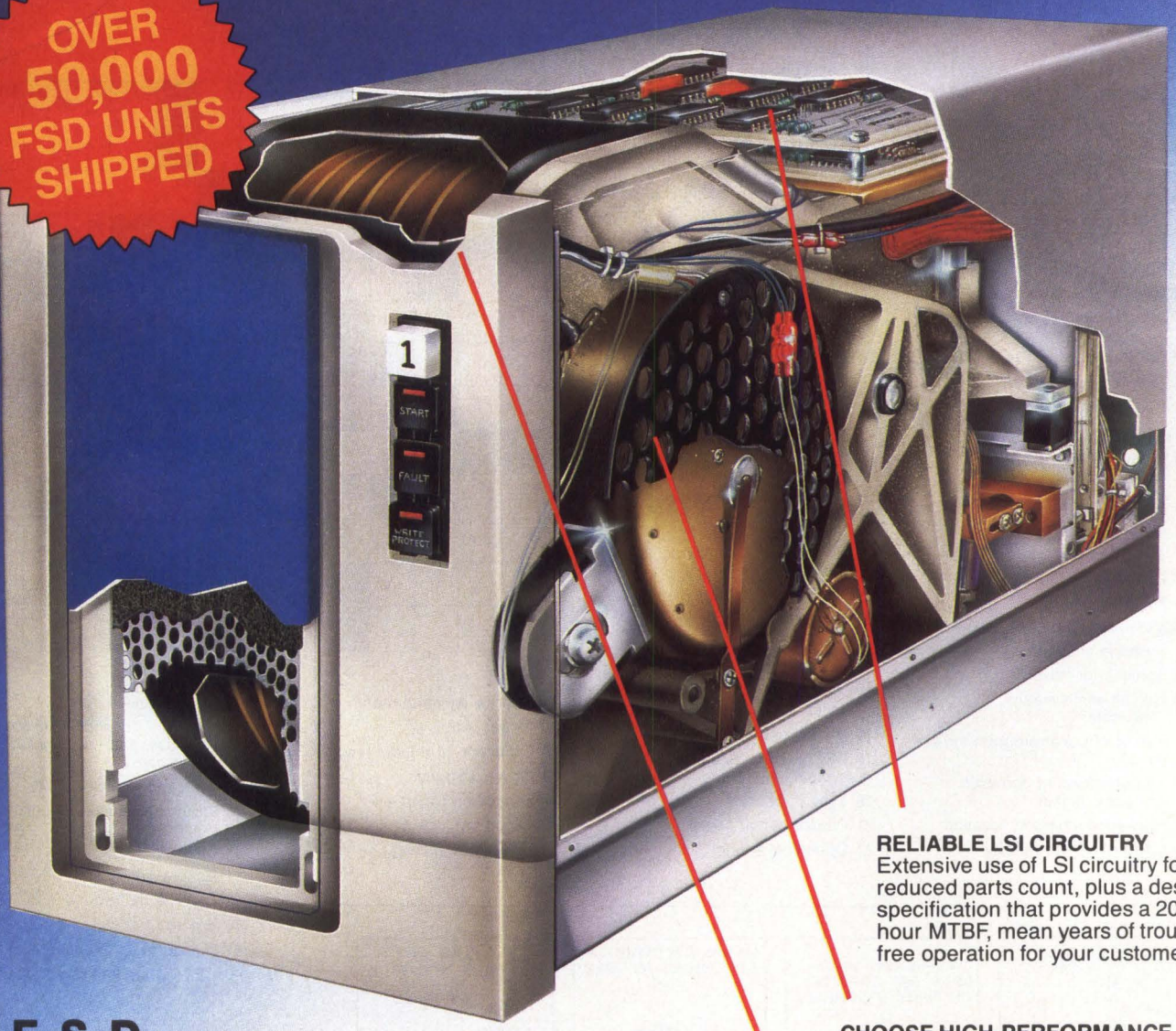

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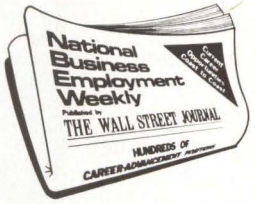

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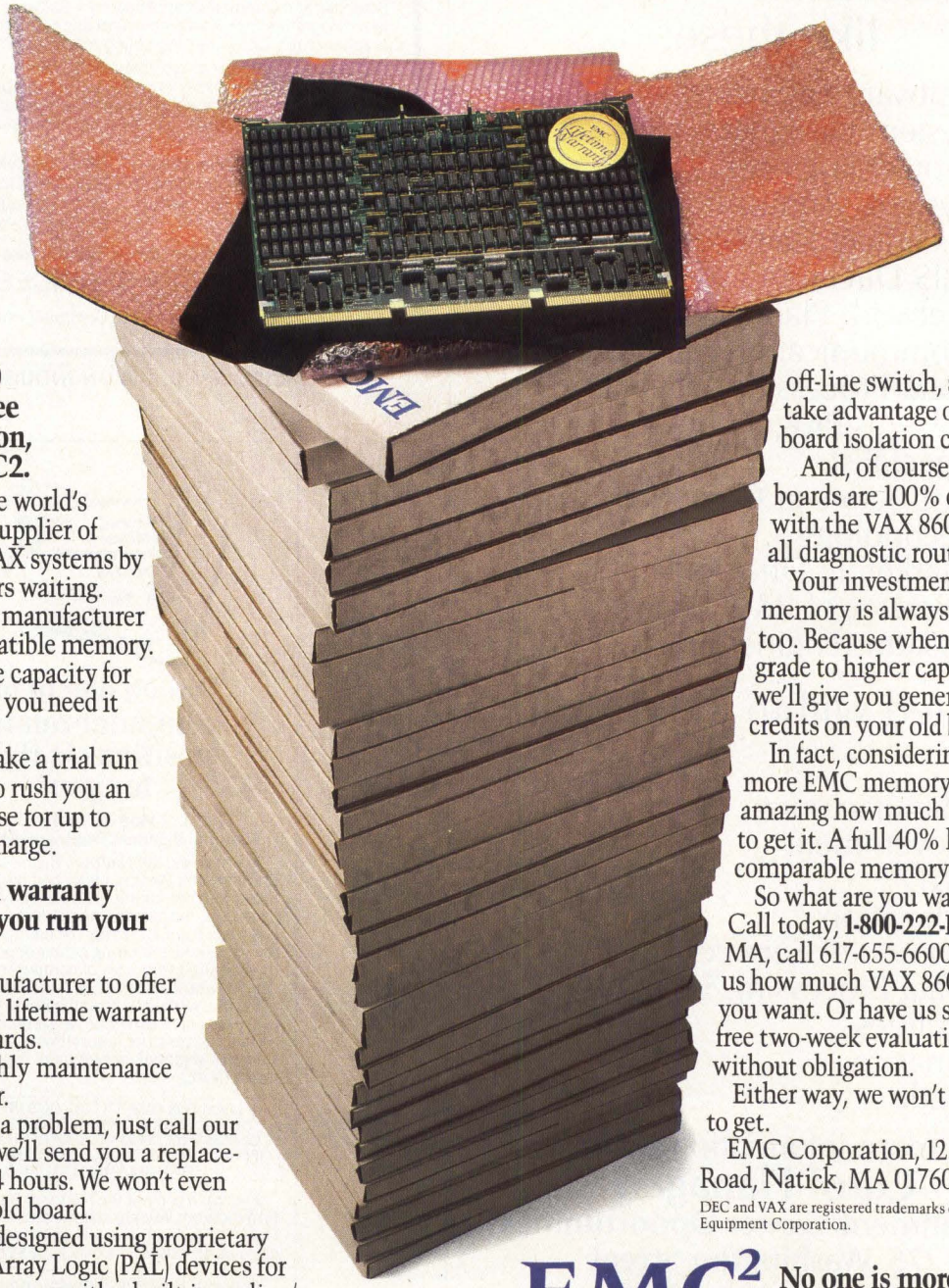

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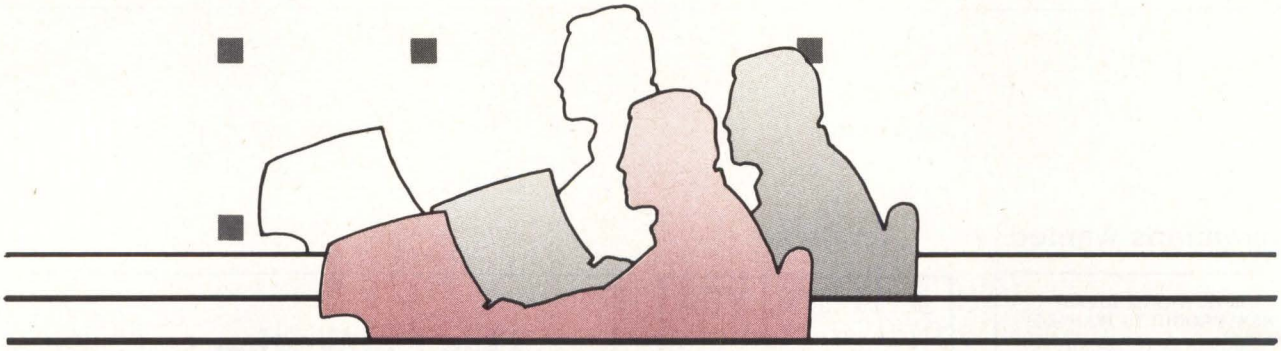

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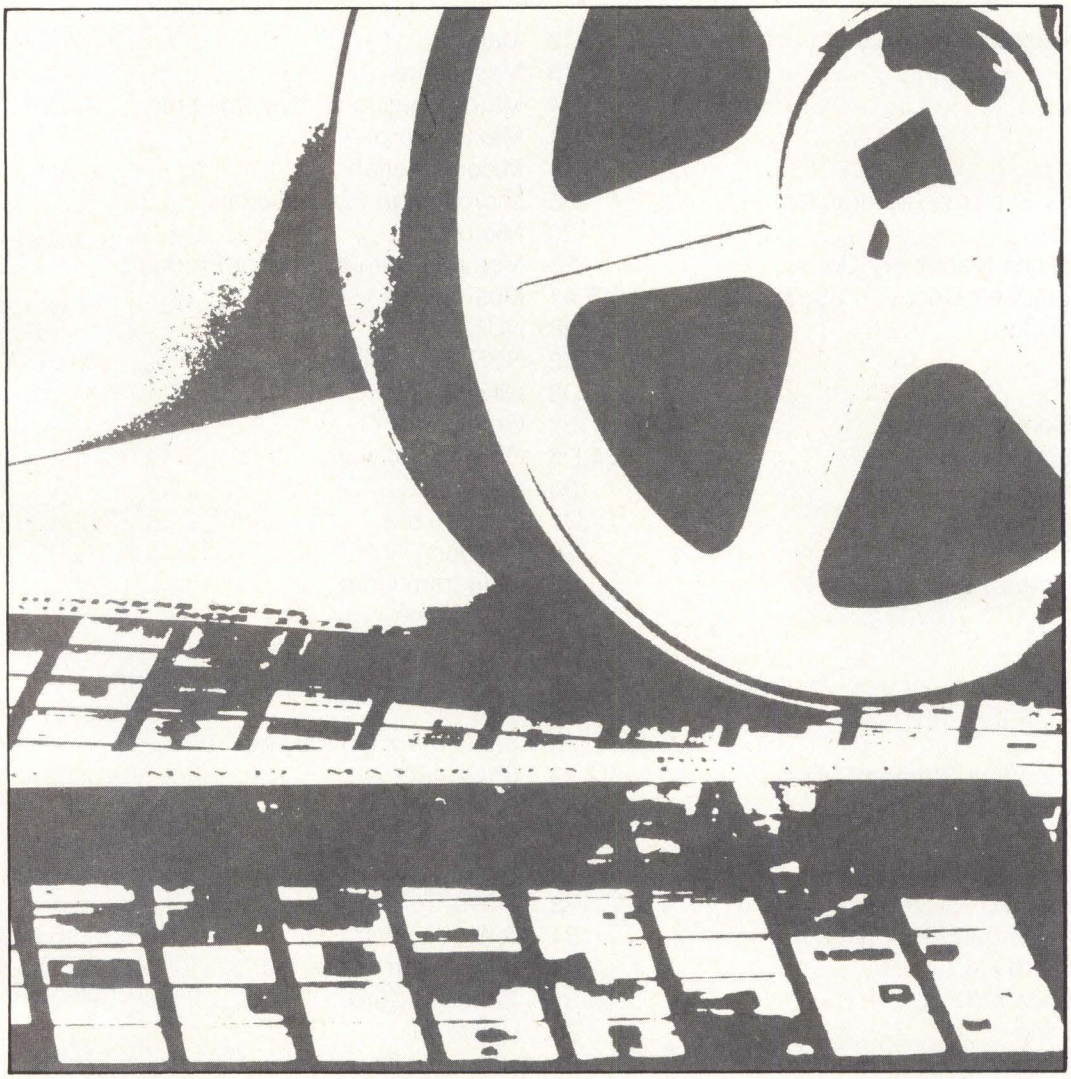

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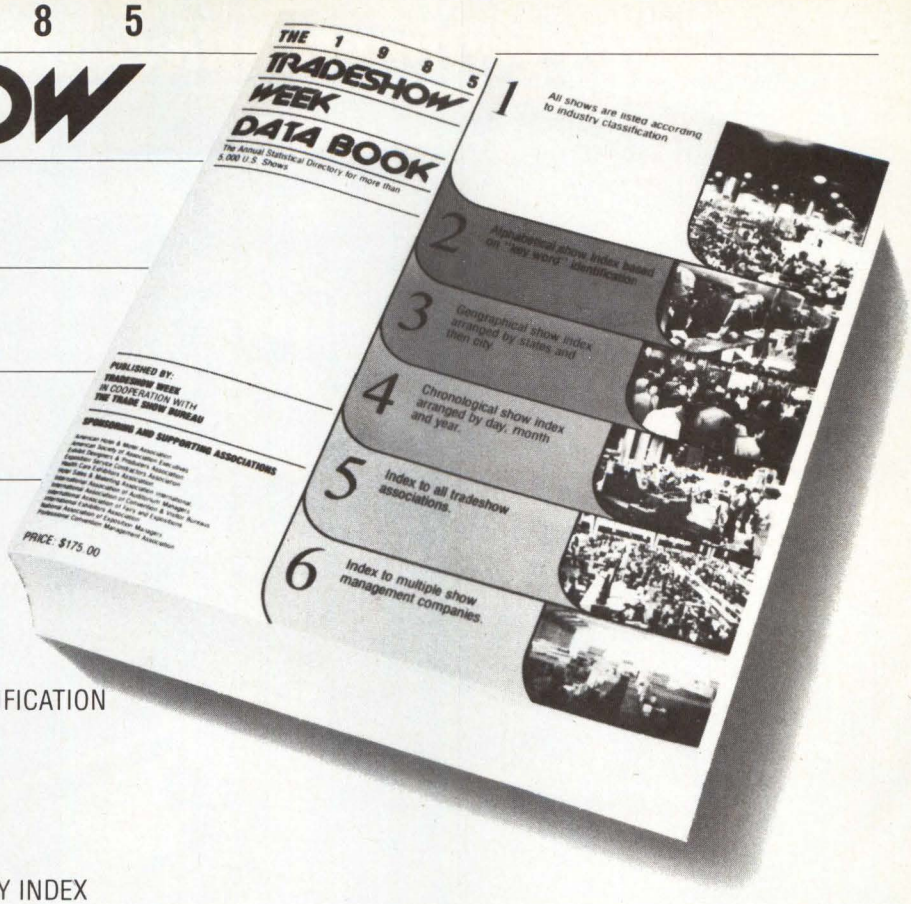

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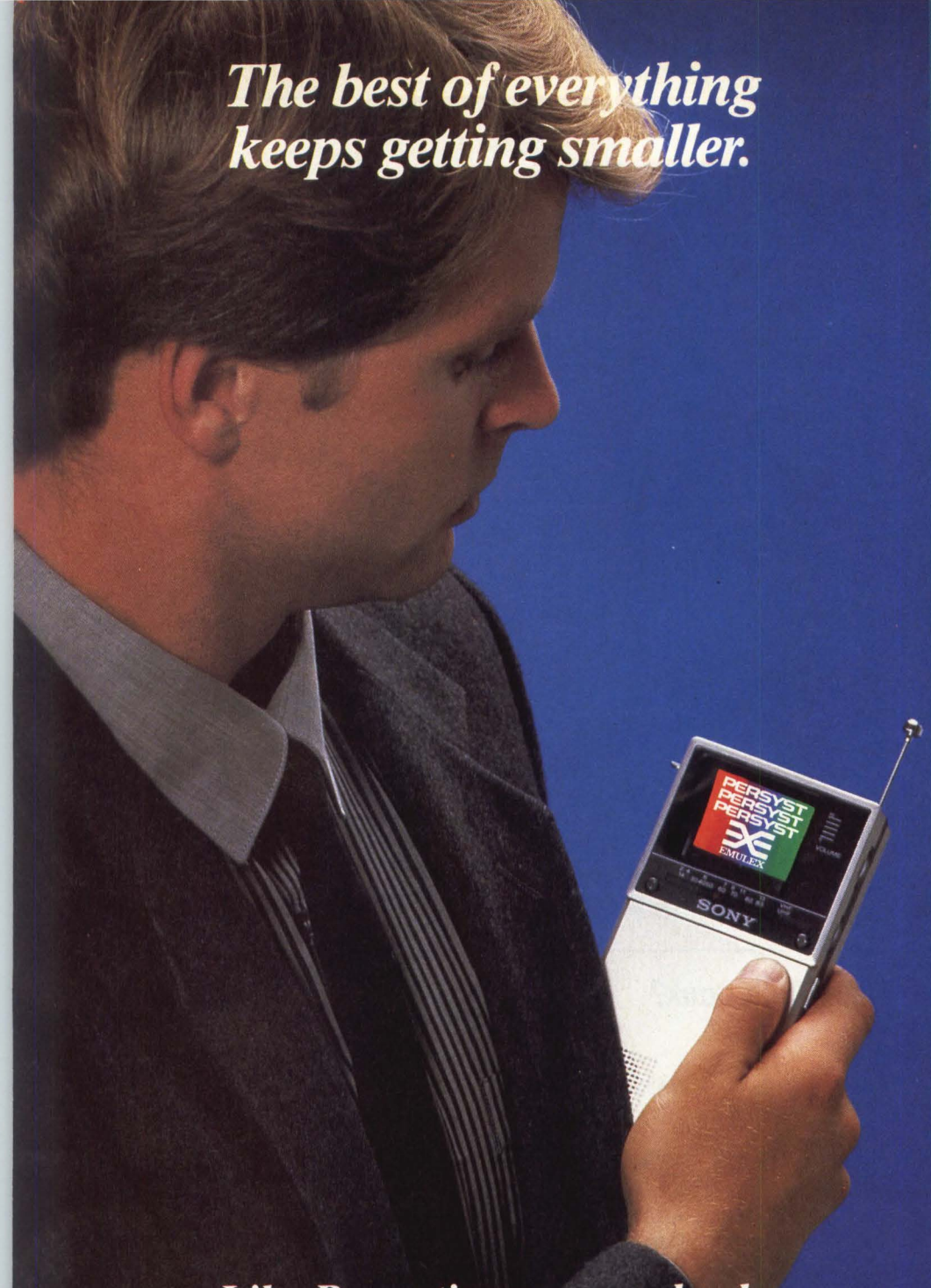

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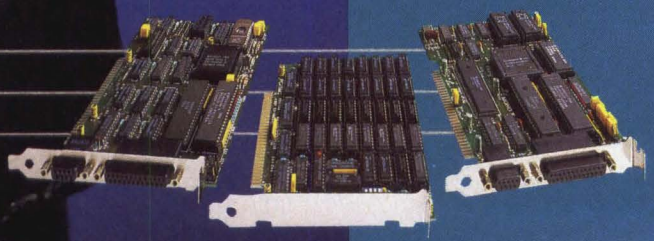

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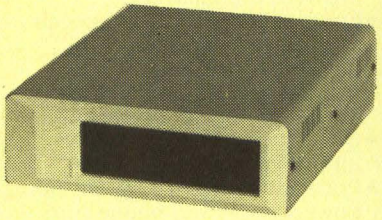

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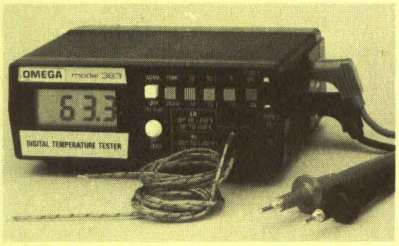

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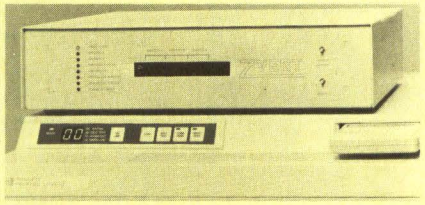

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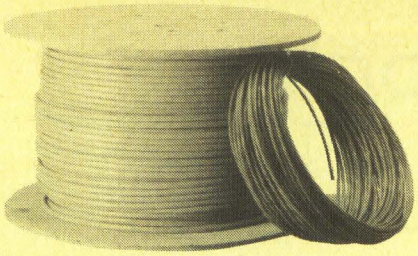

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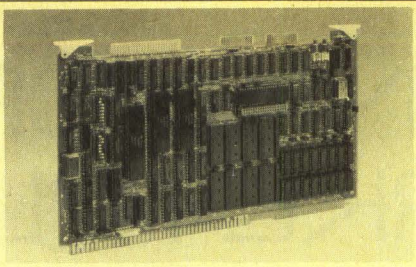

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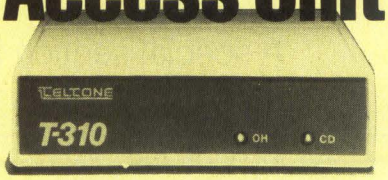

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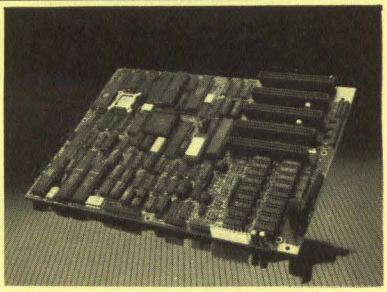

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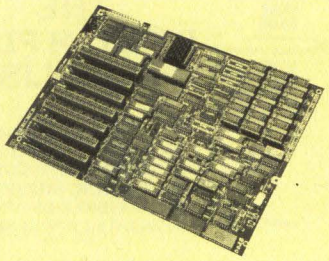

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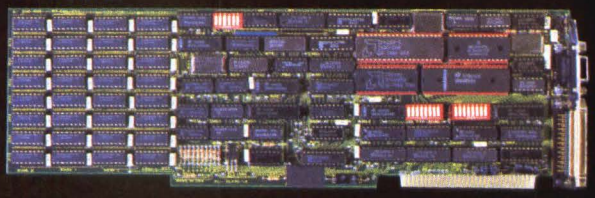

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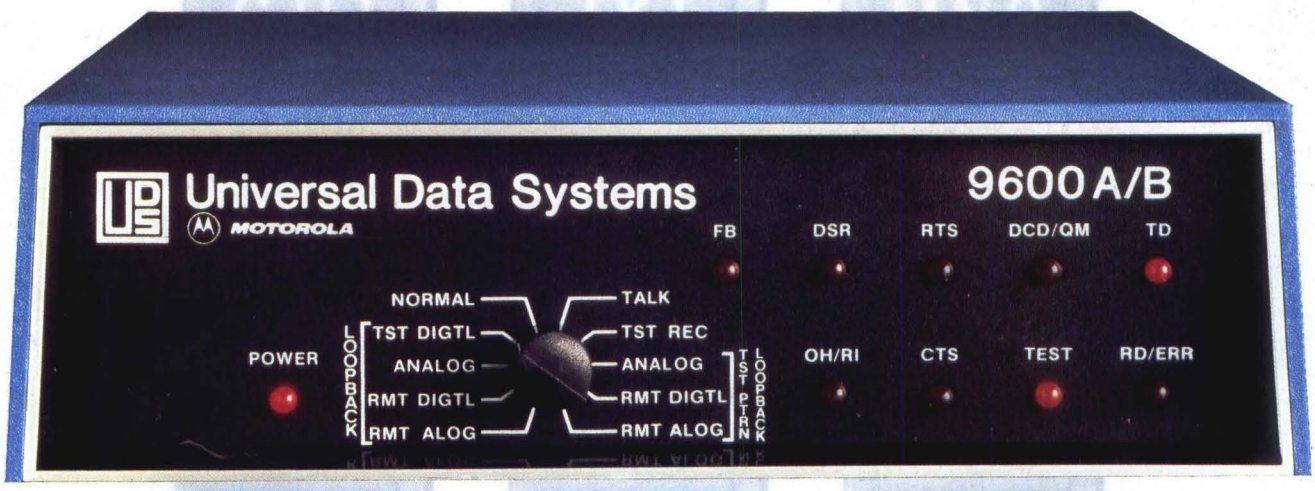

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