Mini-Micro Systems

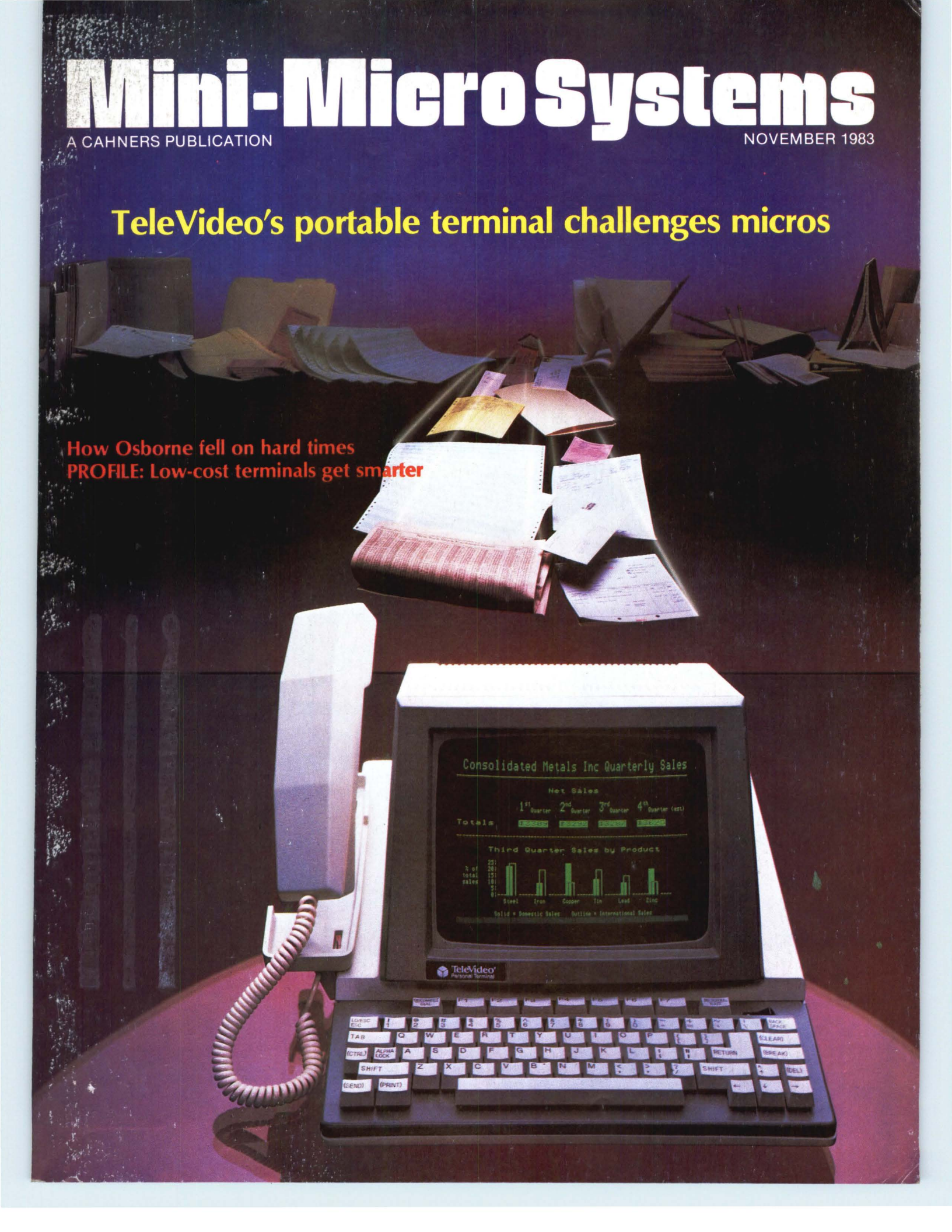
A CAHNERS PUBLICATION

NOVEMBER 1983

TeleVideo's portable terminal challenges micros

How Osborne fell on hard times

PROFILE: Low-cost terminals get smarter



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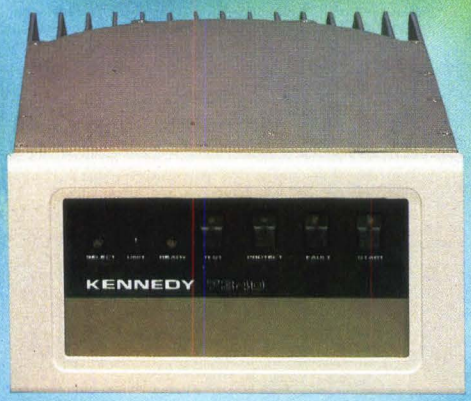

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CIRCLE NO. 136 ON INQUIRY CARD

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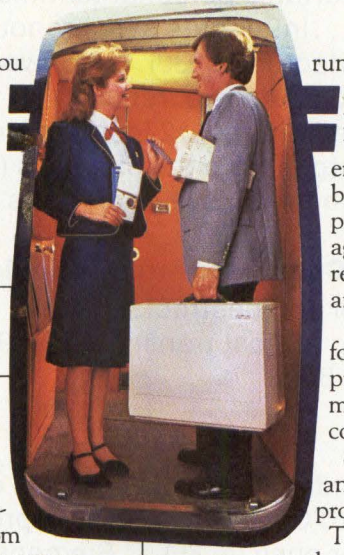

The COMPAQ Portable fits under a standard airline seat for business trips.

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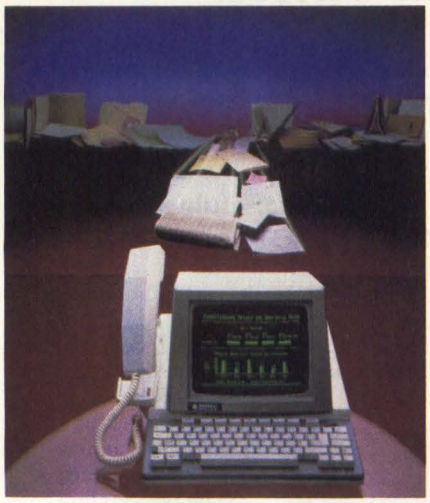

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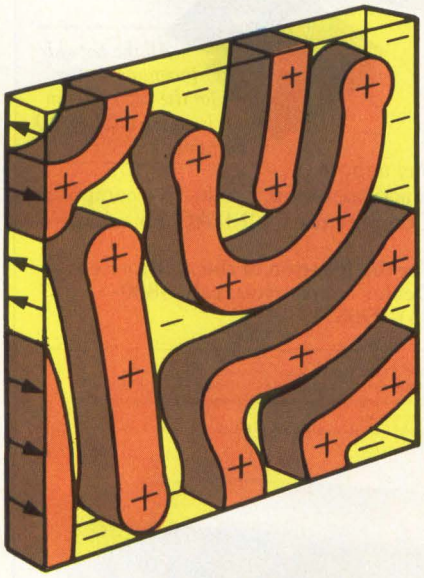

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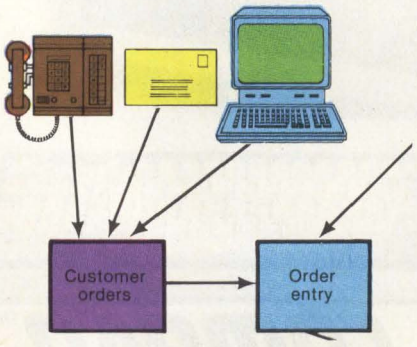

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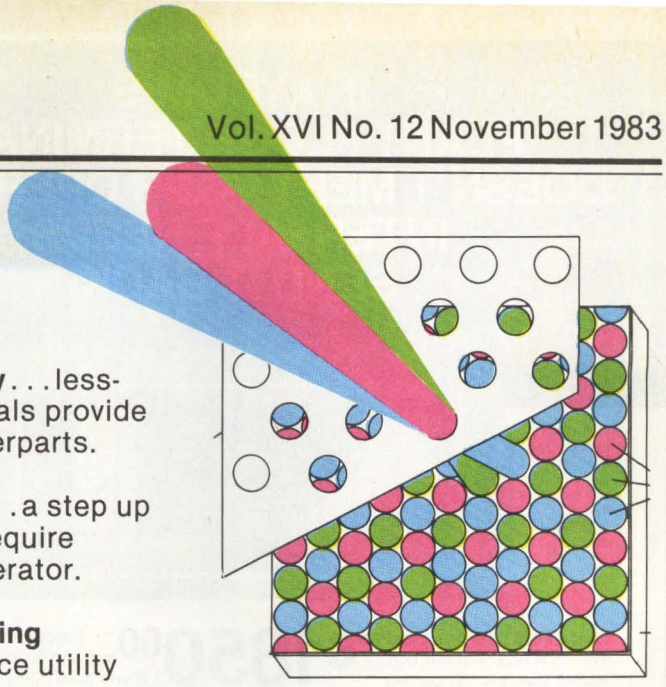

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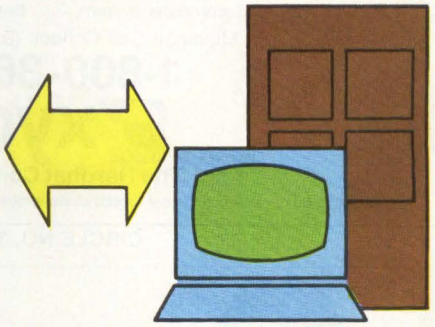

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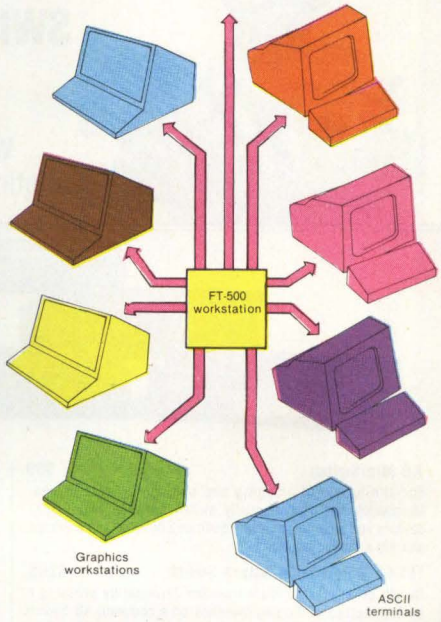

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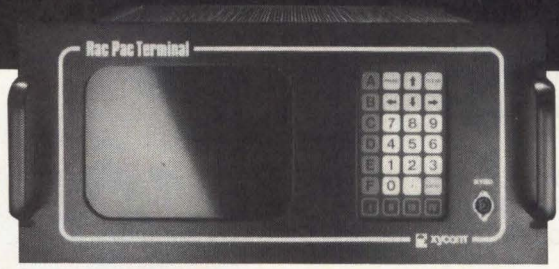

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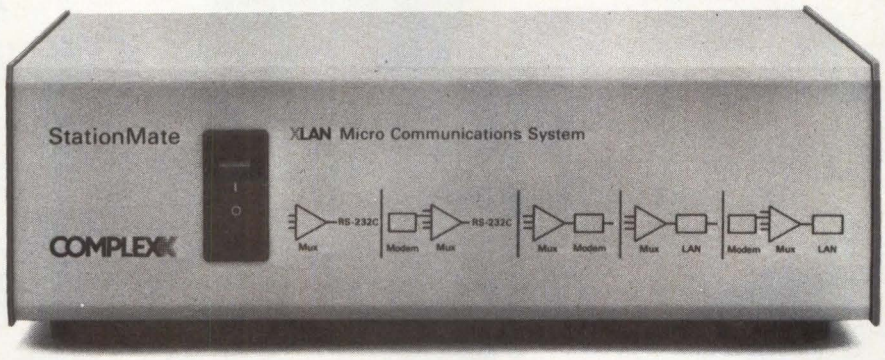

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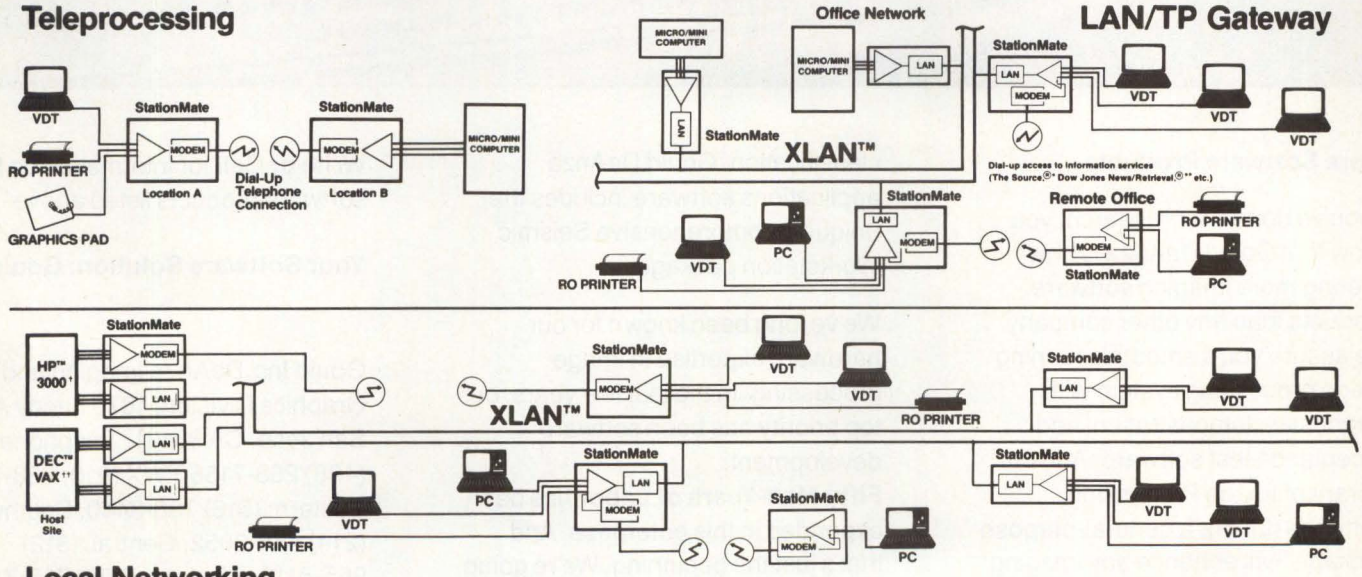

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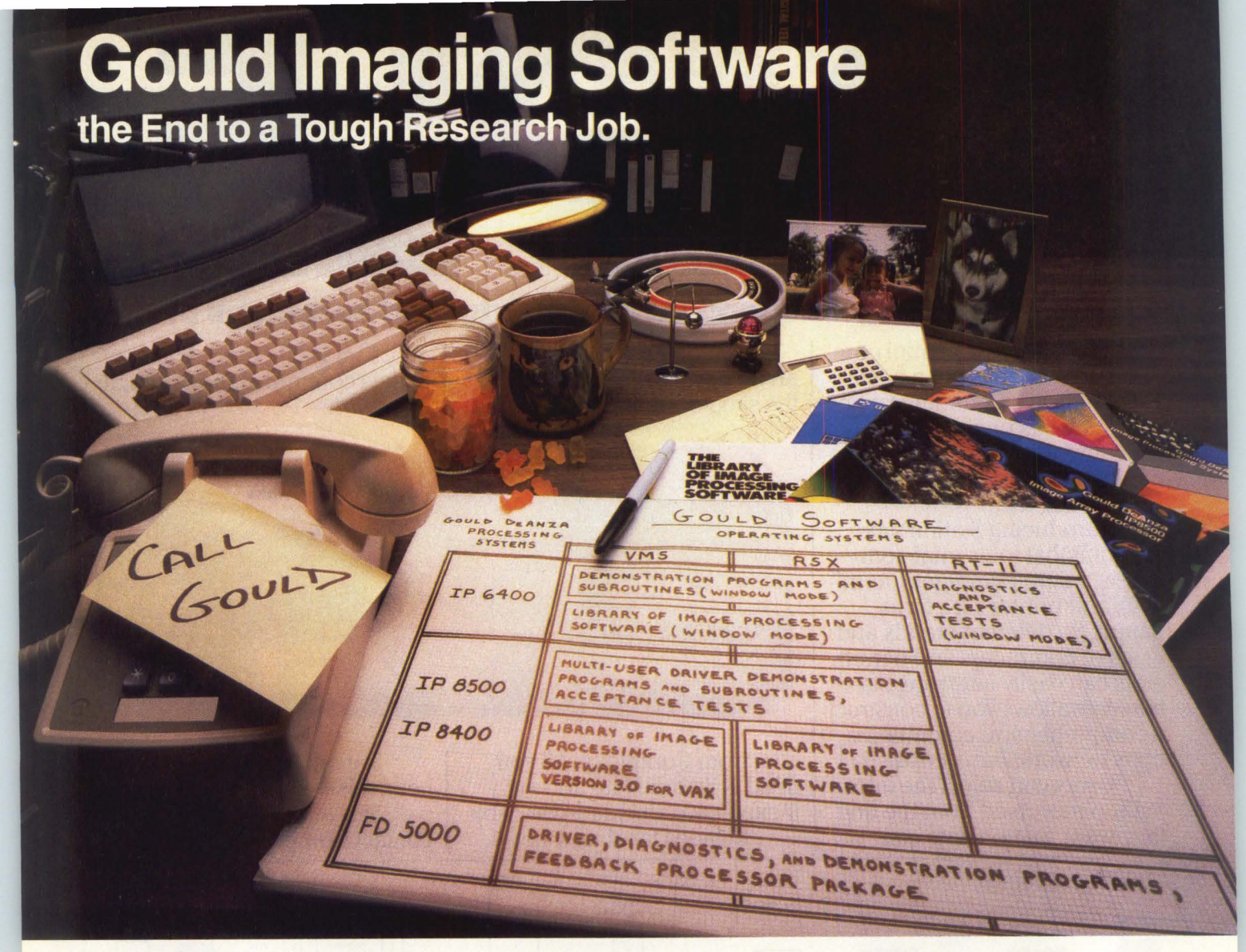

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CIRCLE NO. 6 ON INQUIRY CARD

Editorial

Video display terminals: help or hazard?

The National Review Council (NRC), in a report released this summer, concludes that video display terminals (VDTs) do not apparently threaten operators' vision. However, the NRC indicates that terminal designs and operations as well as physical and psychological environments do contribute to job stress and associated operator complaints. Other similar studies, performed recently by the U.S. National Institute for Occupational Safety and Health (NIOSH), the Massachusetts Division of Occupational Hygiene, the Bureau of Radiological Health of the U. S. Food and Drug Administration and Canada's Department of Communications, have all found the VDT radiation is virtually undetectable and therefore not a health hazard.

Despite these assurances, VDT operators—the majority of whom are women—continue to complain about a wide range of physical and mental ailments such as eye, neck and back strains; miscarriages; birth defects; blurred vision; headaches; and fatigue. The NRC reasoned that VDT workers' comfort, performance and stress have been adversely affected in many cases by designers' and managers' failures to apply to equipment and jobs well-established principles of good design and work practices.

To combat these assertions, some companies have instituted ergonomic-driven terminal designs and corrective VDT user practices and skill programs. In terminal design, for example, most VDT units now incorporate tilt-and-swivel monitors, detachable keyboards, monitor-height adjustments, non-glare screens and eye-pleasing color phosphors and equipment. In corrective programs, relatively inexpensive and straightforward improved user practices call for frequent, short work breaks, simple physical exercises, improved lighting, worker education and management time-study cooperation. And such measures have resulted in 80 to 100 percent lower incidences of user problems.

Despite these improvements, though, many user support groups remain unconvinced. Such groups as Nine-to-Five (a national organization of women office workers), the National Association of Working Women and six state legislatures (MMS, October, Page 84) prefer mandatory regulations on VDT manufacture and use. Because many OEM and end user organizations have reacted slowly and indifferently to users' health-hazard accusations, these groups are asking for compulsory remedies such as rest periods, adjustable equipment, glare and heat reduction, eye examinations, periodic equipment maintenance and radiation shielding.

Further complicating the problems, says the NRC, is that VDT technology is evolving too quickly to justify specific numerical guidelines such as character size, viewing distance and luminance. It does suggest, though, that judicious use of acceptable guidelines would be helpful. What's needed, therefore, is for employees, employers, manufacturers and government agencies to band together for mutual benefits. With an estimated 10 million VDTs in use today and twice that number expected by 1985, operated by children and adolescents as well as by adults, answers, instead of rebuttals, to users' claims are needed.

George V. Kotelly

George V. Kotelly,
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Impossible?

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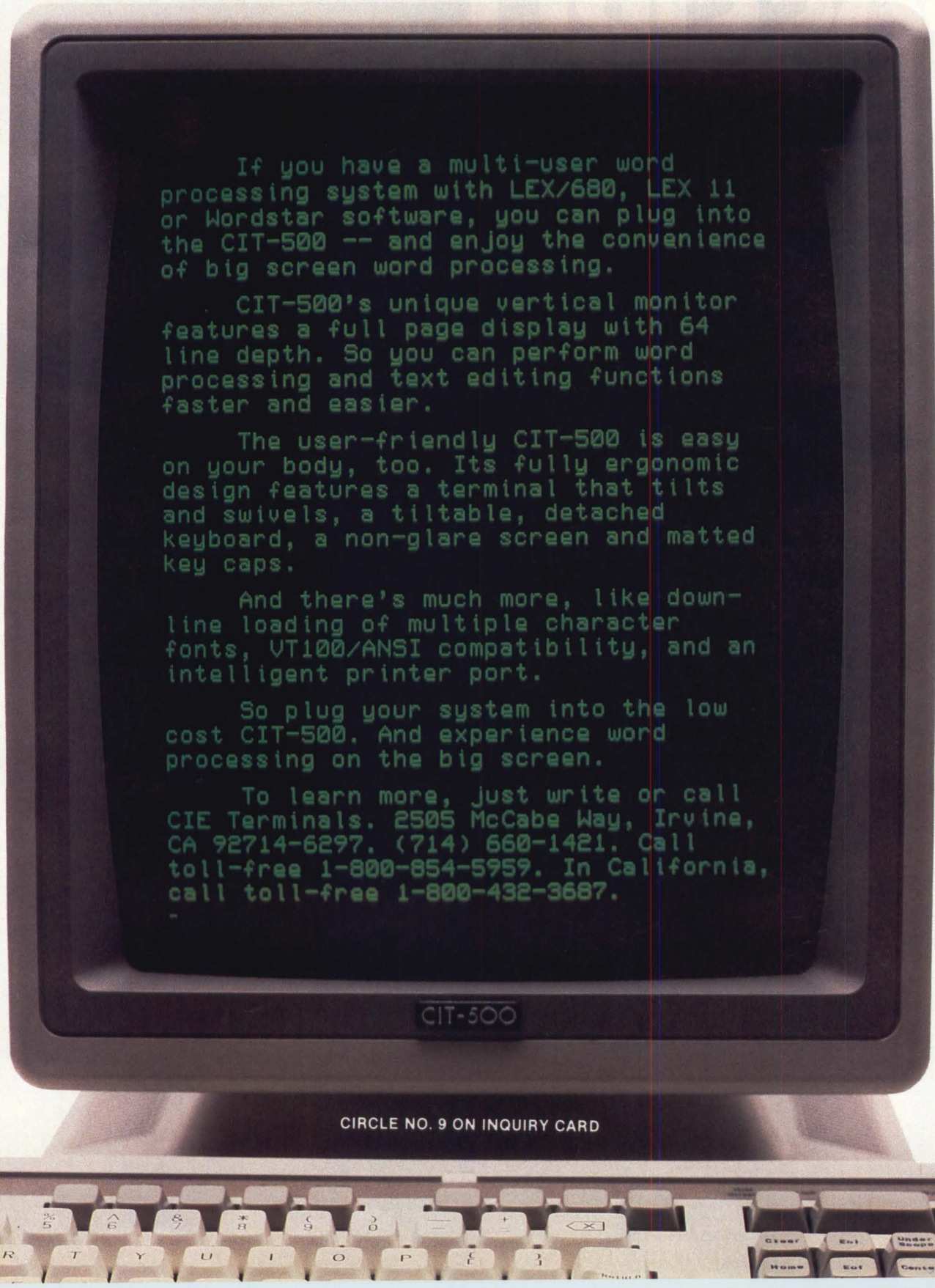

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Breakpoints

JANOME INTRODUCES 3-INCH MICROFLOPPY FOR U.S. MARKET

Janome Sewing Machine Co. Ltd., Tokyo, will introduce a smaller version of the Hitachi/Maxell/Matsushita-style 3-inch microfloppy disk drive. Like the Hitachi drive, the Janome MFD-80 is plug-compatible with the SA400 industry-standard 5¼-inch drive interface and transfers data at the same 250K-bit-per-second rate. It uses Maxell media, which stores 250K bytes per side and can be flipped over for a total of 500K bytes of storage per disk. The mechanics-only version of the Janome drive measures about 3.3 inches wide by 1.4 inches high, allowing as many as four MFD-80s to be placed vertically in the same space typically used by a full-sized 5¼-inch floppy drive. David Stoddard, designer of the Janome drive, says the control and drive electronics for all four can be installed behind the drives. The standard version of the Janome measures 3.6 by 1.6 by 6 inches. The MFD-80 normally uses 40 tracks per side but has spare-track provisions that allow as many as 48 tracks per side to be used, thus increasing maximum storage to 600K bytes per disk. Evaluation quantities are expected to be shipped in January, and the drives are expected to be priced at $125 in lots of 10,000.

SOFTECH MICROSYSTEMS TO INTRODUCE LAN FOR P-SYSTEM

Softech Microsystems, San Diego, a subsidiary of Softech Inc., should introduce the Liaison local-area-network software this month for the p-System. Liaison is expected to consist of system software and application products but is adaptable to a variety of hardware and network media. The initial adaptation will be on Omninet. System software will include the p-System operating system enhanced with networking, a disk server, a print server and a media-adaptation kit. Five application packages initially available will provide database, word-processing, electronic-mail, executive calendar and spreadsheet capabilities.

16032-BASED MULTIUSER SYSTEMS RUN VAX PROGRAMS

Unidot Corp., Golden, Colo., will introduce two multiprocessor systems, the Accord and the Concord, that will use the demand-paged virtual-memory capability of the NSC16032 microprocessor to run unaltered VAX superminicomputer programs with 1M byte or 2M bytes of RAM instead of the 4M to 6M bytes such programs require on VAX systems. The Accord system includes one 16032 processor board with on-board cache, an 80M-byte Winchester drive with DMA controller and 14M-byte cartridge-tape backup and 1M byte to 2M bytes of dynamic RAM. The Concord system adds a second identical processor board that acts as an intelligent slave dedicated to application programs. The systems run the UNIX-variant GENIX operating system at 10 MHz using a Multibus architecture. The microprocessor boards also have a 16081 floating-point processor, a 16082 memory-management unit, two serial ports and 8K bytes of static RAM cache memory. The $14,950 Accord system supports 16 users, and the $17,995 Concord system supports 32 or more users. Volume shipments are expected in January.

BLUEBIRD SOFTWARE PACKAGE TO RUN ON IBM PC

Bluebird Systems, Carlsbad, Calif., will this month demonstrate its proprietary SuperDOS operating system with Business BASIC compiler on the IBM PC. The company has developed the system to provide multiuser application packages for small business microcomputer systems. Bluebird, founded in 1982 by Hal Tilbury after his original venture, Compusource, was acquired by Electronic Data Systems, has targeted Data General Corp. OEMs with its software package, claimed to be available nationwide through more than 50 OEMs. Bluebird reportedly has more than 150 installed systems. The company plans to adapt the software for use on other popular microcomputers in addition to the PC.

Breakpoints

Comdex preview: Lear Siegler Inc.'s Data Products division, Anaheim, Calif., **plans to demonstrate for the first time its new ADM 12 ergonomic terminal** at this month's Comdex show. The new unit features 16 programmable function keys, user-definable scrolling regions for a 158-column-by-24-line horizontal format, an 80-column-by-48-line vertical format and six programmable editing keys. The unit will be priced at $895. Integral 300- or 1200-baud modems and a graphics board will be optional for both the ADM 11 and ADM 12 terminals.

Qume Corp., San Jose, Calif., **plans to unveil its first graphics terminal,** the QVT211GX. The unit is said to be priced at $1,295.

Diablo Systems Inc., Hayward, Calif., **expects to enter the multimode serial matrix printer market** with the introduction of the 11CQ version of its Series 11 printer. The printer produces draft-quality characters at 100 characters per second (cps) and correspondence quality at 30 cps. The 80-column printer will employ a nine-pin print head and will retail for $749. Diablo will also reportedly show a CQ version of the series 32 printer off the show floor. The 32CQ is expected to have print modes of 150 cps for draft quality and 60 cps for correspondence quality.

The 20-cps daisy-wheel Letterpro 20 printer (less than $1,000 retail) **expected from Qume Corp.,** San Jose, Calif., **is Qume's lowest priced printer to date.** Qume will also display its new Superstrike print wheels and ribbons, its first line of supplies not intended for Qume printers. The first Superstrike products will be targeted at Diablo daisy-wheel modems.

Mannesmann Tally Corp., Kent, Wash., expects to announce its new MT-440L series matrix printer in November and to demonstrate it publicly for the first time at Comdex. Priced at $2,695, the unit features 400-cps printing in a draft mode and 100-cps printing in correspondence quality. The printer features an enhanced slew rate, special tabbing to move the print head as fast as 650 cps when covering blank spaces, optional four-color printing and a cut-sheet feeder.

New **Printronix Inc.** printer models are expected. The Irvine, Calif., company's MVP 150B printer-plotter is one of the first matrix line printers with plug-compatible interfaces for popular microcomputers such as the IBM PC and the Victor 9000. The tabletop unit features six operator-selectable print modes. Printronix will also add two models to its P series of line printers, the P300XQ and P600XQ. Printronix expects to lower the matrix line printers' noise level to 55 dBA. The new printers also feature multiple print modes with maximum speed of 400 and 800 lpm, respectively.

Trilog Inc., Irvine, Calif., should unveil its second-generation four-color matrix line printer, the Colorplot II series. At $6,900 for a 300-lpm version, the printer's price is almost half that of its predecessor, the Colorplot I. The printer comes with standard black or four-color ribbons.

Comrex International Inc., Torrance, Calif., is scheduled to introduce the ComRiter III daisy-wheel printer. The unit will feature a 132-column print line and 23-cps speed. Priced at less that $1,000 retail, it will offer bidirectional printing and two-color capabilities. Comrex also plans to introduce an automatic cut-sheet feeder for less than $250 for the printer soon.

Vertex Corp. expects to add a 100M-byte unit to its line of high-capacity, 5¼-inch Winchester disk drives. The unit uses the same number of heads and platters as does Vertex's current 70M-byte model. The drive will implement the Seagate ST-412HP

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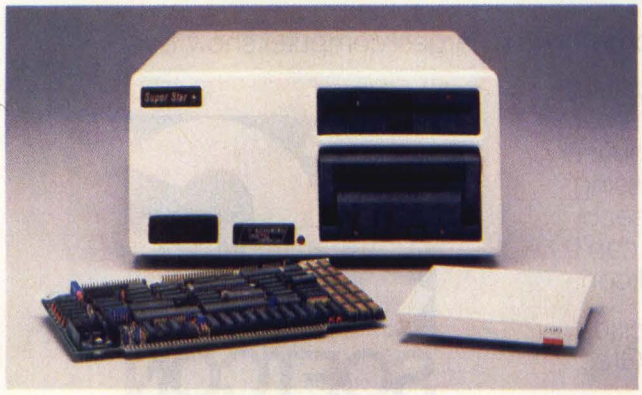

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interface introduced in September. Like the enhanced small disk interface pushed by Maxtor Corp., the ST-412HP interface will achieve a transfer rate of 10M bits per second. The Seagate interface continues to gather the support of drive manufacturers, as Vertex and Computer Memories Inc. join Seagate Technology, Tandon Corp., Atasi Corp., Priam Corp., Western Digital Corp. and Adaptec Inc. in supporting the interface.

Seagate Technology has announced an agreement in principle to acquire privately held high-end 5¼-inch disk drive manufacturer Atasi Corp., San Jose, Calif. The agreement, subject to approval of the boards of both companies and Seagate shareholders, calls for an exchange of 7.2 million shares of Seagate stock—estimated to be worth about $130 million—to Atasi shareholders. Seagate is the acknowledged frontrunner in the low-end 5¼-inch Winchester market. Through the acquisition of Atasi, Seagate will gain a major footing in the high-end market with the company that was the first to ship drives with capacities of 30M bytes or more. A Seagate spokesman says no definitive agreement has yet been signed to determine if Atasi will continue to operate as a separate entity or as a part of Seagate, nor the future role of Atasi management. The spokesman says the final agreement may be approved by Comdex. In addition, the agreement will not change Seagate's plans to introduce its own 50M-byte drive at the Comdex show this month.

Seagate plans to introduce its second half-height, 5¼-inch Winchester drive, the ST-212. It will store 12M bytes on one platter through the use of four read/write heads, two per side. As a result, the drive will feature a 65-msec. average access time, one of the fastest for half-height drives. The drive should be available in evaluation units in December, and production is slated to begin in the first quarter of 1984. The drive will be priced at $1,265 in single-unit quantities and $690 in quantities of 1,000.

The CS/100 local-area network communications server scheduled to be announced by **Bridge Communications Inc.,** Cupertino, Calif., aims at low-cost Ethernet capability for diverse small office computers and personal computers. A CS/100 with four RS232 ports is priced at $3,900. A server with 10 ports is $4,900. The 68000-based CS/100 is a single-board version of Bridge's CS/1, which connects as many as 32 devices. The CS/100 is compatible with all other Bridge products. It supports the IEEE 802.3 specification, and the Xerox Network System protocols, which use levels three, four and five of the International Standards Organization model. An optional IEEE 488 interface provides a link to minicomputers. Data transfers reach 125 packets per second for interactive applications. File-transfer rate is 600K bits per second. Optional software enables file transfers between CP/M, MS-DOS, VMS, UNIX and other operating systems. Availability is set for January.

Innovative Software Inc., Overland Park, Kan., plans to announce a personal-computer spreadsheet/graphics, word-processing and database-management package that is said to provide extensive integration among the programs. Each of the three programs in the Smart Series can run on a standalone basis. Series of commands can be stored and run in sequence automatically. The stored commands can be linked to worksheets in the other programs. The user interface is through cursor movements to a command list at the bottom of the screen. Each program contains a calculator for sine, cosine, binary conversion and other functions. Tentative price is $475 to $695 per program. The system initially runs under PC-DOS. Memory required is 128K bytes.

Officials at **Digital Microsystems,** Oakland, Calif., believe the most economical way to provide IBM PC networking is through a master/slave polling scheme with the company's DMS-816 IBM PC-compatible, disk-less workstations and DMS-3/501 master station. The company plans to introduce its network at Comdex. The $1,695

workstations connect to the $6,500 master station as fast as 500K bps through RS422 ports and twisted-pair or flat-ribbon cabling. The network supports as many as 32 users. The 8086-based DMS-816 has 256K bytes of RAM, expandable to 512K bytes, and a 12-inch display. The DMS-816 also incorporates a Z80A for CP/M applications. The DMS-3/501 master station has a 15M-byte hard disk drive, a 640K-byte floppy drive and a 9-inch screen. The Z80A-based master station can also run CP/M. January availability is planned.

DY-4 Systems, Inc., Ottawa, should announce support of MS-DOS and UNIX on its Dynasty network of disk-based and disk-less workstations, in addition to its current CP/M support. The network uses the Corvus Omninet physical link. The company says performance is speedy because file-server disks are shared, rather than segmented. The network is targeted for large installations in universities, government and business environments. List price of a typical 32-user mixed system with a 20M-byte file server and a printer server would be about $90,000.

Comdex will be the site for **Incoment's** introduction of its Elite distributed-processing and communications computer system. The Ventura, Calif., company describes the product as a two-board, multiuser desktop package that creates a standalone system or an intelligent node in a network. The Elite package will include a microprocessor, 512K bytes of RAM, expandable to 3M bytes, four parallel interface ports and four RS232 communications ports. Single-unit price will be $7,400.

TECHFILES: A quick look at industry developments

Mini files: With its goal a complete 32-bit minicomputer line, **Digital Equipment Corp. is introducing two low-end VAX products,** the VAX-11/725 and the MicroVAX I. The VAX-11/725 uses an 11/730 CPU repackaged for an open-office environment and designed to fit under a desk. Its 8-inch RC25 Winchester disk drive stores 52M bytes of formatted data, half fixed and half removable. The Unibus-based system supports as much as 3M bytes of main memory and interfaces with Ethernet and DECnet. The VAX-11/725 ranges from $24,950 to $36,800, depending on configuration. The one- to four-user MicroVAX I is the first of a range of forthcoming smaller VAXs. Measuring 25 inches deep by 19 inches high by 6 inches wide, the Q-bus-based MicroVAX I will run VAX-11/780, 11/750 or 11/730 programs on its partially very-large-scale-integration-implemented architecture. A system with two 400K-byte 5¼-inch floppies, a 10M-byte Winchester and 512K bytes of RAM will sell for $13,880 or $16,985 with a 28M-byte Winchester and 1M byte of RAM. A disk-less rack-mount version will be $9,995. The MicroVAX I is expected to be shipped in the first half of 1984....DEC is also reportedly planning the future release of a relational database-management system that will be available next year for the VAX line.

Printer files: General Electric Co. has completed negotiations to sell its printer products division, the Data Communication Products Department in Waynesboro, Va., to a group that includes management of the Waynesboro facility and private investors. The company will be called Genicom Corp. There are reportedly no plans to discontinue any GE printer lines, including those announced products not yet in production such as the 4000 series of matrix line printers....**Color ink-jet fans are talking about the potential of several experimental "bubble-jet" printers** being developed in Japan. A Canon prototype reportedly employs 512 jets—128 jets for each of four colors. Resolution is said to be 300 dots per inch (dpi), with groups of 16 dots in a pattern to form super-pixels that will appear in a nearly unlimited variety of shades. Other manufacturers are reportedly working on ink-jet technologies that could produce near-photographic color output at a resolution approaching 1,000 dpi....**Iquad Co., Locust**

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Breakpoints

Valley, N.Y., is reportedly developing a high-speed daisy-wheel printer. Iquad, which recently went public, is said to have a proprietary technology that could produce speeds as high as 90 characters per second. Observers suggest the company's first product could retail for less than $2,000.

Micro files: The fortunes of **Fortune Systems Corp.** have not been too bright recently. The company has been frequently lumped with troubled microcomputer manufacturers, and its stock price has tumbled to far less than the $22 it was last spring. Recently, **founder and chief executive officer Gary Friedman resigned,** reportedly at the request of the board, on the same day that the company called a press conference to define Fortune's place in the market and to introduce some software products. Company officials claim those products will correct some previous products' shortcomings. Friedman cites management-style differences in parting company with Fortune. The company named David Caplan, who Friedman hired just three months before as vice president of research, to succeed Friedman as acting chief executive officer. Caplan disclosed that a search for a new president has been under way for a year because Friedman was expected to be promoted to chairman. As a result, **a permanent successor is likely to be installed soon.** Both Friedman and Fortune board member Tim Pennington of venture capital company Brentwood Associates, Los Angeles, describe the parting as "friendly."...International Resource Development, a Norwalk, Conn., market research company, hints that **AT&T may be planning to introduce a 32-bit microcomputer system based on the Western Electric Bellmac microprocessor and running Bell Laboratories' UNIX.** The AT&T microcomputer is said to be aimed directly at the IBM PC market. An MS-DOS look-alike operating system for the AT&T system could be secretly under development at Microsoft Corp....**A new DEC Rainbow users group reportedly has quietly started at, of all places, IBM Corp.'s PC headquarters** in Boca Raton, Fla. One reason the IBM employees may prefer the Rainbow over the PC is the Rainbow's superior graphics capabilities....List price of the **Direct Inc.** IBM PC-compatible computer that also emulates VT100 and Hewlett-Packard Co. terminals is $3,995 not $23,995 as was printed in the September MMS Breakpoints section.

Random disk files: 3M is the latest manufacturer of 8-inch disk drives to discover its market window shattered by increased competition from the exploding 5¼-inch market. The company has sold its disk drive operations to Disc Tech One Inc., a Santa Barbara, Calif., manufacturer of 14-inch drives. 3M realized very little profit from its 8-inch drive production line in Camarillo, Calif. That line has manufactured 10M-, 20M- and 60M-byte, 8-inch drives since 1981. Despite the sale, no 3M employees in Camarillo lost their jobs; they were reassigned to 3M's thriving data-cartridge production at the same plant. Disc Tech One expects to announce some enhancements to the 3M line at this month's Comdex show. Shugart Corp. recently dropped its SA1100 line of low-end 8-inch Winchesters, and major suppliers such as BASF Systems Corp. and Siemens Corp. have also dropped their 8-inch Winchester lines. **Iomega Corp.** plans to introduce its 5¼-inch form factor drive at this month's Comdex show. After signing a second-source manufacturing agreement with SCI Systems Inc., Huntsville, Ala., for the drive, Iomega has added the weight of flexible media giant Verbatim Corp. to second-source the media.

Notes from overseas: A few months back, France's **Thomson CSF** began manufacturing the 32:16 systems it had written into its contract with **Fortune Systems Corp.** Thomson officials say the company is setting up a maximum production capacity of 600 units a mointh. However, its output at the time of the recent Sicob show in Paris—three months after bringing the project in-house—did not come near that goal. However, Thomson hopes it will be making 300 units a month by January. The

installed base is reported to be around 700 systems, sold by both Thomson's dealers and its direct sales force.

Across the English Channel, Fortune's nemesis, Convergent Technologies Inc., has apparently scored another of its famous OEM deals. In a first, Britian's mighty GEC Plc. says it wants to be a serious contender in the commercial market and sees the new Convergent N-GEN as its entry ticket. At press time, the three-way contract between Convergent, GEC and GEC's American subsidiary, A.B. Dick, was still reportedly unsigned, but GEC officials were treating the pact as a fait accompli, and Convergent was figuring its value around $150 million to $160 million over three years, with $40 million in the first year. No one, however, is willing to estimate how much will go through A.B. Dick and how much through GEC's new office-automation efforts, GEC Information Systems Ltd. GEC's office-automation product line promises to be diversified: the company intends to add telex, teletext, a facsimile machine made by Panasonic and its own Intel-run Datacom 4000 executive telephone with an 80-by-24 screen and a keyboard, running via interfaces to the GEC 4000 mini. The Convergent unit, however, is the company's standalone word-processing-oriented microcomputer/ workstation/ terminal/personal computer. GEC reportedly hasn't ruled out selling the system through both dealer and retail channels. Coupled with the Convergent buy is GEC's decision to try to standardize all its vast holdings and products on UNIX.

Apparently, the home computer business is not the place to be. To the mammoth losses wracked up recently by **Atari, Texas Instruments Inc. and Mattel,** add the collapse of Britain's **Grundy Business Machines** and its one-time best seller, the Z80-based Newbrain, plus the forced bailout of Welsh microcomputer house **Dragon Data.** Dragon shareholders had to ante up $3.75 million in emergency loans to tide the company over until Christmas and save its $300 Z80 Dragon 32. **Plans are afoot in England for a buy-out of beleaguered Osborne Computer Corp.'s local subsidiary, Osborne Computer Corp. (U.K.) Ltd.** Osborne U.K. managing director Mike Healy is orchestrating the prospective move. He says unidentified production and distribution interests and a venture capitalist eyeing marketing and manufacturing rights on the Osborne equipment have approached him about spinning off the company. Although an Osborne subsidiary, 18-month-old Osborne U.K. is a separate legal entity whose only tie to Osborne is a supply line. Healy apparently feels there is still considerable market demand for an Osborne look-alike machine—at least in Britain, where Osborne U.K. has reportedly sold 8,000 to 9,000 units.

Hewlett-Packard Germany officials seem delighted the company deviated slightly from form and set up its new Business Development Group/Europe in Boeblingen, West Germany, rather than at HP European headquarters in Geneva, Switzerland. The chief of the new unit is also German, Klaus-Dieter Laidig, formerly general manager of the Boeblingen Manufacturing Division producing model 250 and 3000 computers. HP officials figure the move will improve their competitive position for a deeper penetration of their native market, which equals France's and Britain's.

Corvus Systems Inc., currently without any presence in Britain, is negotiating with its exclusive U.K. distributor **Keen Computers Ltd.** about setting up a joint marketing venture that would report to Corvus' European headquarters in Geneva, Switzerland. The talks are preliminary, but Corvus expects the new company, whose start-up should be around the first of the year, to be dubbed **Corvus Systems Ltd.,** with Corvus retaining majority ownership. To make it a success, the concern will have to add systems houses to Keen's dealer channels because the Corvus line is relatively unsophisticated.

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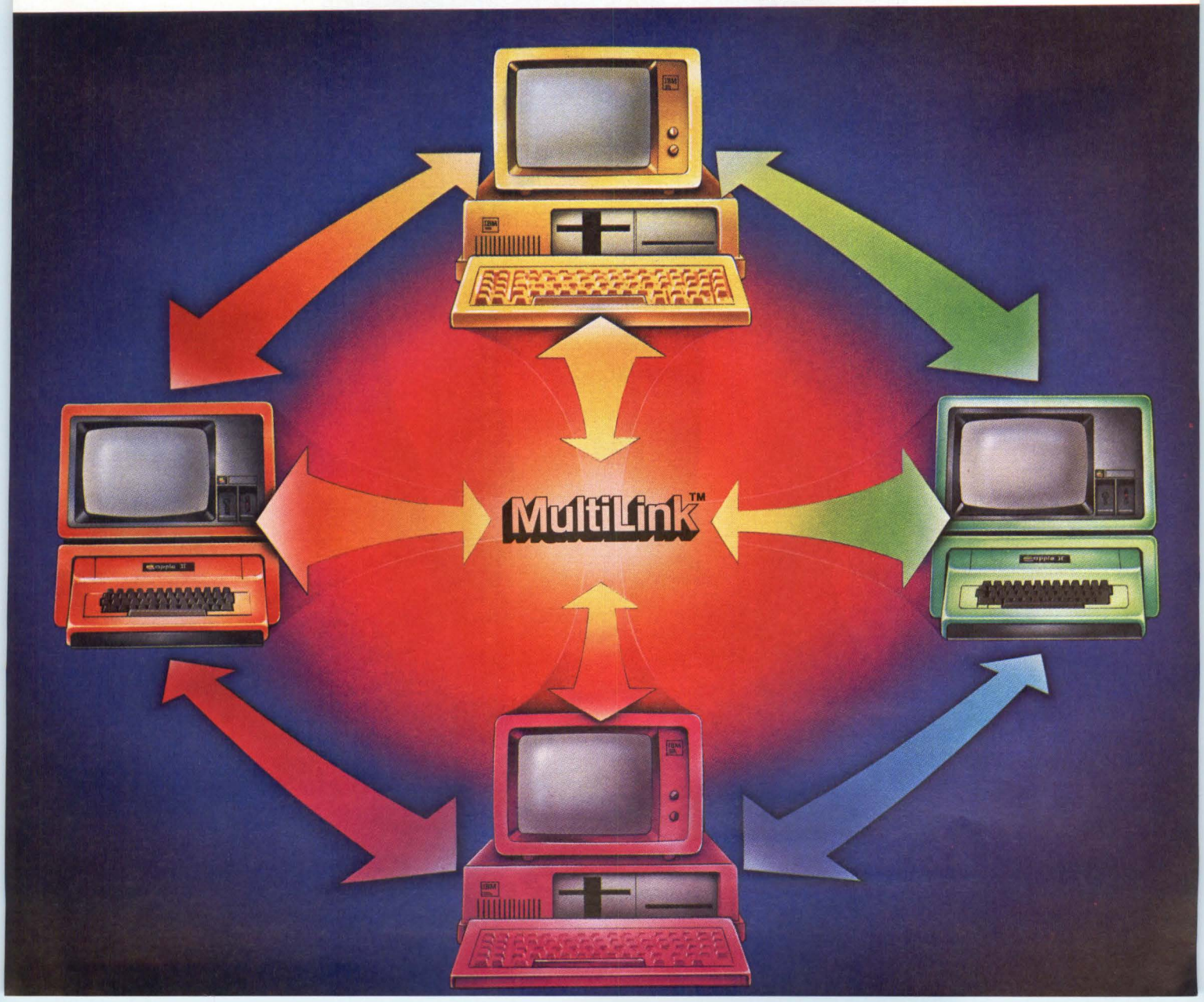

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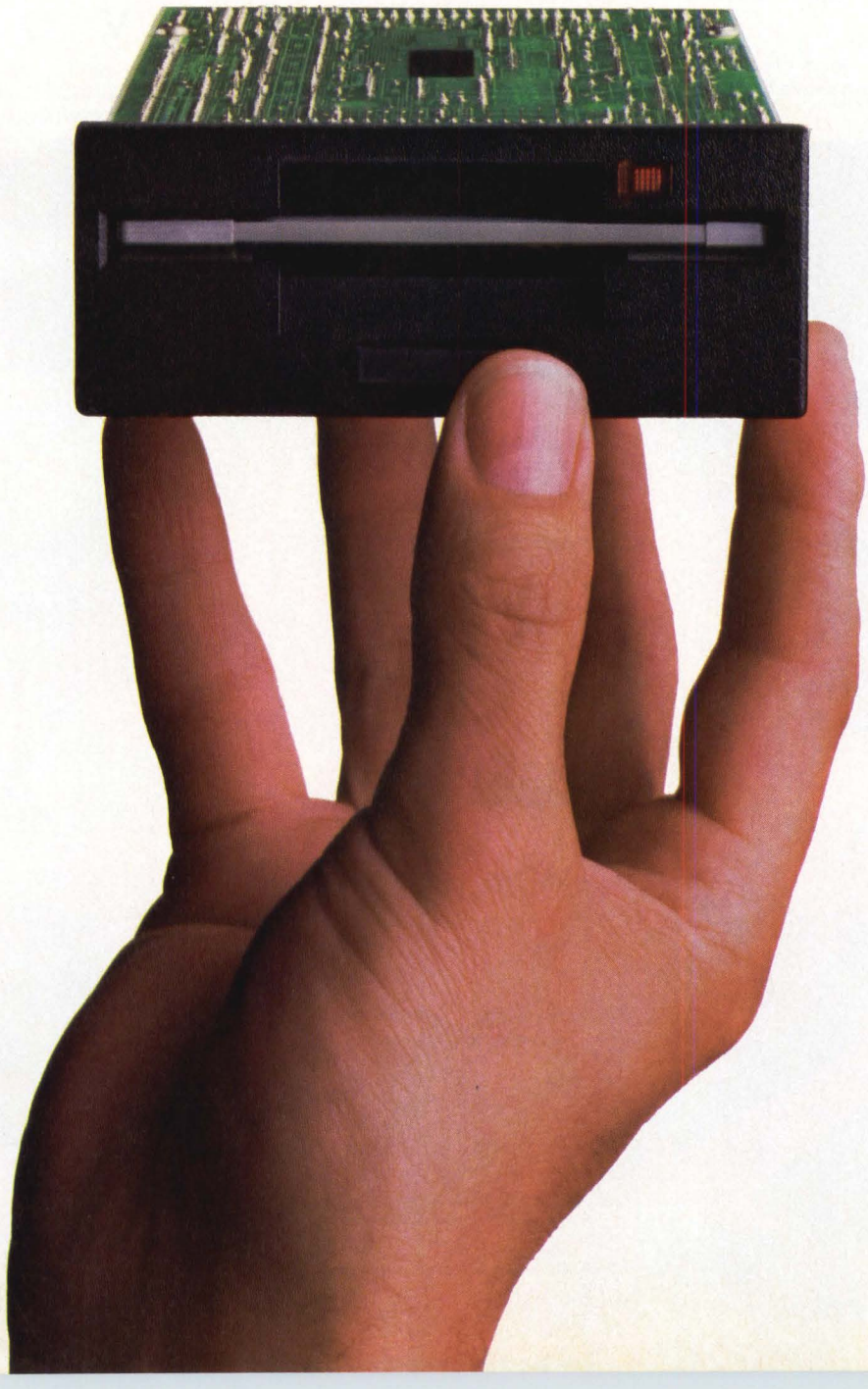

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Shugart's 3.5" microfloppy drive. The SA300 by name.

And, considering where the personal/home/portable computer market is headed (betterfastercheapersmallerwithmorestorage), it's not a moment too soon.

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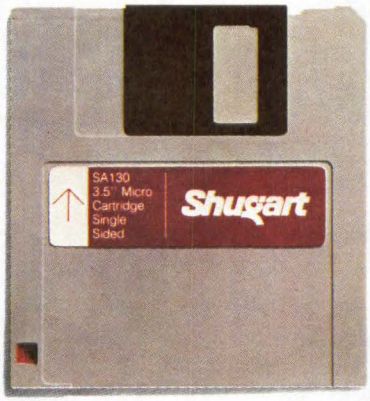

The 3.5" Micro-Cartridge provides maximum media protection.

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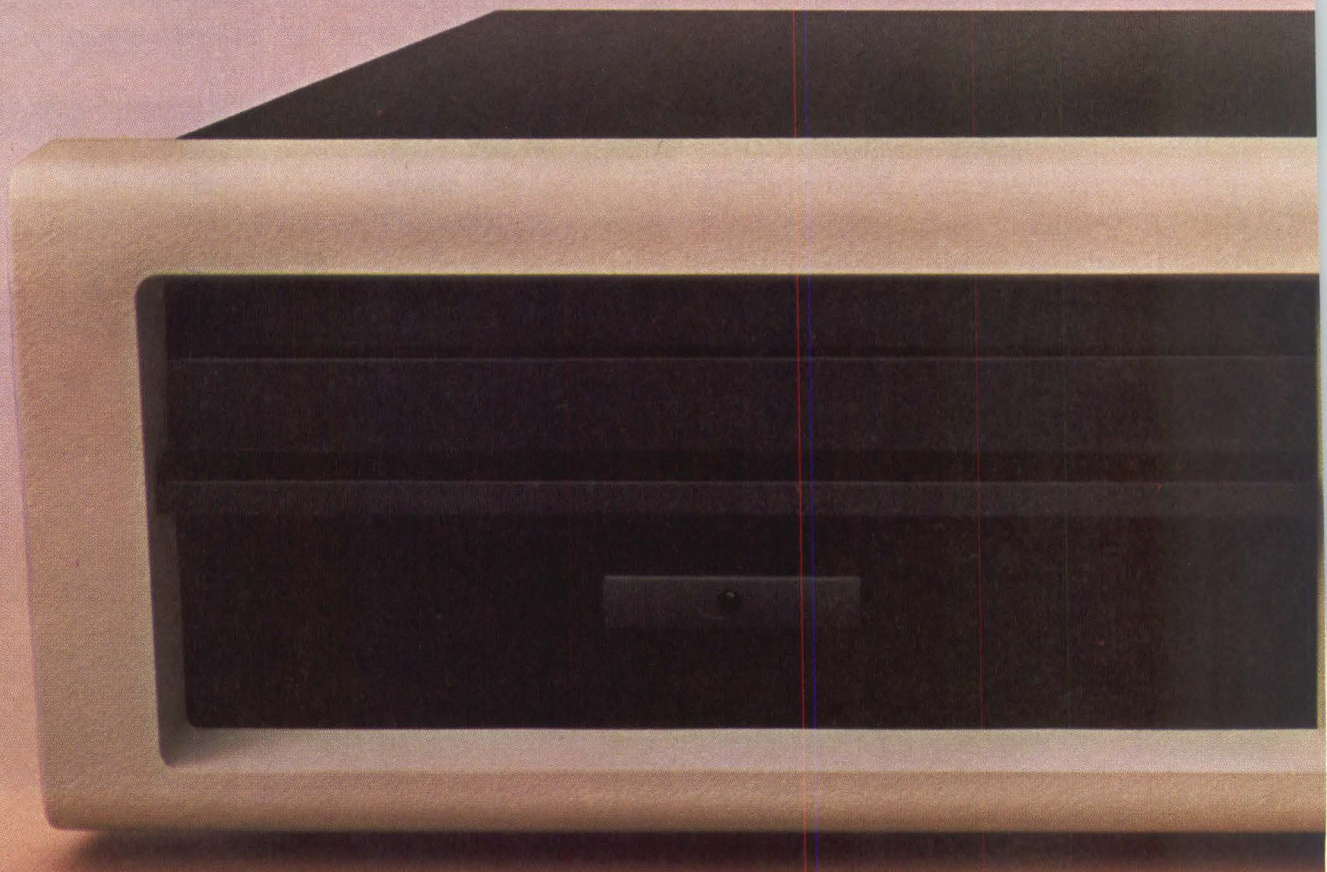

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The people at Digital are a pretty smart bunch. They make some of the finest small computers in the world. So we like to think that if they were to make a new storage system like our 880 Winchester/Floppy, they'd do it the same way we did.

First of all, they'd make it extremely reliable with extensive testing and by using one of the most reliable storage technologies known, the Winchester.

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These different configurations would, of course, be fully compatible with Digital's LSI-11 and PDP -11 computers.

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Finally, since this system would be so dependable, they'd be able to offer their extended service at a much lower price—much like we do with our own HyperService,™ which goes into effect when the 90-day warranty expires and covers everything.

And then, as if it weren't good enough already, they'd offer this remarkable storage system at a lower cost per megabyte than any comparable system.

The fact is, though, Digital doesn't make anything like this.

Which is why we make the DSD 880 Winchester system to go with your Digital computer.

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Advanced error handling: The DR-680 provides an on-board control and status register (CSR) which allows program control of ECC functions and contains the diagnostic information required for error analysis. The CSR can be read or written via the VERSAbus. Additionally, the DR-680 greatly increases reliability by performing error "sniffing" and error "scrubbing" during refresh operations.

Availability: Best of all, the 1.0 MB DR-680 is available now. And it comes with Dataram's standard one-year warranty.

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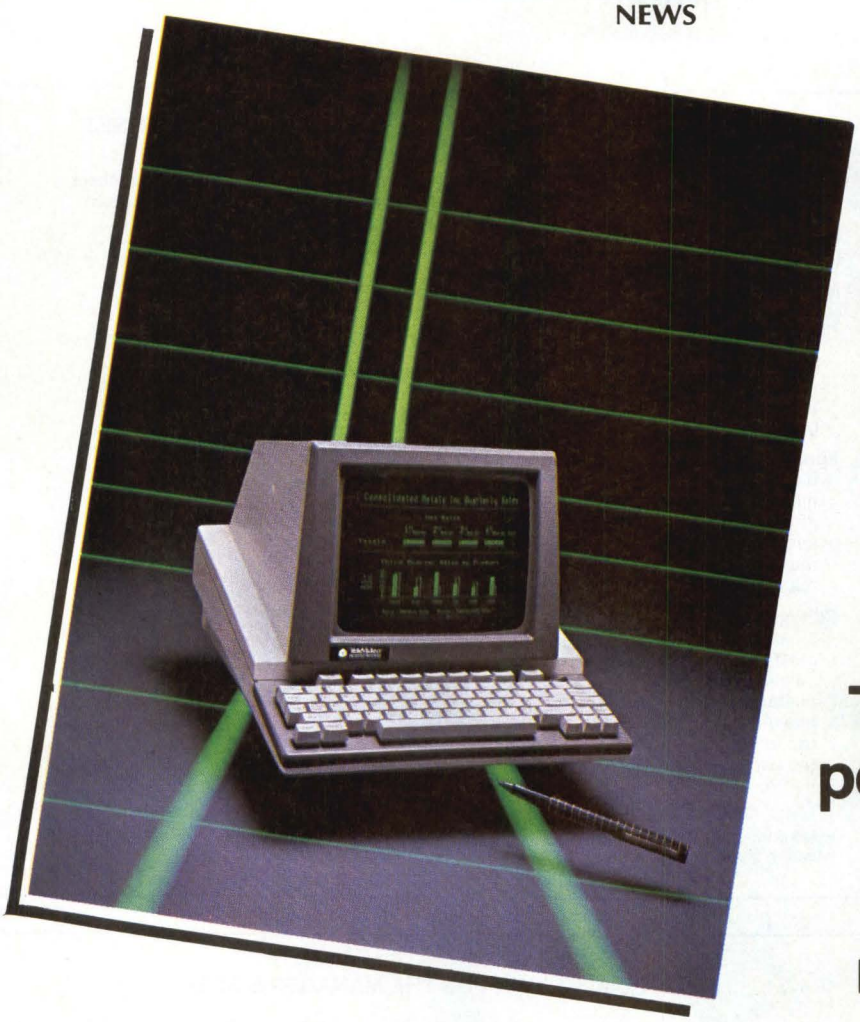


TeleVideo Systems Inc. hopes to push office-automation tools onto executives' desks *with its $469 Portable Terminal. The product can include an integral modem and telephone handset as options; thus, managers can bring it home and still access the corporate database.*

TeleVideo's $469 portable personal terminal challenges microcomputers

Bidding for priority space on the all-too-small executive desk is TeleVideo Systems Inc., Sunnyvale, Calif. This month, the company plans to unveil its Personal Terminal, the first in a series of what the company calls information stations aimed at challenging personal computers and smart telephones.

At an end-user price of $469, the compact terminal has a 9-inch green phosphor screen, an integrated 75-key keyboard and two RS232 ports. It measures 9½ inches high by 12½ inches wide by 15 inches deep and weighs about 12 pounds. An integral modem and telephone handset are optional, as is a carrying case. The Personal Terminal's price just undercuts that of its closest rival, Tymshare Inc.'s SCANSET terminal line. SCANSET prices start at $495, not including an integrated modem that increases the price to $649.

"There are a number of technologies and various strategies competing for very limited executive management desk space," observes Mark Siegel, executive vice president and general manager of TeleVideo's terminal division. "Certainly, personal computers are going to take a share of that desk space, but we believe some people are going to find they're spending too much money for functions they don't need at their workstation."

Siegel points to an emerging market for information-retrieval applications requiring ties to a user's corporate database through direct connections and ties with outside sources or branch offices. "Input into the corporate computer system from this station will be occasional and casual," explains Siegel. "I, for example, do not want to do a spreadsheet and don't need a system on my desk that would allow me to do one. I would like, however, to be able to access the spreadsheets that have already been developed within the company."

To increase price and size economy, TeleVideo has traded off input capabilities. The Personal Terminal's undersized keyboard and 9-inch screen are clearly inappropriate for heavy data entry, editing

and computation. Craig Lynar, director of marketing for TeleVideo's CRT division, concedes that the keyboard is small in comparison to even a normal typewriter keyboard but asserts it is functional for the intended applications. "It is not a toy keyboard," he says. "It's rated at 10 million keystrokes per key [before failure], in comparison to some on the market rated at only 500,000."

The terminal provides seven double-width programmable function keys directly under the screen. Key functions are displayed on a status line. It has 14 shift-selectable functions. The screen displays 5 by 7-pixel ASCII characters on 24 lines at 80 or 40 columns per line (cpl).

The two standard RS232 ports enable the Personal Terminal to connect directly to a computer and a printer. The terminal operates in block mode and accepts most standard TeleVideo protocols. The company does not rule out the possibility that future Personal Terminal versions will emulate terminals from major systems suppliers, but Lynar believes many companies will buy the terminal in volumes that will make protocol converters very economical. TeleVideo plans to support the American National Standards Institute (ANSI) X3.64 standard, which is similar to the Digital Equipment Corp. VT100 specifications on many of its terminals.

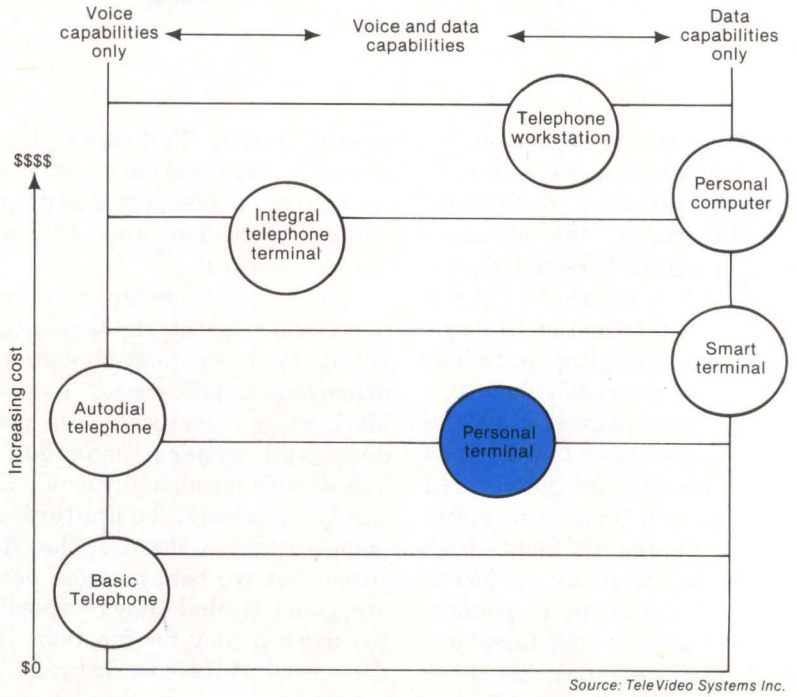
THE PERSONAL TERMINAL FACES OFF AGAINST SCANSET

	TeleVideo Personal Terminal	Tymeshare Scanset
Physical specifications (height × width × depth, inches)	9½ × 12½ × 15	9½ × 10¼ × 14½
No. of keys on keyboard	75	69
CRT screen		
size (inches)	9	9
character font	5 × 7	5 × 9
ASCII characters	128	128
foreign characters	32	105
graphics characters	128	105
Functions		
block mode	yes	no
monitor mode	yes	no
direct cursor addressing	yes	yes
save cursor position	no	yes
read cursor address	no	yes
read terminal ID	yes	yes
Editing		
clear to end of line	yes	yes
clear to end of page	yes	yes
clear screen	yes	no
character insert/delete	yes	no
line insert/delete	yes	no
tab forward	yes	no
tab backward	yes	no

Source: TeleVideo Systems Inc.

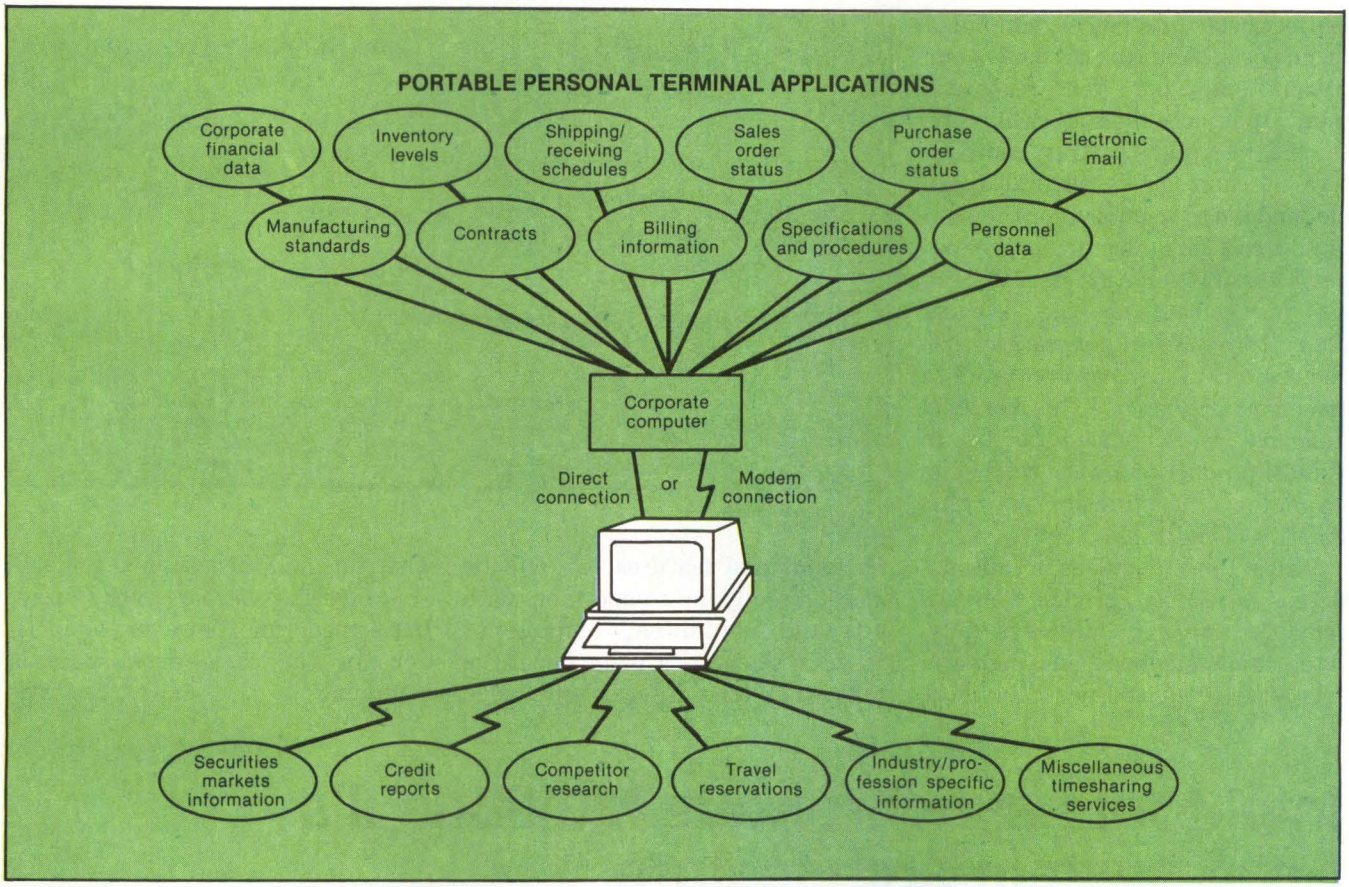
Video attributes claimed by TeleVideo and not on the Tymshare model are reverse video, blinking, half intensity, blank, underline, and double wide and double high characters.

COMPETITION FOR THE MANAGER'S DESK



Source: TeleVideo Systems Inc.

TeleVideo's Personal Terminal *is positioned as a low-cost alternative to more complex telephone workstations and personal computers. Its price is equivalent to units in the high end of autodial telephone equipment, but it is less expensive than most smart terminal and personal computer products that have data capabilities only, thus making it competitive enough to challenge some of those products on an executive's desk.*



TeleVideo's Personal Terminal is for corporate executives and managers *who don't spend much time working with a computer and thus don't need a full-blown microcomputer on their desks. These professionals need access only that information developed within their companies.*

Although telecommunication capabilities play a crucial role in the information-station concept, TeleVideo's first entry in this market will not have an integral telephone system. A 300-baud modem priced at $130 or a 1200-baud modem at about $600 are optional, as is a snap-on phone handset for about $75. The modem attaches to the terminal's logic board. Lynar sees one major use of the programmable function keys as automatic dialing of frequently-used numbers.

To reach the terminal's primary market of corporate managers more effectively, TeleVideo plans to beef up its direct sales to Fortune 1000 companies. The company also sees a secondary retail market developing for home users looking for an economical way to access popular database services. "Our existing distributor network already reaches that market through storefronts," Siegel notes. "But we also will look at the possibility of approaching it through major department store chains."

Siegel believes that the small footprint and versatile applications of the Personal Terminal will make it particularly successful with OEMs and system integrators because firmware can be customized. There is room for an optional 4-by-7-inch board for OEM add-ons such as communications protocol converters. Siegel thinks the Personal Terminal will be used heavily as a display station in local-area networks and distributed-processing environments. There, the terminal will make it economically feasible to add many users.

TeleVideo sees its competition coming from three disparate directions: personal computers, integral "intelligent" phone terminals and traditional low-end terminals. Lynar suspects traditional low-end dumb terminals will have difficulty competing in the information-station market because they are larger and lack user prompts for specific information-retrieval applications.

Although several other manufacturers have introduced low-end terminals with integrated modems, Lynar hints TeleVideo has more price flexibility because of the manufacturing volumes it expects

and because of its newer, simplified technology. "You look at some of our competitors, and you recognize their approach is not really the same," he claims. "[Our competitors'] technology is several years old, and it's too complex for the kind of low-cost manufacturing we believe possible," he insists. "This is also a problem for the integral phone terminals in general, in that they're technically hard to optimize for manufacturing." The Personal Terminal is scheduled to be in volume production by the time of its expected introduction at this month's Comdex.

TELEVIDEO'S PERSONAL TERMINAL'S PAYBACK

If:

- The average manager gets 10 reports or memos per week, each averaging 2.5 pages.
- The average secretary earns $22,000 per year in salary and benefits.
- 30 minutes per week of secretarial time is spent waiting in line at the copier, copying these reports and filing them.
- 10 minutes per week of mail clerk time is spent sorting and delivering these reports.
- The average copying cost per page is 3 cents for paper and processing.

Then:

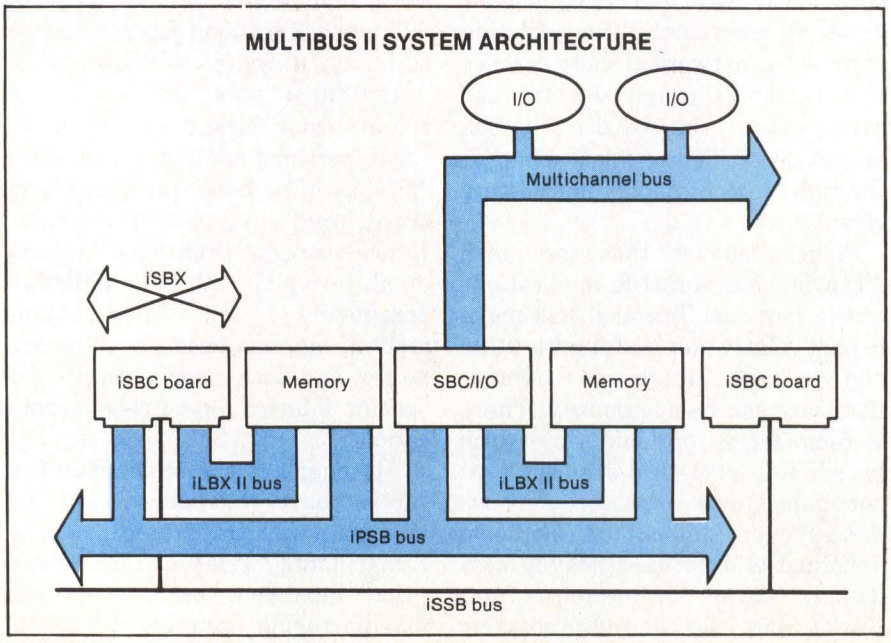
The Personal Terminal will save each manager approximately $7.50 per week or $390 per year (resulting in a 1.2-year payback period) while affording the manager the convenience of having any report he needs at his fingertips.

While TeleVideo does not discuss details of future products in the family, these may include a fully-integrated telephone and memory. "As it evolves and we add more functions and features, we will be more directly in competition with PCs and portables," comments Siegel. "There is a point down the road where the difference between what this and the personal computer evolve into becomes very fuzzy. In the meantime, however, competition for the same desk space is beginning." —*Edward S. Foster*

Intel touts synchronous Multibus II's open system architecture

As the Futurebus standard proposal drew comments from industry participants at a West Coast Institute of Electrical and Electronics Engineers (IEEE) committee meeting recently, Intel Corp. readied its own synchronous bus to propose to the IEEE P896 committee. Intel sources plug the Multibus II as an advanced open system architecture with an improved 10-MHz speed.

By advanced, John Beaston, technical marketer for Multibus II,



The five internal buses in Multibus II *linking iSBC system boards and memory are the parallel system bus (iPSB), which has a theoretical 40M-byte-per-second data rate (with zero access time-memory) and a 96-pin DIN connector, the iLBX II local bus extension with a 48M-byte-per-second data rate if wired through a second connector, the iSSB Serial system bus with 2M bit-per-second data rates that connects via two wires in the 96-pin DIN on the parallel bus, the iSBX local I/O expansion bus that runs at 10M bytes per second and has a separate on-board connector and the multichannel bus that operates at 8M bytes per second through a top edge connector.*

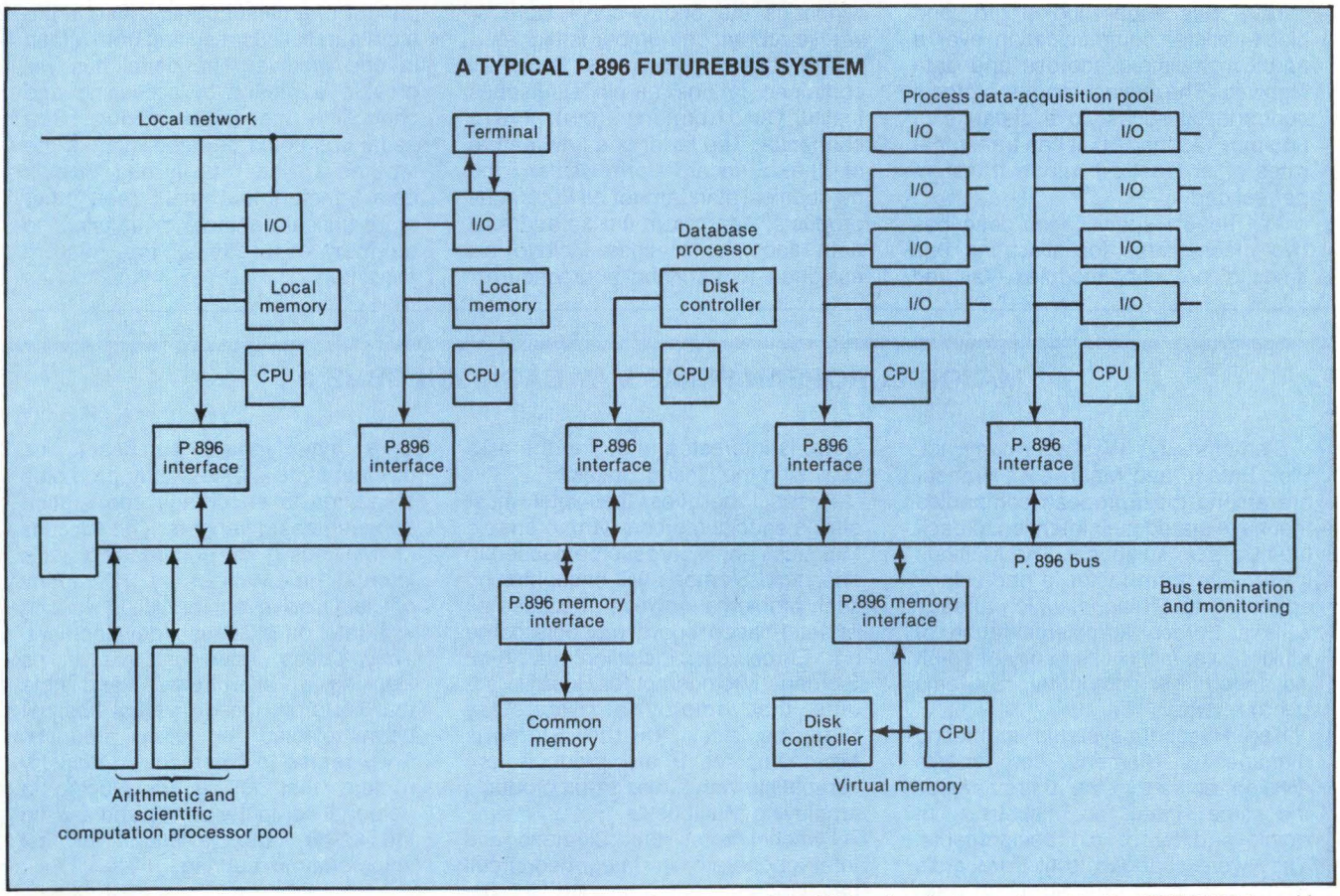
means a synchronous, multiplexed 32-bit bus that will use burst transfers, have data integrity checks and conform to the Eurocard form factor.

In previous synchronous systems, once a read or write cycle has begun, the data must arrive in a stated number of clock cycles. This puts a rigid constraint on the system. Multibus II allows the number of clock cycles to vary according to processing needs. This method prevents a problem that asynchronous systems have when cross talk and static cause extra signals on the control lines. Asynchronous systems read such extra signals directly.

Multibus II multiplexes the addresses and data so that fewer lines are required. The entire bus fits on one 96-bit Deutsches Institut für Normung (DIN) connector. Burst transfers avoid speed loss that occurs when addresses are constantly sandwiched between data cycles.

The Eurocard form factor is becoming increasingly popular because its modular design allows designers to put boards with different numbers of connectors into the same card cage. Instead of an edge connector, which is limited to two rows of contacts, the Eurocard DIN 41612 two-part connector has three rows of pins said to provide more reliable connections. The VMEbus, a competitor of Multibus II, also uses the Eurocard form factor. The VMEbus is backed by Motorola Inc., Signetics Corp. and Mostek Corp. It uses a two-connector, 160-mm.- (6.3-inch-) deep card and requires use of all 96 pins of one connector and the middle row of pins on the second connector.

Beaston says Intel decided a 160-mm.-deep card was too small to get much functionality on it. Multibus II uses a one- or two-connector-wide-by-220-mm.- (8.8-inch) deep Eurocard. "You can use either one," explains Beaston, "because we can put our whole system bus on one connector. So you can use the one-connector-by-220-mm. board to save costs and still have the whole bus interface there."



Intel's Multibus II synchronous bus *may be a sister bus to the synchronous version of Futurebus being reviewed by the IEEE P896.2 working group. In the case of the P896.1 specification for the asynchronous version, there are two assignments made to allocate bus time for competing devices: fair and priority, depending on a device's assignment. The 896.1 bus has 96 lines, all contained in one 96-pin connector. There are 32 address/data lines, six lines for handshake procedures, 13 for arbitration and 23 for logic controls over power and voltage levels.*

He says the two-connector board is typically used because of its more reasonable size. The two-connector-by-220-mm. card has about the same area as a Multibus I card, and, Beaston claims, "You can get about the same functionality on it."

Another advanced feature of Multibus II is its multiple bus structures. Besides the parallel system bus, there are three new buses: a local bus extension called LBX II, a serial version of the system bus and an I/O extension bus. LBX II is primarily a private passage

IEEE WILL REVIEW FUTUREBUS BASED ON EUROCARD FORM

The Futurebus standard, now under review by an Institute of Electrical and Electronics Engineers (IEEE) committee, comprises a family of advanced backplane buses for multiprocessor systems. The most advanced bus in standardization within IEEE is the working group's P896.1. It differs fundamentally from both Multibus II and the upcoming P896.2 because it uses an asynchronous, rather than synchronous, data-transfer protocol.

The P896.1 specification is for a parallel bus supporting single- and block-transfer communication over a 32-bit multiplexed address and data highway. The asynchronous protocol supports broadcast to a distance of 500 mm. (20 inches). It can transfer at rates of at least 10 million transfers per second.

The P896.1 specification describes two mechanisms for allocating bus times to competing modules—fair and priority. Devices whose claim on the bus is approximately equal are assigned a "fairness" class. A member that has had control of the bus desists from making further bus requests until no unfulfilled requests remain. Devices that can wait only a limited amount of time to get onto the bus qualify for the priority-class, whose members have higher arbitration numbers than those in the fairness class. When members of both classes are competing, the winner is the priority-class member whose arbitration number is highest.

The bus employs 96 lines, all contained in one 96-pin Deutsches Institut für Normung (DIN) 41612 connector. The latter is a key feature of the Eurocard form factor, the mechanical standard for all Futurebus products. Apart from the 32 address/data lines, other lines include six assigned to handshake procedures, 13 to arbitration and 23 to the logic that controls power and voltage levels. Futurebus uses a triple-height Eurocard, leaving two other complete 96-pin DIN connectors free for other buses and input/output channels. Other Futurebus variants are expected to provide the same flexibility by using just one DIN connector.

Another feature of P896.1 that probably will be provided with other Futurebus types is an optional serial bus. Its role will be to reduce the danger of a catastrophic failure in the main parallel bus resulting from a fault in one module. The serial bus will provide a means of accessing and controlling the failed module. The serial bus could be used most of the time as a system utility and for bulk data transfers that might delay other more critical transfers or transfers to devices external to the system chassis.

—Keith Jones

MAJOR EUROPEAN FIRMS MAY BACK MULTIBUS II

Siemens A.G., West Germany, ICL Plc., Britain, and Matra S.A., France, are among the European companies that have stated their intention to back Intel Corp.'s Multibus II. The Multibus II Eurocard form factor is particularly appealing to Siemens, which already sells a Eurocard implementation of Multibus I as part of its family of 16-bit Advanced Microcomputer Systems (AMS) boards.

Karl Hirschel, systems marketing manager of Siemens' components division, notes that the AMS bus uses the same signals as Multibus I but employs different pin assignments. They were changed to fit Eurocard's Deutsches Institut für Normung (DIN) 41612 two-part edge connector. Hirschel notes that Western Digital Corp. is interested in selling the AMS boards in the United States.

Hirschel believes that Intel must offer a special motherboard to enable Multibus I and II cards to be housed in one rack. Siemens will encounter no such problems, however, because all its Intel-based board products come on Eurocards, including its 8-bit Siemens Microcomputer Board products that employ a proprietary Siemens bus. All the Siemens Microcomputer Board products are compatible with future 32-bit products employing Multibus II.

Hirschel notes that Siemens and Intel cooperate in integrated-circuit development but compete in the board market. Unlike Siemens, ICL does not sell board-level products but is a major board purchaser. ICL officials state the company promotes standards to encourage cooperation between board vendors. The success of Multibus I is encouraging ICL's interest in Multibus II. Company officials also reveal that ICL is working with Intel on Multibus II development. They stress, however, that ICL is "looking at alternatives" and note that Motorola Inc.'s VMEbus has not been rejected for future products. They refuse to comment on industry rumors that ICL is developing a personal computer configured around the 32-bit Motorola 68020 for first shipments next spring.

—Keith Jones

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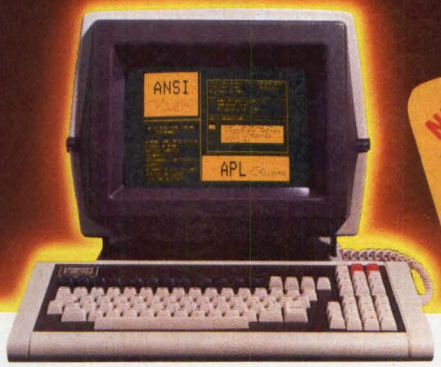

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VT100 compatibility and ANSI standard conformance. Add it to the *concept* display terminal's 132-column performance, in ASCII or APL/ASCII models, with multiple computer capabilities, windowing, programmable function keys, multiple pages of memory, and much more, and you can see why Human Designed Systems has given terminals a new meaning...and that means true economy.

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CIRCLE NO. 18 ON INQUIRY CARD

between a CPU board and a separate memory board. Two additional buses borrowed from Multibus I are Multichannel, a direct-memory-access (DMA) I/O bus, and SBX, which allows users to attach small daughterboards on top of the main board, adding one serial or parallel port per SBX.

Beaston says the most significant advanced feature of Multibus II is its integration of a message-passing protocol into the system bus. Thus, it has a standardized protocol that defines how disk-controller modules, communications modules and CPU modules with different degrees of intelligence communicate with each other. Because the protocol does not change, it resides on a very-large-scale-integration (VLSI) chip to save space. Intel claims the advantage of communications protocol is that it allows the system to be upgraded by, for example, changing from a single-density to a dual-density floppy disk drive. "You can have a single-density disk board that has a message interface and, two years later, you can unplug that and plug in a double-density disk board with a message interface. You don't have to rewrite your software at all," claims Beaston.

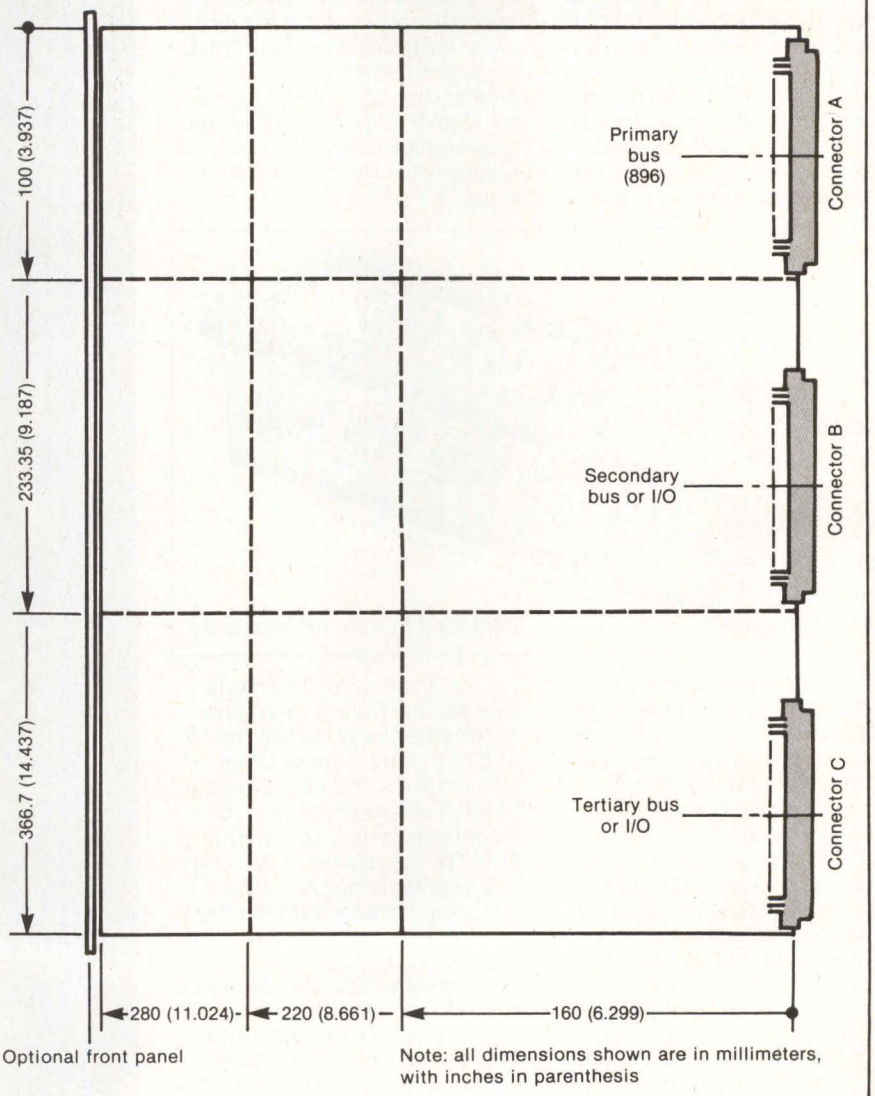
Another facility of Multibus II, called Interconnect, aids in testing, configuration and debugging. Interconnect is a special address space that uses software to identify the boards in the system and choose the hardware configuration of the boards.

Open system architecture is an important part of Intel's design strategy with Multibus II. The goal of open systems is to decrease the lead time between the introduction of a new VLSI component and its integration into systems. The standard protocol for message passing is the key feature of open systems. It allows new kinds of CPUs to be plugged into a Multibus

SYSTEM BUS COMPARISON

	Multibus II	VME	P.896.1
Data width	32	32	32
Address width	32	32	32
Protocol	Synchronous, burst multiplexed	Asynchronous, burst non-multiplexed	Asynchronous, burst multiplexed
No. of masters	20	Less than 20	32

EUROCARDS AS USED IN THE FUTUREBUS



Major new buses, *such as the P896 Futurebus and Intel's Multibus II, incorporate the Eurocard form factor. The dimensions of the triple-height Eurocard used in the Futurebus family of 32-bit buses are shown. The P896 working group of the Institute of Electrical and Electronics Engineers (IEEE) is defining the specifications of the Futurebus.*

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The high cost of on-line transaction processing computer systems has put them out of reach of most small to medium sized businesses. That is, until now.

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Unlike traditional computer systems, the Arete' 1000 was built to a strict list of performance parameters dictated by systems users. It includes features they told us they need, like a high Input/Output bandwidth, large storage capacity, and low per user cost. And virtually none of the features that contributed most to the high cost of on-line transaction processing systems in the past.

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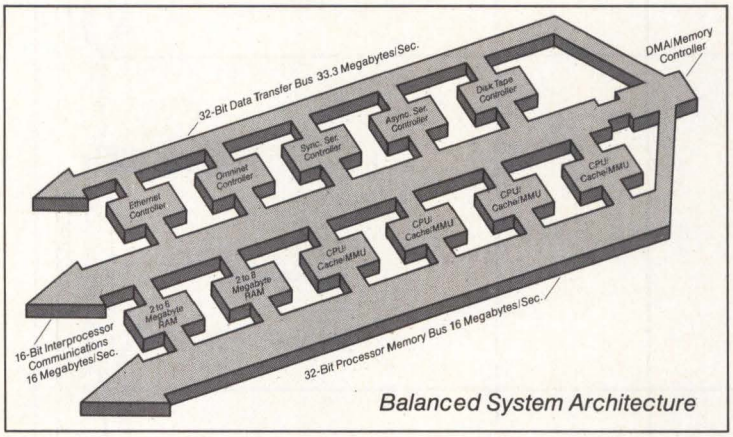
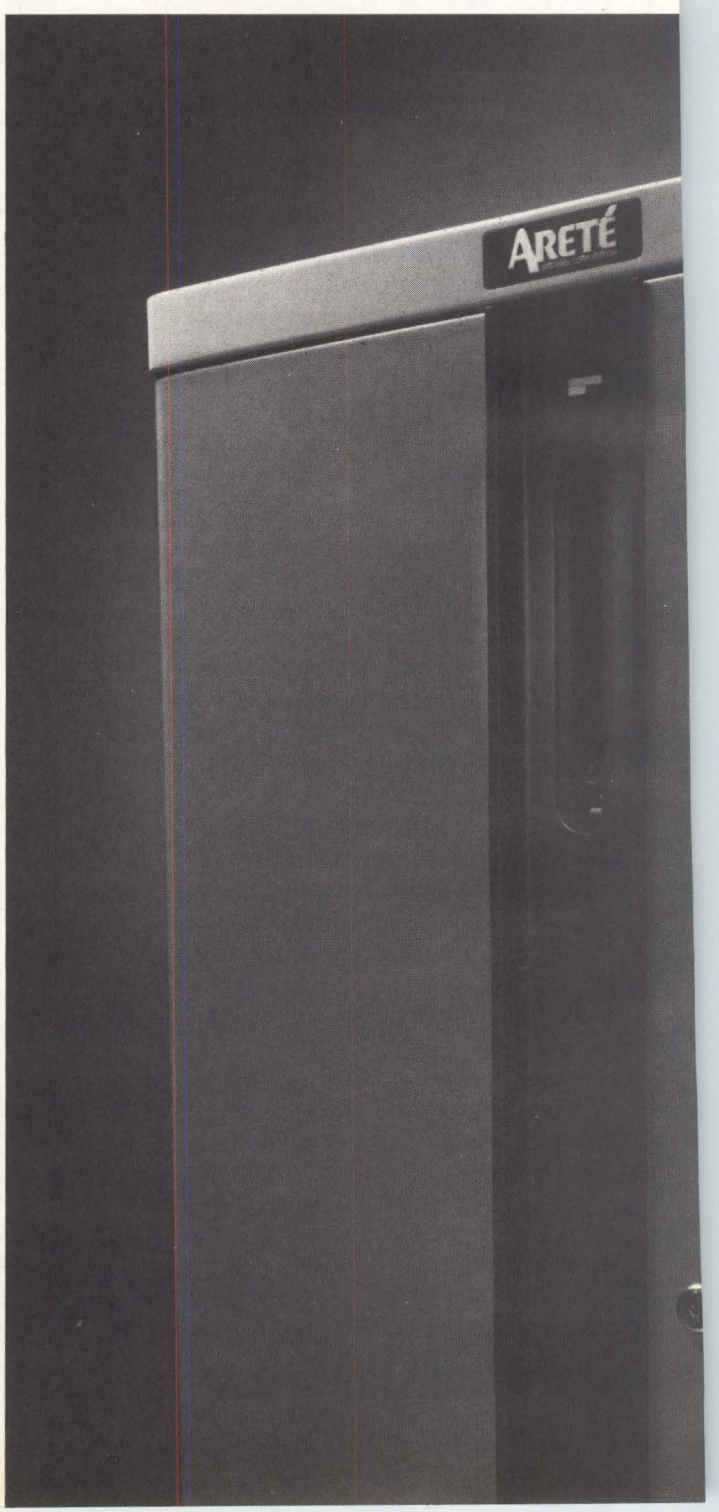
Our engineers created some innovative architectural solutions to harness a proper balance of speed, reliability, and price. For instance, as many as four central processors share a common main memory through a 32-bit Processor Memory Bus. This tightly coupled architecture allows quick response to changing system loads.



Balanced System Architecture

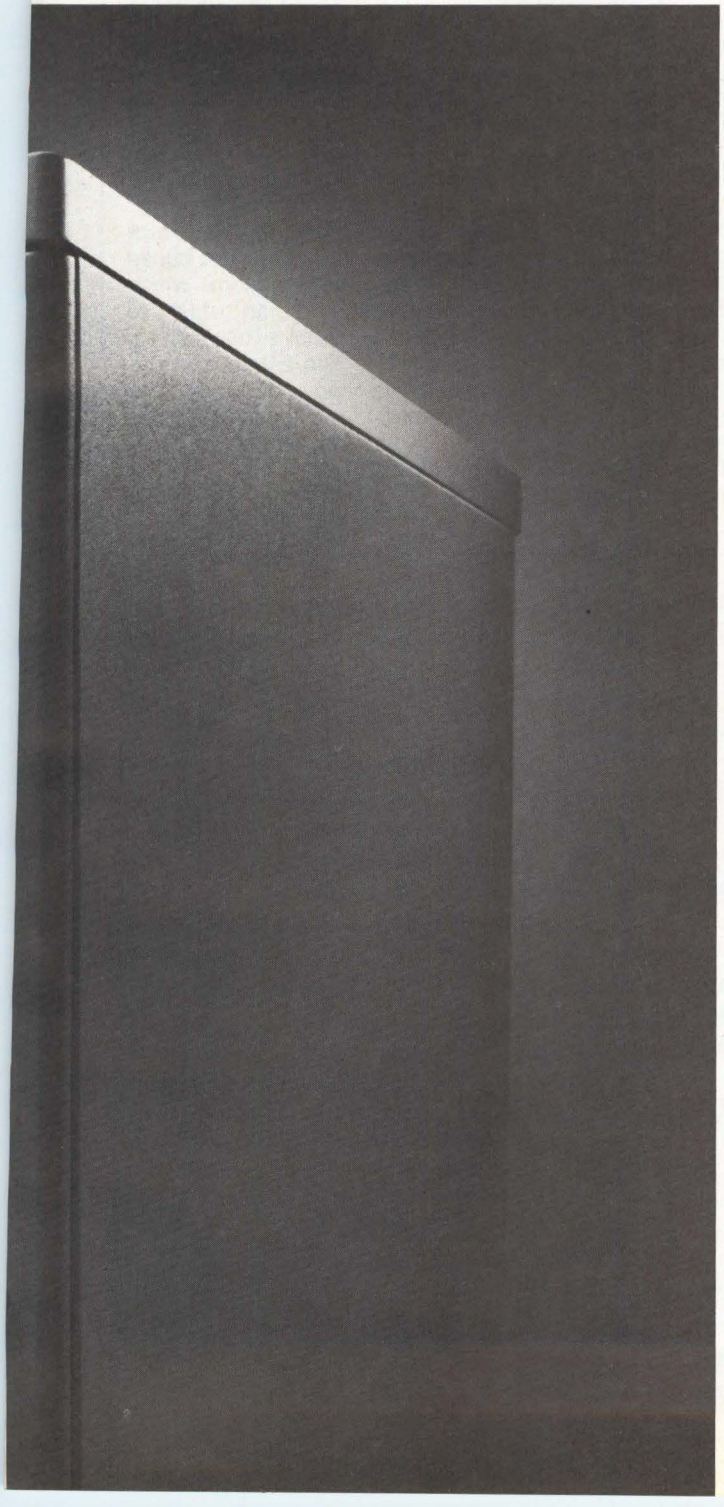
The 32-bit-wide, 33.3 megabyte/second Data Transfer Bus speeds the flow of I/O to as many as 60 concurrent users. Other features like a 4KB cache memory on each central processor, 16 megabytes of high speed RAM, 80 to 156 megabytes of disk storage, and 45 megabytes of cartridge tape storage give the 1000 performance comparable to many minicomputers.

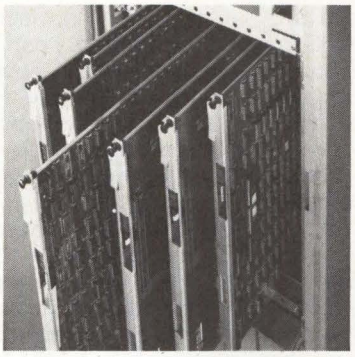
To greatly expand applications and systems software choices, we designed the Arete' 1000 to support two industry standard operating systems, Unix System V and RM/COS. Available languages include COBOL, C, FORTRAN, Pascal, BASIC, and AP/L. This means it's possible to easily and economically move standard software to and from the Arete' 1000.



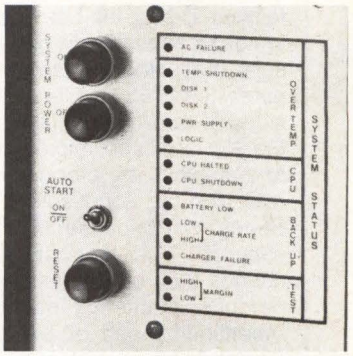
ANSACTION PROCESSING A NEW SET OF RULES.

RULES.





The Arete' 1000's spacious cabinet accepts any combination of CPU or memory boards, DMC, or IOCP boards up to a total of nineteen.



Diagnostic status panel assists in diagnosing system problems.

Rule #3: A low priced computer shouldn't be expensive to own.

The cost of service is a major part of the cost of owning a computer. We've taken steps to keep it to a minimum.

Each of the 1000's component parts has been designed to facilitate testing. And each subsystem has been designed to support automated test procedures. In addition, each of the processors has the ability to test itself. The location and nature of problems is flashed on the system's status panel. A field diagnostic system, which may be run remotely, pinpoints problems in any of four major subsystems. As a result, field service time is kept to a minimum.

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If you would like more information about the Arete' 1000, please call or write Arete' Systems Corporation, 2040 Hartog Drive, San Jose, California 95131. (408) 263-9711.

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CIRCLE NO. 19 ON INQUIRY CARD

EUROCARD 8-BIT BUSES PROLIFERATE, NEED FOR STANDARDS IS QUESTIONED

Besides the group led by Motorola Inc. with its VMEbus, at least two other major U.S. board-level computer suppliers sell bus products employing the Eurocard form factor. Digital Equipment Corp. offers Euro-Q-bus, a Eurocard implementation of the familiar Q-bus for LSI-11-based systems. National Semiconductor Corp. sells the CMOS industrial microcomputer (CIM) line of boards on both sides of the Atlantic. CIM is based on the 8-bit NSC800 microcomputer line and employs the proprietary CIMBUS.

Euro-Q-bus is not sold in the United States yet because of the lack of support. But that situation could change very quickly, states Eurocard products marketing manager Edgar Valentine, based at DEC's Reading, England, office. Valentine notes that Euro-Q-bus employs the same signals as a regular Q-bus but different pin assignments. This change accommodates the Deutsches Institut für Normung (DIN) 41612 two-part connector, a key feature of Eurocard packaging. Valentine estimates that the DIN connector is 10 times more reliable than an edge connector. He points to DEC's need to comply with the form factor requirements of LSI-11 customers in Europe, particularly in applications in which a computer can be a secondary part of a system, such as in process control, communications and defense. He notes that one LSI-11 processor board may have to share an enclosure with as many as 10 Eurocard boards from other suppliers.

The compactness of the single-height Eurocard—100 by 160 mm. (4 by 6.3 inches)—was another major attraction for National Semiconductor when it developed its CIM boards, states Reinhold Hohol, European board-level products manager in Munich, West Germany.

Hohol explains that the CIM products are aimed at hostile-environment applications. U.S. users include the state of Texas, with an application in oil- and gas-pipeline monitoring.

Although CIM boards are form-factor compatible with the STE bus being specified by the Institute of Electrical and Electronics Engineers (IEEE) working group P1000, Hohol insists that there is no need for CIMBUS to be electrically compatible with STE or any other bus. He notes there are about 50 Eurocard-based 8-bit buses sold in Europe. "The bus is irrelevant as long as it provides the same functionality of other buses," Hohol asserts, adding that bus standards are needed only for buses with 16 bits or more, in which development cost is an order of magnitude higher. But P1000's European secretary, Tim Elsmore, counters that STE is needed because of the many different 8-bit buses and the need for a bus that offers processor independence.

—Keith Jones

II-based system. "It isn't at the point yet where an end user with no experience can literally pull out and plug in boards. But it's moving in that direction and [is] closer to Multibus II," notes Frank Costa, Intel's strategic marketer for Multibus II.

An open system must also be processor independent. With asynchronous buses such as VMEbus, different boards and processors can communicate with each other at different data rates without timing problems. With synchronous systems, timing of different modules is more difficult. Multibus II solves the problem of processors and boards having different operating speeds by synchronizing the output of different boards to the speed of the bus at the bus interface. However, Paul Borrill, a research fellow at University College, London, and chairman of IEEE's P896 standards committee, notes that, although synchronizing the boards' output achieves processor independence, the 10-MHz bus speed is the limiting factor of the system. As a result, if Intel wants to increase the data rate of the bus, a new bus standard would be necessary. Beaston notes that, because the bus is now at the forefront of technology, Intel expects it to be a standard for 10 years.

Another feature necessary to make Multibus II an open system is a bridge to Intel's Multibus I system. The company says that, because the theory behind the Multibus I and II is the same, they can communicate with each other using a physical link between the different connectors.

Intel is expected to publish the final Multibus II specifications this month and to present those specifications to the IEEE P896.2 Futurebus committee for consideration as the standard synchronous component of Futurebus.

Borrill believes no conflict exists between the goals of the P896.2 (synchronous) standard and Multibus II, and he expects that Multibus II will be a sister bus to P896.2. Borrill and industry analysts see Intel's willingness—even eagerness—to publish information on Multibus II as an important asset to its promotion as a standard.

—Tom Moran

NEXT MONTH IN MMS

The December issue of Mini-Micro Systems, the annual technology review, is MMS's encyclopedic resource for its unique readership of value-added OEMs and users, and resellers. It consists of feature articles about various technologies, with market and product data in graphs, charts and tables.

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CIRCLE NO. 20 ON INQUIRY CARD

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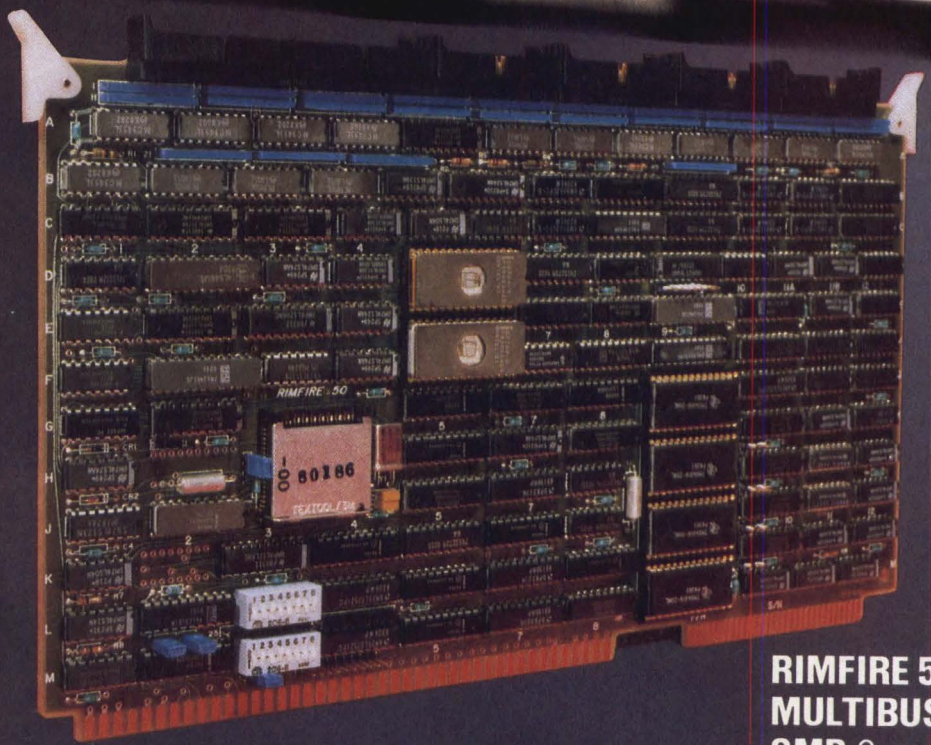

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CIRCLE NO. 21 ON INQUIRY CARD

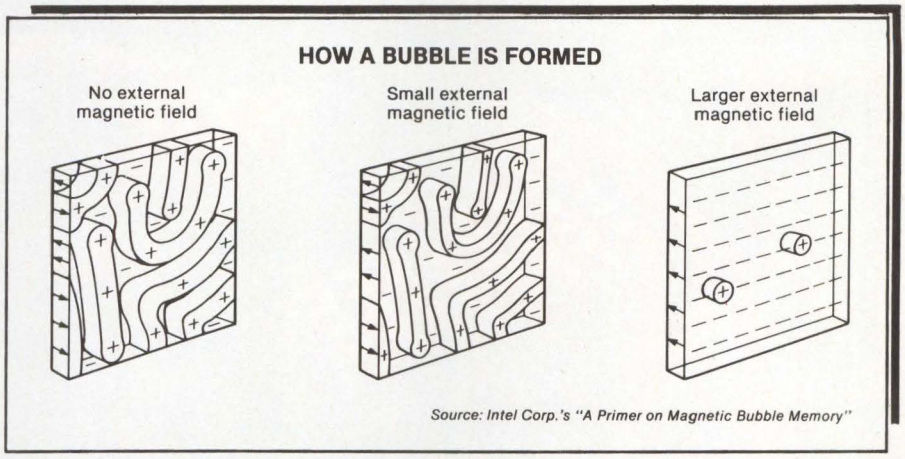
Non-volatile memories rejuvenate as bubble prices burst

In the midst of a semiconductor industry recession in 1981, some of the giants of the industry—Texas Instruments Inc., National Semiconductor Corp. and Rockwell International Corp.—concluded that bubble memories were best left to Lawrence Welk. Intel Magnetics, a subsidiary of Intel Corp., was one of the few with enough faith in non-volatile memory technology to risk its multimillion-dollar development.

Intel's faith paid off. Now, its competitors are scarce, and Intel can stake a major claim to what Dataquest Inc., a San Jose, Calif., market research company, forecasts to be a $100 million market this year. To further the technology, it has signed up its biggest processor-chip rival, Motorola Inc., as a second source and promised its customers dramatic price cuts in the next two years.

The price of the completely configured 1M-bit Intel bubble kit—including controller—will drop from its current $199 in quantities of 5,000 to $99 in quantities of 25,000 in the fourth quarter of 1984. This compares to an average quantity—5,000 price of $150 for a 250K-byte, 3½-inch microfloppy drive. The company also expects to have its 4M-bit (the equivalent of 500K bytes) bubble-memory kit reduced to $150 in similar quantities by 1986.

"Intel had the determination, the capital and the VLSI technology to pursue a complete bubble system," claims Ulmont Smith, a product manager with Intel Magnetics. "The others just couldn't get it all together, so they went on to other things."



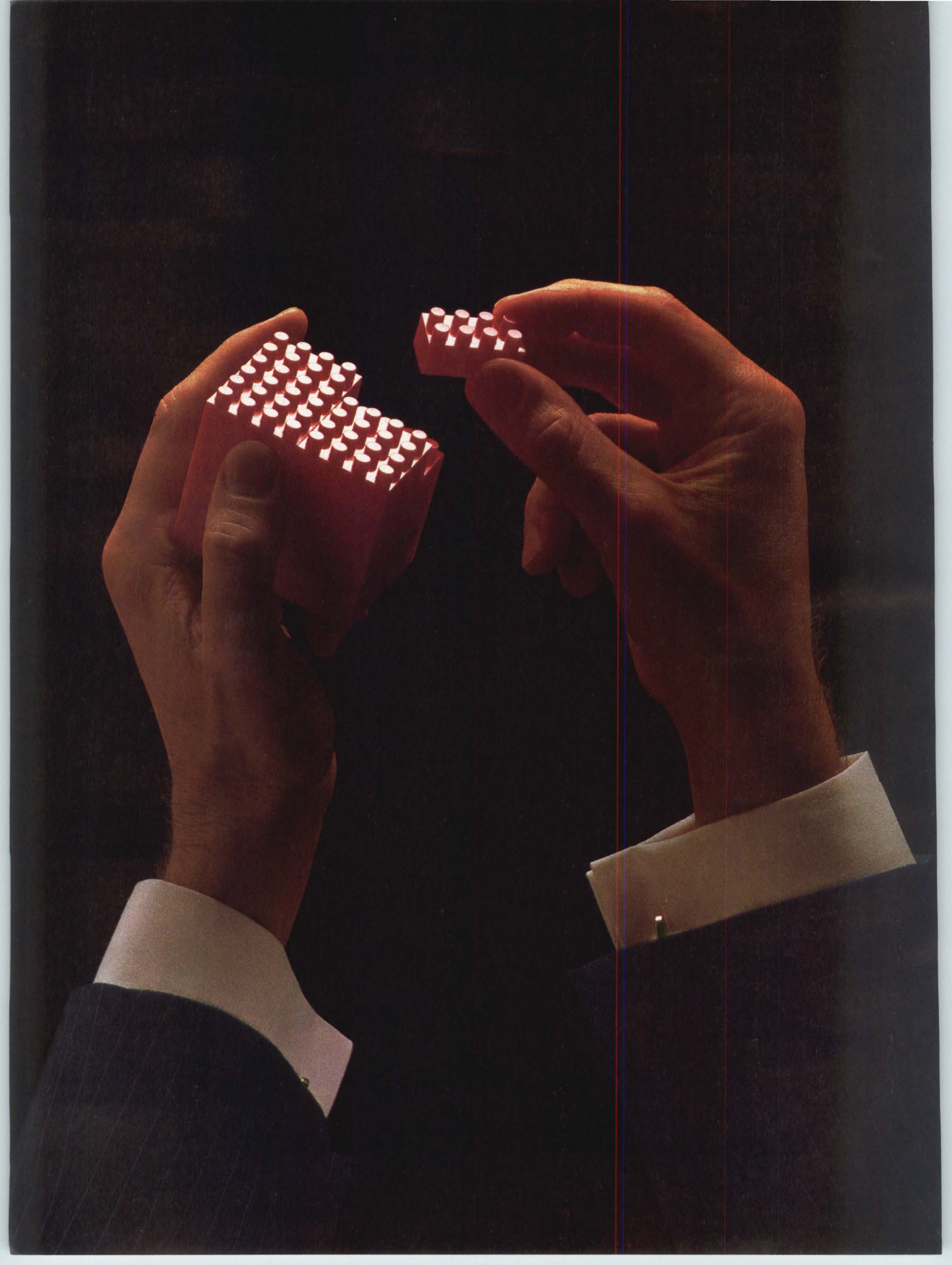
In bubble memory, magnetic domains are constrained to two dimensions *on a very thin-film substrate. Their orientations are perpendicular to the substrate. When not subjected to a magnetic field, the domains appear snakelike (left). When a weak magnetic field is applied perpendicular to the substrate, the domains narrow (middle). A strong, applied-magnetic field decreases the domain lengths until they equal the widths, or are cylindrical (right). When viewed under a microscope from above, the domains look like circles, or bubbles. The bubbles move on the substrate from areas of lesser to greater magnetic field strength.*

Intel anticipated the coming of the portable computer market. The new briefcase-sized computers not only require less real estate for memory devices but also operate in less-than-ideal environments. Bubbles are featured in briefcase systems like those from Teleram Communications Corp. and Grid System Corp. Others, like Tandy Corp.'s Radio Shack division and Convergent Technologies Inc.'s new briefcase computer user programmable read-only memory (PROM) cartridges. "Some designers were tired of waiting for the bubble market to emerge," says Jim Moore, a senior analyst with Dataquest.

When bubble memories were introduced in 1979, the 1M-bit Intel kit was priced at $2,500. At that level, applications were limited to high-end users demanding the rugged characteristics of the bubble over the mechanical weakness of rotating memory devices. In most cases, this meant military applications and sensitive portable scientific instruments.

As a result, many of the heavyweight manufacturers that followed Bell Laboratories into the bubble memory market sensed an ultimate victory for rotating mass-memory devices over bubbles in an increasingly price-conscious market. Few were willing to risk the multimillion-dollar investment necessary to fabricate the bubble's garnet wafer devices. The garnet wafers are 10 times more expensive than the silicon wafers from which semiconductors are drawn.

Bubble memories are high-density, solid-state memory devices in which data is stored as bubbles in a flat, very thin, magnetic wafer. The wafer is magnetically polarized in one direction; the bubbles are



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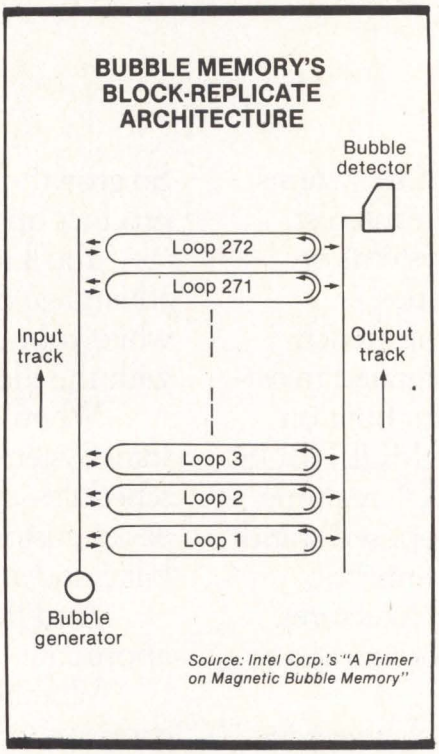
cylinders of reverse magnetic polarity extending through it. Instead of stationary bits being read from a rotating disk, the binary-coded data is read from moving bubbles on stationary media. Under a microscope, the bubbles appear as fluid circles that move in fixed tracks and loops on the garnet substrate. When data is read, a bubble is duplicated—one bubble continues around a loop retaining its memory while the other proceeds along an output track to the read location.

Unlike rotating memories, subject to physical and mechanical limitations, the bubbles can operate in extreme temperature environments. Since they have no mechanical parts, they are less subject to breakdown. Intel advertises a 40-year mean time between failures (MTBF), guaranteeing users trouble-free operation for the life of most systems.

Intel's Smith notes that bubble memory has less power consumption—an important feature in portable units—because it allows the bubble to be turned off completely when the memory is not being accessed. "Most users access a disk about 10 to 15 minutes of each hour a system is in use—yet the disk continues to rotate continuously," he adds.

While pointing out the advantages of bubbles over rotating storage devices, Smith admits that most future systems will continue to use a disk system because of increased storage capacity—current bubbles top out at 4M bits, or 0.50M bytes. Smith believes bubbles can coexist with disk systems, and it is likely they will complement each other. "Bubble memories are likely to be a buffer between RAMs and rotating memory devices," he says.

He envisions a future portable system in which a briefcase computer with bubble memory can be down-loaded into a desktop system with a rotating memory device for permanent storage.



Bubble-memory data storage is in a block-replicate architecture. *The architecture has a number of endless storage loops. Bits of successive pages circulate continuously. Two tracks—one input, the other output—are the vehicles for the controller to write and read data in the storage loops. Exchange or replication of data between tracks and loops occurs in all loops simultaneously, which is the key to the block-replicate architecture.*

A second growing application for bubble memory is the factory-automation market, where extreme ruggedness and environmental tolerance is often required.

Bob Nelson, president of Bubbl-Tec, Dublin, Calif., a division of PC/M Inc. that makes industrial controllers for the Intel bubble memory, says price decreases have not come fast enough. Bubble memories that can operate at 0 to 70 degrees Celsius are still priced between $385 and $445, depending on quantities. Intel's Smith admits the industrial-strength bubbles are still high on the price curve, but he expects they too will ultimately drop in price as volumes and demand become higher.

Meanwhile, Intel sees very little chance of a resurgence of bubble memory competitors. "Most of the companies that were involved in bubble memories were not at the point we were in 1979 when they disbanded their programs—they would have too far to catch up," Smith says. "New start-ups also are not too likely in this market because of the large financial commitment required to fund this technology."

Intel will be content to compete with its foreign bubble memory competitors, including two formidable competitors from Japan—Hitachi Ltd. and Fujitsu Ltd. Most of all, Smith believes, competitive price pressures will come from competing technologies like microfloppy and half-height minifloppy drives and PROMs.

—Robert A. Sehr

OLIVETTI SETS UP U.S. VENTURE CAPITAL COMPANY

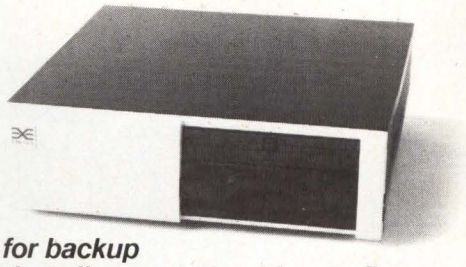
With $120 million estimated to be invested in U.S. electronics companies, Italy's Olivetti S.P.A is adding to its holdings through a 20 percent share in a U.S. joint venture-capital company. Olivetti officials note that the new firm's total funds will be $100 million and that Olivetti's partners will be "a group of U.S. and European organizations." They confirm Olivetti's long-term interest in selling a minority share in itself to a U.S computer company. Olivetti is currently negotiating to reduce the French government's share of the company to less than 10 percent from more than 30 percent.

EMULEX TALKS DEC 7

MACRO STORAGE FOR MICROS...

Good ol' RL02 has a lot going for it: 10.4 megabytes of removable storage, proven reliability, a massive OEM and end-user investment in RL02-based software. But no upward mobility. The only way to expand from micro to macro storage is to add more RL02 cartridge drives.

AT THE CUTTING EDGE...



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EIGHT-TO-ONE REDUCTION...

The host adapter plugs into any standard QBus slot. The balance of the subsystem, including an integral power supply, is contained in a single rackmount enclosure that occupies one-eighth the space of four DEC RL02s and requires one-fourth the power. Per-megabyte device and media costs are slashed. Average seek time is reduced significantly.

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SABRE's 8-inch cartridge disk drive features 10 megabytes of fast and easy backup. Media spins in a lightweight, removable, easy-to-handle cartridge. With a transfer rate that is up to eight times faster than that of a conventional 8-inch floppy, and even faster than a streaming tape cartridge. And this ruggedized drive is more resistant to shock and vibration than any other fixed or removable media disk drive. Through the flexible magnetic disk media and the unique design of the drive, users enjoy Winchester-like high-performance and reliability.

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Liberty offers $745 terminal with more features, 12-inch screen

Liberty Electronics' $745 Freedom 200 terminal *has more features than earlier family models. It's monitor slopes down to meet the terminal's base, making it easier to access the chassis' four board slots. Another ease-of-use feature is the extra-wide keyboard that groups keys by function.*

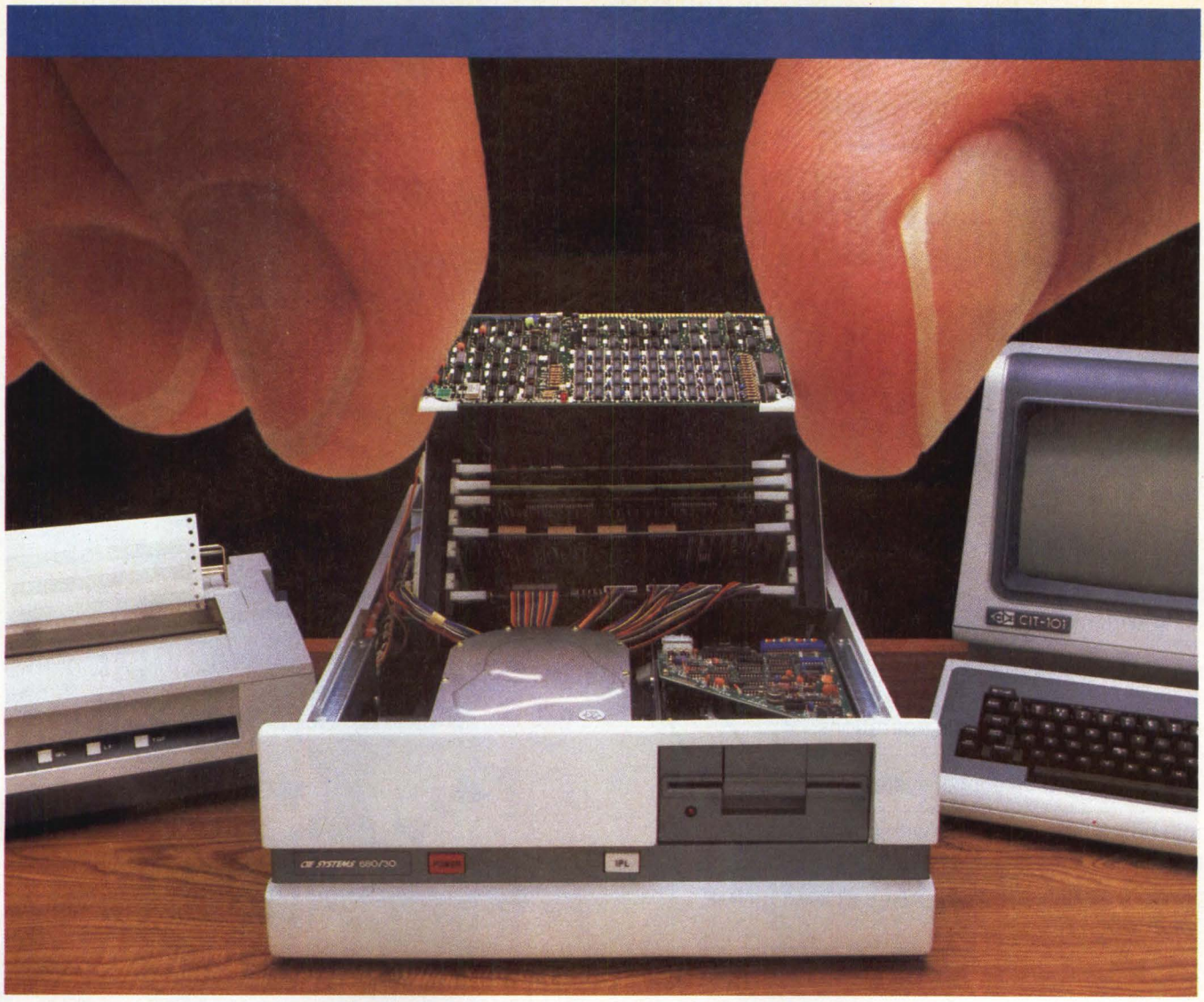
Liberty Electronics USA, one of the most price-driven companies in the highly price-conscious low-end terminal market, expects this month to make its first thrust into a higher performance category with the Freedom 200 terminal. The 12-inch terminal features an extra-wide keyboard with the keys clustered by function for easier use.

The San Francisco company only two months ago reduced the price of its low-end Freedom 100 model by $100 to $495, in part to make room for the Freedom 200, which is to have a list price of $745. George Chao, president of Liberty, feels that terminal manufacturers in general have "muddied the waters" on basic price/performance issues in the low-end market, a problem he claims the positioning of his two terminals should help rectify. "You have to make sure the user is not confused, and, with these two products, the difference between the features is clear and is accurately reflected in the difference in price."

The most striking change in the new terminal is the keyboard, which is 4 inches wider than is the Freedom 100's and reduced more than 50 percent in height. Characteristics the Freedom 200 has inherited from the Freedom 100 include a 12-inch, 24-line-by-80 character, green phosphor screen with a 25th status line, a 128-character ASCII set plus extended graphics characters, a 7-by-9-dot character cell on a 9-by-12-dot character field, 10 programmable function keys and non-embedded video attributes. The monitor can be fully tilted and swiveled, and the low-profile, detached keyboard is said to meet Deutsches Institut Für Normung (DIN) standards.

Other Freedom 200 features include a soft setup mode for the programmable function keys. That mode accesses 256 bytes of non-volatile RAM that can be allocated to any combination of keys. An optional 4K bytes of RAM can be added for another four pages of memory, which can be used either as video memory or as print buffer.

The terminal operates in block-



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CIRCLE NO. 24 ON INQUIRY CARD

conversation and local-communication modes. User-programmable keys include the print and send keys. The extra-wide keyboard can include seven cursor-control keys and seven dedicated editing keys. Other capabilities of the terminal include smooth scrolling, split screen, double-height/double-width characters, programmable answer back and screen saver.

Compatible with Freedom 100 protocols, the Freedom 200 will also offer standard emulation modes for the TeleVideo 950 and Lear Siegler ADM 31. Liberty believes the two products they have chosen to emulate better represent the Freedom 200's market than the lower-end terminals that the Freedom 100 emulates. "To offer the kind of features we do on this new terminal and emulate a dumb terminal would not allow the user to derive the benefit of the inherent features," says Chao. The Freedom 200 cannot use its non-embedded attributes in emulation mode.

The Freedom 200's monitor slopes down at an angle to meet the base, giving easier access to the chassis containing the unit's four boards. "In the typical pedestal approach, you have to dump the whole unit on its head to get the boards out," says Liberty marketing director Tim Meadows. "With the Freedom 200's design, you remove two screws, and the entire chassis slides out. Servicing the unit is much easier." The chassis also has an empty slot for additional OEM boards. Meadows adds that the angled design should provide better heat control than a flat mounting.

Chao believes the Freedom 200 will set a new price/performance standard. "We are offering high-end terminal performance with features that are not going to be found on [most] other terminals in this price range." he claims. He calls Wyse Technology's Wyse 50 (MMS, September, Page 24) the Freedom 200's main price/performance rival. "I think the Wyse 50 is a good terminal. The one advantage it has over us is the 14-inch screen and 132 columns. That is the wave of the future, but, outside of the VT100-compatible market, the software doesn't support it now."

HOW THE FREEDOM 200 AND WY-50 COMPARE

	Liberty Electronics USA	Wyse Technology
Product	Freedom 200	WY-50
List price	$745	$695
Display size	12 inches	14 inches
No. of columns	80	80/132 selectable
Screen adjustment	tilt and swivel	tilt and swivel
Keyboard	low profile, extra wide	low profile
No. of keys	128	100
Meets DIN requirements?	yes	yes
Function keys	10 programmable	16 programmable

Liberty will market the Freedom 200 through distributor, OEM and end-user sales channels. The terminal will be manufactured on a dedicated line at Liberty's Taiwan facility, with production units scheduled for availability no later than February. OEM quantity discounts are available.

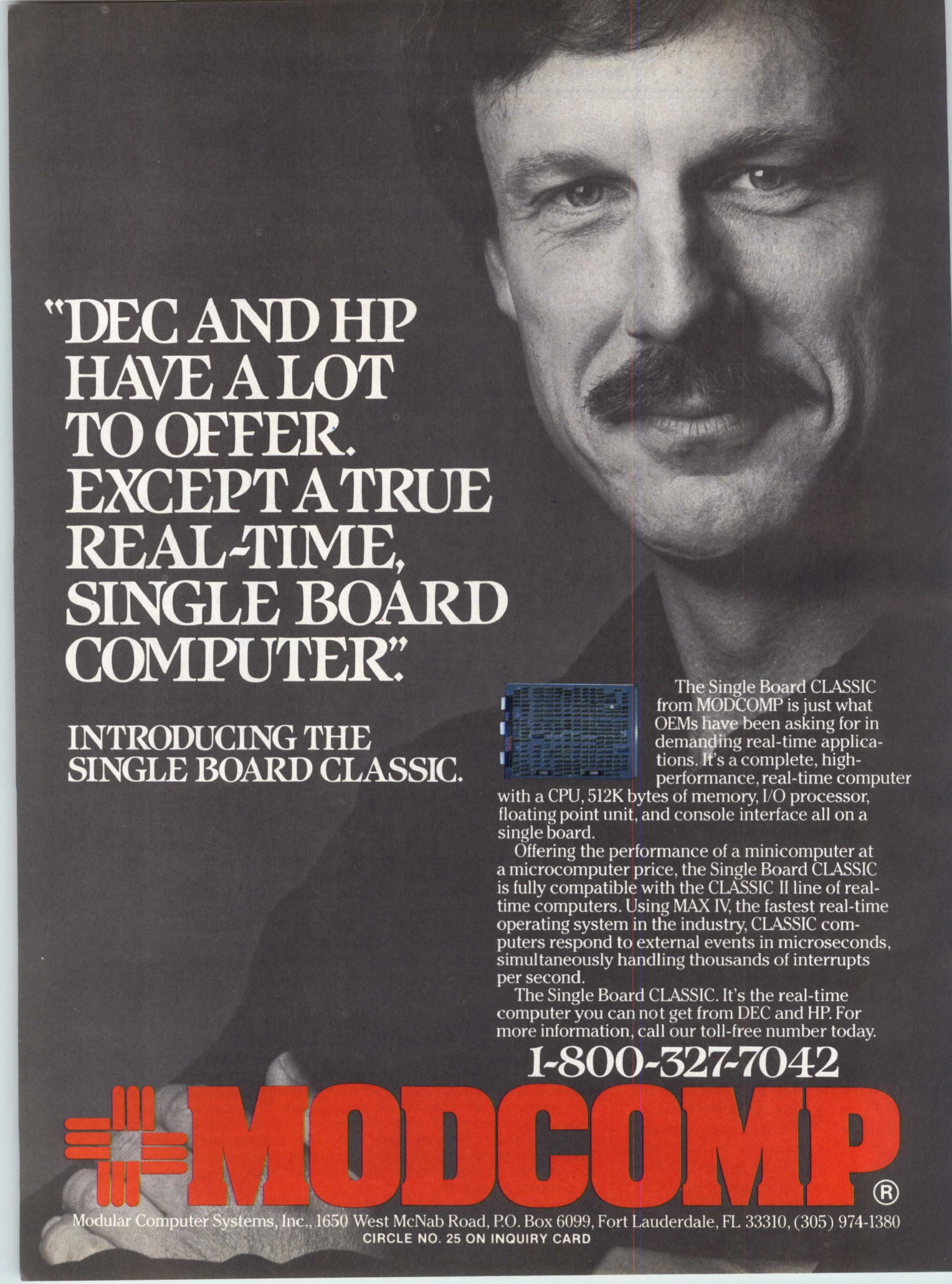
—Edward S. Foster

STUDY MISSION TO JAPAN WILL HIGHLIGHT MICROCOMPUTER SOFTWARE

A study mission aimed at hardware, software and multinational companies interested in joint ventures with Japanese companies is scheduled for Dec. 4-16 in Tokyo, Japan. The mission's focus will be on microcomputer software for business use and include sessions and company visits. It will address applications, operating systems, languages, software conversion, distribution and support and joint ventures. Richard J. Matlack, president of InfoCorp, a Cupertino, Calif., market research and competitive analysis concern specializing in microcomputer systems, will lead the mission. Joint sponsors are the Technology Transfer Institute and *Mini-Micro Systems* magazine. For more information, contact Mr. Hideaki Hashizume, General Manager, TTI, One Penn Plaza, Suite 1411, 250 W. 34th Street, New York, N.Y. 10119, (212) 947-2648, Telex: 420057; TTIUI.

MEMORY SUBSYSTEM ANNOUNCED FOR IBM PC

National Memory Systems Corp., Livermore, Calif., has introduced its PC-8000 memory subsystem for the IBM PC and PC look-alikes. The subsystem provides as much as 1G byte of storage. The company says the system is intended for use in very large database applications, software development or as a file server in a network. The PC-8000 consists of a controller and one or two disk drives storing 16M to 500M bytes each. The system is said to be compatible with fixed- and removable-media drives. Average access time is 17 msec. The company says the $25,400 system can run with the Compaq, Victor 9000, Columbia MPC, Eagle PC and other PC-compatible systems.



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CIRCLE NO. 25 ON INQUIRY CARD

HEARD ON THE HILL

By Stephen J. Shaw
Contributing Editor, Washington

AI emerges from the shadows

Slowly but earnestly, companies in the artificial intelligence (AI) field are bringing out the tools to build the heralded Fifth Generation computer systems. It's likely to take several years for any AI-based products to have a major impact in the commercial market. But 1983 could be the year AI emerges from its R&D cocoon.

Many significant product developments are coming from recently formed companies devoted exclusively to AI. More than 20 new enterprises have appeared during the past two years, notes Louis Robinson, editor of *AI Reports* and former executive director of the American Association for Artificial Intelligence (AAAI). Those 20 enterprises form the vanguard of the nascent AI industry. That industry is devoted to revamping the relationship between humans and computers by developing systems that can perform logical inferences, draw on the knowledge of experts in specific applications and be accessed in "natural" languages—that is, in terms familiar to human operators.

Such AI systems were displayed and described at a recent five-day AAAI conference. Testifying to AI's broadening appeal, the conference attracted more than 2,000 participants, including 75 representatives of the general and trade press. More than 30 companies sponsored technical exhibits, and many more were represented on panels along with university and government research organizations.

There was a minor flurry of product releases at the conference from both computer industry bulwarks such as Digital Equipment Corp. and Xerox Corp. and recent AI start-ups. But offerings aimed at further AI development applications outnumbered systems and programs for end-user applications. A broad range of strictly commercial AI products appears to be several years away.

"It's hard to build commercial products in any relatively new field of science," commented Larry Harris, president of AI Corp. "It's especially hard in AI because of the long development cycle, two to five years from prototype to product."

Harris told several hundred conference participants that more industry-specific products have just begun to be developed. He demonstrated AI Corp.'s Intellect software package, a general-purpose natural-language program that allows database access by entering conversational English onto a keyboard. IBM Corp. announced in June that it will include Intellect in its Information Center product line.

Other AI hardware and software products featured at the conference include:

- The Lambda system from Lisp Machine Inc. (LMI) offering both UNIX and LISP in 32- or 40-bit architecture. Instruction execution on the 68000 processor, which contains the Berkeley UNIX native software environment, can reach 1 million instructions per second (MIPS) with cache memory and a 10-MHz processing speed. LMI also announced that Texas Instruments Inc. had acquired a 25 percent interest in LMI. The Lambda uses TI's NuMachine.
- General Electric Co. displayed a computer-aided troubleshooting system, the CATS-1 for locomotive-engine-repair applications. GE has placed the system in beta test at the Conrail and Burlington Northern railroads. The $40,000 system incorporates a PDP-11/23 processor.
- DEC showed off the XSEL expert system that is not yet available commercially, says a DEC spokeswoman. It has been used successfully in-house to assist sales personnel in defining system configurations for customers. The XSEL system reportedly has helped DEC reduce the number of systems that is shipped in improper configurations, requiring follow-up sales calls and reorders.
- Symbolics Inc. began shipping its 3600 symbolic-processing system in June to customers including Bell Laboratories, GE, Mitre Corp. and Fairchild Industries Inc. Symbolics president Russell Noftsker estimates that the company has reached sales of $3 million monthly, largely due to the 3600 system used as an R&D tool to develop AI expert systems.
- Another recent start-up, Inference Corp., introduced an inference engine, called ART, that can be combined with knowledge bases to construct a variety of expert systems. A license agreement has been reached with Control Data Corp. to use ART in CDC product development, states CDC company president Dr. Alexander Jacobson. Inference is attempting to reach a similar deal with DEC and is searching for a joint venture partner to develop an expert financial-system package.

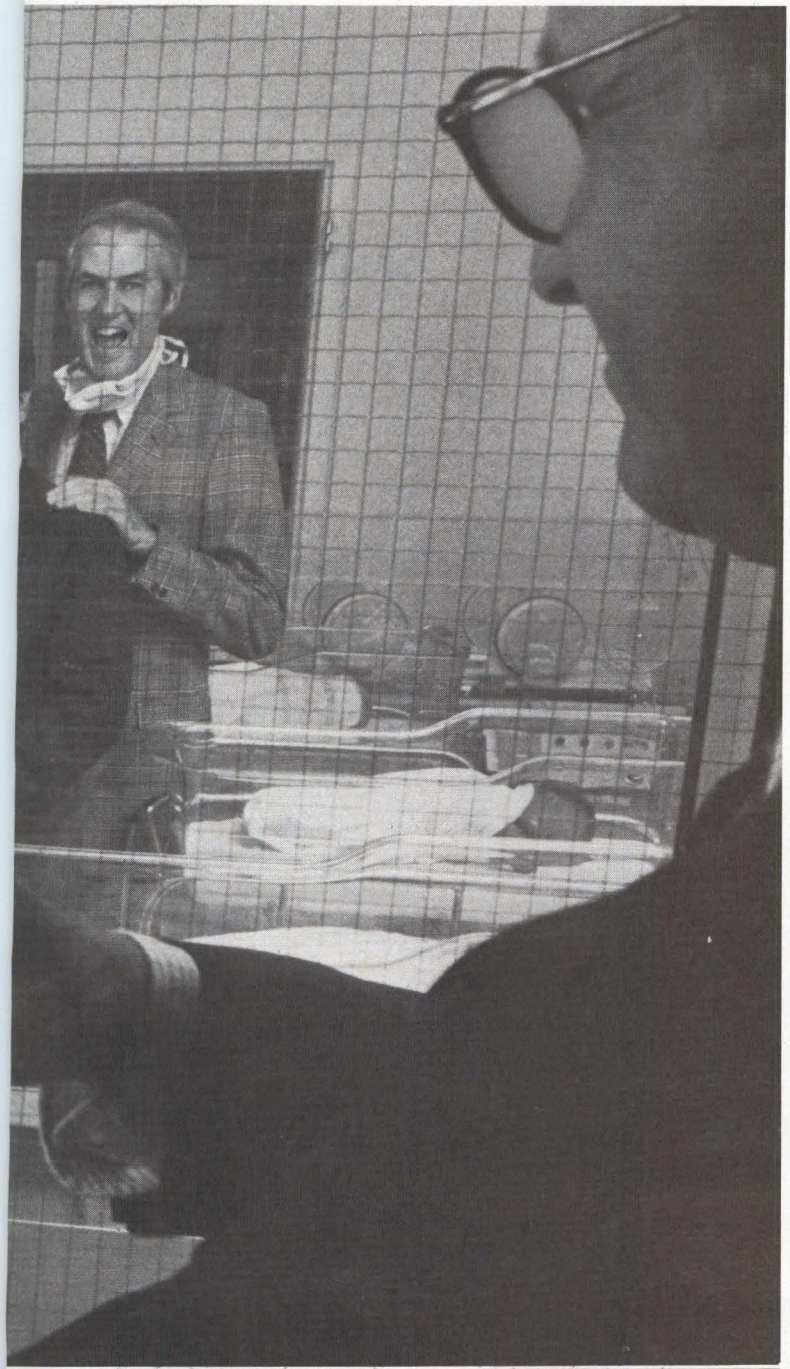
The Suit and Chip proudly debut their baby.

"To look at it, would you guess it has the power of an IBM mainframe?"

The Suit beckoned us closer. "For the VM/CMS users, and there are some 600,000 of them concentrated in big business, financial institutions and government, this little baby means new life for their existing programs and applications."

A 'personal mainframe' no less.

The Chip chimed in. "It is a personal mainframe that provides greater productivity for the individual user, enhances the performance of existing applications, leverages a company's investment in IBM systems and software, and provides access to sophisticated, modern computing environments such as FOCUS™ and RAMIS II™



—and all at a price affordable by the single user.

We were talking with the Suit and the Chip at their new headquarters in Trumbull, Connecticut. They founded Canaan Computer Corporation in 1981. Prior to that, the Suit, Bob Bernard, was the founder of National CSS, a leader in the development of commercial time-sharing. The Chip, Nick Pisarro, was a major technical contributor there. We asked what makes the Canaan Computer stand out of the teeming mass of new computers.

CMS user freed at last.

"It's simple," explained the Suit. "Recent developments like multi-window graphics and Ethernet™ are giving some buyers of new computers vastly increased capabilities. But as far as the IBM mainframe user has been concerned, these new powers don't exist. The CMS user has had to be satisfied with decade-old technology. With the introduction of the Canaan Computer, that CMS user can now have it all."

Multi-window graphics, dedicated interactivity.

"What we have done," said the Chip, "is develop a machine that provides these state-of-the-art capabilities, and runs the user's IBM mainframe programs with no changes required. So, for the very first time, CMS users , or even non-users who want to take advantage of all that IBM software , can have very high-resolution graphics, networking for shared resources, super interactivity, more computing power than they can ever get on a shared centralized computer—and all in a package the size of a two-drawer file cabinet."

Multi-window graphics, local area networking, a dedicated processor for each user: is there anything else you want the business community to know, we asked?

"Yes," said the Suit. "Our address. So they can write or call for more information. Or to order a machine—they're ready for delivery now. It's Canaan Computer Corporation, 39 Lindeman Drive, Trumbull, Connecticut 06611 (203) 374-5592. Ask for the Suit."

CANAAN

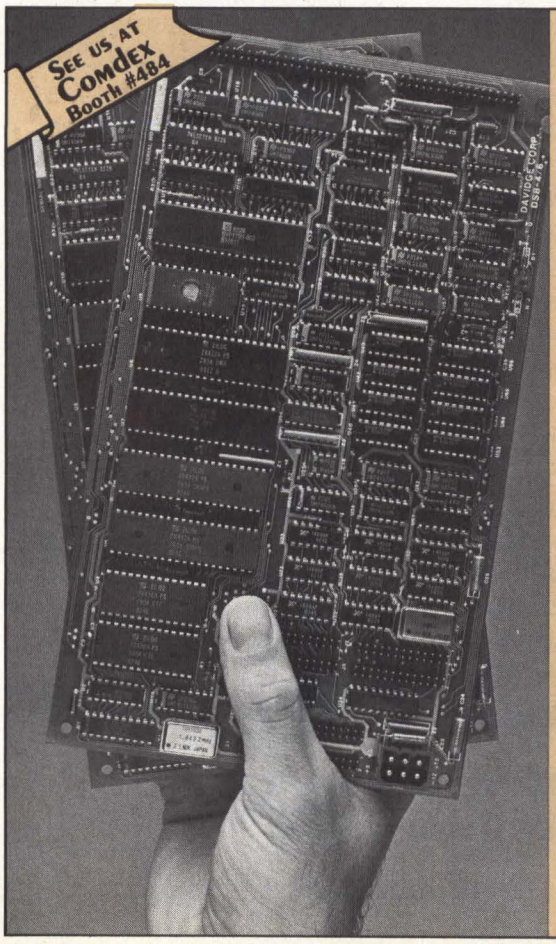
CIRCLE NO. 26 ON INQUIRY CARD

Software protection again under review; Apple aces Franklin

As a federal court of appeals issued a ruling favoring Apple Computer Inc. in its fight with Franklin Computer Corp. over software copyright infringement, the Copyright Office of the Library of Congress was reviewing industry suggestions on how to improve procedures and protect trade secrets for copyright registration.

Under current procedures, software programs are available for public inspection during review procedures preceding copyright and once copyright has been granted. The public can inspect software programs either by browsing through the Copyright Office's massive files or directly through the Freedom of Information Act. Industry comments filed in response to a Notice of Inquiry (NOI) Docket RM83-4 urge tighter access restrictions and more leeway in how the programs are filed for registration. The current registration methods, many of the comments claim, only reduce the number of software copyright applications because the software suppliers choose to rely on the protection offered by the Trade Secrets Act rather than risk revealing proprietary information through the copyright process.

Under state common law, the courts have upheld an individual's or organization's right to protect proprietary information. However, infringement of trade secrets is sometimes difficult to prove when a product is widely marketed and when no contract exists between disputing parties, states Michael Keplinger, policy planning advisor at the Copyright Office. Remedies for trade-secret infringement vary from state to state. Copyright protection was explicitly extended to computer software programs in 1980 in an amendment to the Copyright Act of 1978. The Copyright Office usually requires submission of programs in two forms: source code—high-level and assem-



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CIRCLE NO. 28 ON INQUIRY CARD

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bly languages—and the first and last 25 pages of a program's printout. The 25-page requirement, notes Keplinger, was devised in 1980 to protect programs for mainframe computers; for shorter minicomputer and microcomputer programs, now being filed in larger volumes than ever, the requirement to submit the 50 pages can mean that the entire program printout must be submitted in the relatively easy-to-read source code.

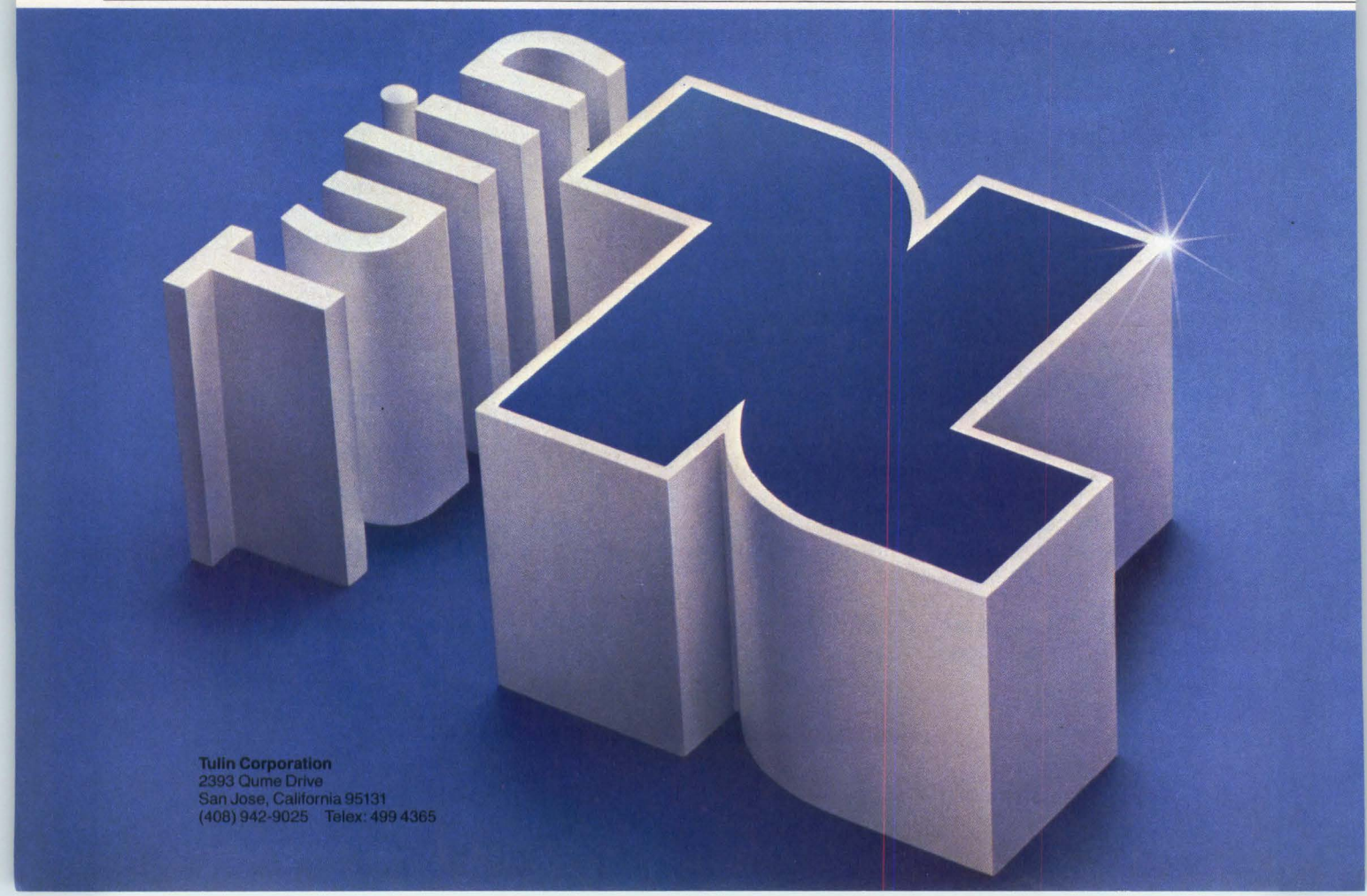
Copyright applications can also be submitted in object code—statements in the "01" format of machine language. The Copyright Office accepts all software programs for registration. They must be accompanied by a written statement from the author testifying to the program's original content, but the Copyright Office makes no claim as to authorship authenticity.

The NOI is designed to elicit industry opinions to help solve the dilemma now plaguing Copyright Office computer specialists: "How do we accept software without allowing public access to the material?" asks Keplinger. With approximately 2,000 software programs submitted each month, the Copyright Office is also attempting to avoid inadvertently abetting software pirates.

Manufacturers of video games feel the effects of the software-protection issue most keenly. Atari Inc. advocates that the copyright agency accept object code and a portion of the source code embodying an extract from the graphics display. "If Atari were required to disclose source codes as a condition of copyright registration, we would be forced to choose between sacrificing our trade-secret rights on the one hand or sacrificing our copyright remedy on the other," Atari stated in its comments to the NOI.

Some small software engineering companies have flatly refused to seek copyrights, preferring to forgo the legal remedies against infringement available under copyright rather than risk their trade secrets. "We have never sought a copyright on any of our software because we refuse to make our source code available...and we have approximately 500,000 source-code lines," commented AAA Technologies and Specialties Inc., Houston.

Manufacturers' trade groups,



CHARACTERISTICS OF PROTECTIVE MECHANISMS

Considerations for software	Copyright	Patent	Trade secrecy
Consistency with other copyright areas?	Yes	No	No
Availability of protective mechanisms for some programs?[1]	Yes	Unclear	Yes
Universal availability of protective mechanisms for all programs?[2]	Yes	No	No
"Process" protectible?	No	Yes	Yes
Suited for mass distribution?	Yes	Yes	No
General considerations			
National uniformity?	Yes	Yes	No
Protection effective upon	Creation of work	Successful prosecution of applications	Entrance into contractual relationship
Cost of obtaining protection	None	Moderate	Moderate
Term of protection	Life + 50 years or 75 years	17 years	Possibility of both perpetual protection and termination at any time
Cost of maintaining protection	None	None	Significant
Cost of enforcing rights against violators	Moderate	Moderate	Higher
Protection lost by	Gross neglect	Unsuccessful litigation	Disclosure

[1]Serious doubt exists about whether programs are proper subjects for patent protection.

[2]Even if programs are patentable, only those that are truly novel and non-obvious are protected. Trade secrecy is unavailable when the contents of a program have been disclosed.

Source: Final report of the National Commission on New Technological Uses of Copyrighted Work, Library of Congress, 1979.

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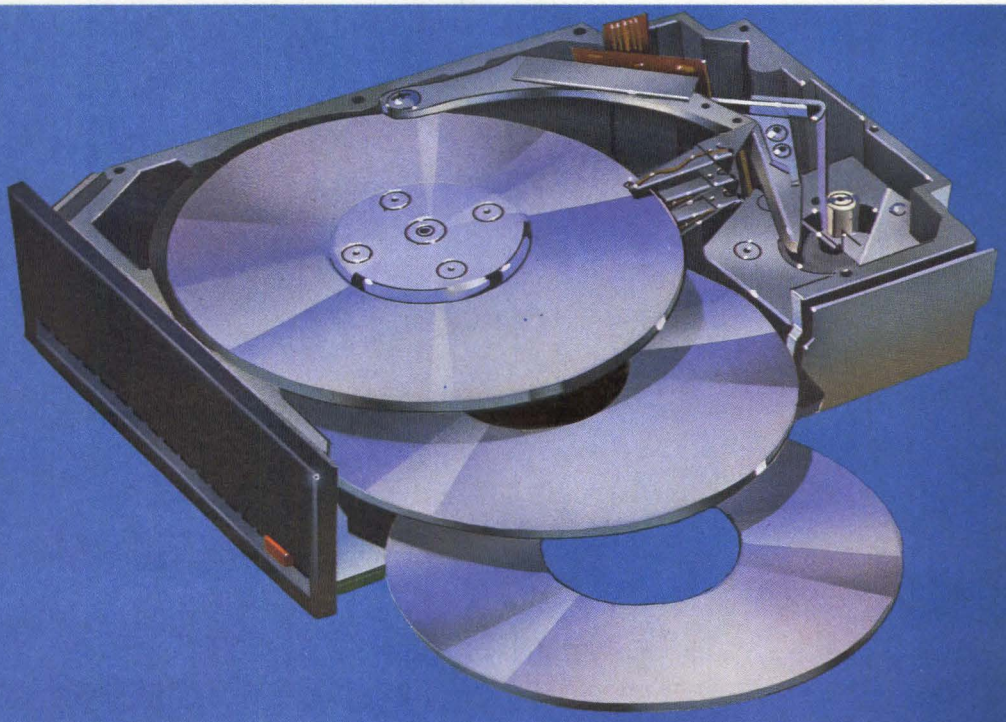

TULIN FITS IN.

CIRCLE NO. 29 ON INQUIRY CARD

See us in the West Hall, Comdex

including the Computer and Business Equipment Manufacturers Association (CBEMA) and the Association of Data Processing Service Organizations (ADAPSO), urged that a "secure deposit" procedure be implemented. ADAPSO called on the Copyright Office to retain only a small identifying portion of the source code, such as a diagonal page strip. CBEMA proposed eliminating public access to copyright applications during review.

In the Apple-vs.-Franklin case, the Third Circuit Court of Appeals in Philadelphia overturned a lower district court's decision not to impose an injunction against Franklin to stop the Cherry Hill, N.J., manufacturer of Apple-compatible systems from selling 14 operating-system software programs Apple claims are protected by its copyright. The appeals court remanded the case to district court with instructions to consider the computer software fully protected under Apple's copyright. "Copyrightability of computer programs is clearly established after the 1980 amendment to the Copyright Act," said the court in its opinion.

The decision also chided the earlier ruling for its uncertainty about whether a software program in object code could be considered the same as a "literary work" for copyright protection. The court also rejected Franklin's assertion that the programs in question—operating-system software—were specifically excluded from copyright protection.

The medium through which the software program is expressed does not alter the available copyright protection either, according to the court. Franklin had argued that programs impressed on ROM devices are not subject to copyright.

Predictably, Apple was cheered by the decision. The company is aggressively pursuing companies it believes are infringing its copyrights. Recent victories have been secured in France, Germany and the Netherlands. "We're naturally pleased and gratified by the decision," comments an Apple spokeswoman. "It's good not just for us but for independent software writers."

Franklin intends to continue its defense at the district court level, says company president Joel Schusterman, with other issues that were not considered by the appeals court.

—Stephen J. Shaw

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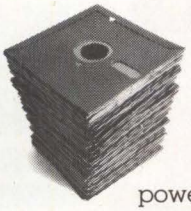

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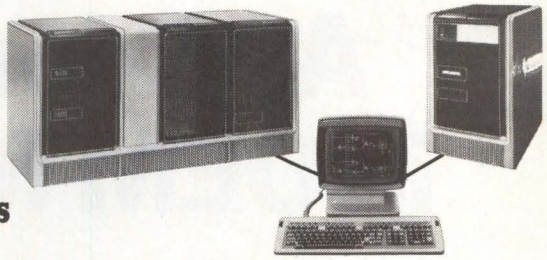

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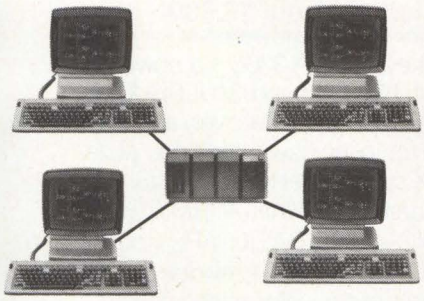

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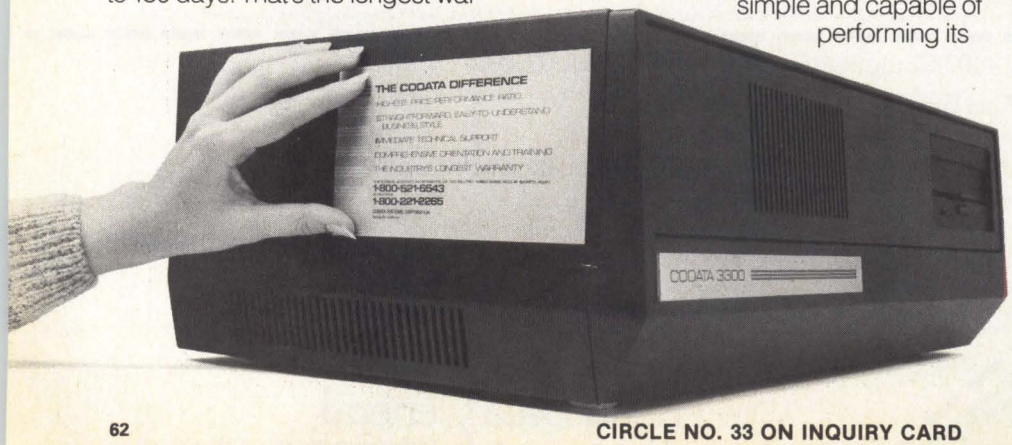

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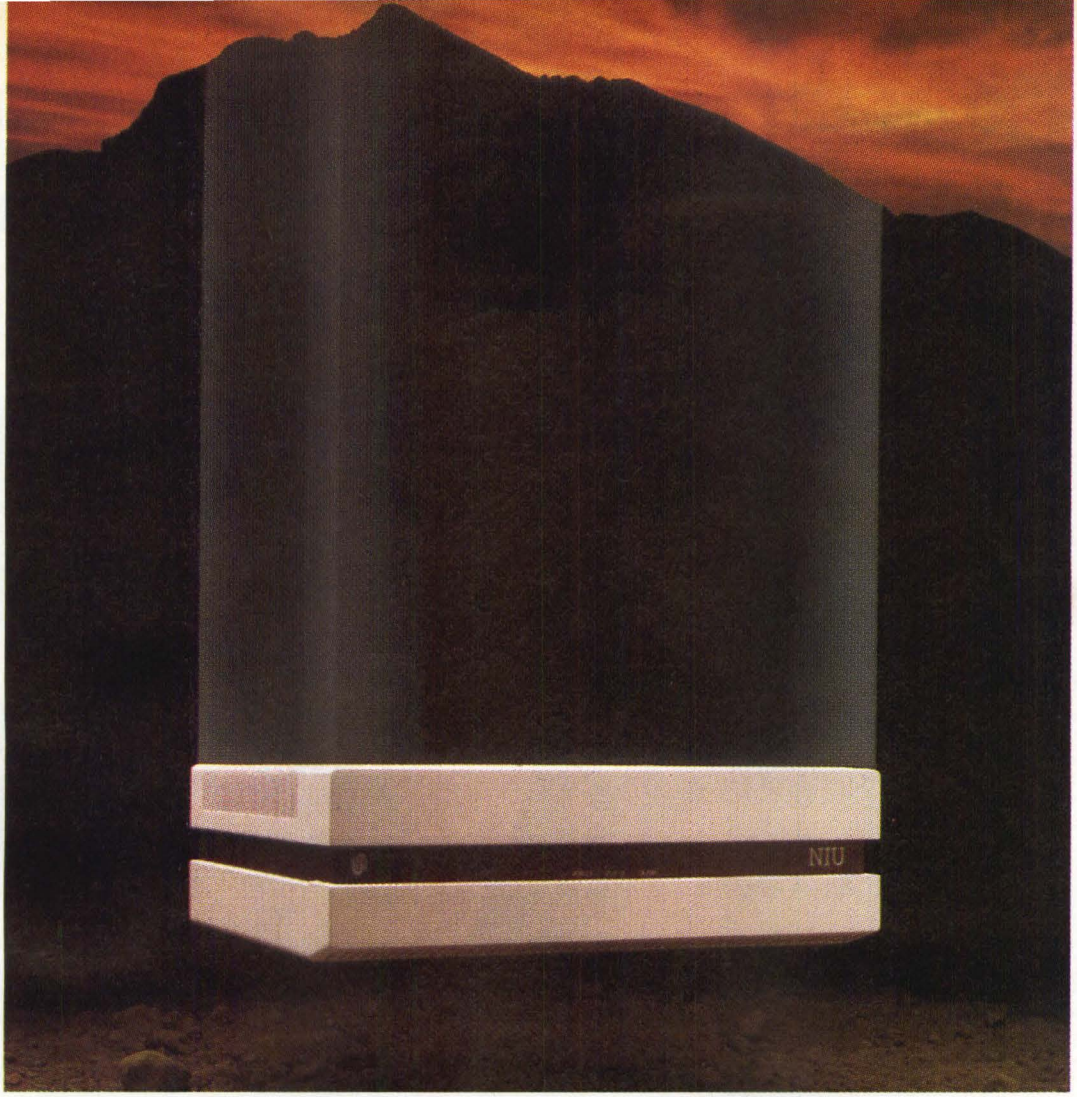

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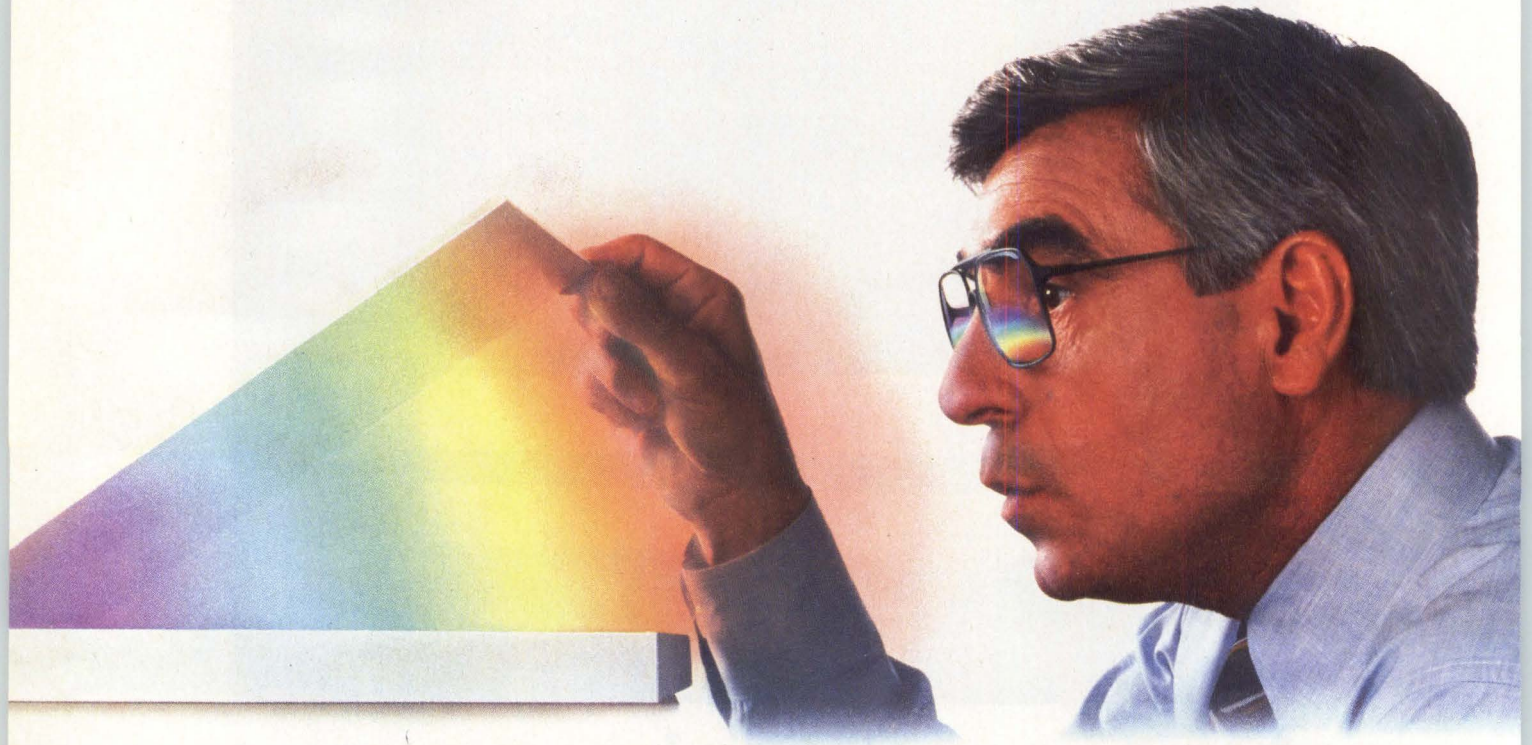

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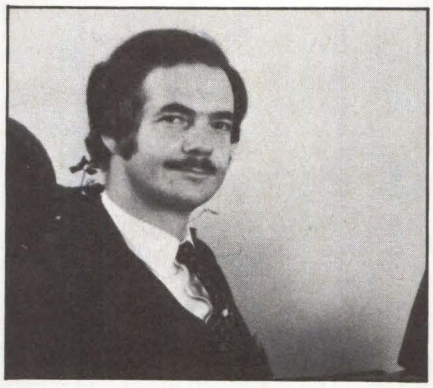
CORPORATE AND FINANCIAL

Osborne Computer self-destructs

Osborne Computer Corp., the Hayward, Calif., pioneer in popularizing portable computers for business, apparently fell victim to its own arrows in mid-September. Rapid market success but few cost controls led to a series of layoffs ending Sept. 9 leaving only 75 paid employees, down from 1,000 in Osborne's heyday. Four days later, unable to locate a cash-rich suitor to acquire it and having a $4.5 million lawsuit threatened by two creditors, Osborne filed for Chapter 11 bankruptcy protection.

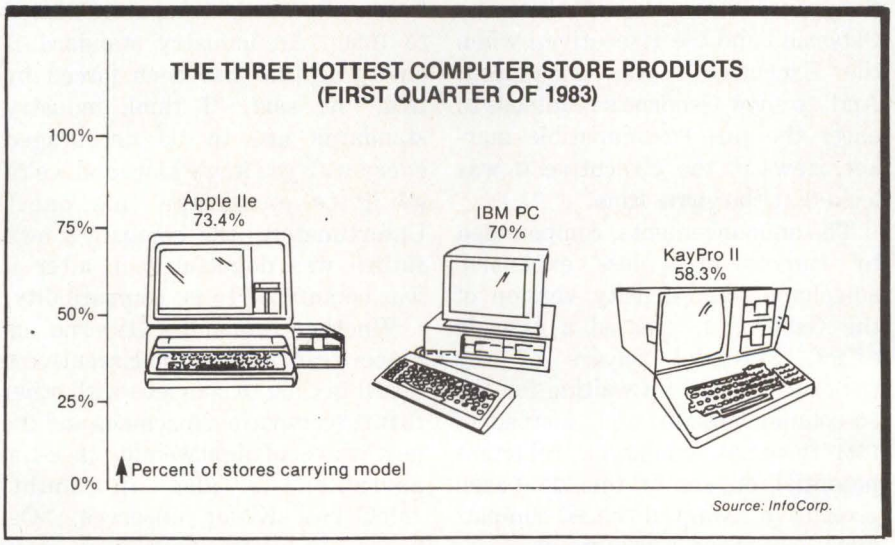


Adam Osborne, founder and chairman of Osborne Computer Corp. *and a pioneer in portable computers, was readying to follow the leader with an IBM-compatible portable, the Executive II, when his company was forced to file for Chapter 11 bankruptcy protection.*

Consumers saw the company's Osborne I portable computer as the Volkswagen of personal computing —not beautiful but a great bargain. Considered the first reasonably affordable full-featured portable computer, the Osborne I included bundled programs whose retail price exceeded the combined price of the product's hardware and software. About 120,000 Osborne I units have been sold, notes Tom Hayes, product manager for Osborne's recently introduced Z80A-based Executive I system. Hayes adds that 15,000 Executive Is have been sold.

Since last spring, Osborne had laid off 384 employees, closed its New Jersey production plant and severely reduced overseas operations. Analysts believe the layoffs and closures were caused by poor sales related to product delays, system reliability problems, slow and inaccurate reactions to the booming portable microcomputer market and a series of premature product announcements. "They [Osborne] underestimated the importance of IBM compatibility and KayPro's capabilities both in manufacturing and sales," opines John R. Kiefer, senior analyst at InfoCorp, a Cupertino, Calif., market research company. InfoCorp figures show Osborne dominated the transportable computer market until this year. In 1982, Osborne shipped about 73,000 units. This year, 27,000 units were shipped in the first half. The year is expected to top out at less than 40,000 units, according to InfoCorp. KayPro, meanwhile, doubled last year's shipments to 40,000 by midyear, an amount expected to more than double again by year-end.

In January, company founder and chairman Adam Osborne hired Robert Jaunich, formerly of Consolidated Foods, as president and chief executive officer to run the daily operations of the company. At the time of Jaunich's hiring, a former employee claims, overemployment was a problem, and financial controls were virtually nonexistent. Osborne also announced plans to go public in March. Both strategies to save the company failed. Osborne's false start on the stock market signaled something was wrong. And, states one insider who asks not to be named, Jaunich's appointment was the final blow to employee morale. "Up to then, Osborne was a lot like the little train that could. Everyone's spirit was really high, and things got done because you believed they could be



InfoCorp's first-quarter 1983 computer store survey shows Osborne missing *from the hottest product trio in stores. Other InfoCorp studies list Osborne second that quarter as most frequently mentioned by stores as having lower than expected sales and contributing to an inventory overstock. Osborne was simultaneously undergoing a top management change to control costs and employment and was preparing to go public and to usher its follow-on products to market.*

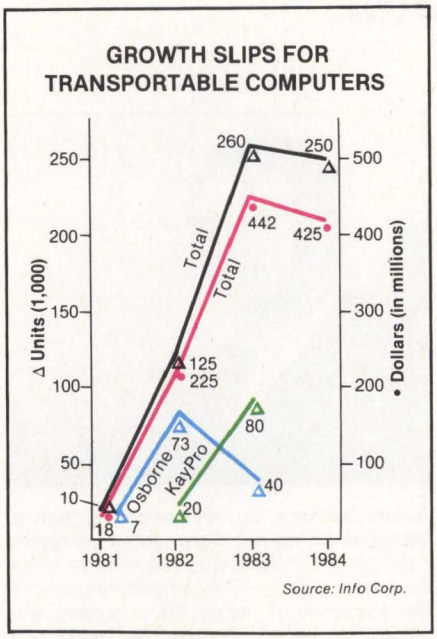
done. But, when Jaunich came on board, he went around saying, "You're not doing that right," and suddenly, things started falling apart," says the source.

When Jaunich joined the company, he found enough problems to chill the hopes of even an inveterate optimist. Despite revenues approaching $100 million, Osborne reportedly never had a period of substantial profits. Vice president of finance Donald Waite will not confirm these reports. Financial controls were established, but the company's other problems remained.

Almost from the beginning, Osborne suffered from a series of premature, overly-optimistic announcements, usually emanating from Adam Osborne himself. The company promised owners of early Osborne I's with single-density disk drives that upgrading to dual-density versions would take two weeks, but they typically had to wait months. Adam Osborne says there were problems with new disk drives; the electronics of some of the oldest systems had to be almost completely rebuilt, resulting in nearly new disk subsystems.

Much more devastating than the upgrade delays were the ill-timed March and April announcements of the Executive I and II portable computers and a high-level leak concerning the never-officially-announced Vixen, described as a smaller, lighter 80-column-display version of the Osborne I. The Executive I and II each have 128K bytes of memory and 7-inch amber monitors. The Z80A-based Executive I features IBM terminal emulation. The IBM PC-compatible Executive II was to include Z80A and 8088 processors.

Many analysts believe that neither the Executive I nor II should have been announced until their



Transportable computer growth is expected to peak this year. *Nonetheless, KayPro still is expected to grow in relation to former leader Osborne Computer Corp., which InfoCorp estimates shipped 27,000 units until mid-1983. Growth then slowed to yield an estimated yearly total of less than 40,000 units shipped.*

production was ramped up and Osborne I production was ramped down. But the company believed there would be markets for both the Osborne I and the Executive I when the Executive I was announced. And, to show Osborne's readiness to enter the IBM PC-compatible market, news of the Executive II was leaked at the same time.

The announcements, compounded by rumors of a less expensive 80-column, dual-density version of the Osborne I, created a cascade effect. Potential buyers of the Osborne I ended up waiting for the 80-column version, and, instead of IBM terminal emulation, reluctant potential buyers of the Z80-based Executive I wanted the PC-compatible, 8088-based Executive II.

Despite a promise from product manager Hayes that when the Executive I was introduced the new product would immediately arrive in production quantities, production delays lengthened, aggravating the situation. Egil Juliussen, an analyst at Future Computing Inc., a Richardson, Texas, market research company, confirms delayed production of the Executive I, noting, "There was no cash flow [at Osborne] for several months." Sales in April were virtually nonexistent. In the meantime, other manufacturers such as KayPro, Compaq Computer Corp. and Morrow Designs Inc. took the lead in low-end, full-featured personal systems away from Osborne.

As recently as Sept. 6, Osborne was confident and enthusiastic about the Executive II, claimed by Adam Osborne to be the "most compatible" of the IBM PC compatibles. Both Adam Osborne and Jim Schwabe, product manager for the Executive II, say the company had successfully tested as many as 40 MS-DOS programs on the Executive II, including heavily graphics-oriented programs such as Flight Simulator and Lotus 1-2-3.

Recently, Osborne described the future of personal computers as tied to IBM. "An industry standard is emerging that has been forced by IBM," he said. "I think industry standards are to be encouraged every way you know how, and we're going to encourage this one." Unfortunately, the company's own future was doubtful soon after it was committed to PC compatibility.

Whether remaining Osborne engineers can develop the Executive II board in time to compete with other IBM PC-compatible machines and the new wave of lightweight knee-top portables is also in doubt. InfoCorp's Kiefer observes, "Osborne, in cutting expenses, may have cut the R&D budget too quickly [as money began running out in April], which will affect their competitive posture on future

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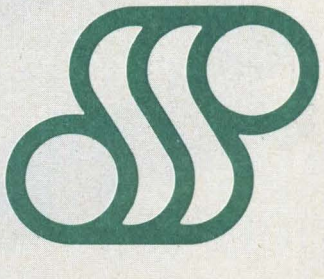

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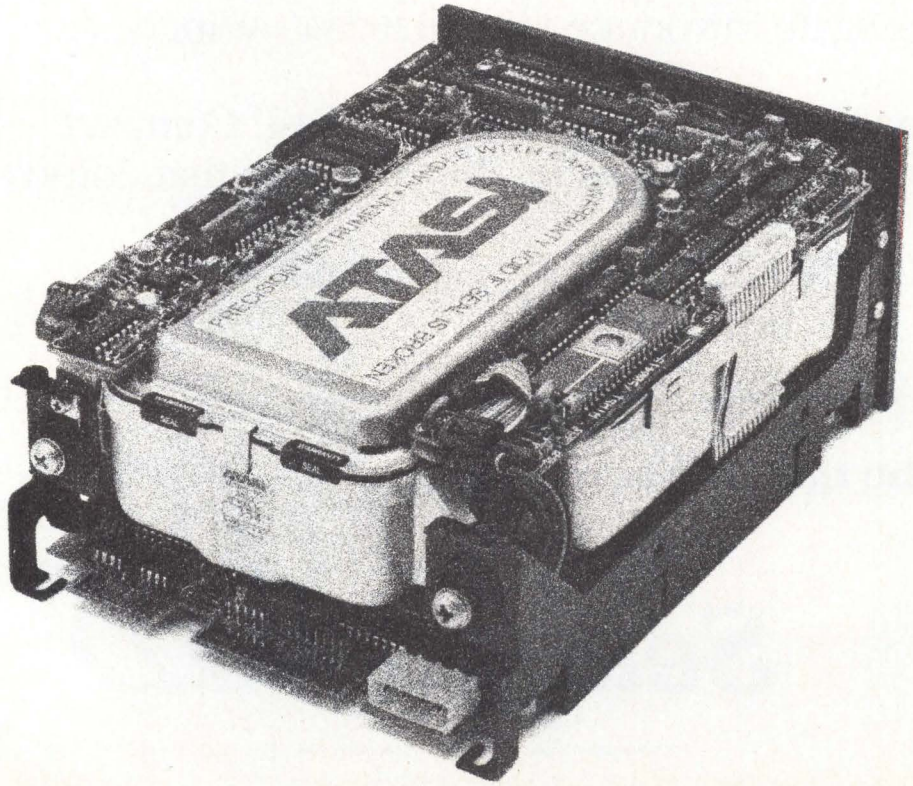

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products." InfoCorp's market projections show that, "after the early dramatic growth, we see the transportable market shrinking because of the increasing power of the Gavilan-, Grid- and Sharp-type lightweight computers," he adds. InfoCorp's figures indicate that annual unit and dollar sales for transportables will decline from 260,000 units and $442 million in 1983 to 150,000 units and $225 million by 1987.

At press time, Osborne was still attempting a comeback. Adam Osborne and Jaunich retain their positions. Financial officer Waite says Osborne has received permission from the bankruptcy court to obtain $600,000 in loans to buy the company more time to make agreements with its creditors and try to find financiers. "We know we've got a difficult row to hoe, but the people here are very upbeat," he comments.

—*Tom Moran*

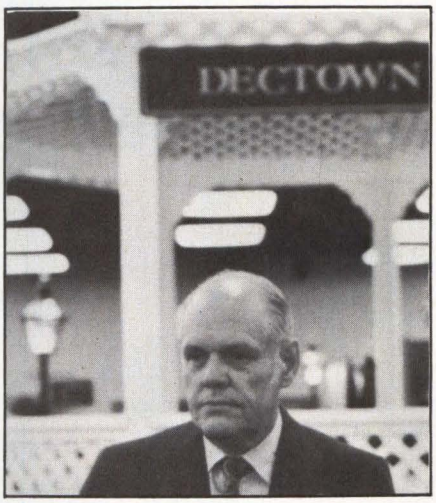
DEC faces fierce competition during critical transition

Digital Equipment Corp., the $4.3 billion leader in minicomputers and second-largest computer maker in the world, until 1981 stated its strongest asset boldly on a fleet of company vans: "We change the way the world thinks." For the first 24 years of its history, DEC's products virtually sold themselves on superior technology and strong software. DEC reigned king in laboratory applications and in most major markets it entered—terminals, superminicomputers and board-level microcomputers.

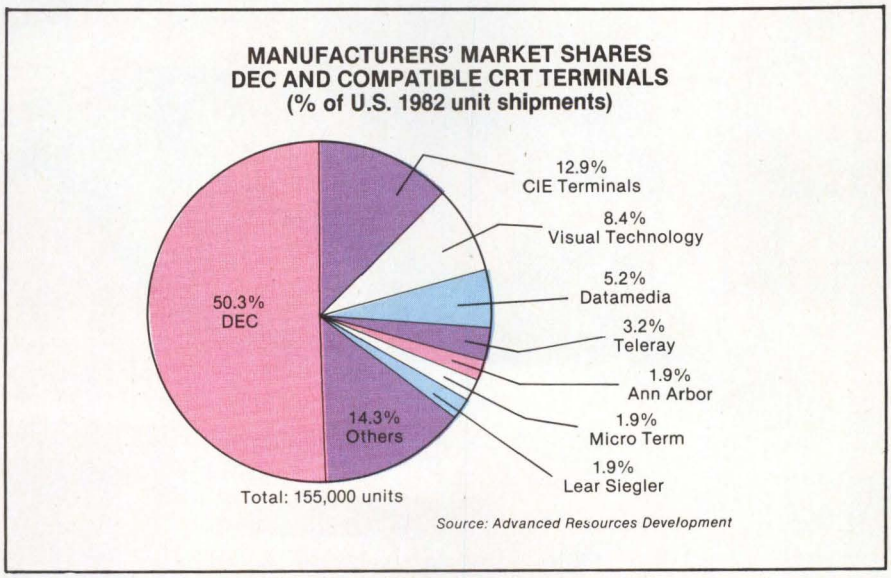
The company's luck has changed. The signal that DEC must change to win big in new markets and stay on top in old ones came in mid-1982 when, probably for the first time, DEC failed to lead in a major new growth market—personal computers. In this market, DEC found that having reliable products is not enough.

Being late with personal computers lacking software didn't help. Attempting to turn on a dime to address this new market, DEC stumbled along over the past year, unsuccessful at gleaning a major market share with its personal computers. Meanwhile, IBM Corp. moved aggressively to command a leading share of that market with about 400,000 hard disk- and floppy disk-based systems expected to have been shipped by year-end, Future Computing Inc. studies show.

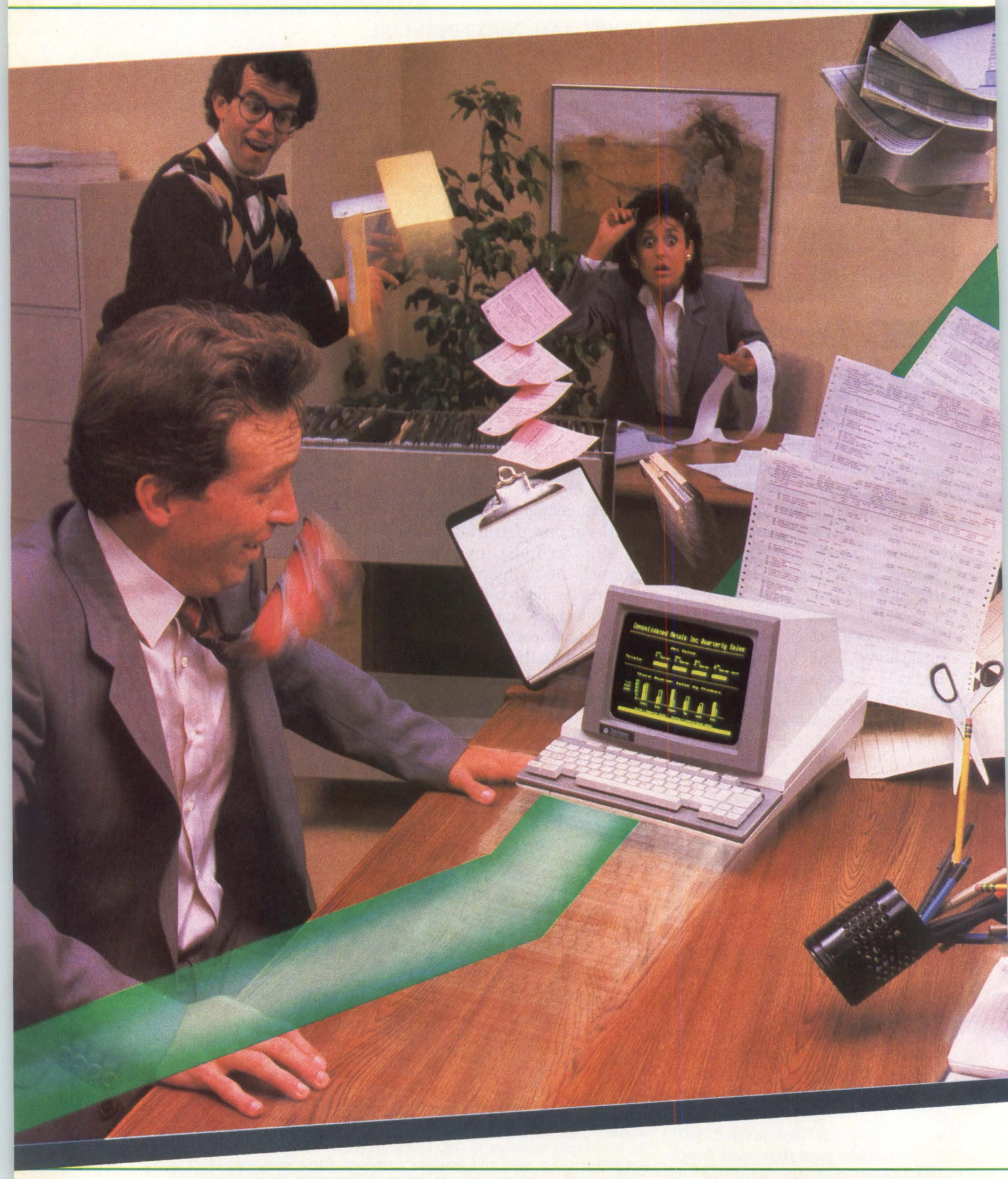
DEC says it shipped 50,000 personal computers in the first six months of manufacturing and hopes to ship 100,000 by year-end. Internal DEC figures show the company estimates the market for small business systems, including its personal computers, VAX and Micro PDP-11 lines—for businesses with less than $100 million in annual sales—at $6.2 billion and growing



All eyes focused on DEC president Ken Olsen *as he faced tough questioning during press day at DECtown, the company's exhibit for its sales staff and customers.*



DEC plans to update its VT100 line with the VT200 series, *which has more features and includes graphics and color models. DEC has a handsome installed base to work from with the forthcoming terminals. In 1982, unit shipments of 155,000 were worth $220 million. Nearly one-half of those were from emulator suppliers, whose combined effect is slowly eroding DEC's market share, according to Advanced Resources Development.*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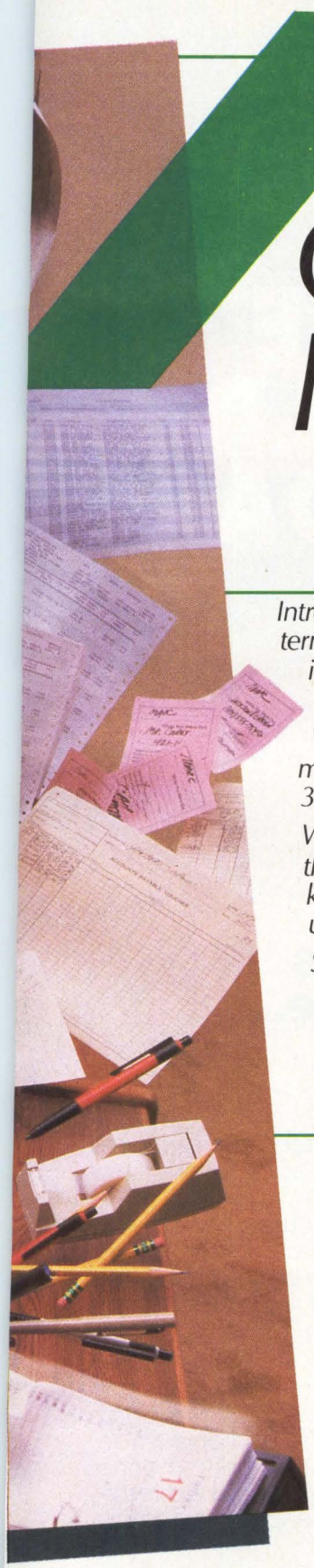

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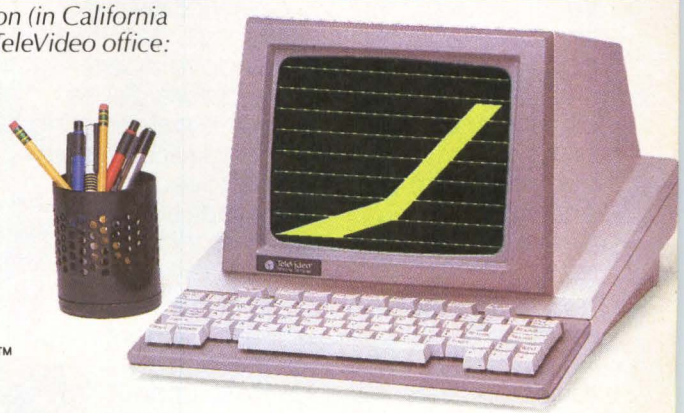

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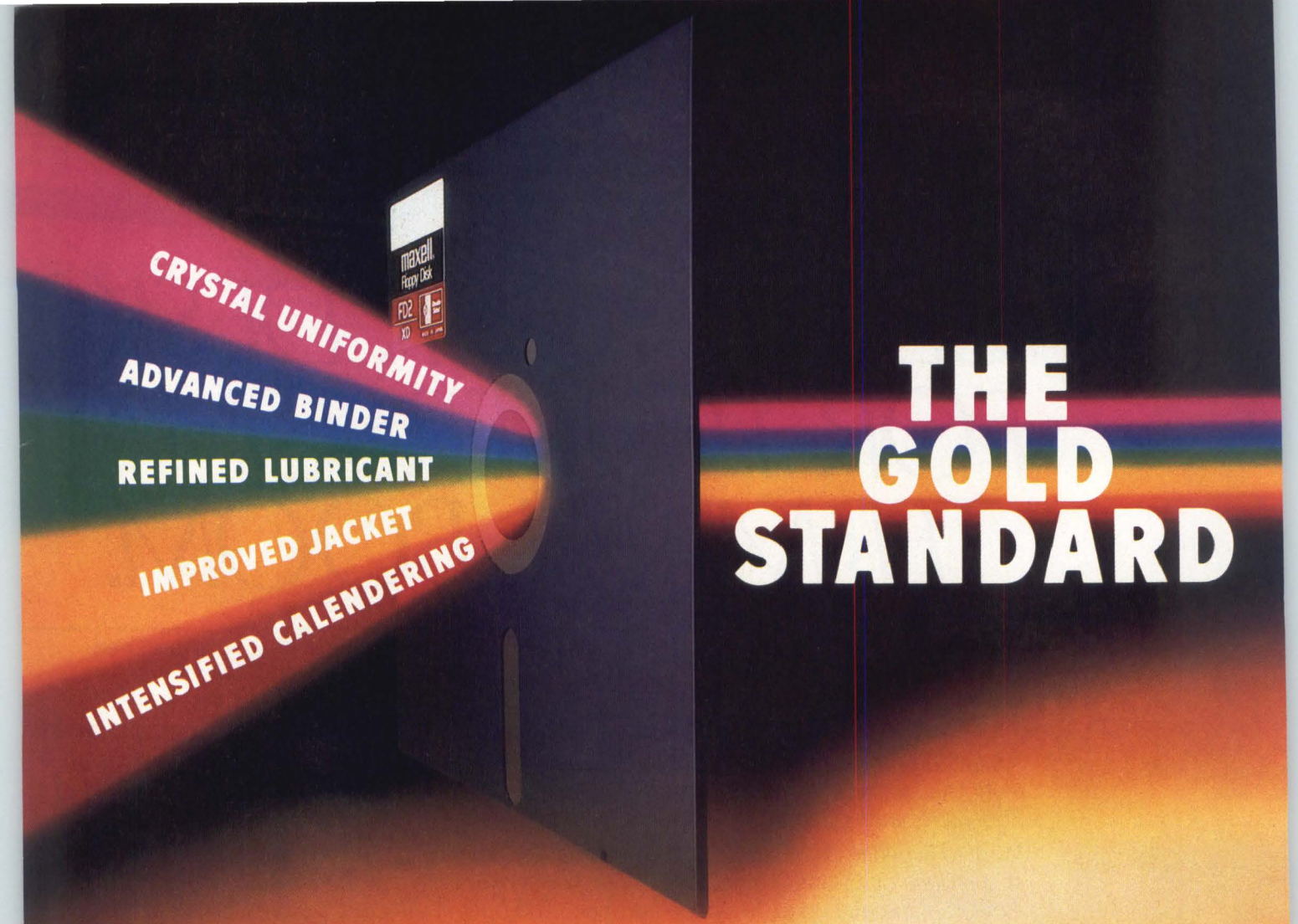
TeleVideo Systems, Inc.

CIRCLE NO. 38 ON INQUIRY CARD



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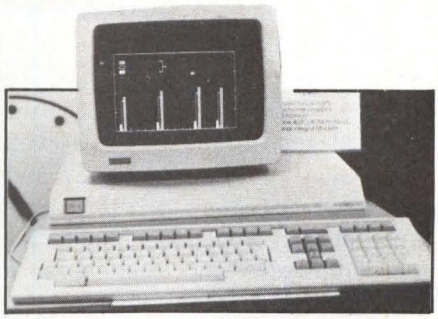
CIRCLE NO. 39 ON INQUIRY CARD

25 to 30 percent annually.

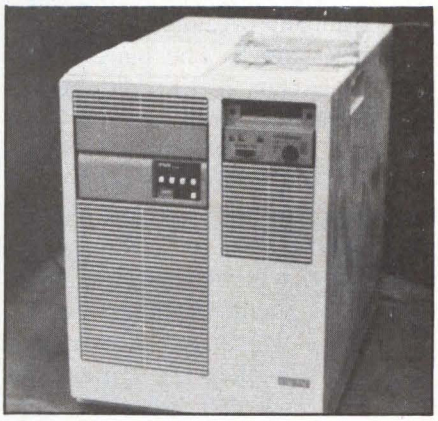
While bidding in the competitive personal computer market for the first time and possibly encountering IBM's might head-on also for the first time, DEC endured other major changes. Its breadwinning industrial markets bowed to recession, and long-term capital equipment projects that previously could tide DEC over poor economies vanished, resulting in worse bottom-line results. New markets meant heavier money commitments to R&D. New technologies and competitors eroded DEC's prices for the first time. A series of key executives and managers quit, beginning with Stan Olsen, brother of DEC president Ken Olsen. About a dozen resignations followed, culminating with the resignations of C. Gordon Bell, the chief technologist, who left to join Encore Computer Corp., a new enterprise formed by ex-Prime Computer Inc. president Kenneth Fisher, and, in early September, Andrew C. Knowles III, the chief marketer (Knowles is credited by insiders with being the catalyst behind the PDP-11 VAX, VT100, semiconductor and other major markets DEC entered). Many of these people joined start-ups, some saying DEC's internal entrepreneurial environment diminished. The company also reorganized several times to better address new markets. The near decade of 30 percent or higher yearly growth ended as DEC posted a 1983 earnings dive of 32 percent.

Compounding the major market, organizational and cultural changes at DEC is the company's lateness with follow-on products for nearly all its major lines.

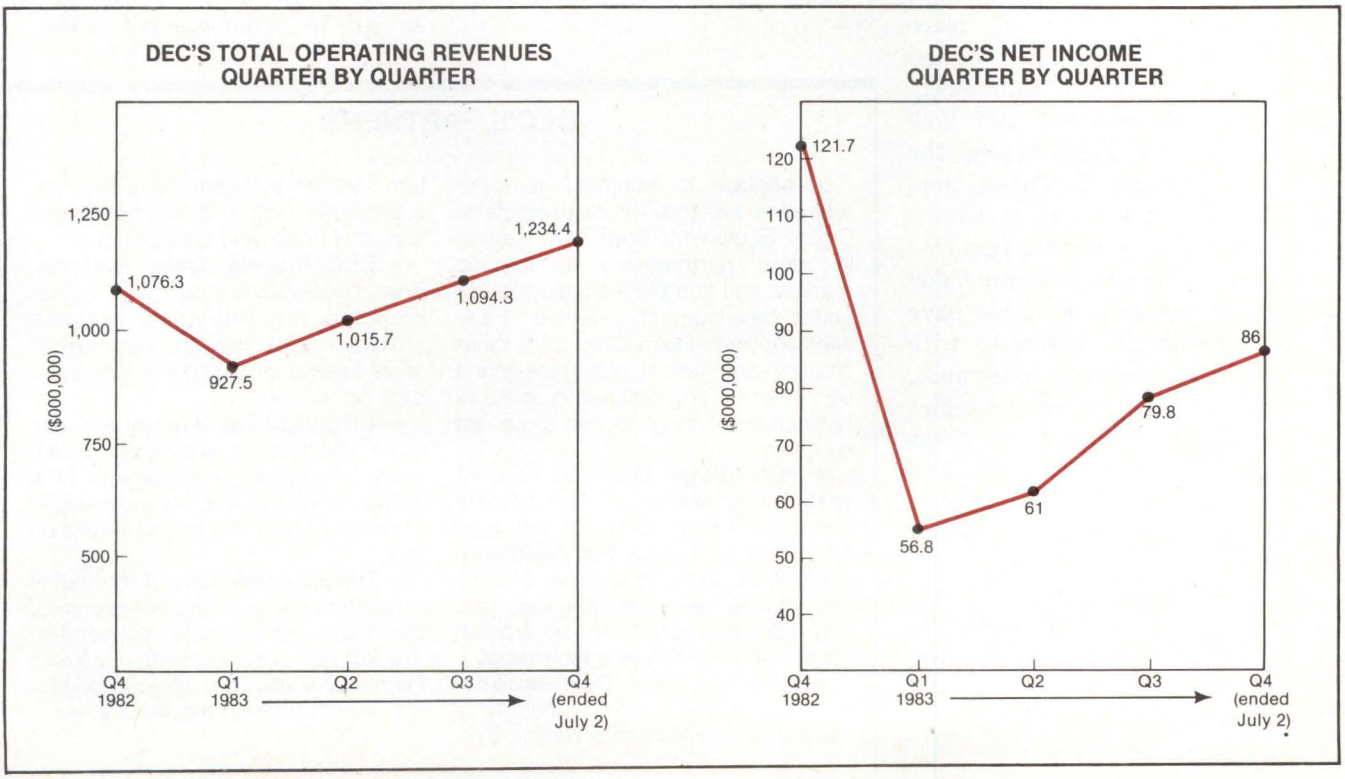
But the Maynard, Mass., giant appears to be laying the groundwork for a strong rebuttal in 1984. In late August, the company rented the 60,000-square-foot Hynes Auditorium in Boston to stage a one-and-one-half- week gathering of



The forthcoming VT200 family *includes the VT240, which has the functions of a VT100 terminal, plus a printer port, advanced video, 15 programmable function keys, monochrome graphics and ReGIS and Tektronix 4010/4014 protocols.*



DEC's VAX-11/725 *is positioned as a standalone system that is about 40 percent smaller than the 11/730.*



its worldwide sales force. About 7,000 salespeople showed up, as well as families of DEC employees and preferred customers. DECtown was an exhibition of DEC equipment for DEC employees and customers, a show of the company's current and future strategies in mimic office, hospital, educational and other application settings.

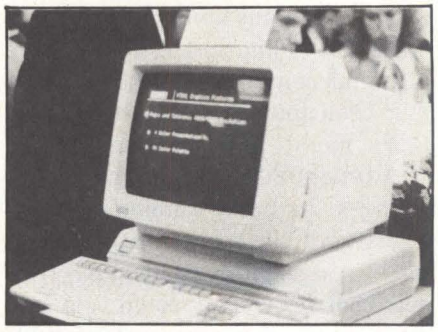
"This DECtown extravaganza is to tell [our] goals to the salesmen," says company president Olsen. "All strategies are in one place." In a one-day session at the show, DEC let Wall Street analysts and the press go on an Easter egg hunt throughout the exhibit floor; about 10 new products stood among old-timers in the booths. These included the low-end VAX-11/725, which is about 40 percent smaller than the VAX-11/730, three VT200 series terminals, intended to replace the aging VT100 line, two new disk drives, a hard disk version of the Rainbow called the 100 Plus, the Rainbow 100 with more memory.

The hoopla, which took place after nearly a year's "quiet" period at DEC, helped smooth communication gaps between DEC and Wall Street analysts. Just before the meeting, Frederic H. Cohen, analyst for L.F. Rothschild, Unterberg, Towbin, New York, removed DEC's stock from his recommended list. "The upshot is that we have grown increasingly frustrated with the current operating performance, unclear about long-term strategies and hence less confident about our estimates for fiscal 1984 and beyond," he states.

Despite DEC's uncharacteristic openness at DECtown, many analysts still voice concern about whether DEC is out of the thick of its financial and product dilemmas. "There was no immediate news [at DECtown] to suggest that the severe margin pressures would abate near term," reports Shearson/American Express analyst Donald Brown. "New products falling into place through next summer suggest the potential for a strong 1985 fiscal year."

It's clear from DECtown and Olsen's comments during the event that DEC's strategies hinge on very-large-scale-integration (VLSI) technologies in the product lines, personal computers and interconnecting different system products.

Olsen acknowledges DEC doesn't dominate the personal computer market but says the company is not giving up. "Every time we introduced a product, it appeared we were the last ones," he says. "For example, 16-bit computers. We waited and did it right," he claims. "We'll tolerate all the criticism until we come out with something really good," he emphasizes. Olsen believes the personal computers picked by OEMs will be of the highest industrial quality, and that's his goal for DEC's personal computers.



The VT241 color terminal *does not have the profile of the Rainbow microcomputer but does include RGB output to drive a color projection system.*

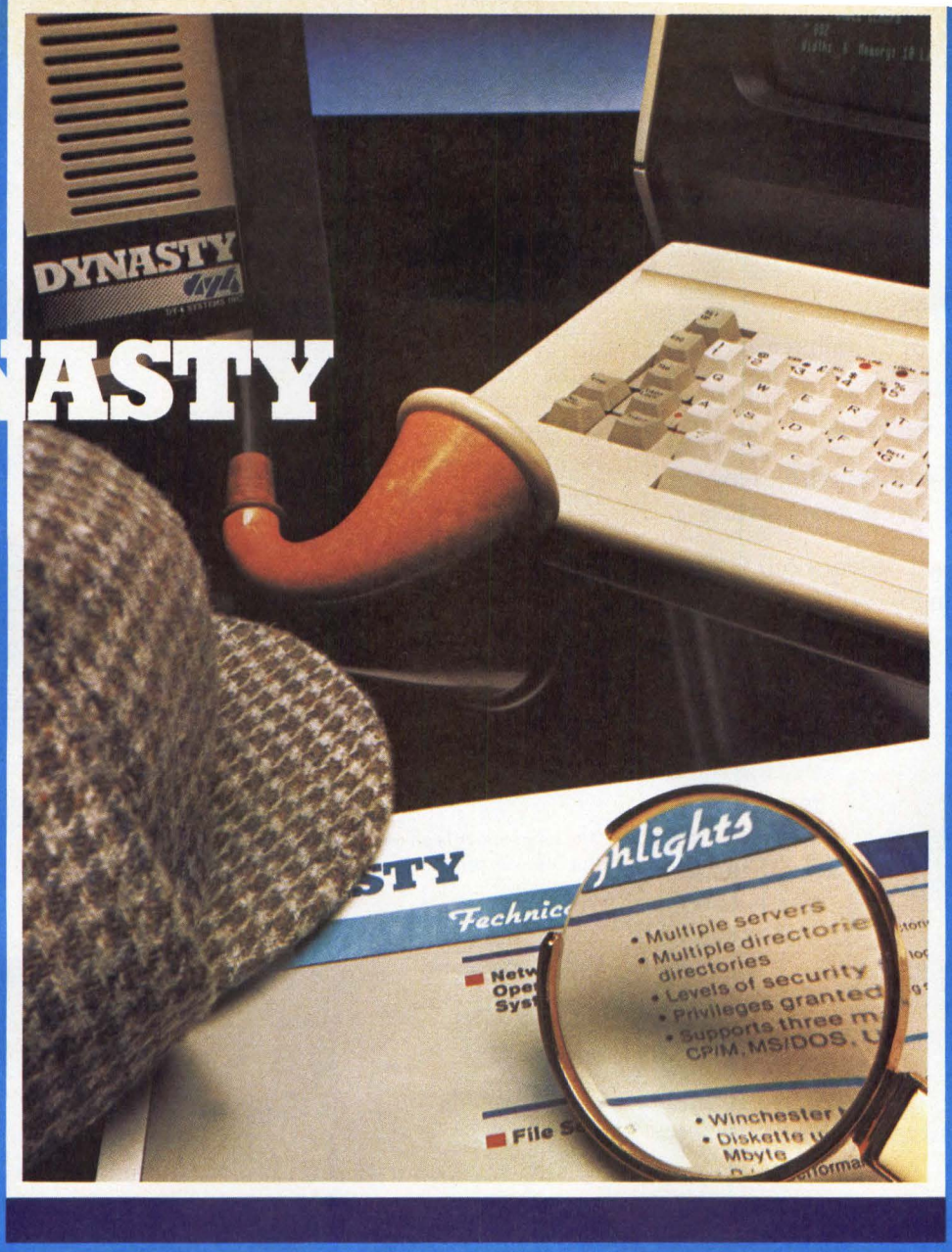
Some analysts have criticized DEC's not differentiating between its terminal and personal computer lines. The Rainbow, for example, was an outgrowth of the VT100 terminal line. The analysts hint DEC should spin off personal computers into a separate division. "We may separate personal computers into a division for organization," acknowledges Olsen. "But I do see terminals and personal computers together. It's never clear which does the job." He will not split the sales force or go to commissioned sales.

DEC'S PARTNERS

In addition to adopting standard operating systems for its computers, Digital Equipment Corp. is engaging in more partnerships to expand markets and bring in technologies not under development in-house. Early alliances with Rolm Corp., Northern Telecom and Xerox Corp. embellished DEC's networking options. A spate of partnerships have occurred since last summer:

- **DEC/Trilogy Ltd.** DEC has invested $26 million for a 9 percent interest in Trilogy. In return, DEC gets an option to license the company's wafer scale semiconductor and possibly devote part of a new DEC manufacturing plant to a product stemming from Trilogy's technology.
- **DEC/Scientific Calculations.** Both companies will cooperatively market Micro-Electronics Design System (MEDS) software on DEC's VAX superminis. MEDS is for automated layout of integrated circuits (ICs).
- **DEC/Phoenix Data Systems.** This cooperative marketing agreement is for Phoenix's MASKAP software that verifies very-large-scale-integration (VLSI) mask sets and runs on the VAX.
- **DEC/VLSI Technology Inc.** Another cooperative marketing agreement to promote components of a graphics system for computer-aided IC design. Again, the software runs on VAX.
- **DEC/Ramtek.** One of the earlier arrangements in computer graphics, the DEC and Ramtek cooperative marketing agreement covers Ramtek's MARQUIS graphics workstation, which runs on the VAX.

DYNASTY



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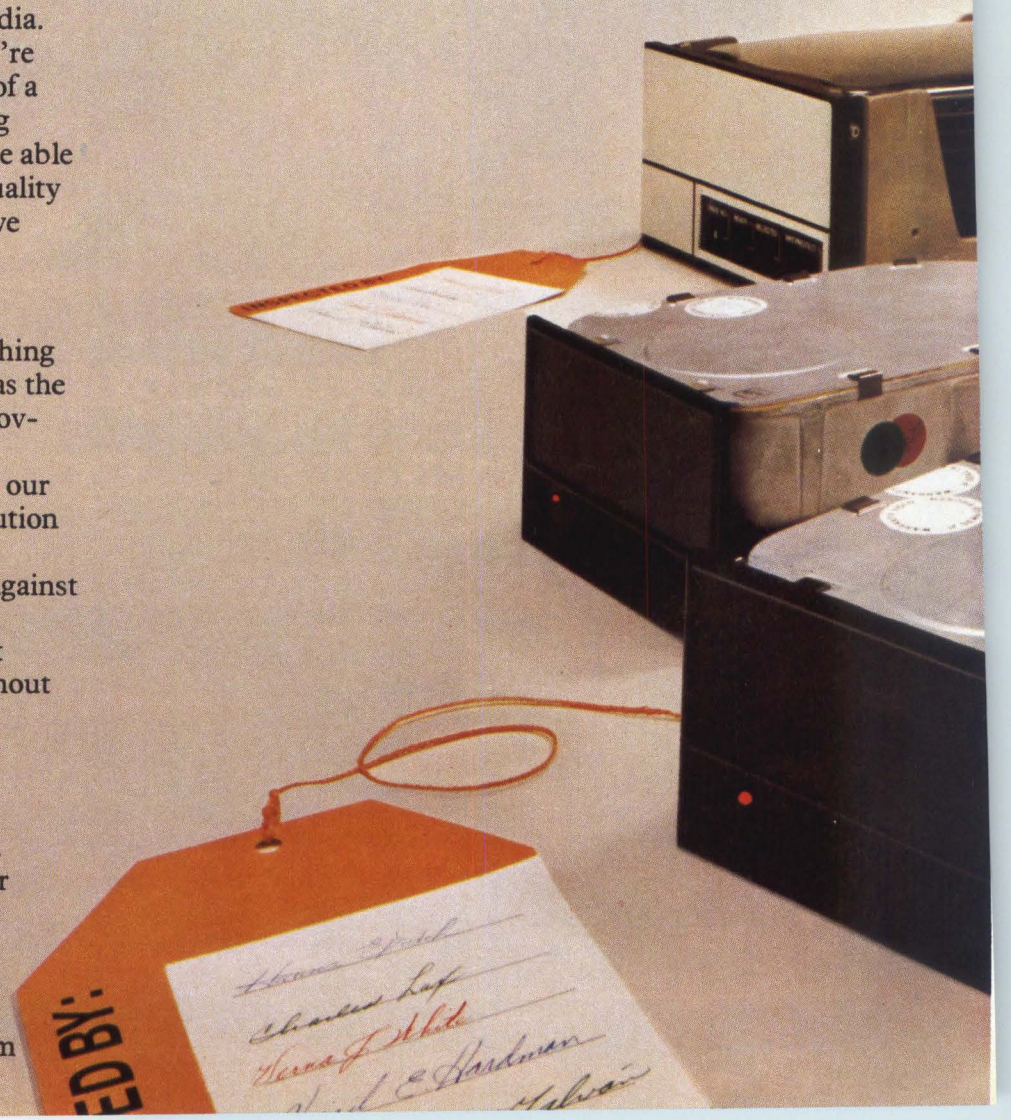
	D-507	**D-514**	**D-519**	**D-526**	**D-720**	**D-740**	**D-760**	**DP-100**
Capacity								
Unformatted								
Per drive (MBytes)	6.38	12.75	19.13	25.5	26.9	44.9	62.7	11.6
Per surface (MBytes)	3.18	3.18	3.18	3.18	8.95	8.95	8.95	5.8
Per track (Bytes)	10,417	10,417	10,417	10,417	10,416	10,416	10,416	13.440
Formatted								
Per drive (MBytes)	5.01	10.02	15.04	20.04	21.1	35.2	49.3	10.6
Per surface (MBytes)	2.51	2.51	2.51	2.51	7.045	7.045	7.045	5.3
Access time								
Average (msec)	80	80	80	80	35	35	35	60
Maximum (msec)	230	230	230	230	85	85	85	110
Discs	1	2	3	4	2	3	4	1
Recording surfaces	2	4	6	8	3	5	7	2

The chart above is an overview of the Disctron product line.



drives this month but... one drive at a time."

	8"		
	DP-400	D-1100	D-1600
	46.4	121.9	157.5
	11.6	17.4	22.9
	13,440	13,440	20,160
	42.4	111.5	SMD
	10.6	15.9	20.9
	60	35	30
	150	60	60
	3	4	4
	4	7	7

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William L. Morgan
President

CORPORATE AND FINANCIAL

The sales force at DEC, after the series of reorganizations, has come under the control of John Shields, vice president of field operations. Shields came from field service, which he still controls, and is considered one of Olsen's two chief lieutenants. He represents perhaps the most dramatic personnel shift at DEC recently. Insiders say Shields is very aggressive. He built the field-service operations strongly and developed loyalty among his troops. Despite analysts questioning why a field-service person would control sales, Olsen believes Shields' background in field service is a strong asset. "He sets responsibility clearly to measure people," notes Olsen. "Job allocations and measurements are very important in sales," he adds.

Additional changes from the reorganization include consolidating operations of the 12 U.S. "entrepreneurial" product groups into three regional management centers, leaving the product groups with only marketing duties. Formerly, product line managers were responsible for marketing and parceling out annual budgets to manufacturing and sales for the future six quarters. Marketing is a weakness analysts say DEC must correct, especially with the company's focus on major accounts sales encompassing all product lines. "I also criticize the marketing of the company," says Olsen. "We try so hard to present products in a technical, honest way. Sometimes, we're tedious in our approach. We still have a way to go," he admits.

—Lori Valigra

DIGITAL EQUIPMENT CORP. 12-YEAR FINANCIAL SUMMARY

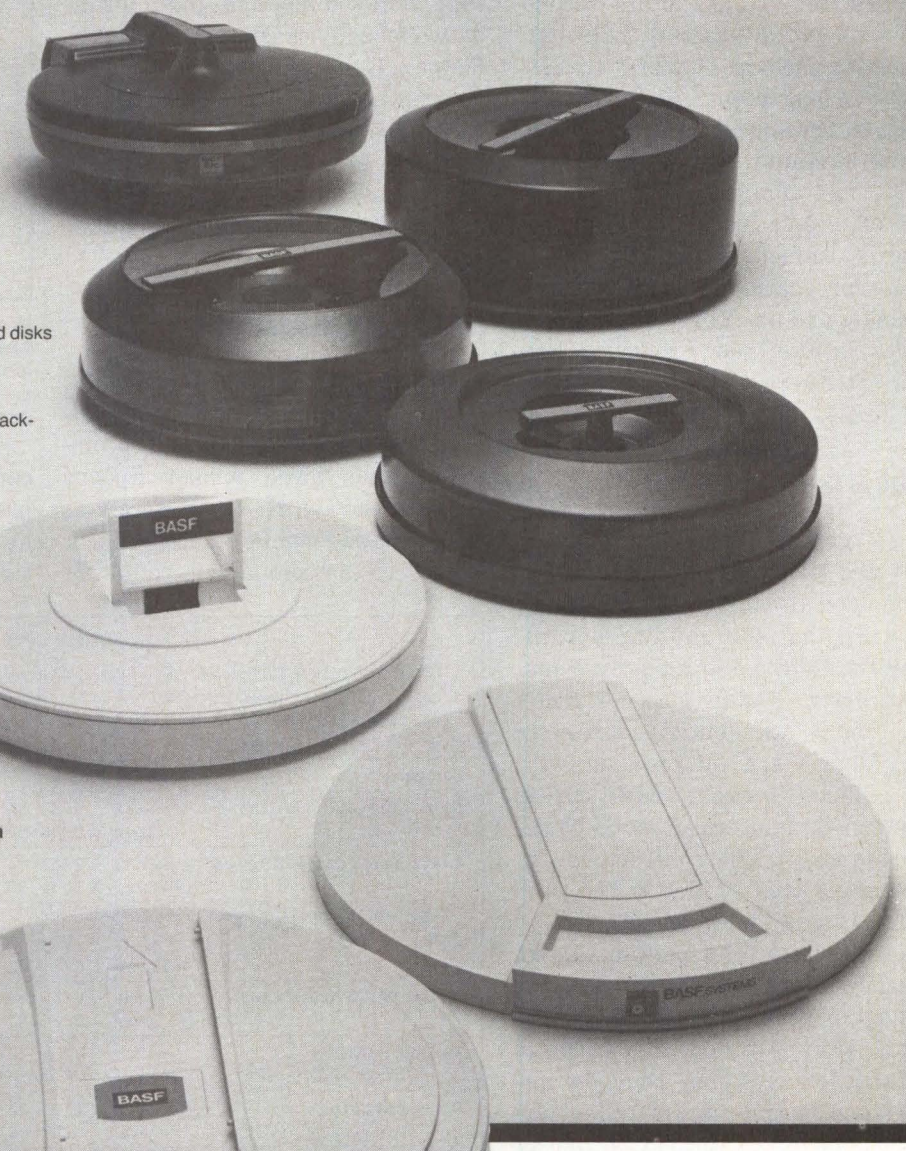
	Equipment sales revenues ($ millions)	Service and other revenues ($ millions)	Total operating revenues ($ millions)	Net income ($ millions)	Net income per share ($)
1983	2,867.4	1,404.4	4,271.6	283.6	5.00
1982	2,793.7	1,087.1	3,880.8	417.2	7.53
1981	2,384.2	813.9	3,198.1	343.3	6.70
1980	1,779.4	588.6	2,368	249.9	5.45
1979	1,381.8	422.3	1,804.1	178.4	4.10
1978	1,128.1	308.5	1,436.6	142.2	3.40
1977	847.5	211.1	1,058.6	108.5	2.78
1976	586.6	149.6	736.3	73.4	1.98
1975	433.2	100.6	533.8	46	1.28
1974	360.8	61.1	421.9	44.4	1.27
1973	229.1	36.4	265.5	23.5	.72
1972	166.3	21.3	187.6	15.3	.50

Source: Digital Equipment Corp.

FORTHCOMING PRODUCTS AND RECENT ANNOUNCEMENTS FROM DEC—AT A GLANCE

- VT200 series: VT200, VT240, VT241(expected by year-end)
  - VT220: VT100 functionality, printer port, advanced video, 15 programmable function keys, advanced ease-of-use features
  - VT240: VT220 functionality plus monochrome graphics, REGIS protocol, Tektronix 4010/4014 protocol, optional integrated modem
  - VT241: VT240 functionality plus color and RGB output to drive a color projection system. Has nine- or 25-pin EIA or 20-MA current-loop interfaces
  - The products include a new keyboard. They will replace the VT100 series products, although DEC will continue supporting VT100s
- RD series 10M-byte, 5¼-inch Winchester disk drives: RD51A, RCD51-AA/AE, RCD51-CA
  - RD51A: for Micro PDP-11, announced May 1983, available now
  - RCD51-AA/AE: for Pro 350; storage subsystem with disk drive, announced June 1983, available now
  - RCD51-CA: for DECMate II; storage subsystem with disk drive, controller, diagnostic software, announced August 1983, available second quarter, 1984
- DECtalk "talking" typewriter
- VAX series
  - VAX-11/725 VMS compatible, repackaged 11/730 that's about 40 percent smaller, closed system regarding add-ons, 26M bytes fixed/26M bytes removable Winchester disk storage, 3M bytes maximum memory, Ethernet
  - DEC president Ken Olsen alluded to five VAXs to be released over the next two years: Micro VAX/1, due in October, a VAX with a floating-point processor, a larger VAX and two high-end VAXs
- Personal computers
  - Professional 350 upgrade: doubled main memory to 512K bytes, added floating-point functions as standard, added a 10M-byte hard disk drive, improved performance 25 percent (announced)
  - Rainbow: MS-DOS support added, price cut of 40 percent for the Rainbow's 192K-byte RAM option. More than 700 application packages are available (announced)
  - Tool Kit available for third-party software developers for the Professional 350 (announced)
  - Rainbow new 100 and 100 Plus: new 100 comes with double the main memory, or 128K bytes, and is expandable to 896K bytes rather than 256K bytes on the earlier model. The power supply is larger, mainly to accommodate the 10M-byte Winchester disk for the Rainbow 100 Plus (expected in late September)
  - Higher performance office-automation product expected next year.

LEADER OF THE PACK



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For DEC: 100 and 200 MB 12-high packs, front-load single disk cartridges, 80 and 300 MB storage modules.
For Honeywell: Phoenix single disk cartridges, 80 and 300 MB storage modules, 100 MB packs.
For IBM: 100 and 200 MB 12-high packs, top and front-load single disk cartridges.
For Wang: Phoenix single disk cartridges, 80 and 300 MB storage modules, top-load single disk cartridges.

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CORPORATE AND FINANCIAL

Financings

Atasi Corp., San Jose, Calif., grabbed $21 million in its second round of venture-capital financing. Investors include Citicorp Investment Management and General Electric Pension Trust.

Businessland Inc., San Jose, Calif., has arranged a $25 million line of credit with the Bank of America to facilitate Businessland's plans for nationwide expansion. Businessland has 13 retail computer stores in the San Francisco Bay area, Southern California, Arizona and Texas.

Wet ink

In a contract valued at $3 million, **Drivetec Inc.**, San Jose, Calif., has committed to supply its 3.3M-byte, 5¼-inch, half-height SuperMini-floppy disk drives to Rana Systems, Chatsworth, Calif. The contract's duration is 18 months....**Kennedy Co.**, Monrovia, Calif., has signed a $1 million contract with Great Western Computers, Rancho Cucamonga, Calif. The contract covers Kennedy 8- and 14-inch Winchester disk drives and a nine-track magnetic-tape transporter....**MAI Canada Ltd.**, a subsidiary of Management Assistance Inc., New York, will provide Basic Four Information Systems Division microcomputer and minicomputer systems and support to the Century 21 real estate franchise network in Canada. The contract covers at least 150 Century 21 offices and is valued at $1.5 million to $4 million.... Mouse Systems Corp., Santa Clara, Calif., will supply mice to be used with VisiCorp's Visi[on] decision-support software for microcomputers. The Mouse Systems device is an optical mouse that tracks motion by counting lines. More typical mechanical mice sense motion by the use of a metal ball underneath the mouse. List price of the mouse is $249....In a four-year, $20 million contract, **Paradyne Corp.** will supply 12,000 modems and multiple network-analysis controllers to J.C. Penney Co. Inc....The U.S. Army Communications and Electronics Command (CECOM), has awarded **SofTech Microsystems Inc.**, Waltham, Mass., a $3.8 million contract to provide maintenance for the Ada Language System.

Industry monitor

MicroPro International Corp., producer of the WordStar word-processing package for microcomputers, has hired former Sperry Corp. executive **H. Glen Haney** as president and chief executive officer "to direct the company in rapid but controlled growth." Haney was vice president of business strategy and new markets for the Sperry Computer Systems division.

H. Glen Haney, former Sperry Corp. executive, *has been hired by MicroPro International Corp. as president and chief executive officer. He is expected to lead the company in "rapid but controlled growth."*

BOX SCORE OF EARNINGS

This monthly table lists the revenues, net earnings and earnings per share in the periods indicated for companies in the computer and computer-related industries. Parentheses denote losses. Comments are from corporate summaries unless otherwise noted.

Company	Period		Revenues	Earnings	EpS
Altos Computer Systems	year	6/25/83	$74,587,000	$7,921,000	.58
	year	6/26/82	$50,957,000	5,708,000	.50
Avant-Garde Computing Inc.	3 mos.	7/31/83	3,033,000	199,000	.07
	3 mos.	7/31/82	1,338,000	85,000	.03
Centronics Data Computer Corp.	6 mos.	7/3/83	88,368,000	641,000	.06
	6 mos.	6/27/82	55,994,000	(13,686,000)	(2.19)
Cipher Data Products Inc.	year	6/30/83	76,429,000	5,161,000	.50
	year	6/30/82	55,124,000	2,236,000	.30
Cullinet Software	3 mos.	7/31/83	25,798,000	3,641,000	.24
	3 mos.	7/31/82	16,137,000	2,373,000	.17
Datapoint Corp.	year	7/31/83	540,192,000	8,077,000	.40
	year	7/31/82	508,486,000	2,405,000	.12
Masstor Systems Corp.	6 mos.	7/3/83	10,836,000	(1,689,000)	(.18)
	6 mos.	7/4/82	9,011,000	528,000	.06
Rexon Inc.	9 mos.	7/3/83	10,136,000	(66,000)	(.03)
	9 mos.	7/4/82	7,789,000	(241,000)	(.14)
Tandy Corp.	year	6/30/83	2,513,297,000	278,521,000	2.67
	year	6/30/82	2,061,212,000	224,085,000	2.17

Comments: Centronics Data Computer Corp. revenues for the second quarter grew to $44.6 million from $29.7 million in the same period a year earlier. The company showed a net income of $357,000, or 4 cents per share as opposed to a loss of $3.1 million, or $1.86 per share, a year earlier. Centronics said it reduced inventories (by $4 million), bank borrowings (by $8.5 million) and expenses during the quarter.

Datapoint Corp. said its domestic markets for office and computer products were up strongly in the fourth quarter, but international orders remained sluggish. Datapoint's fourth-quarter revenues were $137.5 million, compared to $140.8 million a year earlier. Net earnings were up to $4.3 million, or 21 cents per share from $3.3 million, or 16 cents per share in the fourth quarter of fiscal year 1982.

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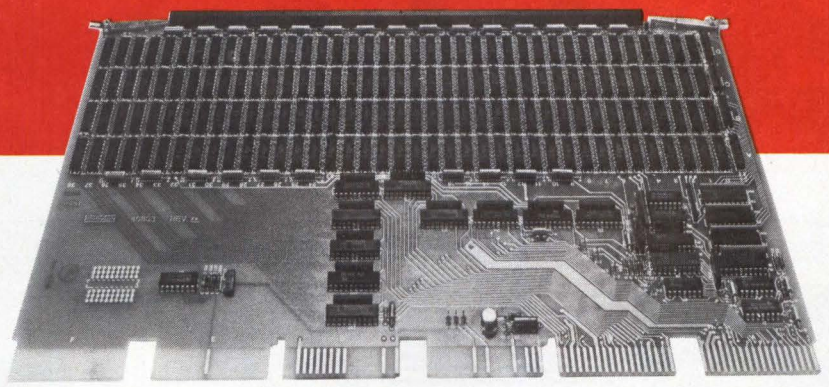

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PDP-11	DR-214	hex	1.0 MB
PDP-11	DR-144	hex	256 KB
PDP-11	DR-244	hex	1.0 MB
VAX®-11/750 PDP-11/70	DR-175	hex	256 KB
VAX-11/750 VAX-11/730	DR-275	hex	1.0 MB
VAX-11/780	DR-178	extended hex	512 KB
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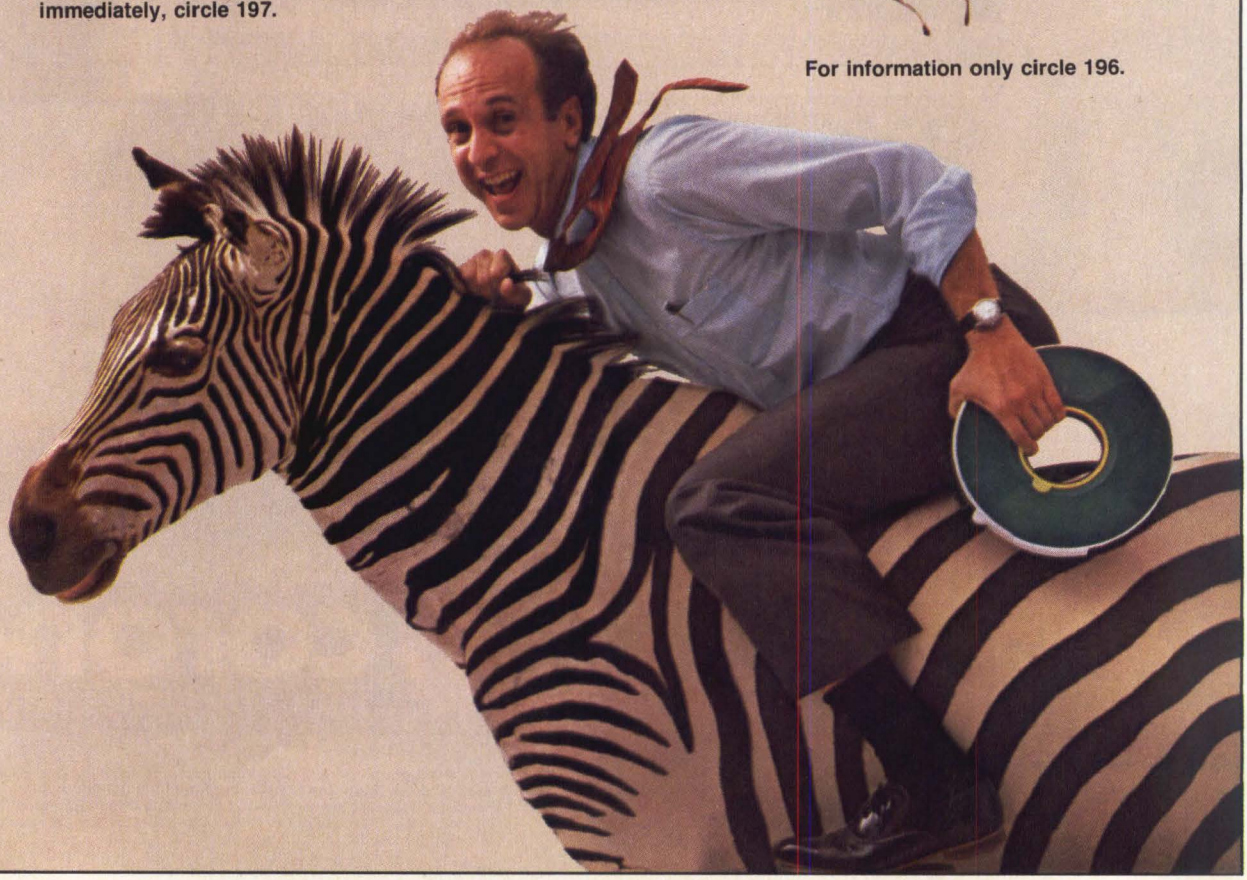

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Processor-independent STE bus standard expected from IEEE

By early next year, the P1000 working group of the IEEE's microprocessor standards committee may approve STE, a proposed 8-bit bus standard competing with the STD bus and said to offer complete microprocessor independence. STE, which will be conceptually like an 8-bit high-speed input-output channel, will use the Eurocard form factor, as does the IEEE 32-bit Futurebus and Motorola Inc.'s 16-bit VME bus. The STD specification, which may also soon be approved by the IEEE, is already widely used, particularly in Z80- and 8085-based control applications.

Bill Shields, chairman of the P1000 group and president of Seaport Computer Systems, a San Diego design consulting company, hopes that IEEE will publish STE early in 1984, following approval by the P1000. He explains that the most fundamental difference between STE and STD is that STE uses an asynchronous rather than synchronous data-transfer protocol. STE also allows direct addressing of 1M byte of main memory, compared to STD's maximum of 64K bytes. Like the Eurocard, the STE uses the Deutsches Institut für Normung (DIN) 41612 two-part edge connector. Another STE feature, aimed at complete processor independence, is the assignment of exactly the same signals on every pin, regardless of the microprocessor attached to the bus. The STD specification calls for four unassigned pins.

Although no major computer manufacturers plan to use the STE bus, Shields insists many people are anxiously awaiting a Eurocard-based bus standard. They include other consulting companies, laboratories, government and military users and some small manufacturers of STD-based systems.

The STE's asynchronous protocol allows for speed differences between different boards, such as a high-speed microprocessor (master) board and a slower memory board on the bus, explains Tim Elsmore, European secretary of the P1000 group. Thus, microprocessor independence is further enhanced.

In the STD camp is Matt Biewer, chairman of the IEEE P961 group preparing a separate STD standard proposal and vice president of Pro-Log Corp., Monterey, Calif., a manufacturer of STD-based boards for control applications. He argues that STD's synchronous protocol provides a wait state for speed differences, although the delay may be longer because of the STD's fixed length of the wait states' time intervals. Biewer also points to the added complexity of STE's asynchronous protocol, a fact that Elsmore acknowledges.

Shields notes that STE's direct addressing of 1M byte of main memory helps accommodate 16-bit microprocessors. Although Biewer admits STD is limited to 64K bytes unless memory-extension boards are used, he believes the problem is eliminated if the Intel 8088 is used. This is because the 8088 can multiplex 2 bytes. He also admits that using the MC68000 series chips, however, could present a problem.

Biewer admits STE could beat STD in the European market, where Eurocard is favored. He acknowledges that Europeans do not like the edge connectors of the STD bus, preferring instead the more expensive but more reliable DIN 41612 two-part connector.

Biewer acknowledges the four unassigned pins in the STD specification allow for the unique signals generated by peripheral control of some microprocessors. For example, he points out, Zilog Z80 peripheral cards generate signals incompatible with master boards without Z80 processors. As a result, a board manufacturer may have to specify compatibility with only a subset of STD such as STD Z80 or STD 8085 (for the Intel 8085).

Elsmore claims that STE users can directly swap a master board on an STE system with any other master without changing any other boards. However, this level of processor independence means incorporating signal-modification logic on STE boards, on which space is at

COMPARISON OF STD AND STE BUSES

	STD	STE
Data-transfer protocol	Synchronous	Asynchronous
Main memory addressing (bytes)	64K	1M
Connector	Edge	2 part
Pin signal assignment	4 unassigned pins	All pins assigned
Size (inches)	6.5 × 4.5	6.3 × 3.94

OVERHEAD OVERSEAS

By Maureen O'Gara
Contributing Editor, West Germany

Ericsson prepares major personal computer push

L.M. Ericsson, the multibillion-dollar Swedish telecommunications and computer company, is planning its first major assault on the personal computer market, using West Germany as a launchpad. The giant firm could muster the talent and resources to do a creditable job in its desire to grow in integrated office systems. If successful in Germany, Ericsson may expand to the rest of Europe and to the United States.

However, Ericsson is not a mainstream (United Kingdom, Germany, France) European company. The obstacles it must overcome to address the European market are similar to those faced by U.S. companies entering Europe.

Since Ericsson is not part of the European mainstream, it has no special hold on markets.

Ericsson has done some homework and decided personal computers are where it wants to be. It's also decided there are two markets worth fighting for: the United States and Germany. Ericsson thinks so much of America that it's transferring the president of its computer subsidiary, Ericsson Information Systems, Sweden, where he had worldwide responsibilities, to the United States, where he will handle only the stateside operation.

The other market in the major leagues is Germany. All the players are in Germany: American, German and other European companies are represented. It is the largest, most competitive, most performance-oriented and most technically sophisticated of the European markets, Ericsson believes. That's why it was chosen as Ericsson's testing ground. "If it can survive in Germany, it can survive anywhere in Europe," according to Ulrich Giesen, Ericsson Information Systems GmbH's dealer organization manager.

Ericsson's research indicates the German market is worth 100,000 machines a year, with 80 to 90 percent sold to small companies. The bigger companies, those with 1,500 employees or more, are buying the rest. Ericsson's forecasts indicate that when the market grows to 400,000 personal computers a year in 1986-1987, as many as two-thirds of the machines will be sold to big companies.

Giesen's studies show there is no market for personal computers among German businesses employing 50 to 1,500 people. That is minicomputer turf for the immediate future,

To Ericsson, the findings mean product differentiation. Personal computers have to be IBM-like to some degree, it knows, because IBM Corp. sets the pace. Big companies, however require more bells and whistles than do small buyers because they will use the PC as a terminal or workstation requiring mainframe communications, videotex implementation, teletext hookup, etc.

Ericsson, facing the problem so many others have, can't muster complete IBM compatibility right away. Last month, it introduced what it terms a "somewhat compatible" MS-DOS box called Step One that is priced 10 percent under the IBM PC. Coming up next year are additions to the family that will increase its compatibility. But it would be fool's play, Ericsson reasons, to take IBM on head to head.

Its future boxes will have to offer more bang for the buck than do IBM's. The additions planned for the second quarter of 1984 aren't priced yet. Both will be MS-DOS-based, one about IBM's equivalent, the other four times faster. All three units, though aimed at different market segments, will be sold through dealers.

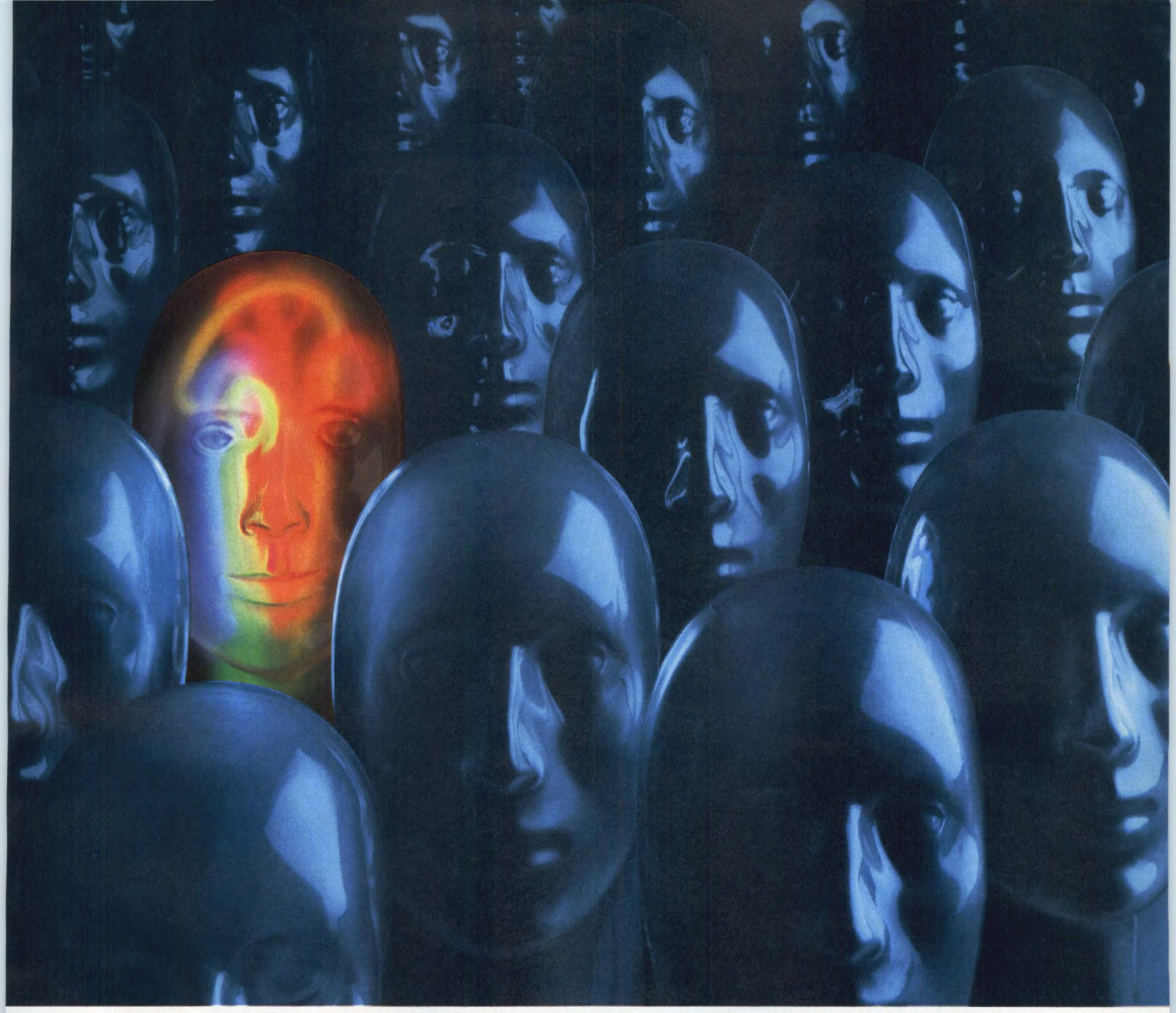
Ericsson's research shows that all but the top 10 dealers in the German personal computer business are losing their shirts.

Normally, Ericsson says, a German dealer isn't selling more than 20 boxes a year. But the dealers haven't established themselves in tight vertical markets. Based on long-standing tradition, they service the local community where they probably grew up and are known and respected. One month, they sell a system to the butcher, the next month to the baker, the next to the dentist and so on. With typical systems going for 15,000 Dmarks, the average dealer, Ericsson says, is making 60,000 to 80,000 Dmarks a year (roughly $23,000 to $30,000) gross profit, a figure that can't pay for hiring salesmen, training customers, providing support and investing in software.

After considering these data, Ericsson concluded what is needed is a different sales strategy.

Suppose, Ericsson said, it were to set up a string of Ericsson Support Centers around the country to develop vertical software, train customers and do support. Ericsson would tap for these centers some of the independent software companies and system houses struggling to make a living. They wouldn't come out of Ericsson's budget. These independent companies would be transformed and dedicated to the Ericsson product line. Each center would make part of its income supplying five to eight small independent dealers. The centers would supply the dealers with software and more or less "force" the dealer into vertical marketing.

Ericsson figures IBM will eventually command a 30 to 40 percent share of the European personal computer market. It's setting its sights on 10 to 15 percent for itself.



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a premium. He also recognizes the need for the logic to be implemented in compact low-cost circuitry such as programmable logic devices. Not surprisingly, Biewer also emphasizes STE's size problems, noting that its single-height Eurocard form factor measures only 6.3 by 3.94 inches. STD—at 6½ by 4½ inches—is only slightly bigger but does not have to accommodate STE's additional logic.

But an added advantage of adopting the Eurocard form factor is the possibility of housing an STE bus and its boards in the same enclosure as a VME or Futurebus system. Elsmore explains that VME uses all three 32-pin rows in one 96-pin DIN 41612 connector but only the middle row of the second DIN connector in its double Eurocard housing. STE's signals are all assigned to the outer two rows of one DIN connector, facilitating integration with Motorola's VME bus. Elsmore believes that physical integration with Futurebus should be even easier because all Futurebus signals are assigned to the three rows of one connector, freeing all the pins in the second connector for STE.

Shields sees STE also being used in a VME system as the input/output bus in place of Motorola's own I/O bus. He notes that one manufacturer of VME-based computers, Victory Computer Inc., San Jose, Calif., is considering using STE in this way. Victory's engineering vice president, James Willot, acknowledges that his company plans to evaluate STE as an alternative to the Motorola I/O bus because of such STE advantages as support of multiple master boards. But Victory is delaying this plan until issuance of a final definition of STE.

Mostek Corp., joint developer of the STD bus, is committed to the Eurocard form factor in the 16-bit arena and is copromoting the VME bus with Motorola. However, Mostek does not appear interested in promoting STE even in Europe. Mostek's European strategic marketing manager for systems technology, Winfried Osswald, believes that there is no great need for physical compatibility between STD and VME because they address widely differing markets. STD is mainly for process control. He notes that STD is well represented in most parts of Europe with the notable exception of West Germany, which is most devoted to the Eurocard. There, the Eurocard-based products of Siemens A.G. outsell STD. The 8-bit Siemens microcomputer board family employs a proprietary Siemens bus.

— Keith Jones

Siemens, Bull, ICL aim research at better knowledge-based systems

The know-how to build sophisticated management-support systems could be among the fruits of a Joint Research Institute being established in Germany by three of Europe's leading computer manufacturers—Siemens A.G., West Germany, Compagnie des Machines Bull, France, and ICL Plc., Britain. Staffed by 50 scientists, the institute will investigate the fundamental techniques to implement knowledge-based systems that will substantially improve expert systems.

The three companies are involved in publicly funded research schemes. These include the European Strategic Program of Research and Development (ESPRIT) backed by the Common Market and, in ICL's case, the British government's Alvey program (MMS, July, Page 81).

ICL technical director Mike Watson believes that, because knowledge engineering is vital to the institute's three backers, they need an initiative dedicated to knowledge engineering to augment ESPRIT. The many companies participating in ESPRIT are diverse, and many have interests outside commercial computing. Knowledge engineering is just one of several technologies ESPRIT is investigating.

Walter Heilmann, coordinator of Siemens' participation in the institute, notes the field of knowledge engineering is large enough for several parallel research projects. Siemens, Bull and ICL are also working internally. ICL's Watson envisions his company's knowledge-engineering scientists typically

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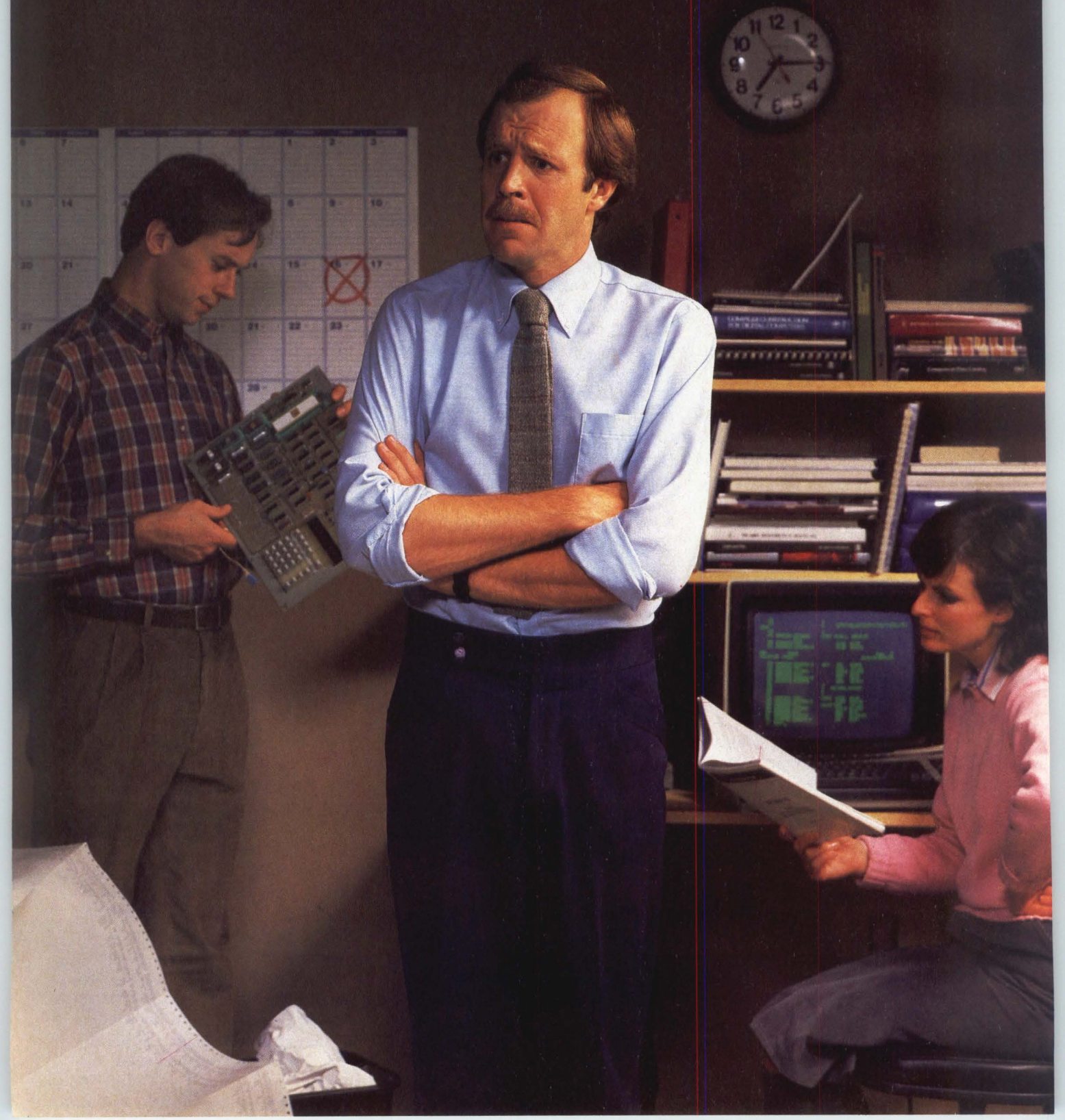

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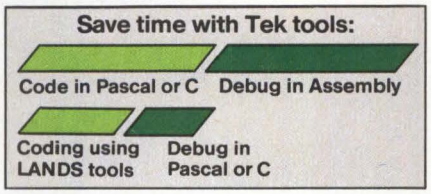

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```
        end;~
VAR~
        current : state;~
        ~
PROCEDURE wait(seconds : integer); EXTERN;~
                (*  waits for "seconds" seconds and returns  *)~
~
FUNCTION pedestrian : boolean; EXTERN;~
                (*  returns true if a pedestrian pushed the crosswalk button  *)
~
PROCEDURE maple(newcolor : color); EXTERN;~
                (*  changes Maple Street light to "newcolor"  *)~
~
PROCEDURE crosswalk(newmessage : message); EXTERN;~
                (*  changes crosswalk signal to "newmessage"  *)~
~
~
BEGIN   (*  trafficlight  *)~
        current.light := green;~
        maple(current.light);~
        crosswalk(dontwalk);~
        WHILE true DO ~
        BEGIN~
                WHILE NOT pedestrian DO  (*  nothing  *) ;~
                current.light := yellow;~
                                        current.time := yellowlength;~
                maple(current.light);~
                wait(current.time);~
                writeln;~
Parsing complete, no errors detected.
```

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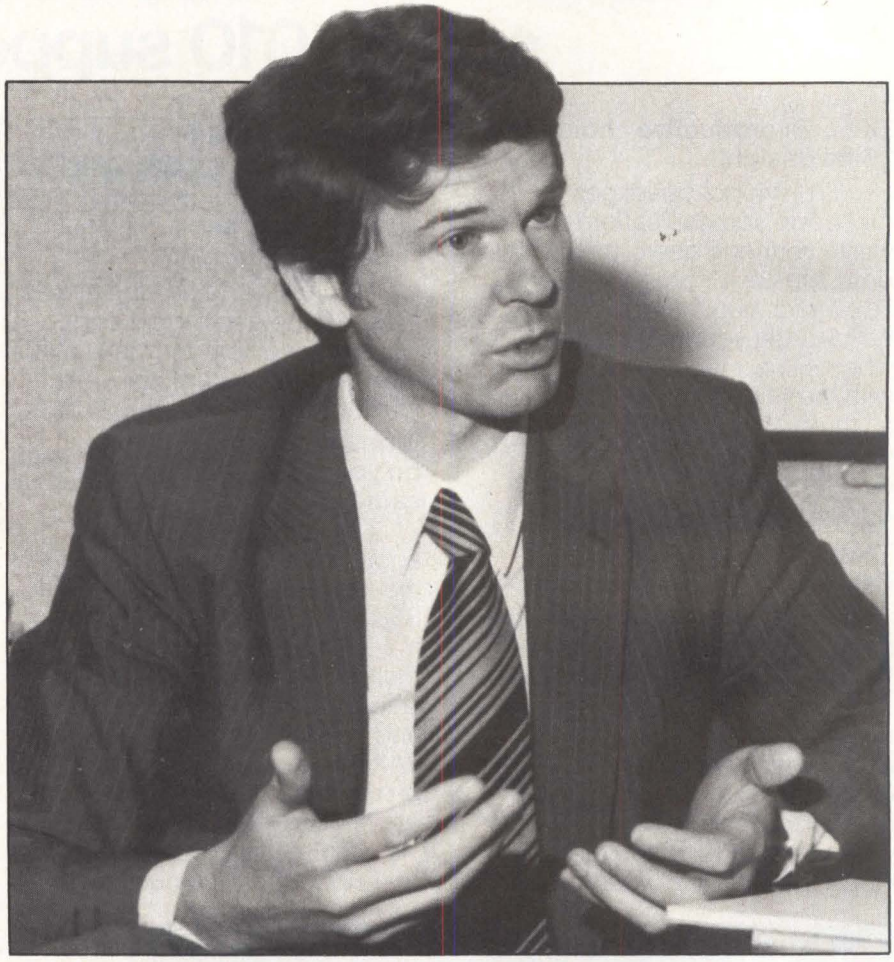
working at the institute for three years and then returning to ICL's laboratories.

Watson reveals that ICL's biggest effort will be in the knowledge-engineering part of Britain's Alvey program. But, he adds, "The Joint Research Institute will provide ICL with access to the European culture. We need the extra stimulus of outside ideas." ICL chose Bull and Siemens as partners because, explains Watson, "we have collaborated with each other for many years and understand each other." He points to close cooperation among the three companies within the European Computer Manufacturers' Association (ECMA), in which they have worked on formulating networking standards. Bull officials cite the roughly equal size of the three participants as another common trait.

The three partners will have equal and free access to the institute's research results but seem to have no plans to make this information available to other companies. Bull officials say U.S company Honeywell Inc. is unlikely to have access to research results even though it works closely on development programs with Bull's mainframe division, Bull-Systèmes, formerly Cii Honeywell Bull. Likewise, ICL and Siemens will not let Fujitsu Ltd. in on their activities, despite the Japanese company's interest in knowledge engineering and its close trading ties with the two European companies. ICL and Siemens sell Fujitsu's large mainframes in Europe.

The three participants stress that their cooperation is confined to pre-competitive research. "We are not developing products," ICL's Watson states. "Our joint work will not lead to any specific box." Having acquired the fundamental know-how from the institute, the three companies will individually develop products. But Watson does not expect such products to appear before the end of the decade. He expects the systems—at least those requiring large knowledge bases—initially to require mainframe computer power. But he acknowledges that small machines are also potential hosts and sees them being used immediately as workstations. Heilmann at Siemens believes there are "many possibilities" for potential hosts.



Mike Watson, *ICL Plc. technical director, reveals that products based on work at the Joint Research Institute for knowledge-based systems may not appear until the end of the decade.*

Watson reveals that an important part of the institute's work will be investigating database structures for unstructured inquiries. The institute will also put much effort into the man-machine interface and languages to implement knowledge-based systems, notably Prolog and LISP.

Current knowledge technology enables an expert to enter facts about his specialty. Those facts can then be used by a non-expert to tap the expert's knowledge in a question-and-answer session. Diagnosis is one application for such a system. Watson expects future knowledge-based systems to offer more sophisticated facilities, such as advising managers on how to reach business decisions and assisting in decision making by management groups. The systems, as a result, might help form company policies.

—Keith Jones

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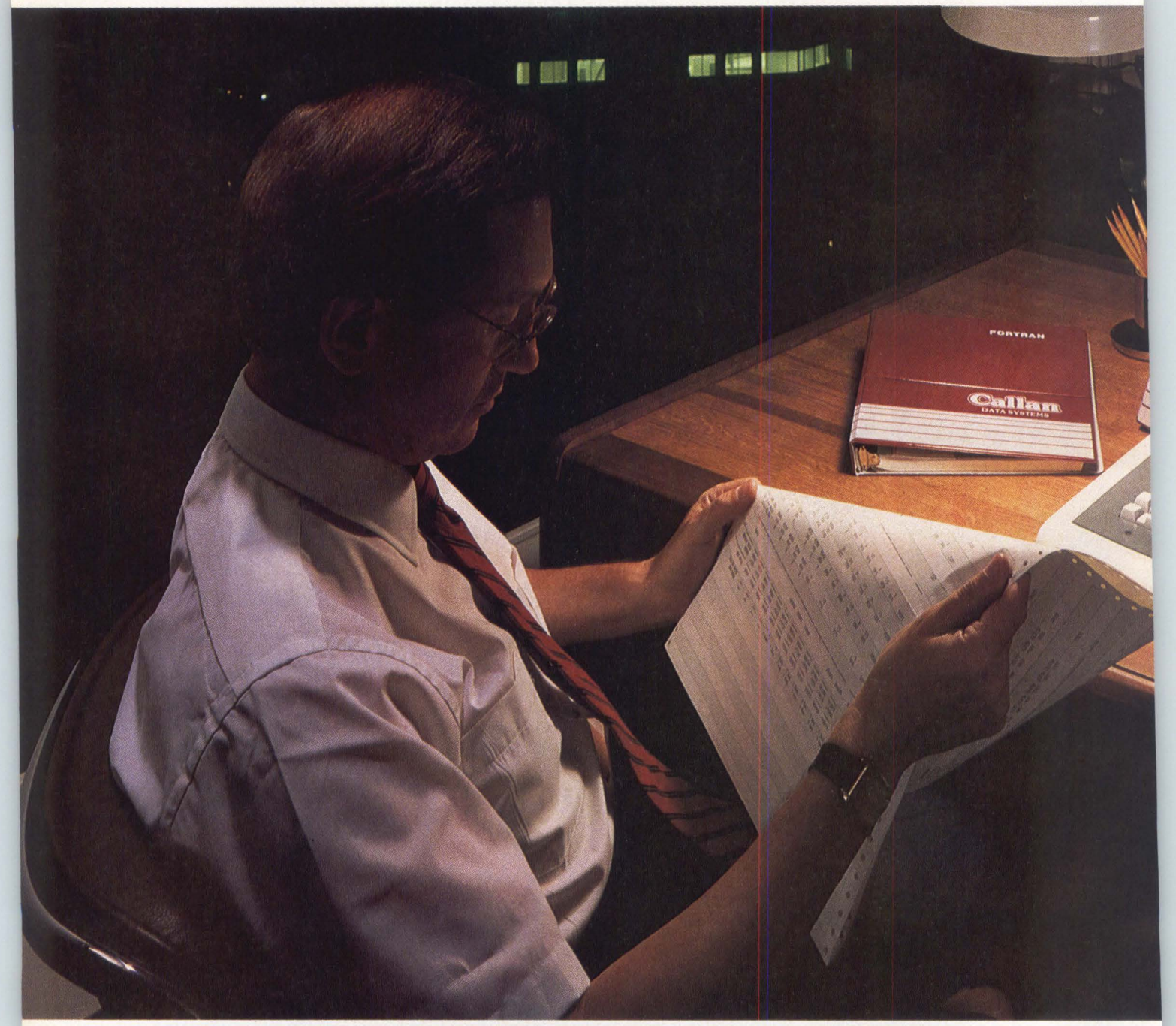

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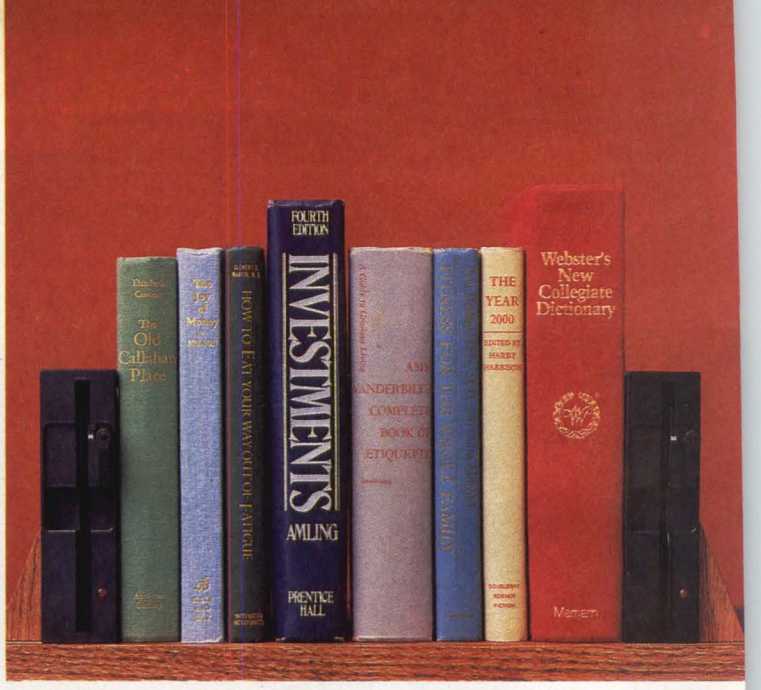
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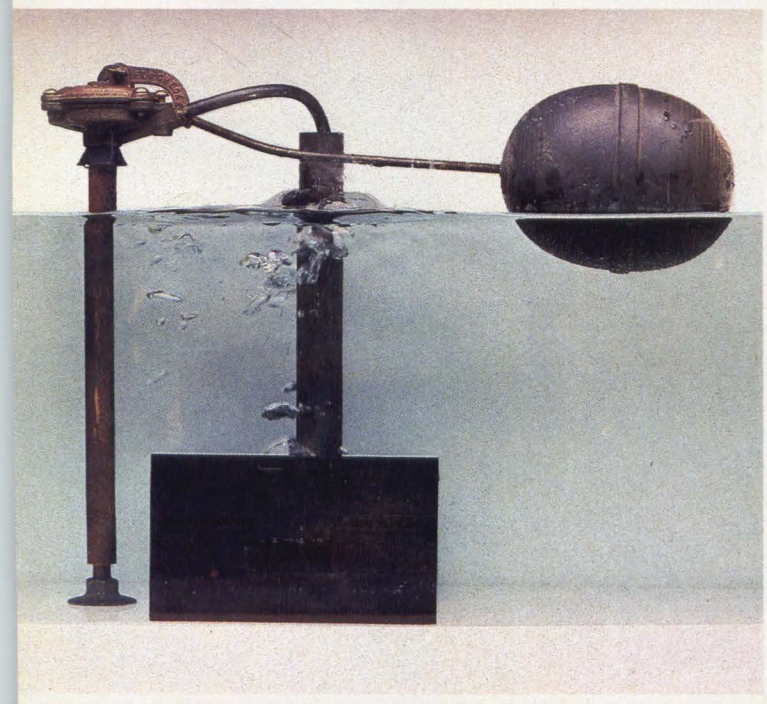

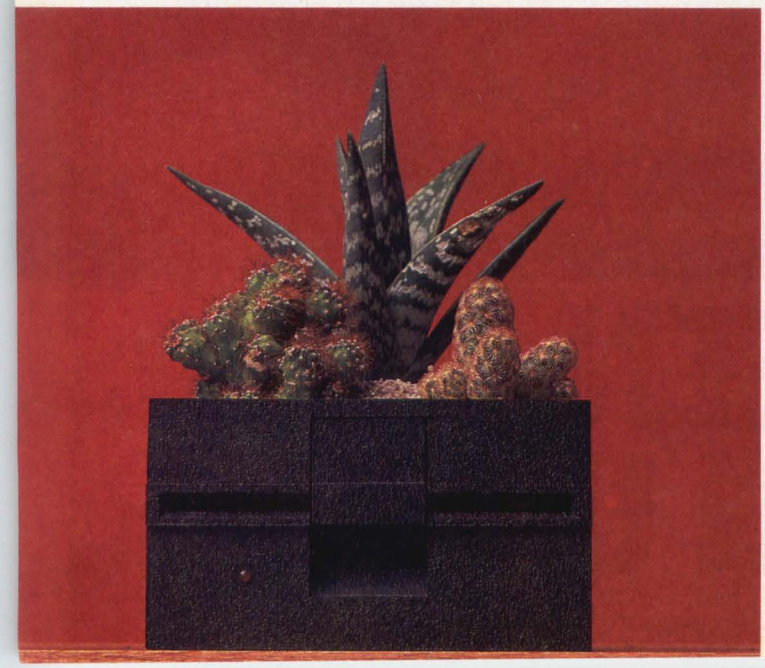

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CIRCLE NO. 51 ON INQUIRY CARD

Crowded disk drive market forces entrepreneurs to be cautious

By Robert A. Sehr

The hills around Santa Clara Valley are alive with the sound of money. For a while, a new company with plans to manufacture 5¼-inch disk drives seemed to form there every month. Rather than offering innovative products, however, most companies were cautious: they took a predecessor's successful idea and made it more marketable. Those with new engineering ideas could hope for modest sums of venture capital and could expect skeptical looks from others who gladly let them take the risk of opening a new market.

The most successful 5¼-inch disk drive companies in the OEM market are Seagate Technology, Scotts Valley, Calif., and Tandon Corp., Chatsworth, Calif. The annual revenues of each have grown to more than $100 million in the past three years, despite the fact that neither made startling technological advances. Seagate took an early risk by reducing the 8-inch Winchester to 5¼ inches. However, Seagate founder Al Shugart had laid the groundwork for the smaller drive when the company he had founded previously, Shugart Associates, developed the 5¼-inch minifloppy drive. Consequently, a market for Winchesters working in conjunction with minifloppies already existed.

Tandon entered the market by using Seagate's design—willingly shared by the then-small Seagate eagerly seeking another manufacturing source—and capitalized on having the right product at the right time. As large established companies like Control Data Corp., Memorex Corp. and International Memories Inc. were competing in the 8-inch disk drive market, Seagate and Tandon swam alone in an open sea of orders.

In the past three years, Seagate and Tandon have spawned much competition, most of it catering to the same low-end market for 5¼-inch drives. With 200,000 5¼-inch drives shipped in 1982, according to industry analyst James Porter in his *1982 Disk/Trend Report*, and IBM Corp.'s PC XT making 10M-byte Winchesters standard for top-of-the-line personal computers, there appears to be plenty of incentive to enter the market.

Despite the market's growth, manufacturers face a problem. The 5¼-inch Winchester industry has very low margins, the result of low-cost, frequently offshore manufacturing that doesn't permit much sophistication.

Eugene Kleiner, *a partner in venture capital firm Kleiner, Perkins, Caufield & Byers, says it took his partnership only five to six months to discover that Quantum Corp. would succeed and Ontrax Corp. would fail. In addition to providing financing, he adds, it's the duty of venture capitalists to help focus a product.*

New companies stick to old technology

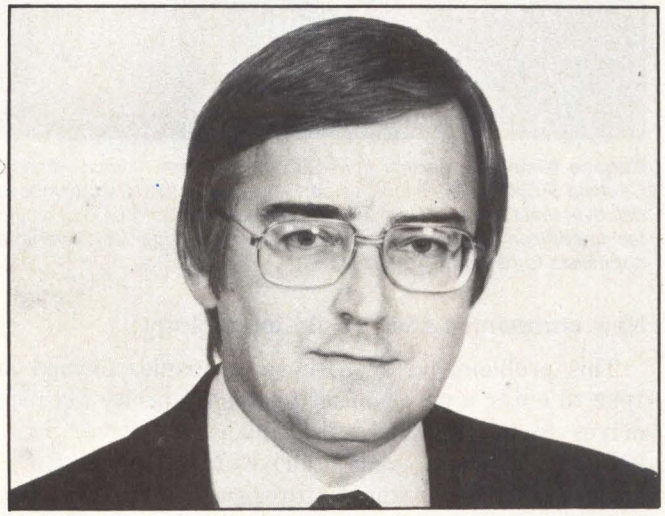
This problem led even those companies formed in 1982 to enter a new market for high-capacity 5¼-inch drives to be cautious rather than innovative. Some industry observers point to drives from Maxtor Corp. as having some gee-whiz features such as a motor in the spindle. This increases capacity by leaving enough room within the 5¼-inch box to stack eight platters. Maxtor claims to be merely "repackaging solid, reliable technology." However, Maxtor marketing director Skip Kilsdonk admits that the company has bet its future on the success of volume production of the high-capacity (140M- to 380M-byte) drive. "This is the product that the company is based upon," he comments. "I don't see us revising it." Maxtor founder and president Jim McCoy agrees. "Our risk is in the execution; that is, high-volume production," he emphasizes.

Few of Maxtor's competitors are willing to take even that much of a risk. Most pattern themselves on what has already worked for older, larger disk drives. Two other entrants in the 5¼-inch market, Atasi Corp. and Evotek Corp., use the same embedded-servo and voice-coil actuator design that served in 8-inch and even older 14-inch drives. However, both companies are evaluating new designs: combinations of plated media and, ultimately, thin-film heads to increase bit and track densities. But they're waiting for these technologies to

be tested in other form factors before risking change in the cutthroat 5¼-inch market.

One exception to the mass retreat from risk is Tandon. The company recently demonstrated its ability to take big risks by entering the ½-inch tape drive market with a low cost, 50M-byte non-standard cartridge positioned to compete against low-end ¼-inch tape drives in the 5¼-inch form factor. The drive is expected to sell for less than $700 each in volume and fits between the low end of the market for ½-inch tape drives and the high end of the market for ¼-inch tape drives.

Miniscribe Corp., another bold company, has risen quickly in relation to the two market leaders by taking a risk with a one-platter, 5¼-inch Winchester that has



Dieter M. Schulze, *inventor of Ontrax's controversial actuator, believes the failure of Ontrax can be attributed directly to the principals' lack of organizational ability. Schulze explains that management spent most of its time on non-management duties.*

the same capacity as Seagate's two-platter drive. Despite its success, though, Miniscribe still approaches new markets and products cautiously. Industry observers cite the company's delaying introduction of its 3½-inch Winchester until Comdex in November, despite competitive pressures to introduce it at the 1983 National Computer Conference last May.

Some observers view this caution as a sign of the industry's maturity. Only three years ago, companies differed widely on standards for 8-inch disk drives, causing manufacturers such as Pertec Computer Corp., BASF Systems Corp. and Siemens Corp. to leave the market for 8-inch drives. But others criticize that viewpoint, giving the current battles to standardize the sub-5¼-inch form factor and the high-capacity 5¼-inch interface as evidence that the disk drive industry is still immature.

Other industry watchers believe that the recent economic slowdown made venture capitalists more careful in doling out their millions. But funding of 26 thin-film media companies in the past year contradicts such reasoning.

Still others believe that the market is simply too crowded and price conscious to risk trying new technologies. Market leader Seagate might be able to afford to put its plated-media-based 706 cartridge drive on hold because of "concerns about the availability of plated media," as the company announced in April. But other than Tandon, the ranks of 5¼-inch Winchester manufacturers hold few contenders that can afford large expenditures on research and development.

Failure teaches caution to onlookers

The industry-wide climate of caution may have had a specific starting point: May 1981. That's when Ontrax Corp., Sunnyvale, Calif., shut its doors only 8 months after heralding a "revolutionary" product that it hoped would forever change the disk drive industry. Ontrax officials touted their proprietary actuator as capable of the "performance of a voice-coil motor at the price of a stepper" (MMS, January 1981, Page 39). With the proprietary actuator, Ontrax's 8-inch drive was to achieve a then-unprecedented 136M-byte capacity with a track density of 960 tracks per inch. The actuator was comprised of a series of concentric sleeves, each capable of specified linear movement. The design cut costs by eliminating the permanent magnets required by other voice-coil actuators and by using lower cost powder metal.

The company secured $1.5 million from venture capital firm Kleiner, Perkins, Caufield & Byers and attracted interest throughout the disk drive industry. The honeymoon, however, was short. Just four months after announcing the product, Ontrax announced some "production problems" that would delay shipments of products with the actuator. In fact, the engineering team had difficulty in getting the actuator to work. "I worked harder at Ontrax than any other place I have ever worked," says Dieter M. Schulze, inventor of the controversial actuator, who was the company's vice president of advanced development. "I did not get enough assistance, so my time was spent doing preparation work like machining parts rather than perfecting the actuator."

Schulze says that, if Ontrax had been given more time and money, the actuator would have worked. So confident is he of its eventual success that he is developing a new product around the invention. "Venture capitalists do not appreciate the technical effort that

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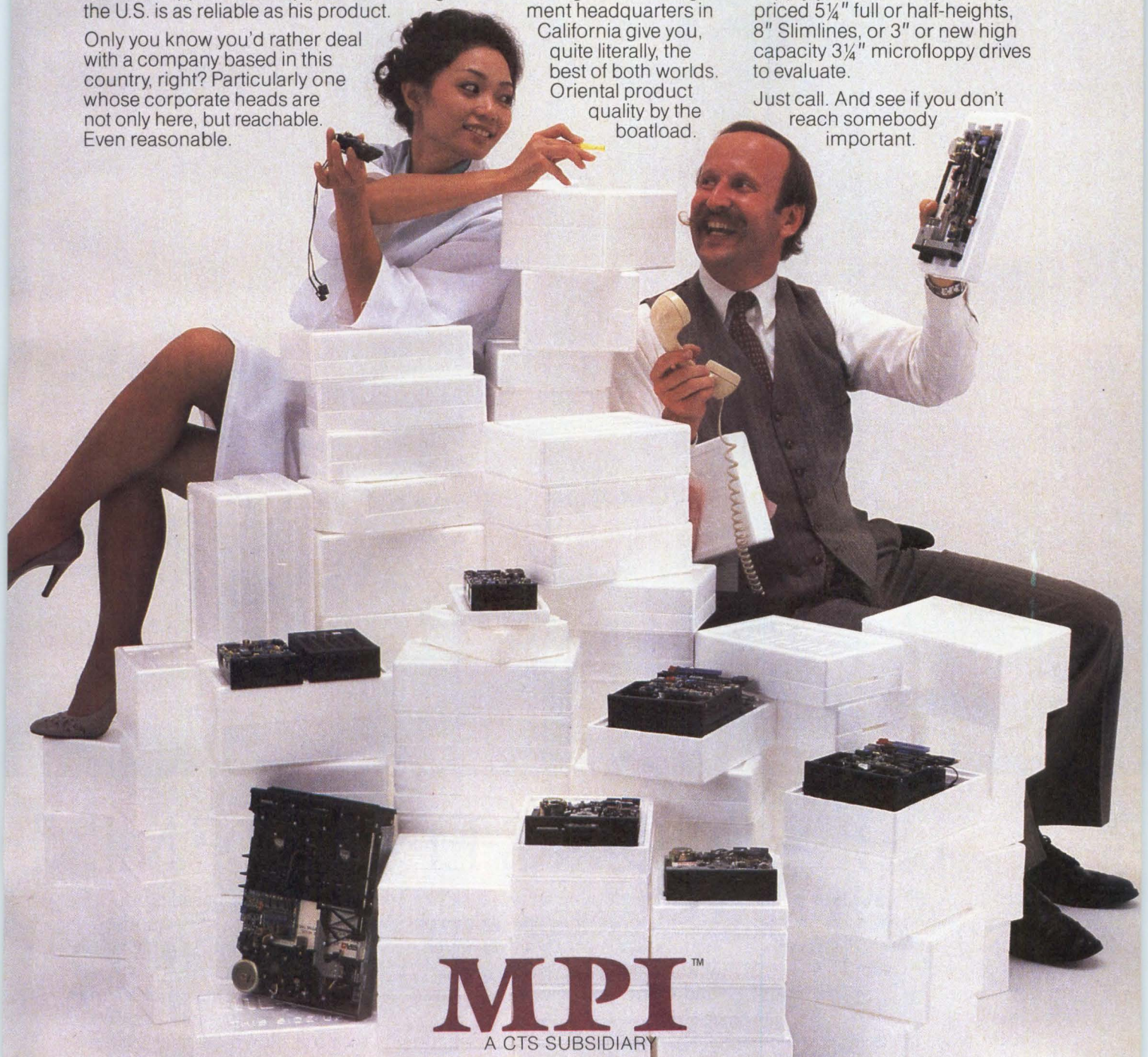

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goes into a product." he contends. "They are more interested in the people running the show. Given the choice of an 'A' team with a 'B' product, and a 'B' team with an 'A' product, they would go for the former."

Not true, asserts Eugene Kleiner, a partner at Kleiner, Perkins, Caufield & Byers. "We really must have both—an 'A' team and an 'A' product—or there's no sense in investing." Kleiner, whose partnership made successful investment in such companies as Quantum Corp. and Prime Computer Inc., says that Ontrax's experience was unusual. "Usually, a company fails because of a marketing problem. This time, it failed because it [the product] could not be manufactured."

That usually doesn't happen, Kleiner says, because he and his partners have or can find the technical expertise to evaluate a product's potential. There was common agreement in Ontrax's case that the actuator could be manufactured. When the venture capitalists discovered that they were wrong, they immediately pulled the plug on the operation.

"It's a sad thing to see a company die," Kleiner observes. "But, in the case of Ontrax, it was done mercifully with as little pain and as little loss of money as was possible. At least it was not a lingering death."

Although he says company officials hoped to ship drives with standard actuators while working on the proprietary actuator, Kleiner believes the effort would have been fruitless. It would have meant throwing "good money after bad," he concludes.

Lesson proves expensive

A mature market like the one for disk drives tolerates few mistakes. "When a company has already had many hiccups, it's not going to make it," Kleiner maintains.

Inventor Schulze asserts that the venture capitalists gave Ontrax and its founder, Joseph D. Koenig, a bad deal. "For $1.5 million, Koenig gave up more than 50 percent of the company," Schulze comments. "As a result, the venture capitalists had a more powerful voice in the operation than they should have."

Koenig, who is starting a medical systems company in Sunnyvale, Calif., does not want to comment on his Ontrax experience. "I'm kind of high right now on my new company, and Ontrax is better left behind us," he states.

The lessons of Ontrax, however, have not been left behind: they stand as a warning to other engineering-driven companies to make sure a product can be manufactured before claiming so publicly.

Another manufacturer of 5¼-inch drives that has a proprietary actuator is Applied Information Memories Inc. (AIM), Milpitas, Calif. The company has been careful to bill its linear actuator as a "technologically simple" design, and it delayed public comment until September. The company says that, although it expects eventually to offer perpendicular recording products, it will first ship a more cautious product employing state-of-the-art magnetic recording.

Jim McCoy, *co-founder of Quantum Corp., started Maxtor Corp. last year. McCoy says Maxtor's product line presents no more of an engineering challenge than Quantum's 8-inch drives did.*

"We're not inventing any machinery here," says Arnold Cooley, AIM's vice president of manufacturing. "Our greatest fear is that the design is so simple we will have a lot of companies reverse-engineering our drive within a short time of its introduction."

Who is left to experiment with untried technology? In the disk drive market, the door is open only to the company most observers feel can withstand market rejection: IBM. With its recently introduced non-standard 4-inch floppy disk drive that has various rotation speeds and uses non-standard media, IBM is ready to fill the bill, as it has many times. It is also possible that the company will take the 4-inch form factor into the Winchester arena in the not-too-distant future, provided the floppies gain acceptance.

"Technology simply cannot stand still in our business," says William A. Wachs, senior OEM marketing representative of IBM's Information Products Division, Boulder, Colo. "Someone has to take the lead. If it is left to us, so be it." □

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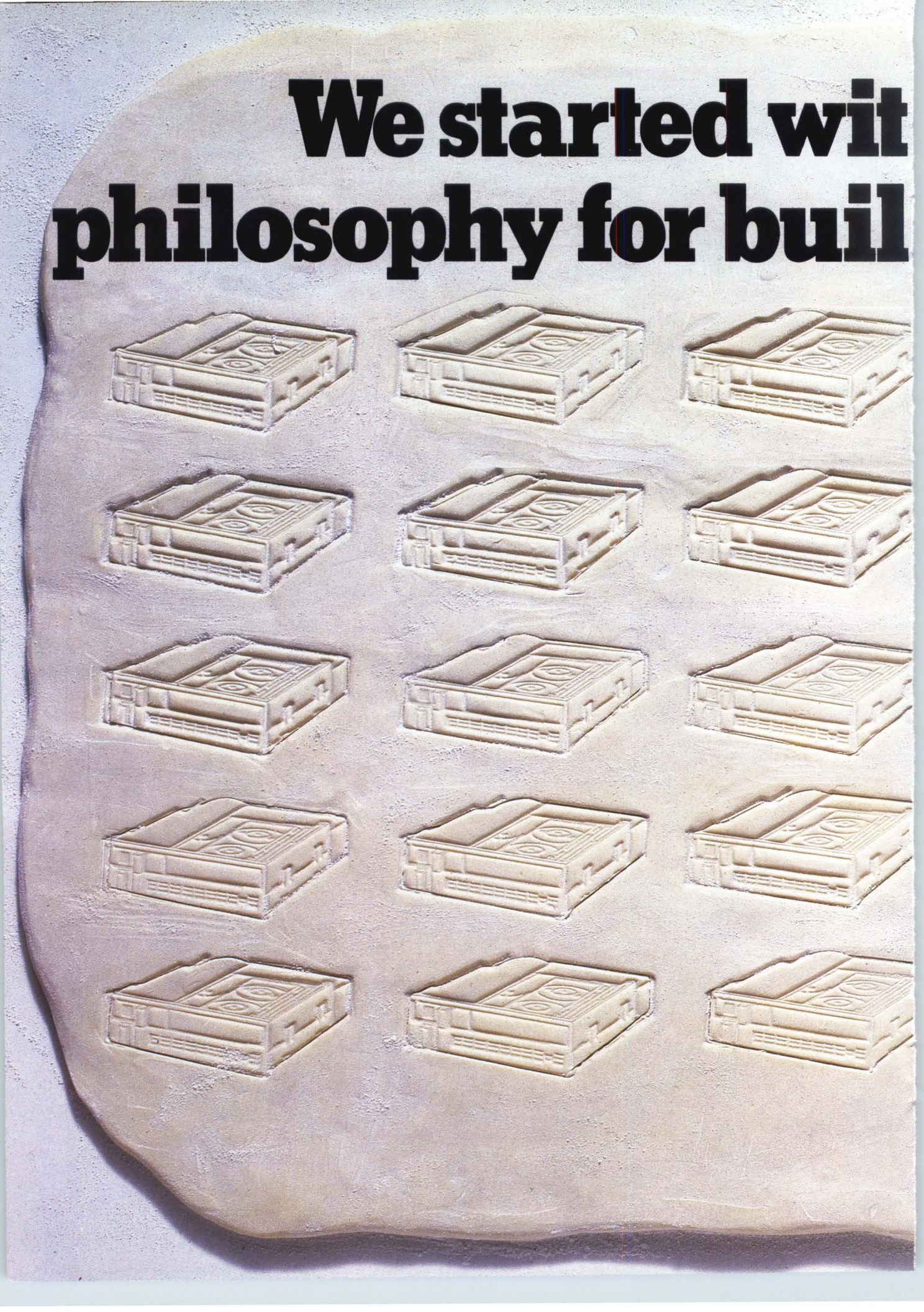

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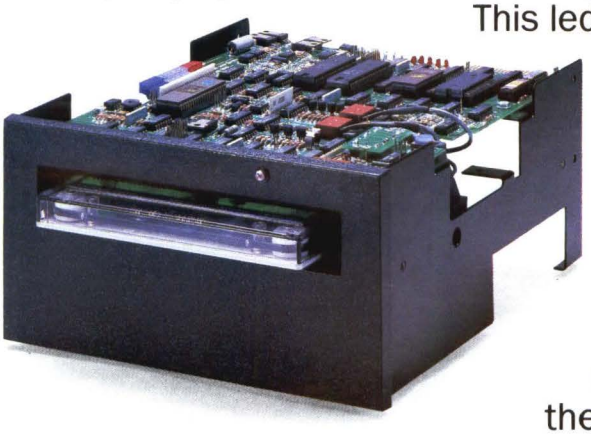

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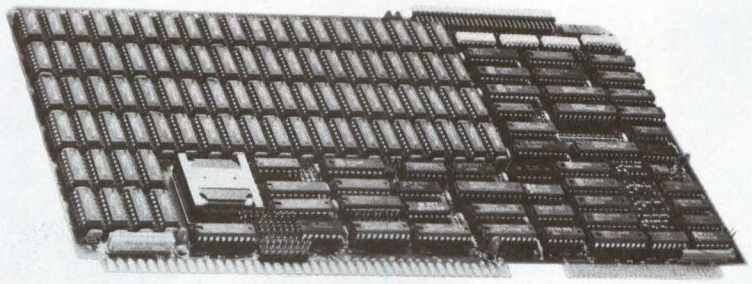

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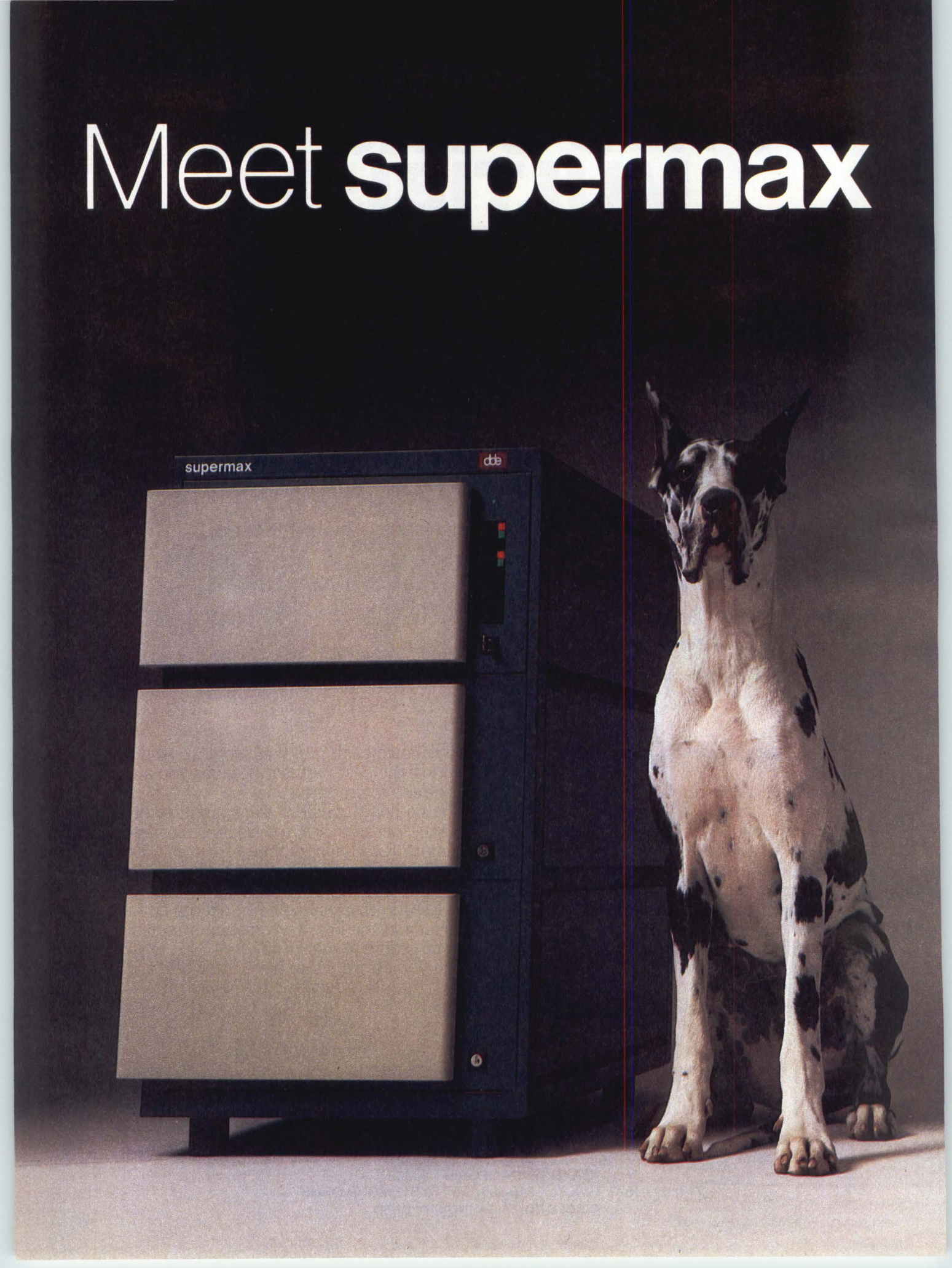

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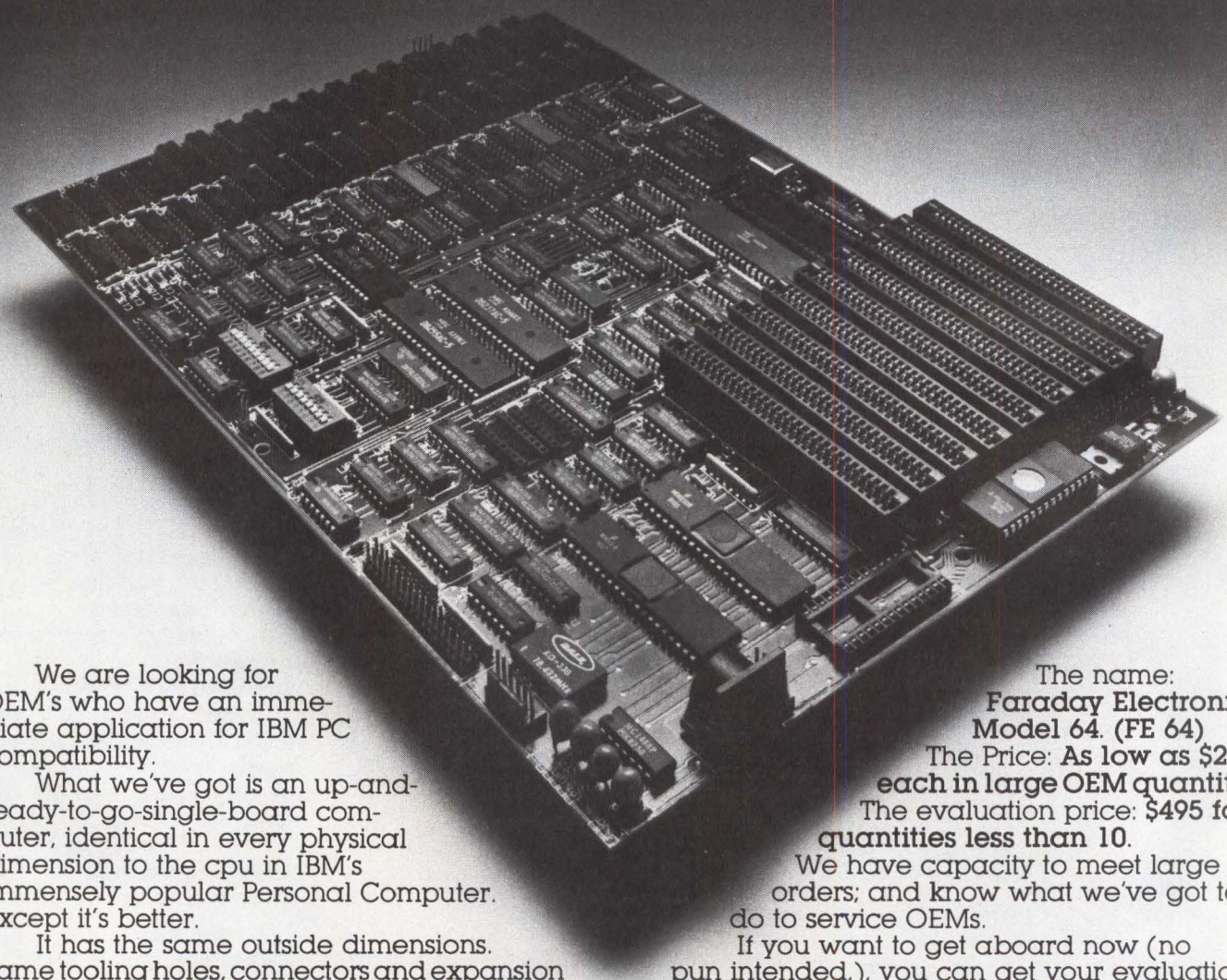

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CIRCLE NO. 56 ON INQUIRY CARD

IBM looks to third parties to provide graphics software for PC applications

By Frank Catalano

By choosing not to provide graphics software for personal computer applications, IBM Corp. has created new opportunities for third-party software vendors. Taking advantage of those opportunities, a number of companies with business graphics programs are going after the 550,000 to 600,000 IBM PCs that are expected to be in users' hands by the year-end, and more entrants are expected.

Despite suspicion among some software providers that IBM may eventually attempt to control the PC software market by altering the PC-DOS (an MS-DOS equivalent) operating system, an IBM spokesman contends that the company welcomes third parties with PC packages. "When we announced the PC, we featured the system's open architecture, around which companies could design their own product," he notes. "We continue to provide manuals and technical documentation to software companies and OEMs, and I see no change in that approach."

IBM sells more than 70 third-party PC software packages, ranging in applications from word processing to accounting, but has yet to endorse programs for dedicated graphics applications. However, IBM is evaluating graphics products from Graphic Software Inc., Aztek Inc. and Integrated Software Systems Corp., among others.

A huge market is at stake. Neil Kleinman, general manager of International Data Corp.'s Pacific Technology Center, a market analyst firm in Santa Monica, Calif., predicts that 2.5 million personal computers will be in use for graphics applications in 1986, representing a market for graphics software of more than 1 million packages worth about $300 million. The IBM PC could account for as much as half of that.

Although some personal computers have been criticized for lacking the screen resolution required for graphics, the IBM PC has drawn praise. It is among the personal computers with "adequate resolutions," comments Bob Katzive, vice president of the computer group at Gnostic Concepts Inc., a market research firm in Menlo Park, Calif. He adds, "It would be foolish for a businessman not to take advantage of their graphics capabilities."

Suited to graphics

Equipped with a black-and-white monitor and a graphics board, the IBM PC provides resolutions as high as 640 by 200 dots. A color monitor and the graphics board provide the PC with resolutions as high as 320 by 200 dots.

John Hemphill, a product analyst with Future Computing Inc., Richardson, Texas, states that those resolutions are sufficient for first-time computer-graphics users who previously either drew charts manually or depended on art departments. Such users, says Hemphill, include middle managers of large corporations and operators of small businesses. He explains they require graphics not for presentations to management, stockholders or customers—who might require high quality—but for presentations to peers and for decision support. "We're talking about a $300 to $500 software package running on a $3,000 to $5,000 computer," notes Hemphill. "Personal computers aren't going to give you the quality of graphics that you'd get from a dedicated graphics workstation or a host-based system.

The base price of the IBM PC with 64K bytes of memory and a monochrome display is less than $3,000. The XT version with two hard disk drives and 128K bytes of memory sells for $4,995. List price of a color monitor is $680, the graphics board sells for $244, and a graphics printer sells for $395.

Hemphill admits that, compared to personal computers, host-based graphics systems and dedicated workstations provide users access to larger databases, interfaces to a greater variety of output devices, more flexibility in manipulating graphics and text and a wider choice of colors and character sets. Host-based systems and workstations sell for $50,000 to $200,000, however, and are intended primarily for MIS departments of large corporations and graphics specialists. "That's not the market our product is addressing," notes Kevin Bull, director of marketing for Aztek Inc., a pioneer provider of IBM-compatible PC graphics software. "We're going after a whole new group of first-time users.

Available products vary

Graphic Software Inc. Cambridge, Mass., became the first to provide a graphics program for IBM PC applications. Since announcing Chartman I in July 1982, the company has added four other programs to its product line. Targeting its software at a spectrum of

users, including corporate executives and sales personnel, the company sells its Chartman series in ComputerLand stores. "We're going after users who analyze numbers as a normal part of their day-to-day jobs," explains Carey Bursten, national sales manager for Graphic Software. "What we're providing is a cheap way to make their analysis easier."

Price of Chartman I is $325. It includes 20 line, bar, pie and text charts and is intended for use with a monochrome display. The software generates hard-copy graphics output using either the IBM PC, Epson America Inc.'s MX-80 or MX-100 printers or Hewlett-Packard Co.'s 7470 two-pen or 7220 eight-pen plotter.

Chartman II sells for $380. It includes all the features of Chartman I but is intended for use with the IBM color monitor. That software supports graphics output with either Integral Data Systems Prism color printer or IBM XY 750 and XY 749 plotters. This year, Graphic Software announced an extended version of Chartman II that runs on IBM's PC XT. "Super" Chartman II sells for $425; users can upgrade Chartman II packages for $50.

Chartman III is a low-end version of Chartman I, and Chartman IV includes scatter graphs and GANTT charts not available on Chartman II. Chartman IV also provides users with statistical curve-fitting features and color bleeding. Chartman III sells for $199; and Chartman IV sells for $300.

All five packages allow users to input data either at a keyboard according to software-driven menus or by accessing data interchange format (DIF) files generated by packages such as VisiCalc or Lotus 1-2-3.

Although the Chartman series is Graphic Software's first and only offering, Aztek, which introduced IBM-compatible PCchart this year, has been in the graphics business for several years. A supplier of graphics hardware and software, Aztek's primary business focus is mainframe- and minicomputer-based slide-making systems.

Aztek hopes PCchart will expand the number of users producing graphics and, in turn, expand the market for its slide-making systems. "We hope to ship as many as 30,000 PCchart packages by the end of this year, and those shipments should drum up a lot of sales of our slide-making systems," claims Bull. "We may end up making more money on PCchart than on our larger systems."

Intended for use with a color monitor and requiring 256K bytes of memory, PCchart allows users to generate charts in 80 formats, using a combination of 64 colors and pattern fills. As with the Chartman series, users input the data they want graphically represented by accessing VisiCalc DIF files. PCchart supports Epson printers and HP pen plotters. Users can output hard-copy slides via a modem or serial data link connected to an Aztek slide system. Aztek provides PCchart customers with listings of graphics-design service bureaus that use the company's slide-making product. Also available in ComputerLand stores, PCchart costs $995.

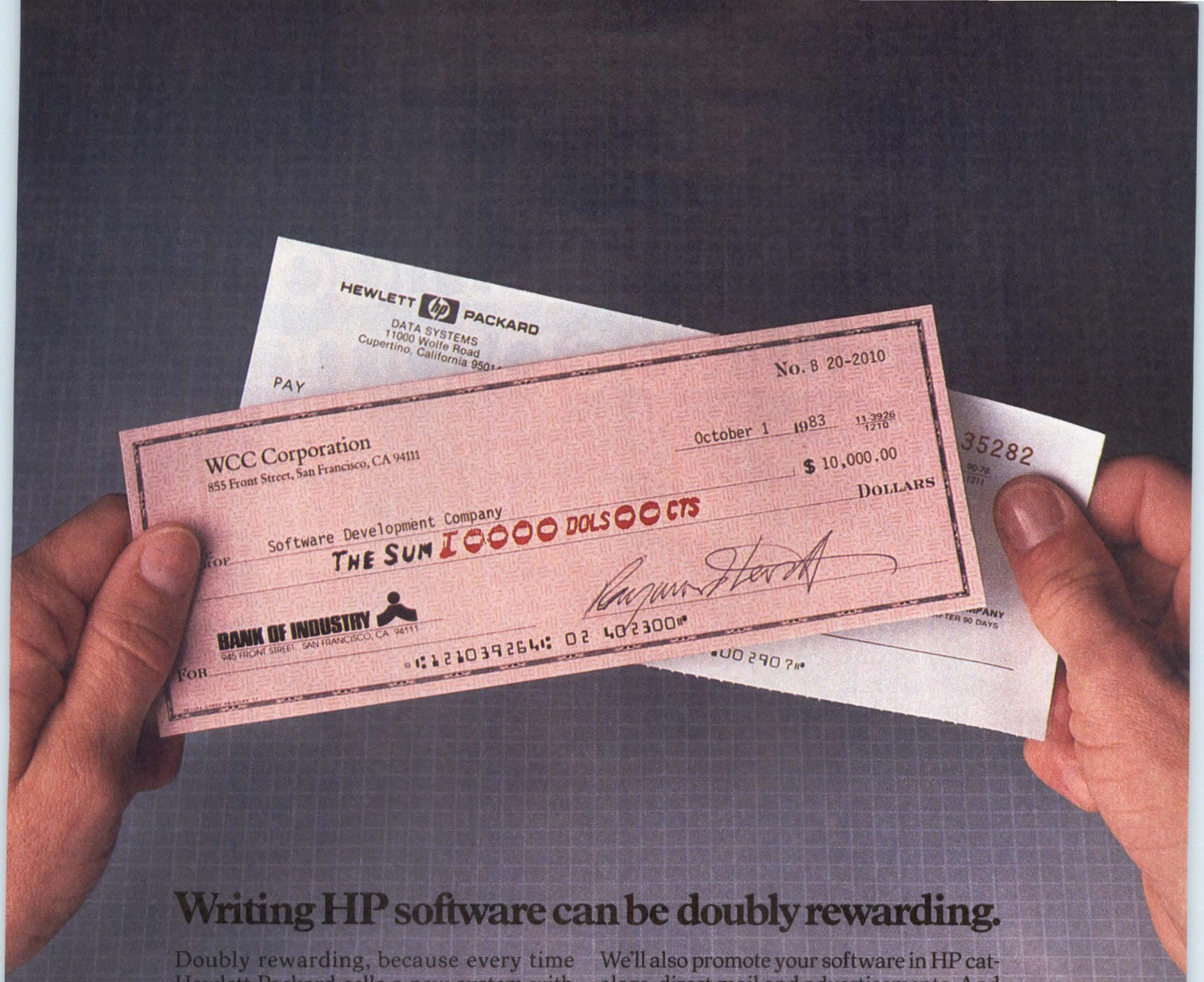
Integrated Software Systems Corp. (ISSCO), San Diego, Calif., took a different approach in designing its PC graphics product. ISSCO's PC display driver package allows the PC to function as a terminal that can access the company's traditional line of host-based graphics software. Jeff Anderson, director of marketing, contends that ISSCO has an installed customer base of more than 140,000 host-based software packages and that many customers are installing IBM PCs. "Like most companies, we're very susceptible to market demand and, more specifically, to the market demand of our customer base," reports Anderson.

The PC display driver consists of one part that resides with the host and translates host-based graphics software into a form the PC can understand. Another part resides with the PC and allows the PC not only to emulate a terminal but also to store and recall graphics images. When the PC is in the terminal mode, users can generate and manipulate graphics. When it's in the standalone mode, users can review graphic images already generated. The package sells for $245, and quantity discounts are available.

More entrants expected

Besides Graphic Software, Aztek and ISSCO, at least 10 other companies, including Centec Corp., Reston, Va., and Graphic Technology Product and Systems Corp., Rockville, Md., supply graphics products for the IBM PC. Bill Ablondi, a market analyst with Future Computing, says that, as sales of the IBM PC increase and as companies introduce plug-compatible systems, more graphics software will become available. The plug-compatibles will be a major force in the total IBM market. Companies such as Corona Data Systems, Compaq Computer Corp., Columbia Data Products Inc. and Eagle Computer Inc. have announced IBM plug-compatible systems. According to Future Computing estimates, IBM sold approximately 180,000 PCs last year and is expected to sell about 390,000 more by the end of this year. Combined sales of IBM and plug-compatible PCs will total 680,000 machines this year, Ablondi predicts, and 1.6 million machines in 1988.

"What that means to software vendors is that there will be a lot of sockets out there that their application packages can be played in," Ablondi concludes. □



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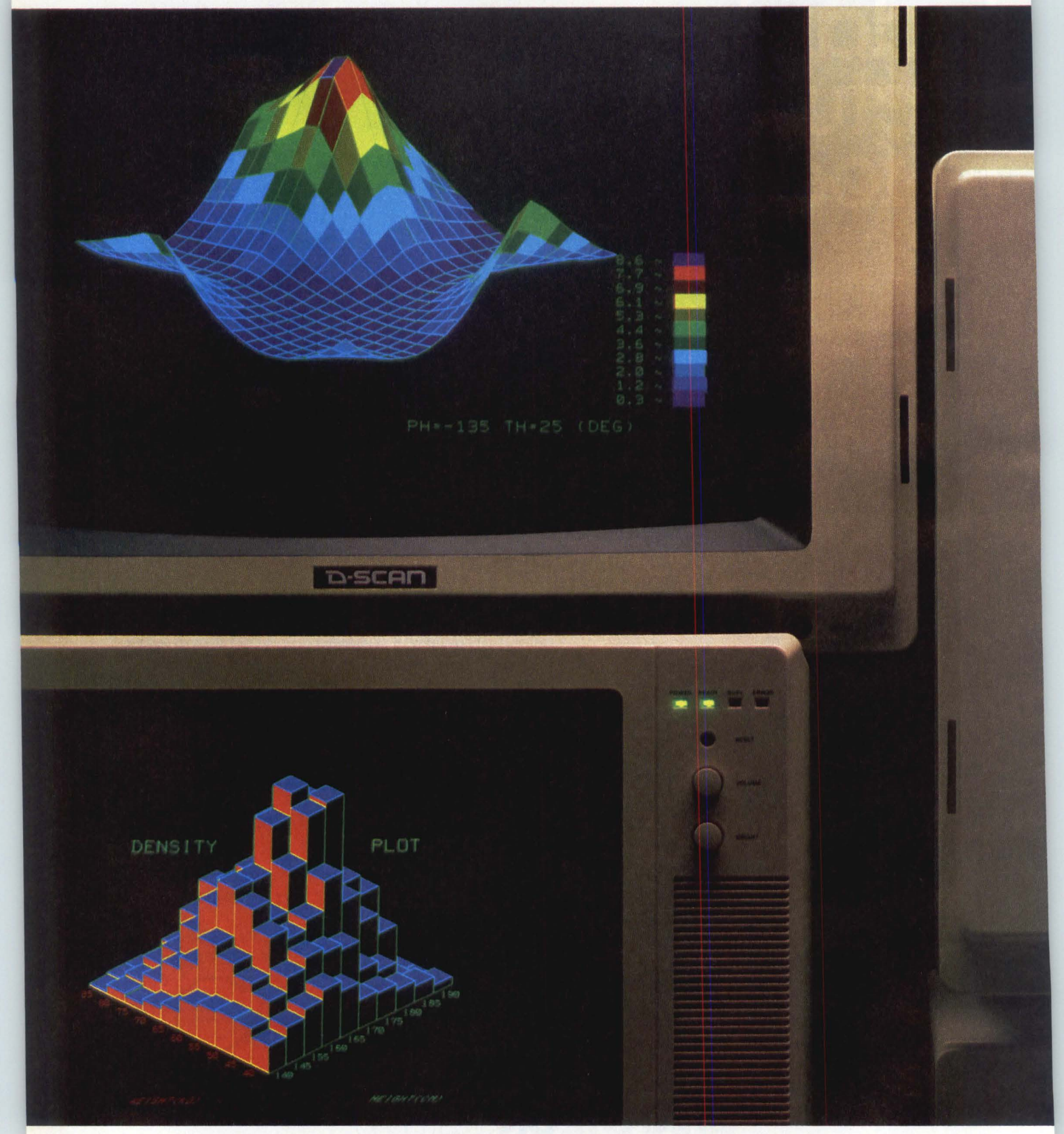
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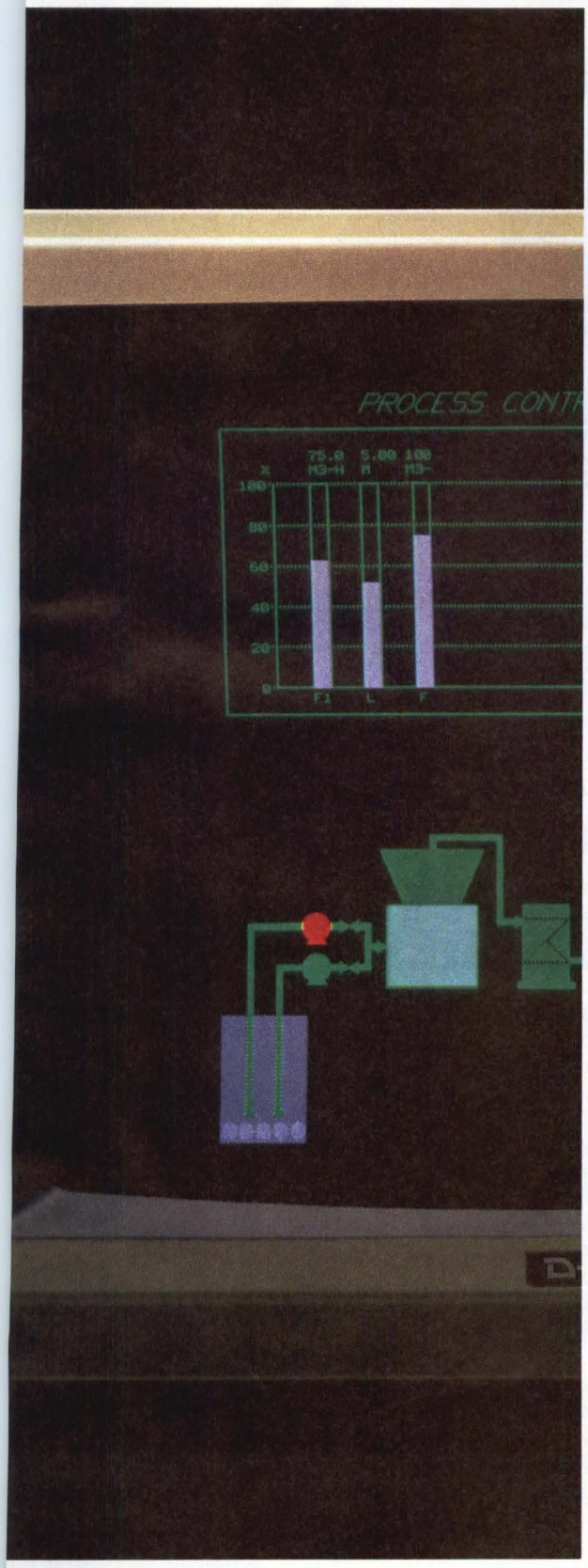

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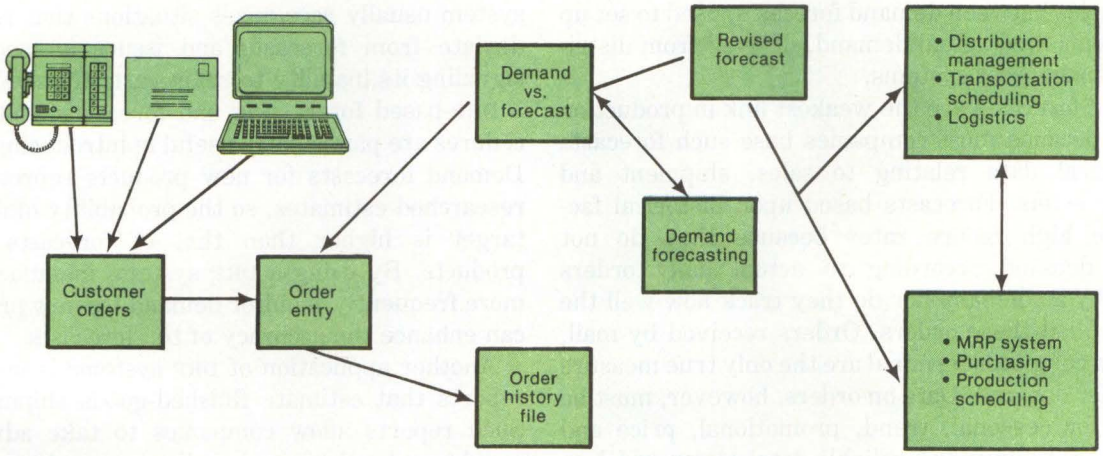

Closing the loop *between on-line order entry and demand forecasting, a distribution-resource planning system (DRP) updates management on discrepancies between demand forecasts, used to set up material-requirement planning (MRP) systems, and actual demand, derived from distribution-management systems. The DRP system provides an accurate, up-to-date database on which to base corporate decisions.*

By James E. Grinnell
Distribution Management Systems Inc.

(Editor's note: Distribution Management Systems (DMS) Inc., Lexington, Mass., is an application software and systems company specializing in the development and installation of minicomputer-based distribution and warehouse-management systems. The company bases its two application packages—the DMS 1000 distribution system and the DMS 1500 warehouse-management system— on Digital Equipment Corp. VAX computers. DMS is an authorized DEC distributor and sells its software packages separately or bundled with hardware. Both the DMS-1000 and the DMS 1500 system can interface with mainframe computers and support remote and hand-held terminals, bar-code readers and labelers.)

After using material-requirement planning (MRP) systems with some success, manufacturers are now turning their attention to distribution-management systems that facilitate not only the distribution but also the warehousing and transportation of finished goods. Although MRP and distribution-management systems apply to different aspects of an organization, both can be implemented as one on-line system called a distribution-resource planning (DRP) system. A DRP system closes the loop between manufacturing and distribution, providing an accurate, up-to-date database on which to base corporate decisions.

MRP systems help managers plan production scheduling, manufacturing-resource allocation, raw-material and component-inventory management and raw-material and component purchasing. To facilitate planning, MRP systems require various data inputs ranging from simple to complex. Those inputs include:

- identifying products that can be produced most economically at each production facility or at different stations in each facility,
- the lead times required at each facility for changing from producing one product to producing another,
- the most cost-effective production quantities required for each product at each facility,
- accurate, time-phased forecasts of demand for each product.

Distribution-management systems, on the other hand, assist management in post-production functions, including order processing, customer service, finished-goods inventory management, billing, accounts receivable and payable and general ledger. On-line systems also contribute to the operation of warehouses, offer

control interfaces to automated materials-handling systems and provide a cost-effective means to transport resources.

The primary benefit of integrating distribution-management and MRP systems centers on closing the loop between on-line order entry and demand forecasting. Closing the loop keeps management updated on discrepancies between demand forecasts, used to set up MRP systems, and actual demand, derived from distribution-management systems.

Demand forecasts are the weakest link in production planning because most companies base such forecasts on historical data relating to sales, shipment and inventory levels. Forecasts based upon historical factors have high failure rates because they do not measure demand according to actual daily orders received by a company nor do they track how well the company filled those orders. Orders received by mail, phone or a computer terminal are the only true measure of customer demand. Data on orders, however, must be adjusted for seasonal, trend, promotional, price and other factors to provide a reliable database on which to build demand forecasts, which play an important role in MRP decisions.

Advances in on-line systems technology and software facilitate recording orders in real time. Companies that install DRP systems that couple on-line order entry with dynamic demand-forecasting software systems can monitor and adjust their demand forecasts and, as a result, make them more accurate.

A successful DRP system has three key elements. First, an on-line order-entry process captures detailed data on all orders received by a company at each order-entry point. Second a computer-based demand-forecasting system uses the data generated by the order-entry system to adjust forecasts based on historical demand. The system produces a variety of forecasts that take into account changing inputs and conditions, such as new marketing and promotional efforts relating to a product. Lastly, a series of programs compares forecasted demand with actual demand. The programs quickly identify all discrepancies between forecast and actual demand and compile a historical record of those discrepancies. This element completes the order-entry/demand-forecasting loop and provides the dynamic demand data required to restructure production, raw-material inventories and other manufacturing elements to meet changing market conditions efficiently.

A system typically generates forecast-vs.-actual demand comparisons in the form of exception notices. At the end of each order-recording period, the DRP system implements regression-analysis procedures to compare forecast performance. Unusually high or low discrepancies are easily identified and printed in report form. Reports can be transmitted to various levels of management for reforecasting applications, or the system can automatically revise forecasts for future demand periods. In automatic reforecasting, a DRP system usually recognizes situations that consistently deviate from forecasts and issues a special report signaling its inability to reforecast effectively.

DRP-based forecasting and forecast-monitoring procedures are particularly useful in introducing products. Demand forecasts for new products represent highly researched estimates, so the probability of missing the target is higher than that of forecasts for older products. By using a DRP system, manufacturers can more frequently monitor demand for new products and can enhance the accuracy of the forecasts.

Another application of DRP systems is in organizing reports that estimate finished-goods shipment dates. Such reports allow companies to take advantage of weight and volume price discounts when scheduling truck, freight and air shipments. □

James E. Grinnell is president of Distribution Management Systems Inc., Lexington, Mass.

NEXT MONTH IN MMS

The December issue of Mini-Micro Systems, the annual technology review, is MMS's encyclopedic resource for its unique readership of value-added OEMs and users, and resellers. It consists of feature articles about various technologies, with market and product data in graphs, charts and tables.

Each topic covers the evolution of the technology and its present significance to MMS readers, including the current state-of-the-technology and state-of-the-market. The issue will address the trends within the technology, plus short- and long-term product and market projections.

Topics covered will include:

- **Databases:** models, interfaces between program and user, distributed databases and applications
- **Office automation:** integrated OA systems, dedicated function systems and software
- **Microprocessors:** architecture, fabrication, simulation and packaging
- **Artificial intelligence:** natural language translation, expert systems and vision systems
- **Co-processors:** communications, local area networks and floating point arithmetic

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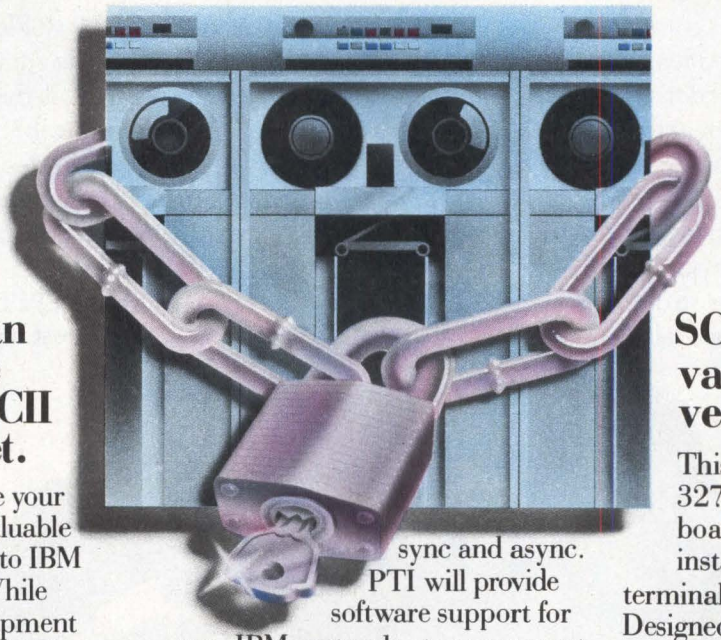
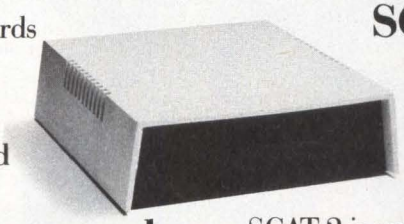


Now OEM's can profit from the expanding ASCII to 3270 market.

Our products give your ASCII peripherals a valuable new capability: access to IBM 3270 environments. While margins on async equipment continue to shrink, the 3270 market is growing at upwards of $200 million per year. So talk to Peripheral Technology—and get your share.

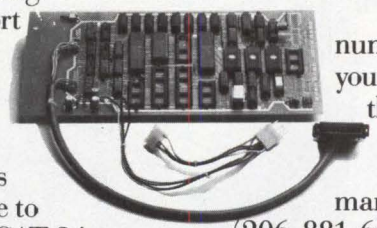


SCAT systems make OEM equipment IBM compatible.

PTI manufactures a full line of protocol converters and terminal controllers for either stand-alone or direct product integration. Used in conjunction with OEM ASCII peripherals or computer device ports, SCAT lets OEM's offer features and functions not available from IBM or other plug compatible manufacturers. OEM's can now give users the economy of dial-up instead of expensive dedicated phone lines between remote and host locations. The elimination of coaxial cables. Support for multiple hosts, both sync and async. PTI will provide software support for non-IBM protocols at your request.

SCAT 2 is more than a "black box" solution.

The versatile SCAT 2 is available for repackaging, private label or may be integrated directly into existing ASCII equipment. PTI will provide engineering and technical support for OEM product integration. SCAT 2 is available in one host or multi-host configurations and is expandable from one to twenty-five ports. SCAT 2 is a very cost effective BSC/SNA controller that satisfies all 3270 communications requirements.



SCAT 1 means value-added versatility.

This compact, reliable 3270 BSC/SNA emulation board can easily be installed in most ASCII terminals or peripheral devices. Designed as a general purpose programmable communications controller, SCAT 1 is available with RS-232 interfaces, compatible with dial-up or dedicated links and transmission speeds up to 9600 bps-full or half duplex. Operation is menu-driven, and two levels of password security are provided.

1-800-822-2208

That's the number to call when you're ready to unlock the profit potential of the 3270 BSC/SNA marketplace (206-881-6691 in Washington State). We know protocol conversion from the boards up, and offer fast delivery backed by nationwide service and support. Peripheral Technology, Inc., 14784 N.E. 95th, Redmond, WA 98052.

Peripheral Technology, Inc™

SCAT is a registered trademark of Peripheral Technology Inc.

See us at COMDEX #W-267

CIRCLE NO. 61 ON INQUIRY CARD

Star targets array-processor system for research applications

A new 32-bit microcomputer based on array-processor technology is available from Star Technology Inc., Portland, Ore. Called the ST-100, the system is intended for research applications that demand high-speed number-crunching capabilities. The ST-100 is targeted for sales to OEMs and large end users in seismic exploration, image processing and signal processing.

The ST-100 incorporates two parallel Motorola 68000 microprocessors into one master control processor. Three CPU boards, each of which includes Motorola 10K-byte gate arrays, handle storage, arithmetic and input/output. Star vice president of research and development Robert Hausman estimates the ST-100's maximum processing speed at 100 million floating-point operations per second (MFLOPS). In terms of processing speed, he notes, the ST-100 is approximately 100 times more powerful than IBM Corp.'s 4300 computer and is about 10,000 times more powerful than a typical personal computer.

Designed to run with a general-purpose host computer, the ST-100 easily interfaces to such systems as Digital Equipment Corp.'s VAX-11/780, Perkin-Elmer Corp.'s 32/40 and 32/50 and IBM's 4300 series and 3081. It is addressable via FORTRAN subroutines that can be executed on the host. Data can be transferred directly from the host's main memory or from mass-storage devices. The I/O transfer rate is 12.5M bytes per second, and the DMA channel transfer rate is 100M bytes per second.

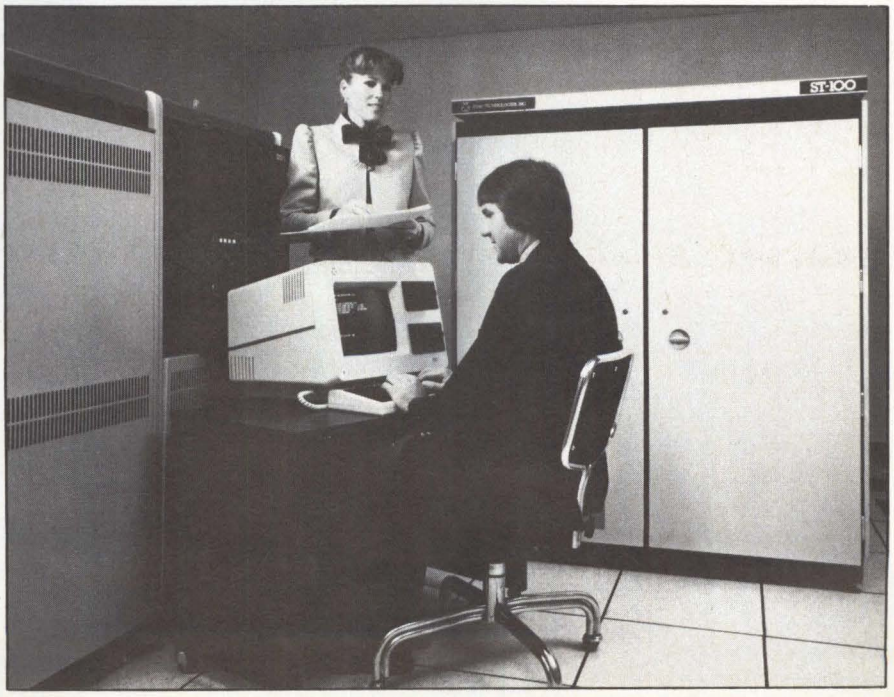
Star sees the primary market for the ST-100 as fuel suppliers. These users need computers that can quickly process large amounts of seismic data from oil and gas exploration. In late July, Star shipped its first system to GEO-X, a Canadian petroleum exploration company. GEO-X will write its own application software for the ST-100 and will configure the system to run with an IBM 4300 series computer.

Star is also targeting the ST-100 for sales to suppliers of image-processing systems for cartology and medicine. The third target market—signal-processing—primarily comprises military suppliers of sonar and radar analysis systems.

While Hausman claims that, although typical turnaround time for the design of a new computer system usually exceeds four years, Star engineers designed the ST-100 in less than 20 months. He attributes the short design cycle to the company's use of custom gate-array, computer-aided design (CAD) and simulation technologies. A technology-exchange agreement between Star and Control Data Corp. (CDC) enabled the ST-100 to be designed on a CDC CAD system. The operating software for the system was written using an ST-100 simulator during hardware design.

Selling for $250,000, a basic ST-100 system includes 500K bytes of main memory and 48K bytes of cache memory; a host interface; and operating, development and maintenance software. Star also provides installation and maintenance support.

Star Technology's ST-100 microcomputer *is targeted for number-crunching applications in the seismic-research, image-processing and signal-processing markets. It is compatible with DEC VAX 11/780, Perkin-Elmer 32/40 and 32/50 and IBM 4300 and 3081 computers.*

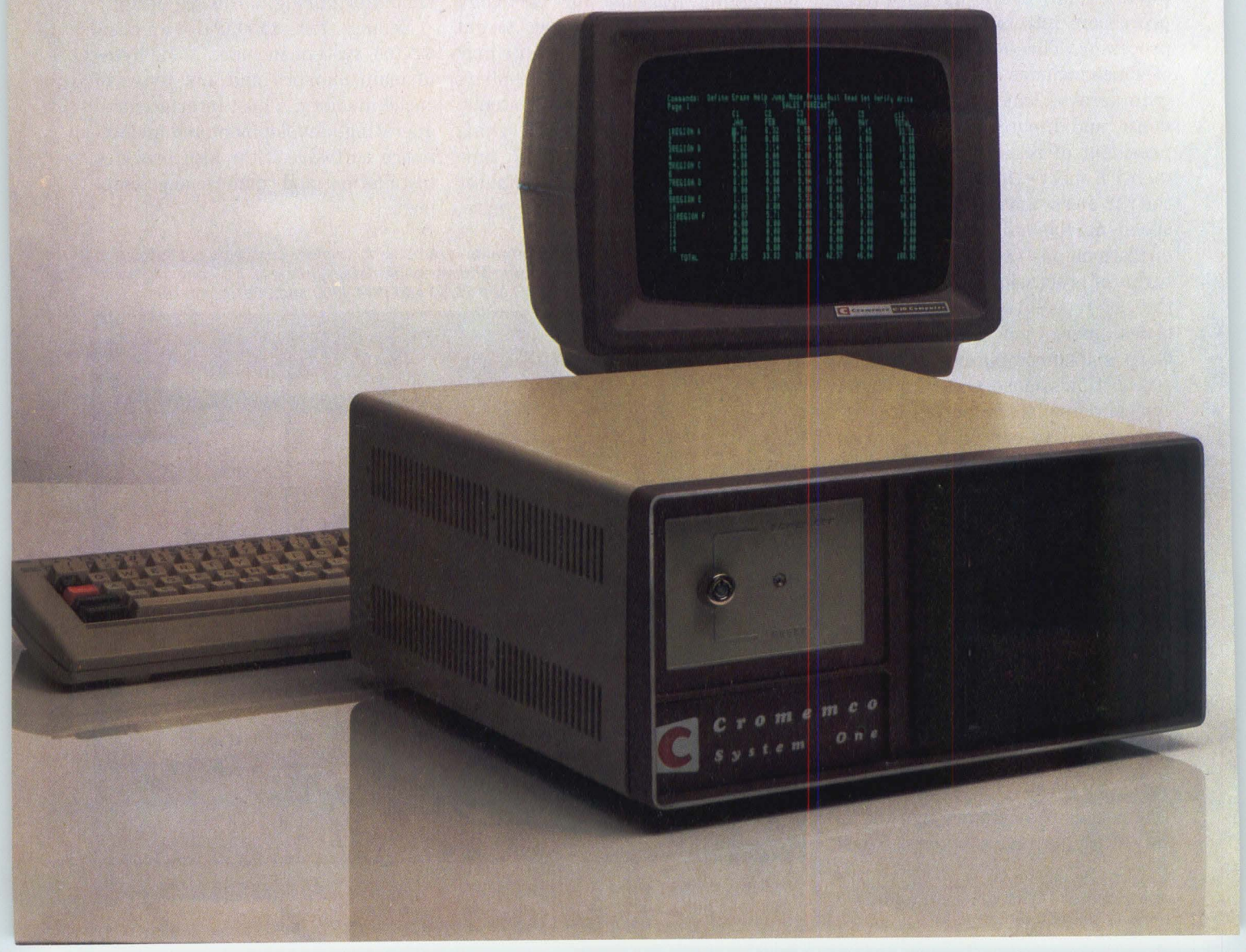


How Cromemco makes its System One doubly valuable.

The Cromemco System One gives you all the versatility and performance you need to tackle the most complex computing problems.

Dual microprocessors give you a 68000-based machine that also runs Z-80 programs. The 68000, with its 32-bit architecture, gives you superior processor capabilities and is supported by an extensive line of high level software. The Z-80A lets you use the largest base of existing application software available. Now you can get the best of both worlds in one integrated, expandable, low-cost system.

It's available with either



a full 21 Mbyte hard disk and a floppy disk or with two floppy disk drives. That puts enough processing power at your fingertips to tackle the tough jobs. But with Cromemco, you get more.

Software is where Cromemco's System One really shines. The CROMIX* operating system, inspired by the UNIX* system, runs on both the 68000 and Z-80A and provides a similar user interface, improved file security, and record level locking. CROMIX is so flexible it lets you run your CP/M* based programs, too.

We offer a full complement of high level languages as well, including FORTRAN, PASCAL, COBOL, C, BASIC, and ASSEMBLER.

The System One is a desktop computer and can support one user or multiple users. It is one of Cromemco's full range of expandable computer systems.

Since all Cromemco systems are based upon the standard IEEE-696 bus, you can configure and expand them with our broad line of board level products. To enhance throughput, our systems can use our C-10 personal computer as an intelligent terminal.

Whenever your applications require reliable computing for business or engineering use, Cromemco gets the job done.

Call us today for our new Systems Catalog or for our nearest dealer or distributor. Or write Cromemco, Inc., 280 Bernardo Avenue, P.O. Box 7400, Mountain View, CA 94039. Tel. (415) 964-7400. In Europe: Cromemco A/S, Vesterbrogade 1C, 1620 Copenhagen, Denmark.

Cromemco

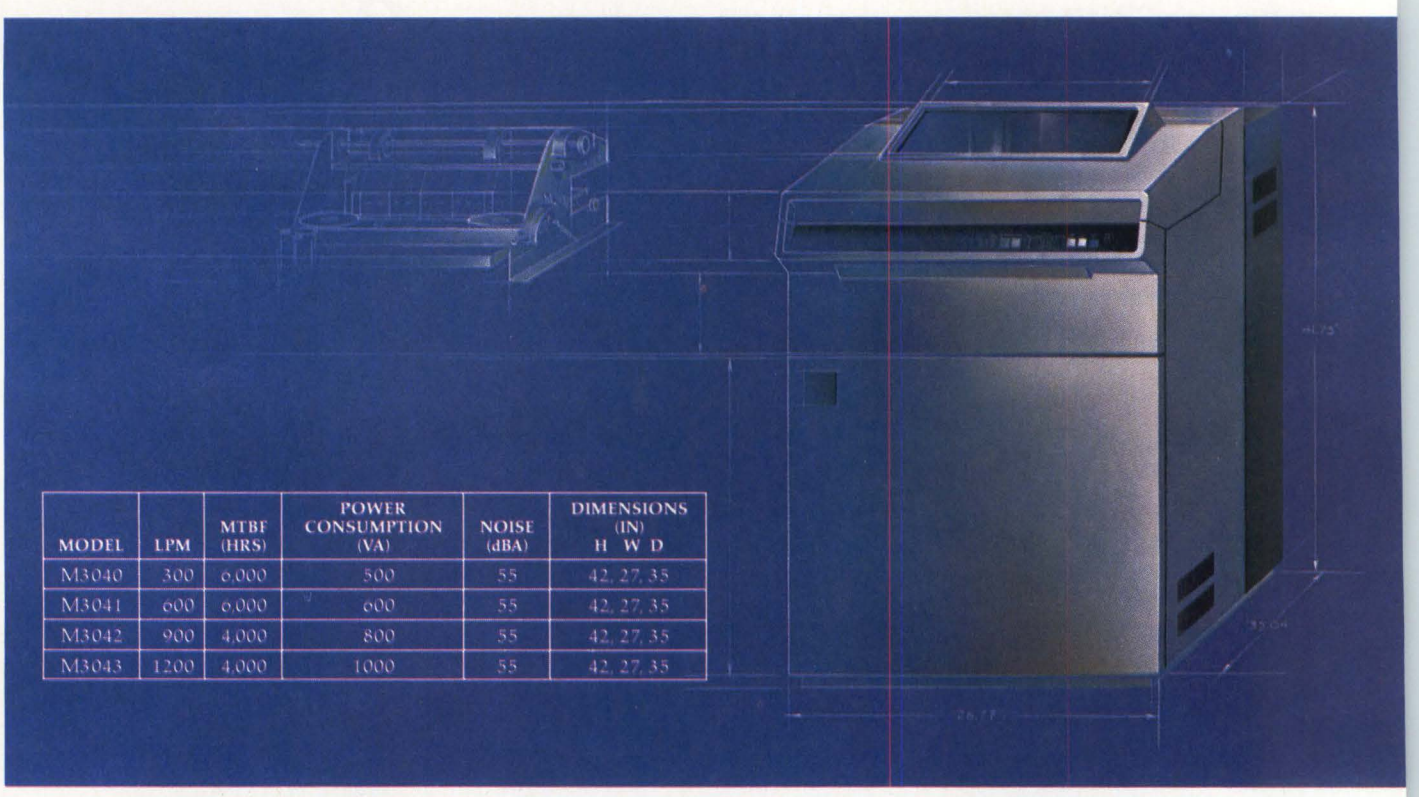
*CROMIX is a registered trademark of Cromemco, Inc.
UNIX is a trademark of Bell Laboratories
CP/M is a registered trademark of Digital Research

CIRCLE NO. 62 ON INQUIRY CARD

The New FUJITSU BAND PRINTER *Series*

When You Know How They're Built, You'll Choose Fujitsu.

That's because the entire Fujitsu Band Printer Series is built to perform, built to fit and built to last. You'll get crisp, high-quality printing when and where you need it.



MODEL	LPM	MTBF (HRS)	POWER CONSUMPTION (VA)	NOISE (dBA)	DIMENSIONS (IN) H W D
M3040	300	6,000	500	55	42, 27, 35
M3041	600	6,000	600	55	42, 27, 35
M3042	900	4,000	800	55	42, 27, 35
M3043	1200	4,000	1000	55	42, 27, 35

High reliability is also built into the Fujitsu printer design. You'll find 6000 hours of Mean Time Before Failure (MTBF) and exceptionally high parts commonality. Service requirements are infrequent and, if needed, are simple to perform.

Fujitsu's band printers are surprisingly compact. They're designed to fit into the smallest space, and at 55 decibels, they're peacefully quiet.

The Fujitsu Band Printer Series is available in speeds ranging from 300 LPM to 1200 LPM in the M3040, M3041, M3042 and M3043 models. Each printer sets a new standard in price/performance. For more information, contact Fujitsu at 3075 Oakmead Village Drive, Santa Clara, CA 95051, or give us a call at (408) 988-8100.

See us at Booth No. 1736
COMDEX™ Fall '83
November 28-December 2, 1983
Las Vegas Convention Center,
Las Vegas, Nevada

FUJITSU

CIRCLE NO. 63 ON INQUIRY CARD

Intelligent controller is alternative to dedicated industrial terminals

A portable intelligent controller from Analogic Corp., Danvers, Mass., saves industrial users the cost of dedicating a single terminal to each computer-controlled machine in their factories. Called the Linker 100, the unit also helps ensure the security of programs controlling the machines.

The Linker 100 weighs 2 pounds. It includes an 8-bit Zilog Z8 microprocessor, a 2-line-by-40-character liquid-crystal display and a 48-character software-definable keypad. Analogic targets the Linker for sales to OEMs and sophisticated end users who can tailor the unit with application-specific software or incorporate it into machines or instruments bearing private labels.

Analogic's Linker 100 intelligent controller *weighs 2 pounds and includes a 2-line-by-40-character liquid-crystal display and a 48-character software-definable keypad.*

"The uniqueness of the Linker is that it's small and portable," explains Douglas J. Tuttle, product manager of Analogic's Industrial Technology Group. "Conceivably, a user could plug it into his office, write a program and then take it down to the factory floor and plug it into a machine." Programs written on the unit can be down-loaded to a dumb machine or instrument controller via an RS232 serial port. Once programs are down-loaded, the Linker can be unplugged and used to reprogram another machine.

"There are two trends in the industry that we're trying to tap into," comments Tuttle. "A lot of machines don't need a dedicated terminal because the times that machine programs need to be altered are few and far between. The other trend is that users are concerned about the security of their programs. Once the Linker is unplugged from a machine, no one can access and change the program running that machine."

A primary application that Tuttle envisions for the Linker is as a programming device for machines that run batch operations. In a paint-mixing application, for instance, machinery might be programmed to mix one color of paint for one hour and another color for the next hour. The Linker would be used to reprogram the mixing apparatus each time a new paint batch is required.

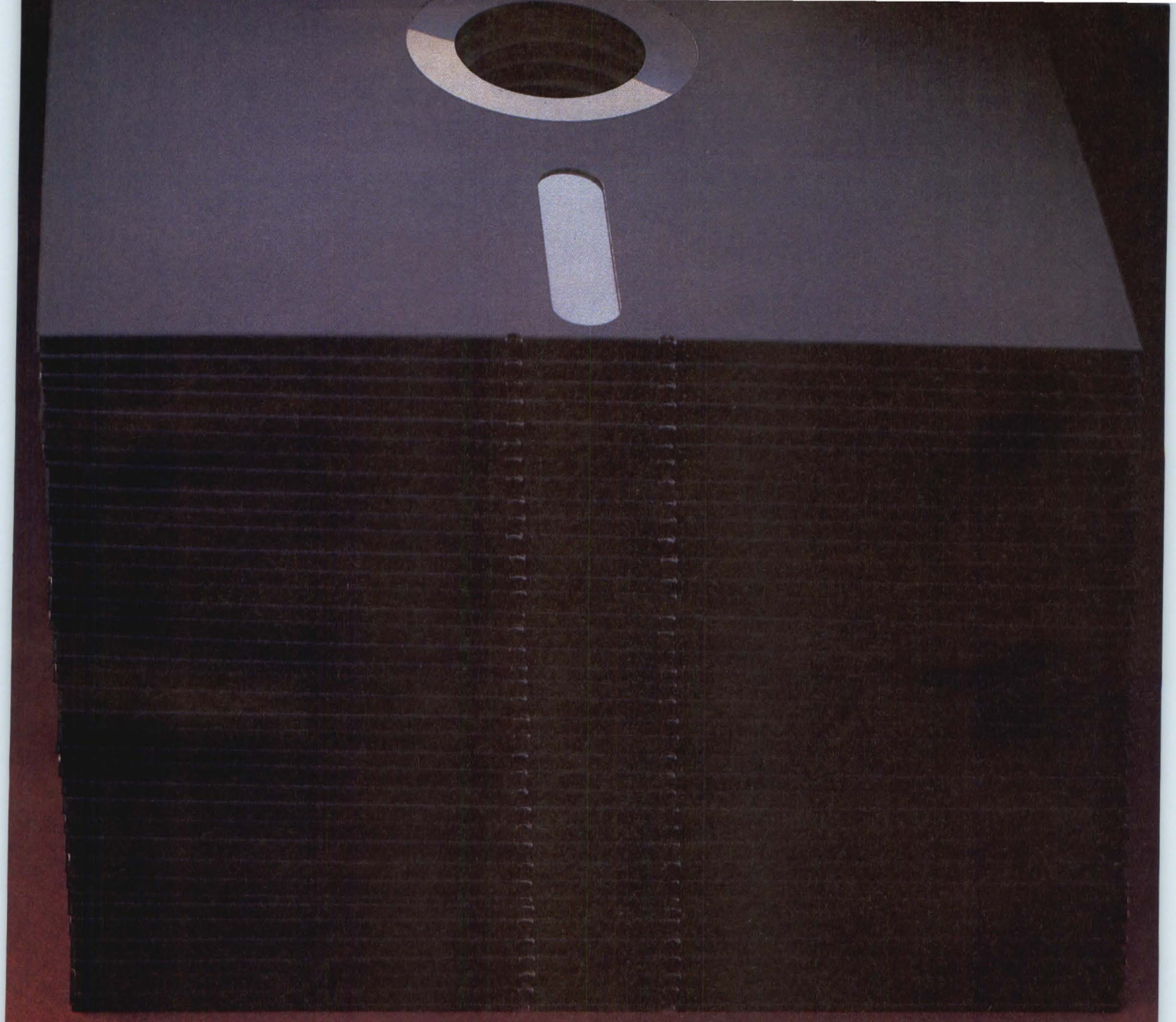
A second application of the Linker is as a ramp-temperature controller. The Linker includes a real-time clock that allows a user to program different events to occur over time. To control the temperature in an oven, for example, a user could program the device to execute a command that raises the oven temperature 5 degrees Fahrenheit every 10 minutes. Once the temperature reaches 100 degrees Fahrenheit, the Linker could execute commands that would maintain that temperature for 20 minutes and then would allow the oven to slowly cool to the starting temperature.

The Linker's display and keypad both include proprietary microprocessors allowing for concurrent overlapped processing. With that feature, the display can be used to monitor the machine's operation while a user reprograms that machine using the keypad. The Z8 microprocessor, meanwhile, could supervise both peripherals. The unit includes 2K bytes of battery-protected RAM, 8K bytes of ROM and 4K bytes of PROM. Programs can be written on the Linker in BASIC or machine code. Price of the system is $400 in 100-unit quantities.

The design solution: Winchester

Save your customers time, space, and money with ¼" data cartridges.
When 3M invented the ¼" data cartridge, they designed it to be fast, dependable, small in size, and big in capacity—up to 67 megabytes today, with more in store for the future. No wonder more and more systems designers are finding it the perfect choice for backing up Winchester drives. 45 megabytes of data can be transferred from disk to tape in under nine minutes—with no time lost for media changes. One cartridge does it all! It would take a stack of 38 eight-inch floppies* to hold the same amount of data. The cartridge is small enough to fit in a coat pocket—and rugged enough to be transported that way, too.

New rules of standardization.
Industry standards are now being formulated which will improve interchangeability of ¼" recorded data cartridges across most major manufacturers' ¼" drive systems.



back-up that eliminates stack-up.

This means concerns about compatibility are diminishing.

The logical choice.

The ¼" data cartridge is the logical choice for designers specifying back-up systems for Winchester drives. It's small, reliable, easy to handle and transport, and has a very low cost per megabyte.

These high capacity cartridges are useful for archival storage and program loading, too. So don't wait, give your customers the future. Put this innovative technology to work in the next computer system you design. Data cartridge drives are available from over 30 manufacturers throughout the world.

For more information:
For more information on how 3M ¼" data cartridges can save your customers time, space, and money, write to Chris Binner, National Sales Manager—OEM Market, Data Recording Products Division, Building 223-5N, 3M Center, St. Paul, MN 55144.

*Double sided/double density 1024 format 8" diskettes.

3M hears you...

3M

Introducing The ONYX Office.™

The new ONYX Office. It makes everyone in the company think they have their own personal computer.

And with the ONYX Office, even small and medium-sized businesses can enjoy the power and versatility of the UNIX Operating system.

With none of the complexity.

And new, brilliantly designed ONYX computers and terminals put an end to the problems that go with personal computers in the multi-user office: availability and high cost per terminal. The cost of an ONYX system for eleven users? Under $2000 per user. Much less than eleven personal computers. With remarkable ONYX Office versatility built in. Including:

ONword.™ The ONYX Office Word Processor.

A Wang™-like word processor with some even more sophisticated functions, including split windows. Its user menu, and a myriad of screen editing features provide tremendous flexibility in formatting, unmatched by any other system.

ONbase,™ the ONYX Office Database Management System.

A fast, powerful relational database system that allows the novice to use it as easily as a professional programmer. Applications can be developed, even by the end-user with ONbase non-procedural tools.

The first integrated office information package for the UNIX™ operating system.

ONmail,™ the ONYX Office Electronic Mail Program.

ONmail creates, sends, and receives mail, supporting hard copy devices and terminals. It uses mailing lists, storing and retrieving documents. The system notes mail received in the user's inbox. Summarizes what has been received, what has been read, what requires priority. Provides for certified, confidential and urgent mail.

ONcalc,™ the ONYX Office Electronic Spreadsheet Program.

Now anyone can now do forecasting easily using these unique ONcalc features: optional data display in bargraph format, financial and statistical functions, internal rate of return; least squares, present value, standard deviation, and future value. Separate spreadsheets can be merged.

Using the power of the UNIX operating system, files and data can be moved between applications, combining functions of ONword, ONcalc, ONbase, and ONmail.

ONYX Office CONNEXION.™

A run-time shell, providing a superfriendly menu and an innovative link between applications. For the software developer and systems integrator the development version of CONNEXION ties vertical applications into the ONYX office to make a complete package.

The Onyx Office, a retail value of $5,000, is now bundled with every ONYX-UNIX system we ship.

Make the Connection

ONYX UNIX

OPERATING SYSTEM

Onyx Systems, Inc., 25 E. Trimble Road, San Jose, CA 95131
In Calif. (408) 946-6330, outside (800) 538-6813

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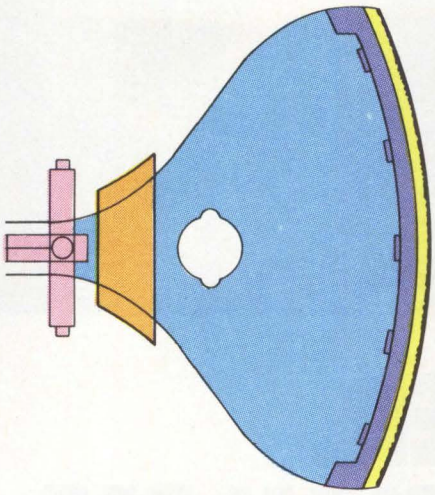
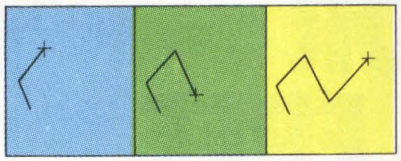
CIRCLE NO. 64 ON INQUIRY CARD

FEATURE HIGHLIGHTS



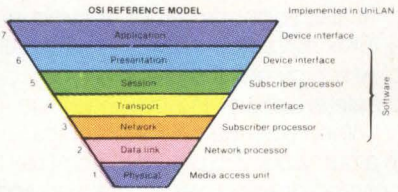
TERMINALS: Low-cost alphanumeric display terminals are no longer "dumb" devices lacking local intelligence and editing capability. Many low-cost terminals now boast impressive performance in terms of data-transmission rates, emulation, editing capabilities and graphics functions, due to advances in microprocessor technology. Turn to p. 141 to consult MMS's survey of 24 terminal manufacturers and their products . . . **Autoconvergence** is the ability to adjust convergence automatically to an original specification anytime during an application. Tektronix Inc.'s model 4115 color terminal, profiled on p. 173 offers a high-resolution display with autoconvergence to provide sharp, true colors and precise data representation for such high-density graphics applications as computer-aided design and mapping . . . The market for digital speech-processing products is projected to increase from $26 million in 1982 to more than $780 million in 1987. A key concern of speech product vendors and system integrators is how to introduce and implement voice technology for end users. See p. 183 for information on a planned threestage approach for **implementing voice-processing strategies** . . . Megatek Corp.'s Whizzard 1650 color **graphics engineering terminal** is a low-cost, versatile workstation with alphanumeric capabilities and a built-in line analyzer. Check p. 201 to see if this device meets your design needs.



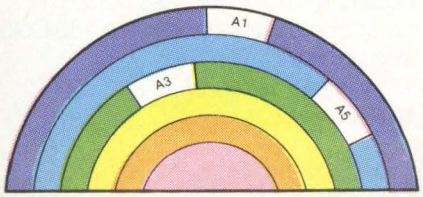
GRAPHIC WORKSTATION: Interested in fast, near-photo-quality resolution that won't tie up the processing power of your 16-bit CPU? Check p. 215 to see how Forward Technology Corp. configured its FT-500 Gateway engineering workstation. It features a specialized graphics board with key raster-scan operations hard-wired into its graphics processor.

COMDEX™
Fall '83

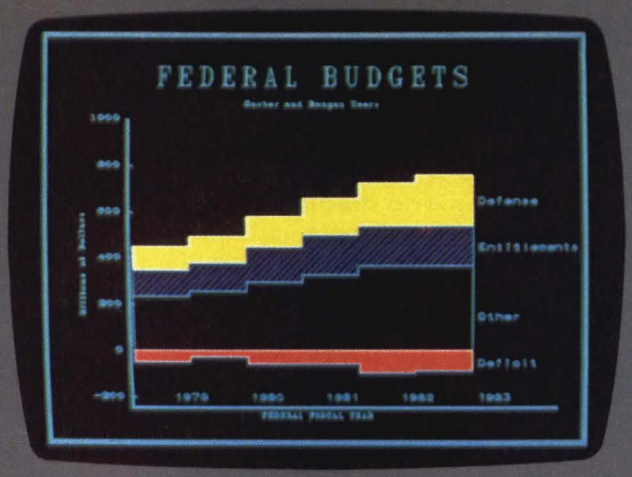
CONFERENCE PREVIEW: Software will hold the limelight when Comdex/Fall '83 convenes in Las Vegas, Nev., Nov. 28 through Dec. 2. Many of the conference's 52 professional sessions will focus on key operating system (OS) trends, integrated microcomputer software packages, major and emerging languages, developments in local area networks (LANS), database software and software interfaces for microcomputer-to-minicomputer or microcomputer-to-mainframe connections. For more highlights, turn to p. 229.

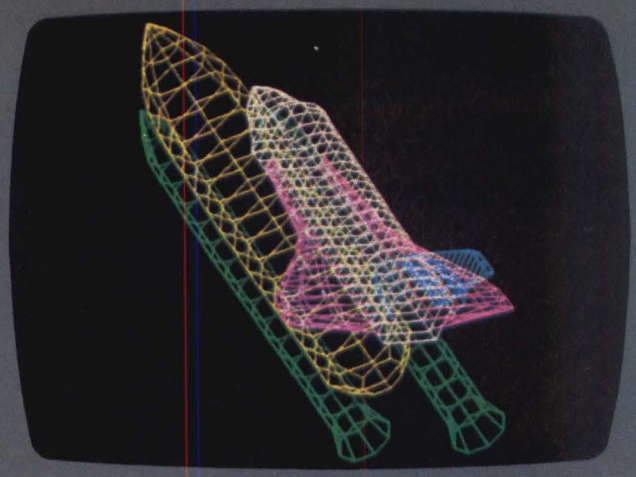


COMMUNICATIONS: Applitek Corp.'s UniLAN uses the UniLINK access method to combine the advantages of CSMA/CD and token passing on one 10M-bit-per-second network. UniLAN uses either broadband or baseband coaxial cable or fiber-optic cable and has modular software. For more information, see p. 241.



SOFTWARE: At the ancient age of 10, UNIX is seen by some as too slow and awkward for efficient microcomputer processing. Several microcomputer manufacturers have introduced enhanced systems that retain UNIX's strongest features while bringing it more into line with the new higher performance hardware. Turn to p. 255 for one company's solution.





RED HOT OFFER. GET THE NEW ENVISION 215 COLOR GRAPHICS TERMINAL AND GET COLOR ALPHANUMERICS FREE.

You're in for a nice surprise. Because when you buy our new Envision 215 Color Text/Graphics terminal you'll also get color alphanumerics. Free.

WHAT YOU DON'T KNOW

What you might not know is that our new 215 is a low priced terminal with two distinct and very usable talents.

It's an intelligent color graphics terminal which also happens to be a high quality color alphanumerics terminal. But this didn't happen by chance.

We designed both capabilities into the same terminal for one very important reason. You. And quite frankly it makes a great deal of sense because now you don't have to buy two terminals when you want to create color graphics and color alphanumerics. Our new 215 does both exceedingly well.

DID WE GIVE OUR 215 TOO MUCH GRAPHICS CAPABILITY?

Before answering, you should know our 215 is the ideal color graphics terminal for an amazingly large number of applications.

In business, scientific and engineering our new 215 tackles complex color graphics with aplomb.

There's actually a good chance you'll run out of ways to use our 215 in your particular job long before it runs out of color graphics capability.

That's because it's supported by ISSCO, Megatek, Precision Visuals and SAS Institute graphics software.

We also made it compatible with the Tektronix® 4014 which means our 215 is supported by a host of other graphics software packages.

SHARP. PUNCHY. VIVID. COLOR GRAPHICS

You don't have to be an art major to create striking graphics with our 215. You can create vivid 8-color graphics from a palette of 64 colors.

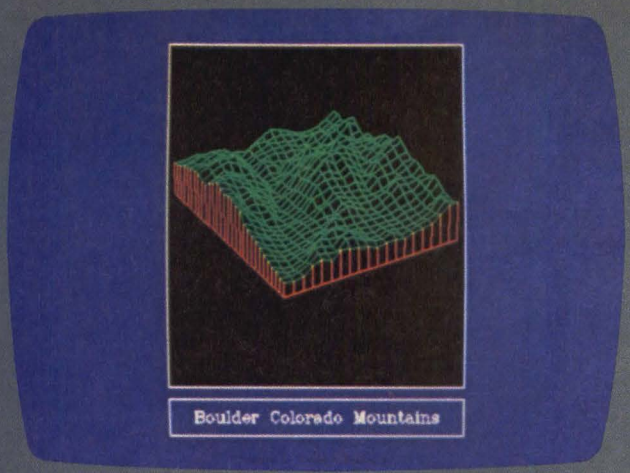
The vivid part comes from the fact that our 215 has a high resolution 640x409 display.

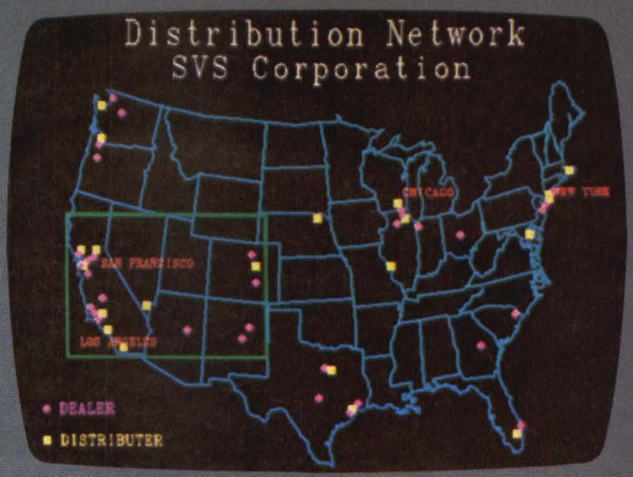
It also supports vector drawing in a 16K x 16K virtual address space. All of which means the graphics you create are sharp. Punchy. And vivid.

When you need color graphics in a hurry, our 215 provides complex polygon drawing, vector drawing and fill primitives as standards. And screen copies are easy because our 215 is compatible with our Envision 430 Color VectorPrinter.™

And there's more!

Tektronix is a registered trademark of Tektronix, Inc.
VT-100 is a registered trademark of Digital Equipment Corporation.





Five different line types are available for vector drawing. Two character fonts are provided. And both fonts can be drawn at four different angles in 16 different sizes.

If all of that's still not enough, don't forget our 215 is also a very versatile color alphanumerics terminal.

INDEPENDENT COLOR ALPHANUMERICS MAKE OUR NEW 215 DOUBLY VALUABLE

We gave our 215 independent memories for graphics and alphanumerics so you can display them separately. Or together.

We also made it VT-100® compatible with programmable soft keys and menu configuration.

You can make characters double width and double height and display 132 column information for maximum viewing.

You can also mix foreground and background colors to highlight different types of data.

A ONE YEAR WARRANTY ON ALL OUR COLOR TERMINALS

When you buy our new 215 we won't forget you. Matter of fact, you'll probably want to know more about our entire family of color graphics terminals. For example, our advanced 230 terminal gives you a local display list for interactive design applications.

Every terminal we make comes with a full one year warranty.

And because they're fully compatible, you can upgrade from one Envision terminal to another as your needs grow. Speaking of needs, you're going to like the human engineering aspects of our terminals almost as much as the capability they give you.

Our 215 for instance is small and ergonomically designed with a detached compact keyboard plus full tilt and swivel convenience. And cursor control can be mouse-driven for optimum operator convenience.

ONE RED HOT OFFER YOU SHOULDN'T PASS UP

We think you'll be impressed with our 215. But don't just take our word for it. Pick up your telephone and call us about a free demo. Or send us the coupon. You'll not only see that our new Envision 215 is a great color graphics terminal. It's also a great color alphanumerics terminal. Best of all, the alphanumerics are yours. Free.

So show a little sporting interest and take us up on our offer. You'll get a red hot demo and a chance to buy two color terminals-in-one. At a price that makes our competitors green with envy. Send us the coupon or call. Envision, 631 River Oaks Parkway, San Jose, CA 95134, (408) 946-9755 or Telex: 176437.

Display samples courtesy of: Megatek and Precision Visuals, Inc.

MM 11/83

OK, ENVISION... I CAN'T PASS IT UP. PLEASE CALL ME FOR A DEMO.

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____

STATE, ZIP _____

PHONE _____

Envision

EMULATION PLUS + AMBER

FROM AMPEX

The figures are in. Ampex Emulation Plus terminals with ergonomically superior Amber now outsell our white and green phosphor VDT's 4 to 1. But the choice is still yours. With all three colors available as standard on all three Ampex ASCII editing terminals, you've got flexibility.

Built-in flexibility to emulate up to 20 popular models*, with eight resident character sets in your choice of detached selectric-type or programmer keyboards. Price flexibility, starting with our new low-cost D125, on up to our D150 and D175. Flexibility to customize both hardware and firmware. And most importantly, maintenance flexibility through a nationwide network of TRW service centers. That's total flexibility.

Find out why Ampex Emulation Plus terminals with Amber are challenging the market with loads of features and flexibility at a price you won't believe. Call your nearest Ampex distributor, or give us a call direct at 213-416-1575.

*Including models from TeleVideo, Lear Siegler, ADDS, Hazeltine, DEC, and SOROC.

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COMPUTER PRODUCTS DIVISION
200 North Nash Street
El Segundo, California 90245

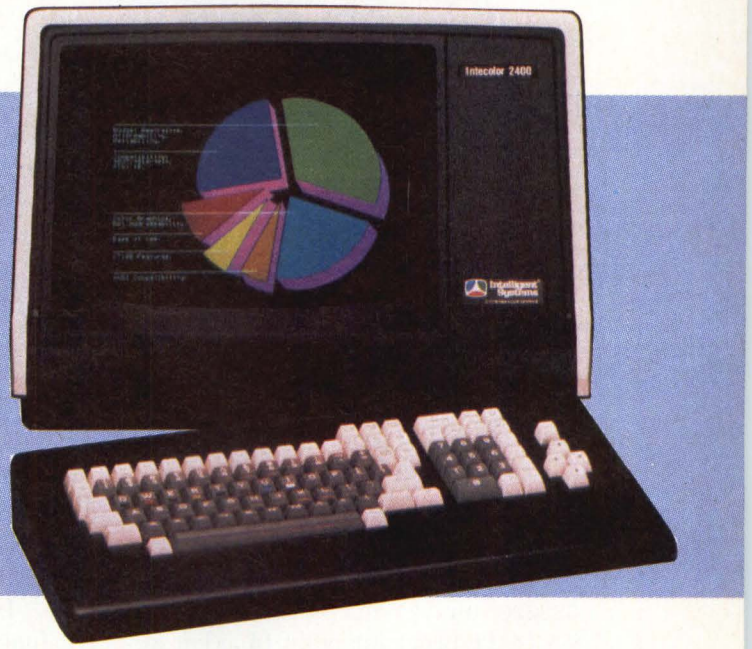
Ampex Corporation • One of The Signal Companies

CIRCLE NO. 66 ON INQUIRY CARD

Low-cost display terminals gain in capability

MALCOLM STIEFEL, Contributing Editor

Less-than-$1,000 full-screen alphanumeric terminals provide features typical of their higher-priced counterparts.



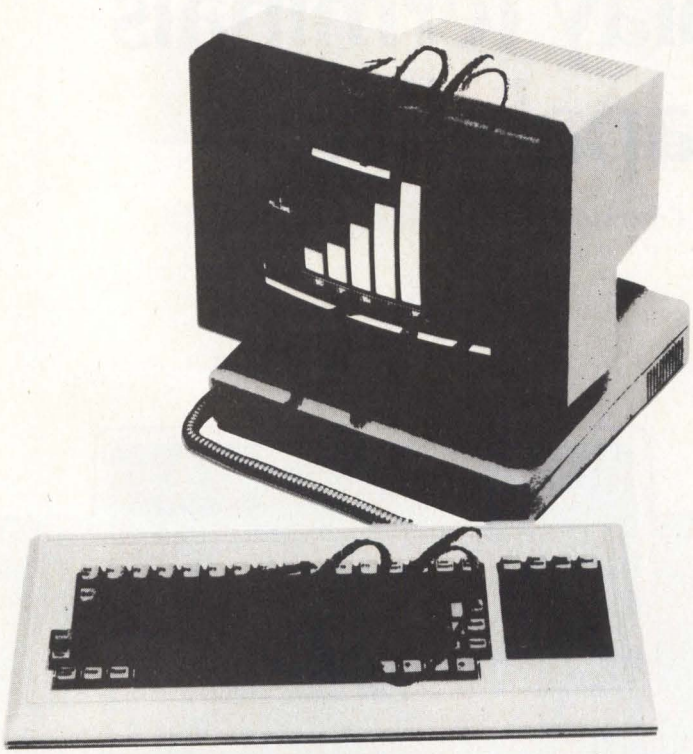
Creating color graphics in eight colors *is no problem with the Intecolor 2405 from Intelligent Systems Corp. The $995 (100) VT100-compatible display terminal also provides eight background colors, setup mode and two pages of screen RAM.*

Low-cost full-screen alphanumeric display terminals are no longer merely "dumb" devices lacking local intelligence and editing capability. Terminals selling for less than $1,000 are rapidly assuming many of the features provided by their higher-priced editing and intelligent terminal cousins. The line between high-end dumb terminals and lower-cost editing terminals is rapidly blurring as advances in microprocessor technology drive prices down and boost local-intelligence-implemented capabilities. Many low-cost terminals can thus boast impressive performance in terms of data-transmission rates, emulation, editing capabilities and graphics functions.

The table profiles full-screen, single-user alphanumeric display terminals comprising a CRT screen, a keyboard for data entry and a communications facility for exchanging data with remote computers and other terminals. A few terminals are configured for read-only operation. Less-than-full-screen, portable terminals employing liquid-crystal displays are not included in the table (see "Accessing computers from the field," Page 144). Most units use an 80-column-by-25-line display, with 25th line serving as a status line controlled by the host computer. Some manufacturers, including DTI Data Terminals Corp. and Teletype Corp., offer 132-column options, useful for spreadsheet applications. Although color can be a valuable attribute, especially in business applications, only four of the terminal vendors surveyed offer color displays in less-than-$1,000 terminals.

Profiling color units

The Intecolor 2405 from Intelligent Systems Corp. is typical of the color terminals surveyed. It provides eight foreground and eight background colors, an 80-by-24 display and 72 optional function-keyed definitions. The VT100 and American National Standards Institute (ANSI) X3.64-system-compatible unit handles 50- to 19.2K-baud data transmission and furnishes vector graphics, a setup mode and two pages of screen



Eleven programmable function keys *(22 functions) ease data entry and manipulation in Qume Corp.'s QVT 108 80-column-by-25-line terminal. Sporting an adjustable tilt/rotate 12- or 14-inch-diagonal screen, the $895 unit transmits at rates as high as 19.2K baud, furnishes five video attributes and includes editing functions.*

RAM for display information. Also providing eight colors for its display, Hazeltine Corp.'s Esprit III color terminal uses a 12-inch CRT, an 80-by-25 screen format and RS232C and 20-mA current-loop interfaces. In addition to 11 programmable function keys (22 functions), it features line graphics, character/line editing and as many as four pages of screen memory. Not to be outdone, Applied Digital Data Systems (ADDS) Inc. offers its 13-inch Viewpoint/Color unit. Furnishing eight colors and reverse-video, half-intensity, underlining and blinking display capabilities, it also sports RS422 and optional current-loop interfaces and business-graphics capability. Last, but not least, Panasonic Industrial Co. offers the $450 10-inch DT-D1000G and the $540 13-inch DT-D1300D color terminals. Both provide a 40-or 80-column-by-25-line display and graphics capabilities.

Transmitting as fast as 19.2K baud

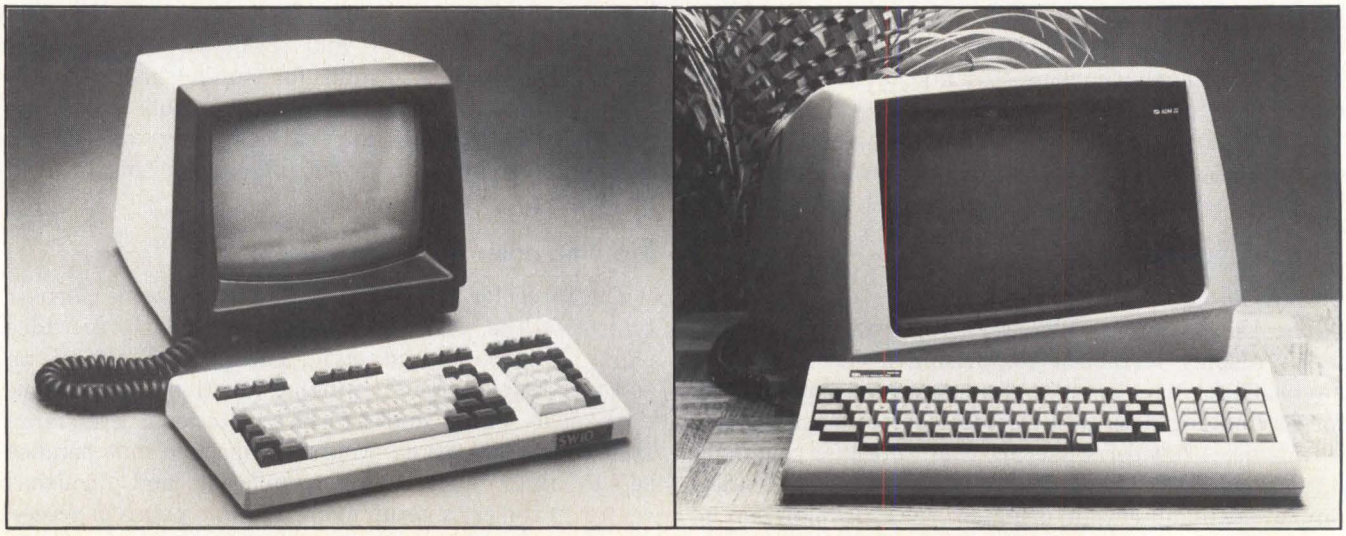
Vendors have made great strides in beefing up the interface capability of low-cost terminals. System users can now communicate at suitably high speeds with a broad range of devices. Many units carry a second port for interconnection with local printers or other peripherals, reflecting the drive toward distributed processing and the off-loading of mundane tasks, such as printing the contents of a terminal screen, from host computers.

Color displays highlight business graphics.

Most low-cost terminals profiled use serial RS232 communications at speeds as high as 19.2K baud, permitting a screenful of characters to be transmitted in 1 second. This data-rate capability proves useful in database or text-file applications. And, if a multipointing arrangement is employed, several low-duty-cycle terminals can share one line at 19.2K baud, thereby providing better performance at lower line charges per terminal.

System integrators searching for still higher data rates should check out Soroc Technology Inc.'s model C540 terminal: it functions at speeds as high as 38.4K

Low-cost but not dumb terminals, *the SW10 from General Terminal Corp. (left) and the ADM 22 from Lear Siegler Inc. both furnish 12-inch-diagonal displays, detachable keyboards, setup modes and numeric keypads. The SW10 also provides eight programmable functions, split-screen capability and 11 international keyboards; the ADM 22 provides editing functions and business graphics.*



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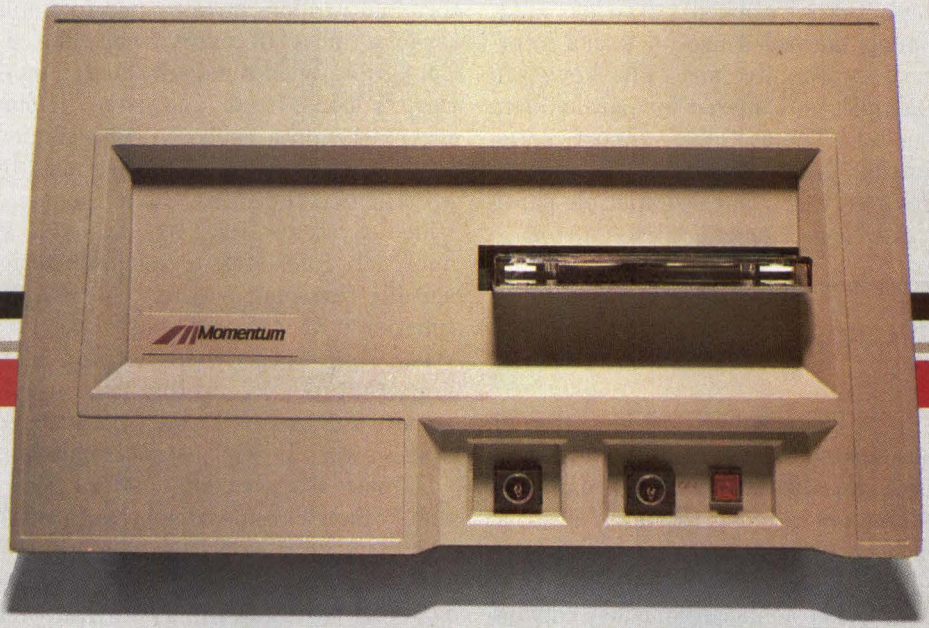

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baud. At the other end of the spectrum are some hand-held, portable units that work at 110 to 300 baud.

Not all the terminals surveyed use an RS232 interface. Cromemco Inc.'s C-1 Monitor and CKBA keyboard combination, for example, is designed for parallel data transfer on the S-100 bus. The unit also supports serial Teletype communication. Nabu Commercial Terminals' model 5000 supports 8-bit Centronics-compatible parallel communication as well as RS232.

DIN low-profile-keyboard standard aids data entry.

Most vendors continue to cling to the RS232 interface, although the newer RS422 standard provides higher bit rates over longer distances. Among the few units that support RS422 are the ADM-11 from Lear Siegler Inc., which also works with RS232, and ADDS' Viewpoint/Color terminal, which has optional current-loop capability. Most vendors, however, will continue to avoid using RS422 until AT&T Information Systems Inc. makes a concerted thrust to push RS422-compatible devices in the field.

The proliferation of protocols and control codes among terminal and computer manufacturers has hampered terminal design. Digital Equipment Corp., for example, uses ANSI-standard escape sequences to control displays in its VT52 and VT100 terminals; other major computer vendors, such as IBM Corp., do not. To solve the problem of incompatible protocols and codes, terminal vendors have turned to emulation, in which a terminal acts in every way like a device that is compatible with a certain host. For example, Ampex Corp.'s D125, D150 and D175 display terminals can accept the data codes, escape sequences and control codes of 18 terminals manufactured by six companies: ADDS, DEC, Hazeltine, Lear Siegler, Soroc and Tele-Video Systems Inc. DTI takes a slightly different approach. Each of its terminals is designed to emulate a specific terminal, such as the Hazeltine 1510+ or to function with a specific host, such as a computer from Basic Four Corp. Emulation capability is particularly important for systems that must work with a variety of remote devices or to an OEM who wishes to make a system work in various environments.

Almost all terminal vendors compensate for their units' monochrome displays through liberal use of highlighting attributes such as reverse video, blinking characters, half-intensity displays, underlining and blanking (RevVid, Blink, HalfInt, Undrln, Blank in the table). Blinking characters can be used to draw an operator's attention to a condition requiring immediate action; reverse-video or half-intensity characters can distinguish protected fields with data to be held

ACCESSING COMPUTERS FROM THE FIELD

Although they don't have full-screen displays, low-cost hand-held, portable terminals can provide access through a built-in or external modem to remote computer systems or databases using regular phone lines or even a pay phone. Axlon Inc.'s (San Jose, Calif.) Datalink 1000 hand-held terminal, for example, furnishes an optional acoustic coupler interface with soft-rubber adapter cups, powered from the terminal, that snaps onto the mouthpiece and earpiece of pay and other non-modular telephones. Powered by four NiCd rechargeable batteries or four alkaline batteries, the $399 1⅝-by-3⁹⁄₁₆-by-6¾-inch terminal has a built-in Bell 103-compatible modem, a 16-character green fluorescent display, a 224-character buffer and keyboard-selectable speeds of 110 or 300 baud. The RS232C serial port can access printers or personal computer systems with communications modems. A 40-character-per-line printer and television video-display interface with 2K wraparound memory buffer are optional. Another notable hand-held terminal is the HT/1000 from Termiflex Corp. (Nashua, N.H.), one of a line of less-than-$600 units. Using a red four-line,16-character-per-line liquid-crystal display (LCD), the 7¹⁄₁₆-by 4³⁄₁₆-by 1½-inch $516.75 (100) device features four user-selectable baud rates spanning 150 to 19.2K, user-selectable parity options (odd, even, mark or space) and four programmable function keys. The battery or line-powered (4.5V to 28V DC) terminal also provides three interfaces (RS232C, RS422, current loop), a self-test mode, cursor positioning, audible key feedback and parity-error display. The sealed keyboard permits it to be used in harsh environments. Finally, consider the MSI/85 from MSI Data Corp. (Costa Mesa, Calif.). It uses a 16-character LCD and includes a 4K-to 32K-byte memory, an integral printer and bar-code-scanning capability. —*J.V.*

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constant, such as titles, from unprotected fields holding variable information. Blanking inhibits the display of system passwords.

Graphics advance

Human-engineering factors and graphics capabilities are becoming increasingly important in terminal design. Epic Computer Products Inc.'s 14E, for example, tilts through a 30-degree range and swivels through a full 360 degrees. Its detachable keyboard and that of the ADDS Viewpoint/Color terminal are claimed to meet the 1985 German Deutsches Institut für Normung (DIN) low-profile ergonomic standard of 30-mm. from desk surface to the top of the home row of keys. Several vendors are adding basic graphics symbols to the standard character sets in response to the apparent growing need for business graphics. With a suitable host-based software package, system integrators can provide users with the ability to create block diagrams, bar charts, pie charts and line graphs, which can be made into slides or transparencies for presentations. Teletype, for example, furnishes 96 line-drawing and graphics symbols in its model 5410. TeleVideo incorporates 15 graphics characters in its model 914 and 924 terminals.

Several vendors, with their sights set on worldwide markets, also offer foreign-character sets. Ampex D150 and D175 terminals, for example, are equipped with eight keystroke-selectable national character sets—for the United States, the United Kingdom, France, Germany, Italy, Norway, Spain and Sweden. Other terminals from manufacturers such as General Terminal Corp., IMS International and Liberty Electronics USA, come in foreign-character versions.

Terminal vendors are paying increasing attention to reliability and product life. For example, a special CRT-saver circuit in the Ampex and Epic terminals disables the display of on-screen information after several minutes of inactivity. The original display is reactivated automatically as soon as a key is touched or data is received from the host computer.

Most terminal keyboards are equipped with standard typewriter keys and numeric keypads, along with cursor-control and communication keys. Some also have programmable function keys that can improve throughput and reduce error from data entry in many applications. The Teletype 5410 is typical of many designs in this regard; it incorporates eight programmable function keys that can be used to recall strings with as many as 50 characters. Screen labels describing the stored strings can be used for accessing as many as 16 characters per key, eliminating the need for plastic strips or tapes on the keyboard. Key contents and labels can be entered from the keyboard or down-loaded from a remote host.

Many terminals have editing capability, reflecting the indebtedness of low-cost terminals to their higher-priced full-editing cousins. Editing functions can include insertion or deletion of lines or characters, erasure to end of page or end of line and replacement of characters by spaces or nulls. Lear Siegler goes further in its ADM 22 terminal. It permits defining protected fields, with erasures covering the area from the cursor position to the beginning or end of a line or page and encompassing all fields or only unprotected fields.

What the future holds

Driven by the steady advance of microprocessor technology, strong competitive pressures, economies of production and expanding markets, low-cost full-screen alphanumeric display terminals have progressed far beyond their dumb-terminal predecessors to encompass many of the features of full-fledged editing terminals. Market growth will continue to be healthy. International Data Corp. (IDC) estimates that shipments of dumb and editing terminals, the main constituents of the low-cost-terminal market, will expand at a 13 percent annual rate through 1986. These technology and market trends are sure to continue, leading to the possibility that *Mini-Micro Systems'* 1986 low-cost-terminal survey will feature full-featured intelligent workstations selling for less than $1,000. □

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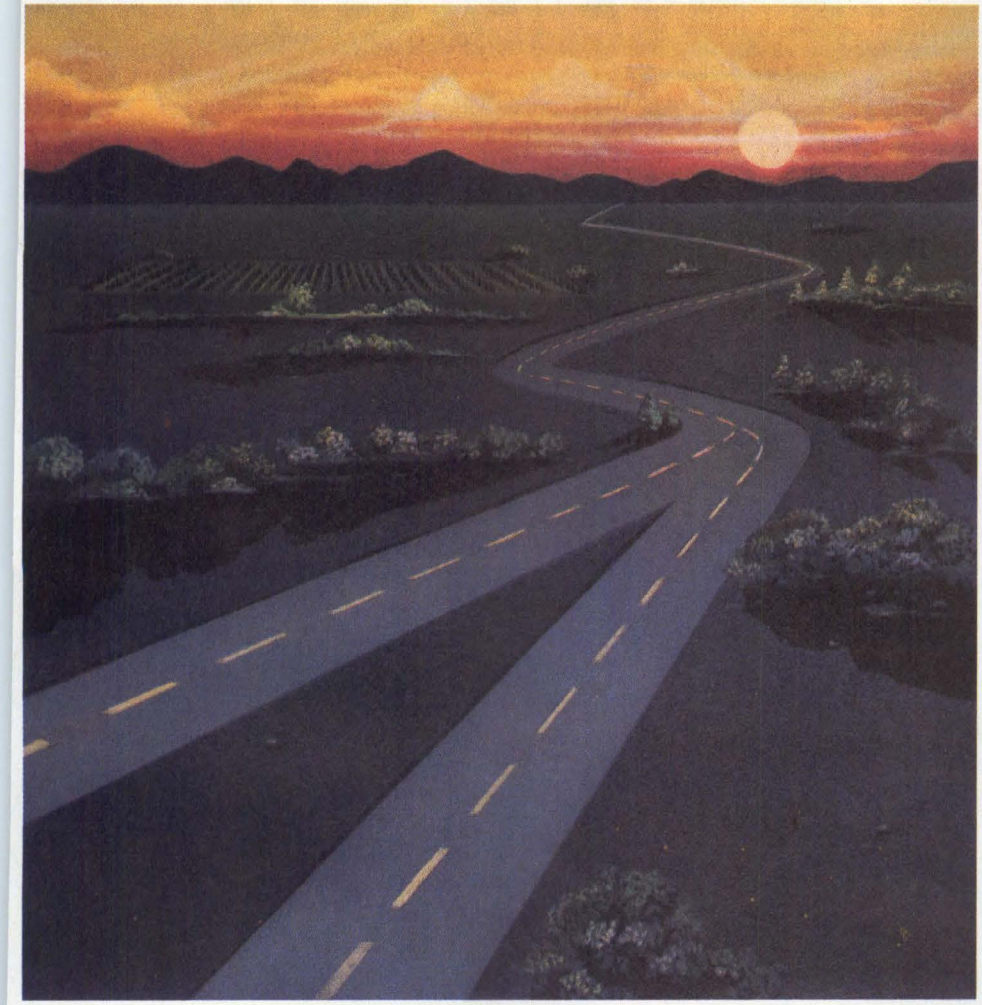

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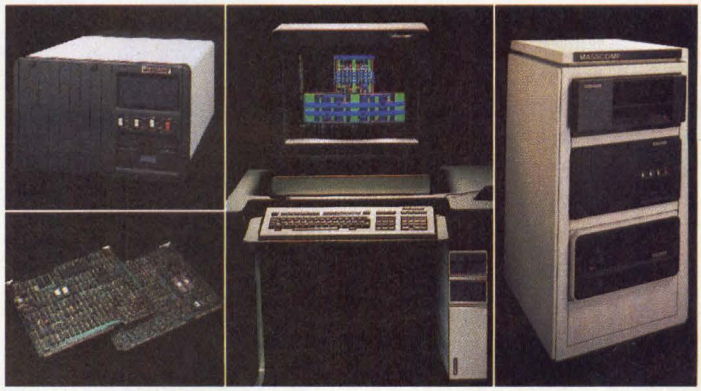

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LOW-COST FULL-SCREEN DISPLAY TERMINALS

Manufacturer, model	Display/Display characteristics	Screen format (col. x lines)	Keyboard	Interface	Price	Special features	Circle no.
Ampex Corp. 200 N. Nash St. El Segundo, Calif. 90245							831
Model D125	12-in. diag. CRT; RevVid, Blink, HalfInt; UndrIn, Blank; 8 national char. sets	80 x 25	numeric pad, 12 function keys	serial RS232, 20 mA current loop; 50 to 19200 baud; X-on/X-off protocol	$679	editing features, setup mode, emulates 16 terminal types	
Model D150	12-in. diag. CRT; RevVid, Blink, HalfInt; UndrIn, Blank, double-size characters; 8 national char. sets	80 x 25	programmer layout, numeric pad, 20 programmable function keys	serial RS232, 20 mA current loop; 50 to 19200 baud; X-on/X-off protocol	$849	editing features, setup mode, block and line graphics, scroll in 48-line field, emulates 16 terminal types	
Model D175	12-in. diag. CRT; RevVid, Blink, HalfInt; UndrIn, Blank, double-size characters; 8 national char. sets	80 x 25	selectric layout, numeric pad, 20 programmable function keys	serial RS232, 20 mA current loop; 50 to 19200 baud; X-on/X-off protocol	$869	editing features, setup mode; block and line graphics; scroll in 48-line field; emulates 16 terminal types	
Applied Digital Data Systems 100 Marcus Blvd. Hauppauge, N.Y. 11788							832
Viewpoint	12-in. CRT	80 x 24		RS232, current loop	$650	graphics capabilities	
Viewpoint/A1	12-in. CRT, 5 visual attributes	80 x 24	detachable	RS232C, CCITT 2.24; switch-selectable communications speeds	$650		
Viewpoint 60	12-in. CRT	80 x 25		RS232, current loop	$895	graphics capabilities	
Viewpoint/Color	13-in. CRT; 8 colors; RevVid, HalfInt, UndrIn, Blink	80 x 25		RS422, current-loop optional	$995, qty. 100	business graphics capability	
Axlon Inc. 70 Daggett Dr. San Jose, Calif. 95134							833
Datalink 1000	fluorescent display, 0.5-x 3.75-in. CRT	80 x 25	typewriter keys	serial RS232, read only; 110 to 300 baud; teletype protocol; built-in Bell 103-compatible modem; 224-character buffer	$399	portable; weighs 10 oz.	
Cromemco Inc. 280 Bernardo Ave. Mountain View, Calif. 94039							834
C-1 monitor & CKBA keyboard	12-in. diag. CRT; RevVid, Blink, HalfInt, UnderIn; graphics, bold, tech/math characters	80 x 25	numeric keypad	S-100 bus compatible; parallel lines, as many as 25,000 bits/sec.; teletype protocol, built-in Bell 103-compatible modem	$885	portable; weighs 10 oz.	
DTI Inc. 30 Uxbridge Rd. Mendon, Mass. 01756							835
Basic IV	12-in. diag. CRT; RevVid, Blink, HalfInt, UnderIn	80 x 24	numeric keypad, detached keyboard	RS232, 20 mA current loop; X-on/X-off protocol; 50 to 19200 baud; compatible with Basic Four computers	$995, qty 1; $850, qty 20		
E52	12-in. diag. CRT; RevVid, Blink, HalfInt, UnderIn	80 x 24	numeric keypad, detached keyboard	RS232, 20 mA current loop; X-on/X-off protocol; 50 to 19200 baud; compatible with DEC E52 code	$995, qty 1; $850, qty 20		
1510+	12-in. diag. CRT; RevVid, Blink, HalfInt, UnderIn	80 x 24	numeric keypad, detached keyboard	RS232, 20 mA current loop; X-on/X-off protocol; 50 to 19200 baud; compatible with Hazeltine 1510+	$995, qty 1; $850, qty 20		

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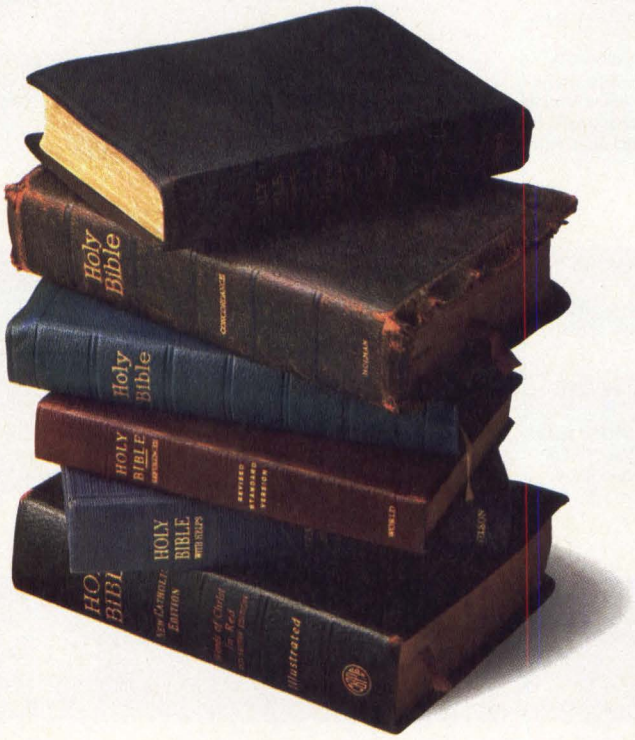

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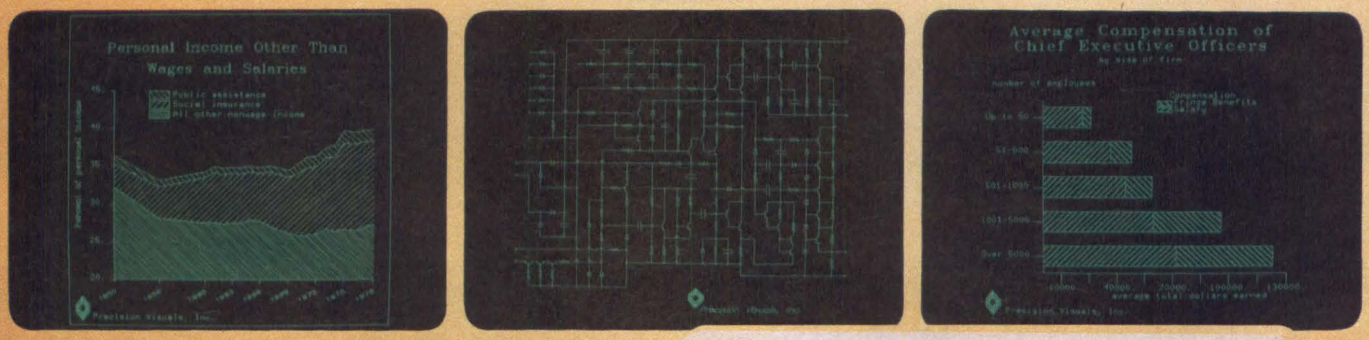
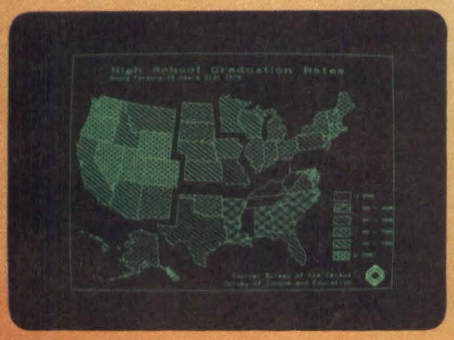
Manufacturer, model	Display/Display characteristics	Screen format (col. x lines)	Keyboard	Interface	Price	Special features	Circle no.
Prism	12-in. diag. CRT; RevVid, Blink, HalfInt, UnderIn	80 x 24	numeric keypad, detached keyboard	RS232, 20 mA current loop; X-on/X-off protocol; 50 to 19200 baud; Prism code compatible	$995, qty 1; $850, qty 20		
FALS 200	12-in. diag. CRT; RevVid, Blink, HalfInt, UnderIn	80 x 24	numeric keypad, detached keyboard	RS232, 20 mA current loop; X-on/X-off protocol; 50 to 19200 baud; Lear Siegler code compatible	$995, qty 1; $850, qty 20		
Genius	12-in. diag. CRT; RevVid, Blink, HalfInt, UnderIn	80 x 24	numeric keypad, detached keyboard	RS232, 20 mA current loop; X-on/X-off protocol; 50 to 19200 baud; Lear Siegler code compatible	$995, qty 1; $850, qty 20		
DTI 6053	12-in. diag. CRT; RevVid, Blink, HalfInt, UnderIn	80 x 24	numeric keypad, detached keyboard	RS232, 20 mA current loop; X-on/X-off protocol; 50 to 19200 baud; Data General 6053 code compatible	$995, qty 1; $850, qty 20		
DTI 200	12-in. diag. CRT; RevVid, Blink, HalfInt, UnderIn	80 x 24	numeric keypad, detached keyboard, function keys	RS232, 20 mA current loop; X-on/X-off protocol; 50 to 19200 baud; Data General 200 code compatible	$995, qty 1; $850, qty 20		
Editor	12-in. diag. CRT; RevVid, Blink, HalfInt, UnderIn	80 or 132 x 24	numeric keypad, detached keyboard, function keys	RS232, 20 mA current loop; X-on/X-off protocol; 50 to 19200 baud; DEC VT100 code compatible	$995, qty 1; $850, qty 20		
Proterm 80	12-in. diag. CRT; RevVid, Blink, HalfInt, UndrIn	80 or 132 x 24	numeric keypad, detached keyboard, programmable function keys	RS232, 20 mA current loop; X-on/X-off protocol; 50 to 19200 baud; DEC VT100 code compatible	$995, qty 1; $850, qty 20		
Epic Computer Products Inc. 18381 Bandilier Circle Fountain Valley, Calif. 92708							836
Epic 14E	14-in. diag. CRT; RevVid, Blink, HalfInt, UndrIn, Blank; 48 foreign characters; line and block graphics	80 x 24	numeric keypad, 8 dedicated and 3 programmable function keys	RS232, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 19200 baud	$995, qty 1; $645, qty 100	real-time clock display, CRT saver circuit	
Hazeltine Terminals **Div. of Esprit Systems Inc.** 100 Marcus Dr. Melville, N.Y. 11747							837
Esprit III Color	12-in. color CRT, 8 colors	80 x 25	detached, 11 programmable function keys	RS232C, 20 mA current loop	$995	line graphics, character/line editing, as many as 4 pages of memory	
Executive 10/102	14-in. CRT	80 x 132	8 programmable function keys	RS232C, 20 mA current loop	$995	line graphics, DEC VT100 emulation, menu-selectable setup	
Falco Data Products 1286 Lawrence Station Rd. Sunnyvale, Calif. 94089							838
Fame 2	12-in. or 15-in. diag. CRT; RevVid, Blink, HalfInt, UndrIn; non-embedded video attributes; tilt and swivel housing	80 x 24	numeric keypad, 20 programmable function keys	RS232, RS422, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 19200 baud	$695	setup mode	
Falco 2	12-in. diag. CRT; RevVid, Blink, HalfInt, UndrIn; non-embedded video attributes	80 x 24	numeric keypad, 20 programmable function keys	RS232, RS422, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 19200 baud	$695	software-based setup mode, compatible with ANSI X3.64	

LOW-COST FULL-SCREEN DISPLAY TERMINALS

Manufacturer, model	Display/Display characteristics	Screen format (col. x lines)	Keyboard	Interface	Price	Special features	Circle no.
General Terminal Corp. 14831 Franklin Ave. Tustin, Calif. 92680							839
SW10	12-in. CRT; RevVid, Blink, HalfInt, UndrIn; double high/wide, split screen	80 x 25	8 programmable function keys, 11 international versions	RS232, 20 mA current loop option, 50 to 9.6K baud; X-on/X-off	$849	ANSI X3.64 compatible, setup mode	
IMS International 2800 Lockheed Way Carson City, Nev. 89701							840
Ultima	12-in. CRT	80 x 25	French, German, Spanish versions	as high as 19.2K baud, full modem interface	$950	graphics capability	
Intecolor **Div. of Intelligent Systems Co.** 225 Technology Park Norcross, Ga. 30092							841
2405	12-in. CRT; 8 foreground, 8 background colors	80 x 24	72 optional function-key definitions	50 to 19.2K baud	$995, qty 100	VT100 compatible, ANSI X3.64 system compatible, VT52 mode, vector graphics, setup mode, 2 pages of screen RAM	
Lear Siegler Inc. Data Products Division 714 N. Brookhurst St. Anaheim, Calif. 92803							842
ADM-3A	12-in. diag. CRT	80 x 24	numeric keypad optional	RS232, 20 mA current loop; teletype protocol; 75 to 19200 baud	$595		
ADM 5	12-in. diag. CRT; RevVid, HalfInt	80 x 24	numeric keypad	RS232, 20 mA current loop; teletype protocol; 75 to 19200 baud	$645	limited editing features	
ADM 11	12-in. diag. CRT; RevVid, Blink, HalfInt, Blank; tilt and swivel housing	80 x 25	numeric keypad, 4 programmable function keys, tilt and swivel mechanism, DIN standard compatible	RS232, RS422, 20 mA current loop; teletype, X-on/X-off and DTR protocol; 300 to 19200 baud	$695		
ADM 22	12-in. diag. CRT; RevVid, Blink, HalfInt, UndrIn; protected fields	80 x 25	numeric keypad, 7 function keys	RS232, 20 mA current loop; teletype, X-on/X-off protocol; 75 to 19200 baud	$695	editing features; compatible with ADM-3A, 5, 31, Hazeltine 1500, and ADDS Regent 25; business graphics; self-test mode	
ADM 23	12-in. CRT; protected fields; RevVid, Blink, UndrIn, Blank	80 x 24	numeric pad, 8 function keys, international character sets optional	RS232C, 20 mA current loop optional; 75 to 19.2K baud	$795	editing functions, block mode operation, 2 pages of display memory, self test mode	
Liberty Electronics USA 100 Clement St. San Francisco, Calif. 94118							843
F-50	12-in. CRT	80 x 25	foreign character sets	RS232C, 20 mA current loop	$395	optional graphics, block mode	
F-100	12-in. CRT	80 x 25	foreign character sets, 10 function keys, numeric pad	RS232C, 20 mA current loop	$495	15 line-graphics symbols, 7 editing functions	
Micro-Term Inc. 512 Rudder Rd. St. Louis, Mo. 63026							844
ERGO-201	12-in. CRT; RevVid, HalfInt, UndrIn, Blink, Blank	80 x 25	16 programmable function keys	RS232	$695	emulates Televideo 925, Lear Siegler ADM-3A, DEC VT52, Micro-Term ACT-5A; setup mode; alternate-character, graphics options; custom mode	

High resolution, low cost graphics should be more than a retrothought.





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The VISUAL 500 provides selectable emulations of the DEC VT52,® Data General D200, Lear Siegler ADM3A,® and Hazeltine 1500 terminals. The VISUAL 550 is DEC VT100® protocol-compatible as well as a character or block mode terminal which complies to the ANSI X3.64 standard.

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VISUAL 500/550

	VISUAL		RETROTHOUGHTS						
			DIGITAL ENGINEERING				SELANAR		
	500	550	VT640S	VT640	DQ650S	DQ650M	SG100 PLUS	SG200	SG480
Vertical Resolution	585	585	240	480	240	480	240	240	480
Horizontal Resolution	768	768	640	640	800	800	1225	1225	780
Dot Density Ratio	1:1	1:1	1:2	1:1	1:3	1:1	1:4	1:4	1:1
Screen Size	14"	14"	12"	12"	12"	12"	12"	12"	12"
Tektronix 4014 Compatible	STD	STD	NO	NO	NO	STD	NO	STD	STD
Data Tablet Support	STD	STD	NO	NO	OPT	OPT	NO	NO	NO
Multi-Vendor Printer Support	STD	STD	OPT	OPT	OPT	OPT	OPT	OPT	OPT
8 Dir. Cross Hair Cursor	STD	STD	NO	NO	NO	NO	OPT	OPT	OPT
Programmable Function Keys	STD	STD	NO	NO	NO	NO	NO	NO	NO
Tilt/Swivel Enclosure	STD	STD	NO	NO	NO	NO	NO	NO	NO
Compatibility	VT52 ADM3A H1500 D200	VT100 VT52 ANSI X3.64	VT100 VT52	VT100 VT52	VT100 VT52	VT100 VT52	VT100 VT52	VT100 VT52	VT100 VT52
PRICE (suggested list*)	$2,495	2,695	3,025	3,355	3,025	3,510	2,890	3,390	3,190

*Retrothoughts price includes DEC VT100® terminal based on published information as of 4/1/83.

CIRCLE NO. 72 ON INQUIRY CARD

LOW-COST FULL-SCREEN DISPLAY TERMINALS

Manufacturer, model	Display/Display characteristics	Screen format (col. x lines)	Keyboard	Interface	Price	Special features	Circle no.
ERGO-301	12-in. CRT	80 or 132 x 25	function keys	RS232	$895	DEC VT100 emulation, 2 pages of memory, graphics options	
Mime-340	12-in. CRT	80 x 24		RS232	$750	emulates DEC VT52, Hazeltine 1410, Lear Siegler ADM 3A; ANSI X3.64, APL compatible	
ACT-5A	12-in. CRT; HalfInt, RevVid, Blink, Undrln	80 x 24	8 function keys	RS232	$995		
Nabu Commercial Terminals Ltd. 330 Weber St. N. Waterloo, Ontario, N2J 3H6, Canada							845
Nabu 3100	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln; double width characters	80 x 24	numeric keypad	RS232, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 9600 baud	$1,095, qty 1; $855, qty 100		
Nabu 4404	12-in. diag. CRT, HalfInt	80 x 24	numeric keypad	RS232, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 19200 baud	$695, qty 1; $525, qty 100		
Nabu 5000	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln	80 x 24	numeric keypad, optional auxiliary keypad	RS232, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 19200 baud; 8-bit parallel, Centronics compatible, read only	$795, qty 1; $615, qty 100		
NCR Corp. S. Patterson Blvd. Dayton, Ohio							846
Model 7901	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln, Blank	80 x 24	numeric keypad	RS232, teletype protocol, 110 to 19200 baud	$850		
Protocol Computers 6150 Canoga Ave. Woodland Hills, Calif. 91367							848
PCI 51	12-in. CRT	80 x 25	detachable, ASCII plus special EBCDIC characters	RS232	$995		
PCI 78	12-in. CRT	80 x 25	detachable, ASCII plus special EBCDIC characters	RS232	$995		
Qume Corp. 2350 Qume Dr. San Jose, Calif. 95131							849
QVT-102	12- or 14-in. diag. CRT; RevVid, Blink, HalfInt, Undrln	80 x 25	numeric keypad	RS232, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 19200 baud	$695, qty 1; $417, qty 1,000		
QVT-108	12- or 14-in. diag. CRT; RevVid, Blink, HalfInt, Undrln	80 x 25	detachable, numeric keypad, 11 programmable function keys	RS232, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 19200 baud; auxiliary serial port	$895, qty 1; $537, qty 1,000	line-drawing capability, 2 pages of memory, set-up mode	
Soroc Technology Inc. 161 Freedom Ave. Anaheim, Calif. 92801							850
C530	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln	80 x 25	numeric keypad, programmable function keys, detached keyboard	RS232, 20 mA current loop; teletype and X-on/X-off protocol; 15.5 to 38400 baud; integral 212A modem optional	$695	optional integral modem, optional expanded non-volatile RAM, line graphics option	
C540	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln	80 x 25	numeric keypad, programmable function keys, detached keyboard, tilt and swivel mechanism	RS232, 20 mA current loop; teletype and X-on/X-off protocol; 15.5 to 38400 baud; integral 212A modem optional	$995	optional integral modem, optional expanded non-volatile RAM, setup mode, line graphics option	

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CIRCLE NO. 74 ON INQUIRY CARD

LOW-COST FULL-SCREEN DISPLAY TERMINALS

Manufacturer, model	Display/Display characteristics	Screen format (col. x lines)	Keyboard	Interface	Price	Special features	Circle no.
Teletype Corp. 5555 Touhy Ave. Skokie, Ill. 60077							851
Model 5410	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln; horizontal split screen; 96 line drawing and graphics symbols; 4 windows	80 or 132 x 24	numeric keypad, 8 screen-labeled function keys, detached keyboard	RS232, 20 mA current loop; teletype protocol; 300 to 19200 baud; auxiliary printer port	$995	ANSI X3.64 compatible	
TeleVideo Systems Inc. 1170 Morse Ave. Sunnyvale, Calif. 94086							852
Model 910	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln	80 x 24	numeric keypad	2 RS232, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 19200 baud	$649	emulates Lear Siegler ADM 3A and ADM 5, ADDS 25, and Hazeltine terminals; logical attributes; block mode, protect-mode options	
Model 914	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln, Blank; tilt and swivel housing; 15 graphics characters	80 x 24	numeric keypad; 3 or 6 non-volatile function keys	2 RS232, 20 mA current loop; X-on/X-off and DTR protocol; 150 to 19200 baud; serial printer port	$699	emulates ADDS Viewpoint terminal, non-volatile setup	
Model 924	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln, Blank; all attributes non-embedded; tilt and swivel housing; block graphics characters	80 x 24	reconfigurable, numeric keypad, 16 or 32 non-volatile programmable function keys	2 RS232, 20 mA current loop; X-on/X-off and DTR protocol; 150 to 19200 baud; serial printer port	$899	off-line editing, languages, logical attributes, non-volatile setup	
Model 925	12-in. CRT	80 x 25	detached	2 RS232, 20 mA current loop option	$995	screen saver, time-of-day clock	
Visual Technology Inc. 540 Main St. Tewksbury, Mass. 01876							853
V50	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln, Blank; tilt and swivel housing; foreign character sets available	80 x 24	numeric keypad, detached keyboard	RS232, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 19200 baud; serial printer port	$695	emulates DEC VT52, Lear Siegler ADM 3A, ADDS Viewpoint, and Hazeltine Esprit terminals	
V55	12-in. diag. CRT; RevVid, Blink, HalfInt, Undrln, Blank; tilt and swivel housing; foreign character sets available	80 x 24	numeric keypad, 12 programmable function keys, detached keyboard	RS232, 20 mA current loop; X-on/X-off and DTR protocol; 50 to 19200 baud; serial printer port	$895	emulates DEC VT52, Lear Siegler ADM 3A, ADDS Viewpoint, Hazeltine Esprit, and Visual 210 terminals	
Wicat Systems Box 539 Orem, Ut. 84057							854
T7000	12-in. CRT; HalfInt, RevVid, Blink, Undrln, Blank	80 x 25		2 RS232C ports, 50 to 19.2K baud	$1000, qty 500	user definable character set in EPROM, optional touch panel, ANSI X3.64 compatible, 2 page I/O buffer	
Wyse Technology 3040 N. First St. San Jose, Calif. 95134							855
WY-50	14-in. CRT	80 or 132 x 26	detached, DIN-standard design, 16 programmable function keys, numeric pad	RS232, transmission to 19.2K baud	$695	soft setup mode, block mode	
WY-75	14-in. CRT	80 or 132 x 26	detached, DIN-standard design, 16 programmable function keys, numeric pad	RS232	$795	conforms to subset of ANSI X3.64, soft setup mode, block mode	
WY-100	12-in. CRT; split screen (vertical, horizontal); RevVid, Undrln, Blink, Blank	80 x 26	detached, numeric pad, 8 function keys	2 RS232, current loop optional; 50 to 9600 baud	$995	editing functions, line graphics, block mode	

LOW-COST FULL-SCREEN DISPLAY TERMINALS

Manufacturer, model	Display/Display characteristics	Screen format (col. x lines)	Keyboard	Interface	Price	Special features	Circle no.
Zenith Data Systems 1000 Milwaukee Ave. Glenview, Ill. 60025							856
Z-19	12-in. diag. CRT; RevVid, Blink, Undrln	80 x 25	numeric keypad, 12 special-function keys	RS232, teletype protocol, 110 to 9600 baud	$999, limited quantities	controlled by Z80 microprocessor; character/line deletion, insertion; business graphics	
ZT-1	12-in. diag. CRT; RevVid, Blinking block, Halfint	80 x 25	detached, numeric keypad, help key	RS232, teletype protocol, 110 to 2400 baud, serial printer port	$499	emulates DEC VT52; accepts log-on sequences to 132 characters from mainframe; line deletion, insertion	
Z-29	12-in. diag. CRT; RevVid, Blink, Halfint, Undrln; tilt housing	80 x 25	numeric keypad	RS232, teletype protocol, 75 to 19200 baud	$849	screen saver after 15 min., on-screen diagnostics	

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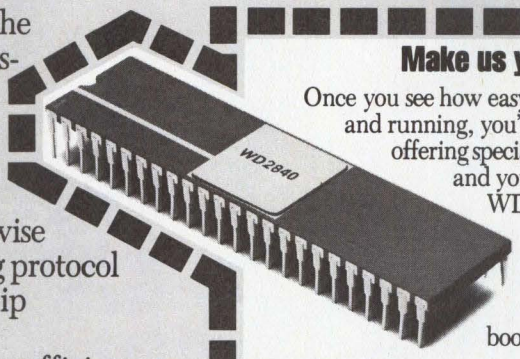

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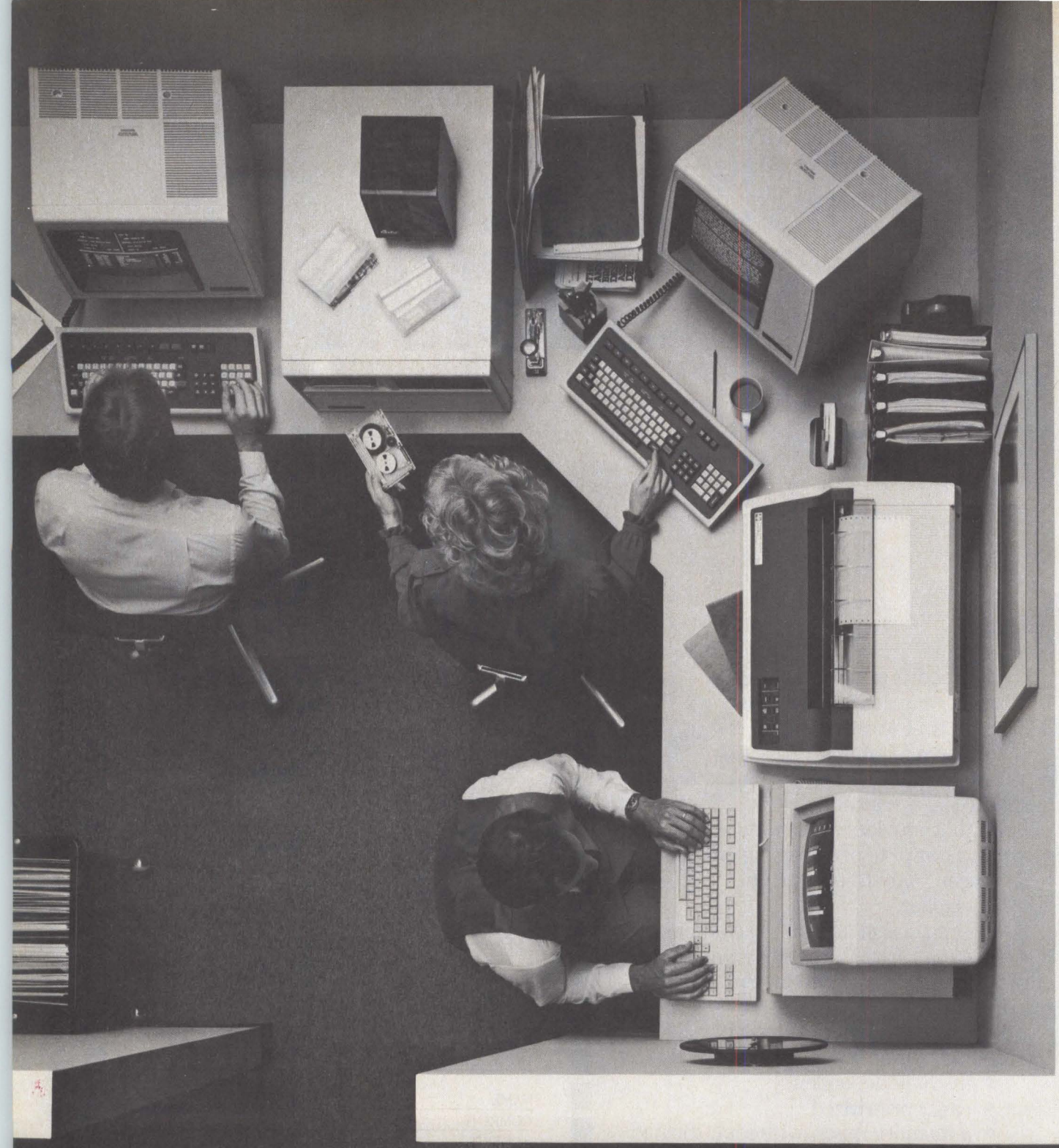

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Have you noticed that the more high technology we put into the workplace, the more human touches the workers put in? There's a real need to soften the interface between people and high technology.

That's why we designed our new High Touch™ terminals to work together with biology, not just with technology.

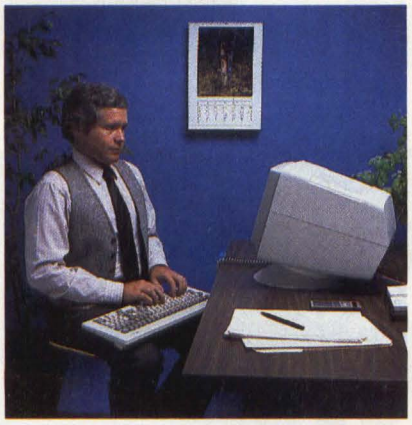
Our new generation of High Touch terminals brings an elegant new touch to our American Dream Machine (ADM™) tradition. The family features three new ergonomic terminals designed to meet the needs of OEMs and end users alike: The ADM 11, ADM 12 and ADM 24E.

There is more to ergonomics than simply tacking on a few faddish features as an afterthought. That's why we put our thinking in up front. And came up with a whole new way for terminals to relate to humans.

No aspect of terminal design escaped our deepest consideration. Or reconsideration. Dozens of little touches add up to the convenience and comfort of High Touch. For example, we put the power "on/off" switch and contrast control knob in front where they're easy to reach.

The monitor not only tilts and swivels, it stops positively in almost any position.

The clean, crisp display features a large character matrix on an easy-to-read green or amber non-glare screen—made even easier to read by the hooded bezel. Screens are available in 12″ or 14″ sizes.



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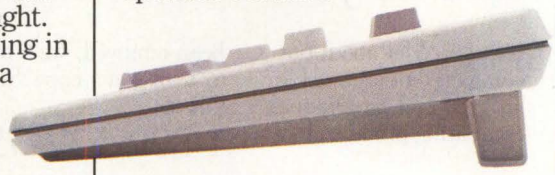
Our uncluttered keyboard, with its logical separations between key groupings, improves your efficiency. The low-profile, DIN-standard keyboard is not only tapered, its angle of tilt is easily adjusted for maximum operator comfort.



Low profile DIN-standard keyboard with adjustable tilt.

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The ADM 11 is a High Touch conversational terminal that accepts data continuously at 19.2 kilobauds. It features separate cursor control keys logically arranged in a cross for ease of use. Four modes are provided for the printer interface: page print,

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	ADM 11	ADM 12	ADM 24E
Programmable Function Keys	4 (Shiftable to 8)	16 (Shiftable to 32)	16 (Shiftable to 32)
Non-Volatile Function Keys	Optional	Standard	Standard
Function Key Legends on 25th Line	From Host	From Host	Standard Non-Volatile
No. of Pages of Display Memory	1	2	2 or 4
Display Memory Configurations (Plus 25th message/status line)	24 lines by 80 characters	(2) 24x80 or (1) 48x80 or (1) 24x158	User-Definable up to 96x80
Scrolling	Standard Scrolling	Smooth, Jump or Horizontal Scrolling Split Screen	Smooth or Jump Scroll Split Screen
Transmission Mode	Conversation Mode	Conversation or Block Mode	Conversation or Block Mode
Editing	Limited	Full Editing & Protected Fields	Full Editing & Protected Fields
Visual Attributes: Reduced Intensity, Blink Blank and Reverse Video. Underline also on ADM 12 and ADM 24E	3 Embedded 1 Non-Embedded	5 Embedded or Non-Embedded, plus Full Screen Reverse Video	6 Embedded or Non-Embedded, plus Full Screen Reverse Video and Highlight
OEM Flexibility	Modifiable Set-Up Characteristics	Modifiable Set-Up Characteristics & Personality	Modifiable Set-Up Characteristics. Add to Program in ROM or Down-Line Load in RAM (56K ROM or RAM. Plus up to 22K Display Available) Room for add'l Logic Boards.

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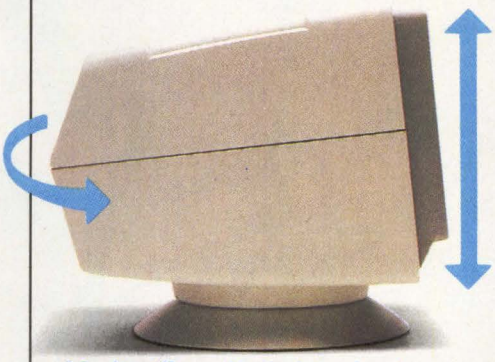

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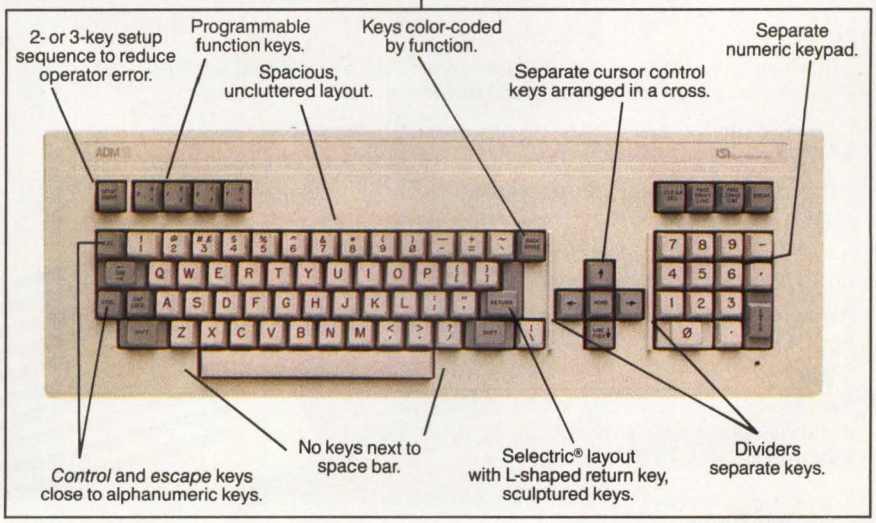

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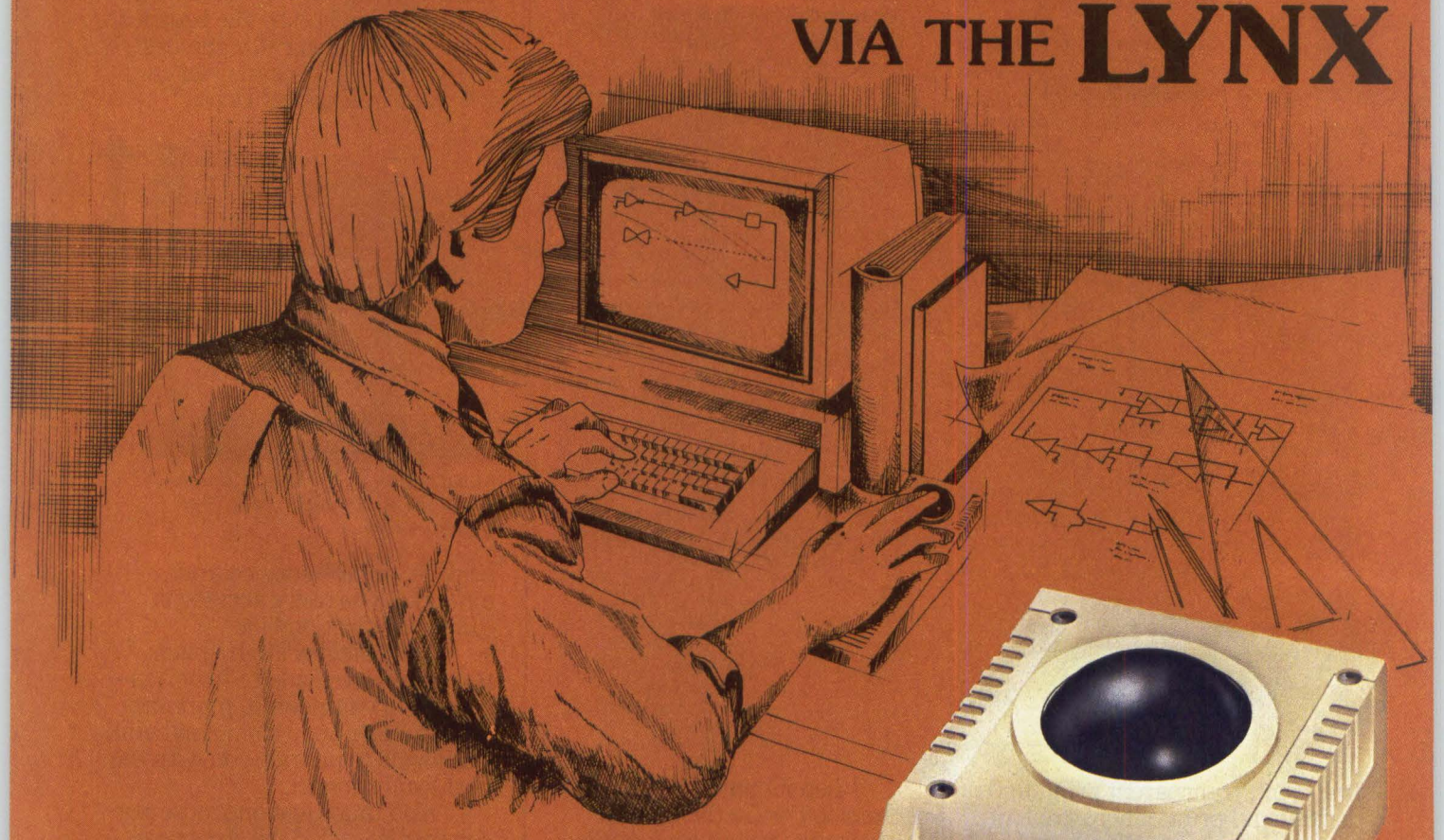

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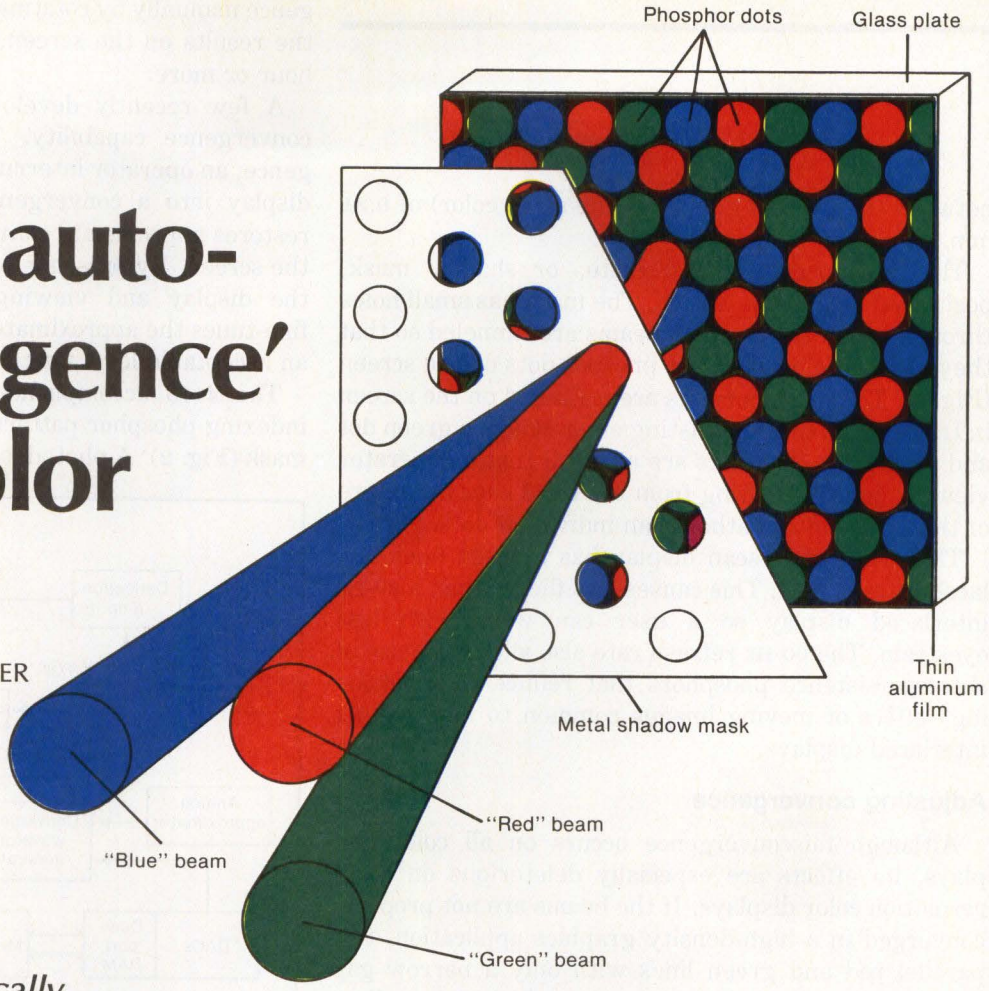
COLOR TERMINALS

Using 'auto-convergence' in a color display

DAN DENHAM, BILL MEYER
and GERALD MURCH,
Tektronix Inc.



Color convergence achieved automatically

A high-resolution color display must provide sharp, true colors and precise data representation for high-density graphics applications such as computer-aided design and manufacturing and mapping. The accuracy of such a system is largely a function of resolution and color convergence. To correct misconvergence, most displays require manual (analog) or digital convergence, both of which require adjustment by a trained technician or an operator. Tektronix Inc.'s model 4115 color display, however, offers a high-resolution display with "autoconvergence" capabilities. Autoconvergence is the ability to adjust convergence automatically to the original specification anytime during an application. If convergence drifts, the operator need only press a button on the display and wait a few seconds for the system to correct the condition.

Resolution in color displays

The 4115 has a resolution of 1024 lines × 1280 pixels. To express color resolution merely in terms of the number of lines, however, is an oversimplification. True resolution is a result of a combination of factors, including spot size, profile, pitch, refresh rate and contrast ratio. The 4115's color beams originate from a delta gun (with two beams at the base of the gun and one on top), providing a smaller spot than is possible with an in-line gun (in which all three beams are arranged in a horizontal line). Normally, a delta gun is more difficult to converge than an in-line gun. Tektronix's autoconvergence system, however, enables convergence as accurate as that of in-line guns, while maintaining the advantage of a smaller spot.

The spot profile is a measure of the energy distribution throughout each spot on the screen. The beam energy should be as evenly divided over a spot as possible. If the spot is blurred at the edges, resolution is decreased. In the 4115, energy is distributed as evenly as possible over the pixel. To increase resolution further, the 4115 has a pitch (the vertical distance

Fig. 1. A delta-gun CRT with a shadow mask *directs the electron beams associated with each of the three primary colors through holes in the mask. The phosphor dots on the screen are arranged in groups of three dots, or triads. The beams pass through the holes so that each beam excites a specific dot on the screen. The triads are small enough that, when viewed by an operator, they are perceived as a mixture of the three colors.*

between the centers of dots of the same color) of 0.31 mm.

The 4115 uses a metal plate, or shadow mask, positioned behind the screen. The mask has small holes through which the electron beams are funneled so that they illuminate the correct phospor dots on the screen (Fig. 1). The phosphor dots are arranged on the screen in triads, each triad consisting of a red dot, a green dot and a blue dot. The dots are so small that an operator viewing light emanating from the triad sees a mixture of the three colors rather than individual dots.

The 4115 raster-scan display has a 60-Hz noninterlaced refresh rate. This causes less flicker than a 30-Hz interlaced display so a user can work with less eyestrain. The 60-Hz refresh rate also allows the use of short-persistence phosphors that reduce the "smearing" effect of moving images common to many 30-Hz interlaced displays.

Adjusting convergence

Although misconvergence occurs on all color displays, its effects are especially deleterious on high-resolution color displays. If the beams are not properly converged in a high-density graphics application, two parallel red and green lines with only a narrow gap between them may appear as one thick yellow line. Thus, misconvergence could lead to serious misinterpretation of data.

Traditionally, a trained technician adjusts convergence manually by rotating potentiometers and viewing the results on the screen. The procedure can take an hour or more.

A few recently developed displays offer a digital convergence capability. To perform digital convergence, an operator interrupts the application to put the display into a convergence mode. The display then restores approximate convergence and draws a grid on the screen. By pressing keys on a keypad connected to the display and viewing the screen, the operator fine-tunes the approximate convergence until it reaches an acceptable level for the application.

The 4115 accomplishes autoconvergence by using indexing phosphor patterns on the back of the shadow mask (Fig. 2). A photodetector senses the light emitted

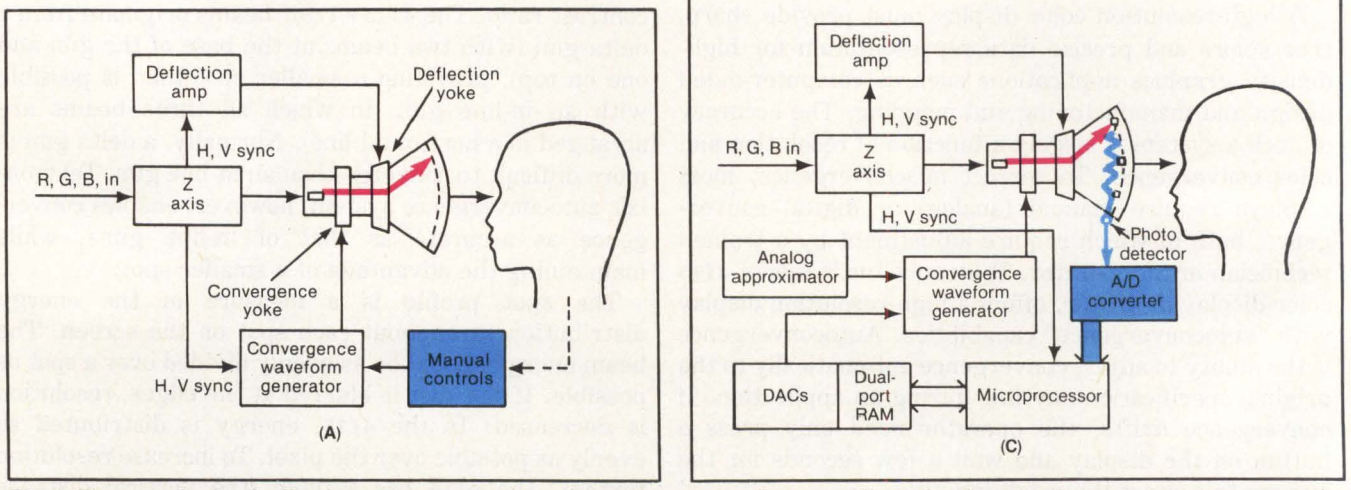
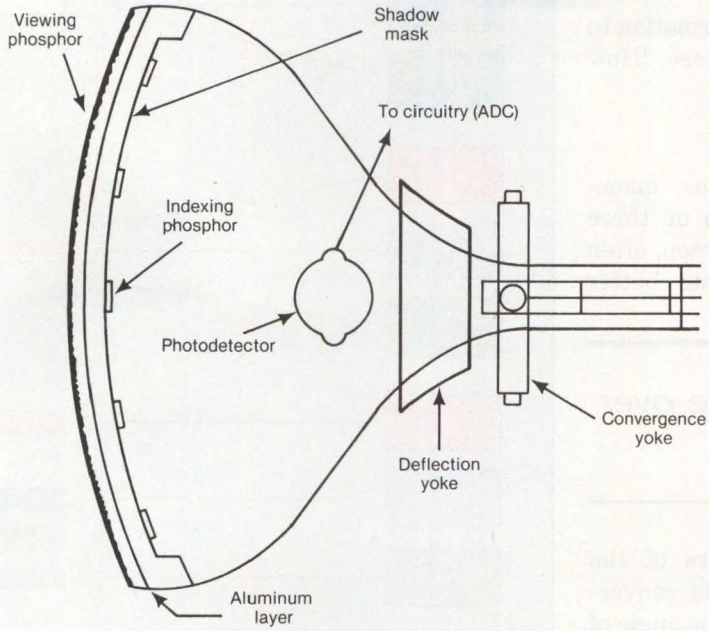
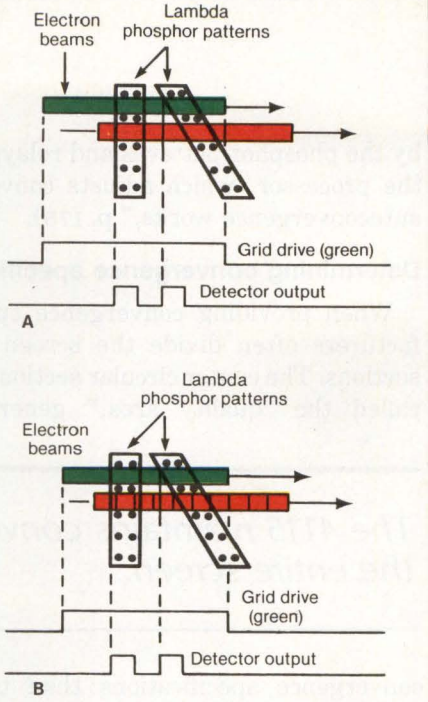
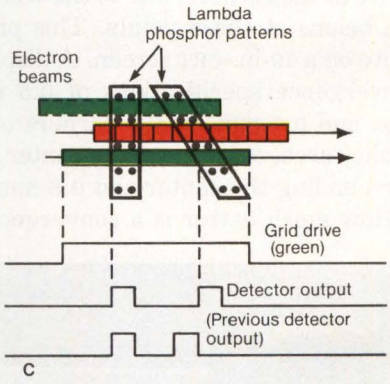


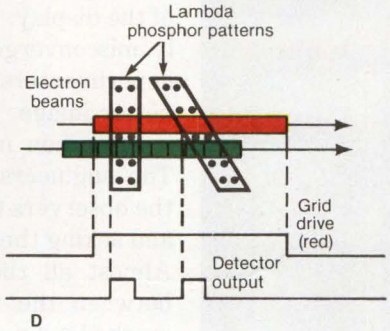
Fig. 2. Three methods of adjusting convergence. *In analog convergence adjustment (A), setting the potentiometers generates a complex waveform that, when amplified, drives the convergence yoke. The yoke's electromagnetic field independently deflects each electron beam to achieve convergence. In digital convergence (B), the display is first converged at the factory. The resulting waveform is stored in dual-port RAM. During convergence, the values in RAM are fed through a digital-to-analog converter to generate the original waveform. The convergence is only approximate because it represents the condition of the new display in the factory. An operator must further adjust the convergence to account for the current condition of the display, which has been affected by such factors as temperature, age and position. Autoconvergence (C) frees the user from performing adjustment, which saves time and provides more precise adjustment. Autoconvergence uses optical feedback to sense the location of each electron beam. As in digital convergence, a complex waveform is stored in RAM in the form of digital values. By modifying these values, which are then fed through a D/A converter and amplified, the display's microprocessor can adjust the beams so that they converge within the specified range.*

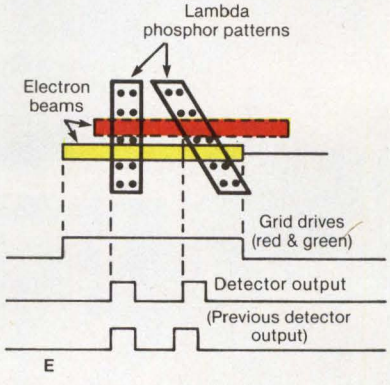
HOW AUTOCONVERGENCE WORKS











As the electron beams scan the screen, phosphor patterns (indexing phosphor) on the back of the shadow mask emit light back into the tube in the same way that the screen phosphors emit light to the viewer. The phosphor patterns do not block the holes of the shadow mask and have no effect on beam energy reaching the phosphor dots on the screen. An aluminum layer between the shadow mask and the screen reflects light from the phosphor dots toward the viewer and prevents errant screen light from reaching the photodetector (above figure). The phosphor patterns are deposited in locations corresponding to 13 representative convergence points on the screen.

Each phosphor pattern is shaped so that the photodetector outputs two pulses—first when the beam scans the vertical line in the pattern and again when it scales the diagonal line (Fig. A, right). Tektronix calls the phosphor patterns "lambdas," because of their resemblance to the Greek letter. The processor can determine the relative positions of the electron beams from the time difference between the two pulses. The processor adjusts the beam positions at each of the 13 locations, enabling the 4115 to maintain its convergence specification across the entire viewing area.

During autoconvergence, the processor directs the display to turn on one electron beam at a time and receives a pair of pulses for each beam. By comparing the pairs of pulses, moving each beam individually and comparing the new photodetector output, the processor can adjust convergence. The autoconvergence procedure is complete when the pulse pairs for all three beams match within the range for the convergence specification.

In a typical autoconvergence procedure, *the green and red beams are turned on to produce a yellow line. The beams are misconverged, however, so separate red and green lines appear (A). The processor turns off the red beam to get a photodetector output for the green beam (B). By moving the green beam and comparing the new detector output with the previous pair of pulses, the processor determines the relative position of the beam (C). The processor then turns off the green beam, activates the red beam and compares the new pair of pulses with the green beam's detector output (D). The processor then computes the misconvergence and applies the necessary correction to the convergence waveform until the pulse pairs match and the beams are converged (E).*

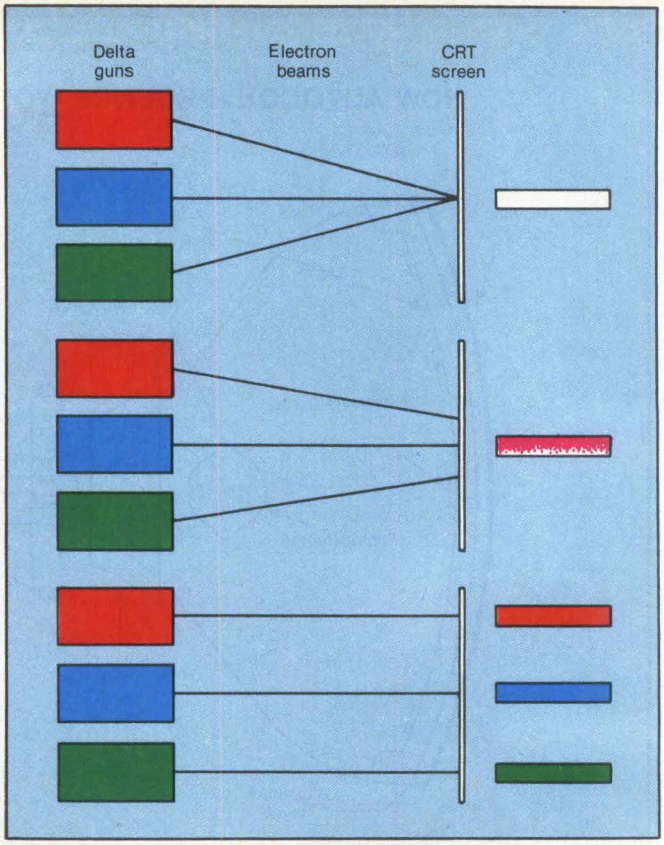
by the phosphor patterns and relays the information to the processor, which adjusts convergence (see "How autoconvergence works," p. 175).

Determining convergence specifications

When providing convergence specifications, manufacturers often divide the screen into two or three sections. The center circular section of the screen, often called the "quality area," generally boasts better convergence specifications than the corners of the screen because it is difficult to maintain tight convergence at the corners, due to the wide deflection angle of the beams at these points. This problem is especially acute on a 19-in. CRT screen. A display, then, may have convergence specifications of 0.5 mm. in the quality area and 0.7 mm. at the corners or, by shrinking the quality area, 0.3 mm. at the center, 0.6 mm. in an area surrounding the center and 0.8 mm. at the corners.

The 4115 maintains convergence over the entire screen.

How much better is a convergence of 0.3 mm. than 0.5 or 0.8 mm.? In designing the 4115, Tektronix engineers tried to answer this question by devising an experiment to find the value at which a user could no longer detect misconvergence. In the experiment, a display's screen was split in half, and two identical images were displayed. Both images initially were converged as well as possible within the technical limits of the display. One of the images was then progressively misconverged to a series of specified values. The experimenters then asked observers to choose the better image. The observers preferred the converged image when misconvergence reached 0.4 to 0.5 mm. The engineers then repeated the experiment, telling the observers that one of the images was misconverged and asking them to choose the better converged image. Almost all the subjects could detect the difference between the two images when the misconvergence reached 0.2 mm. Thus, Tektronix designed the 4115 to meet a convergence specification of 0.2 mm. or better across the viewing area of the screen. □



Misconvergence causes distortion of color *and can result in the display of false information. When the red, blue and green electron beams are properly converged, a solid white line appears on the screen. If the beams are misconverged, the result is a thick pink line. The colors appear separately in a worst-case condition.*

The Tektronix 4115 *is designed for high-density graphics and has an autoconvergence capability that automatically converges the CRT's electron beams for precise color presentation. The system is priced at $19,500.*

Dan Denham is an engineering project manager, **Bill Meyer** is a design engineer, and **Gerald Murch** is the director of the perceptual research group at the Information Display Division of Tektronix Inc., Beaverton, Ore.

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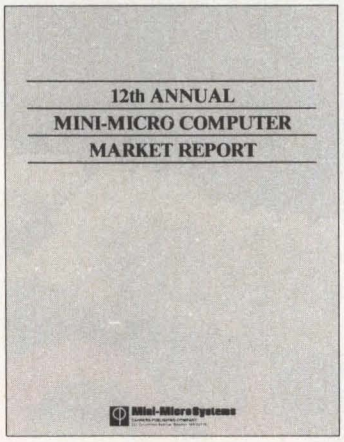

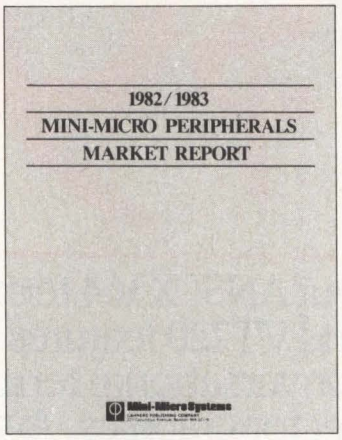

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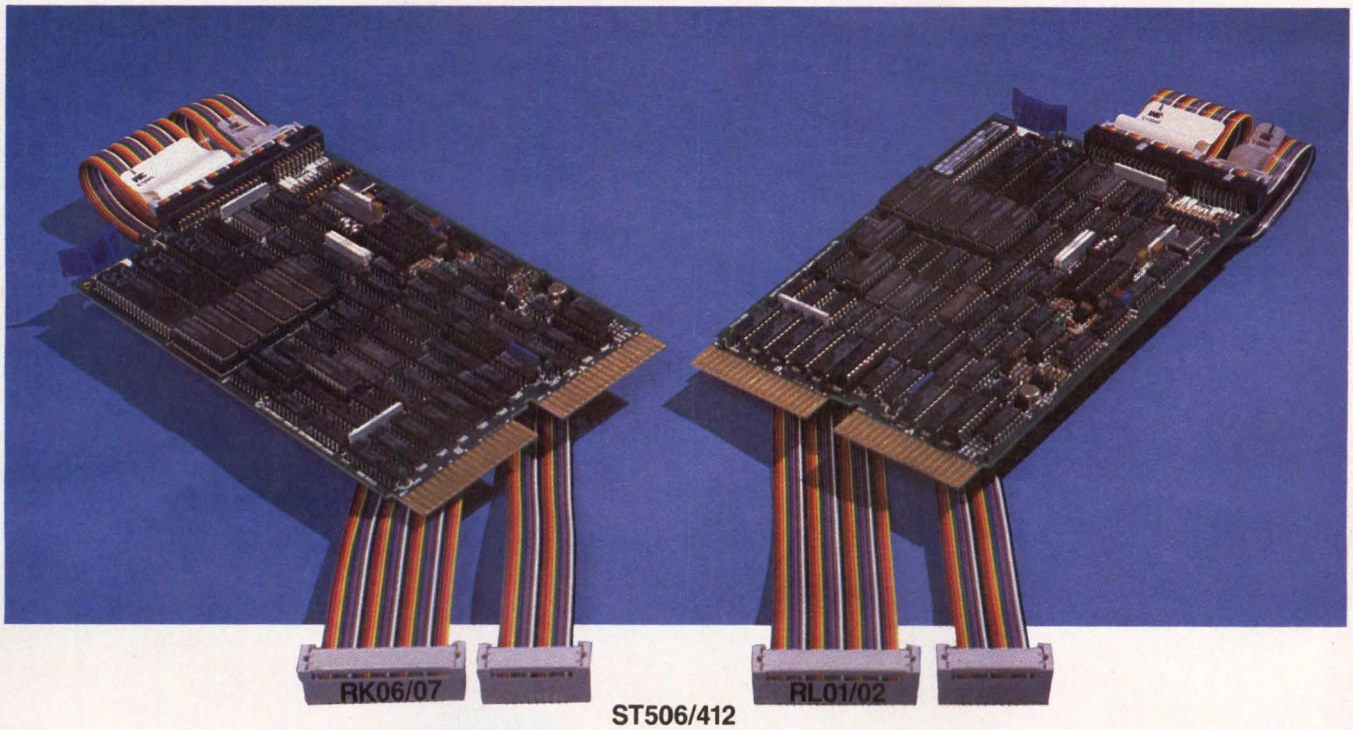

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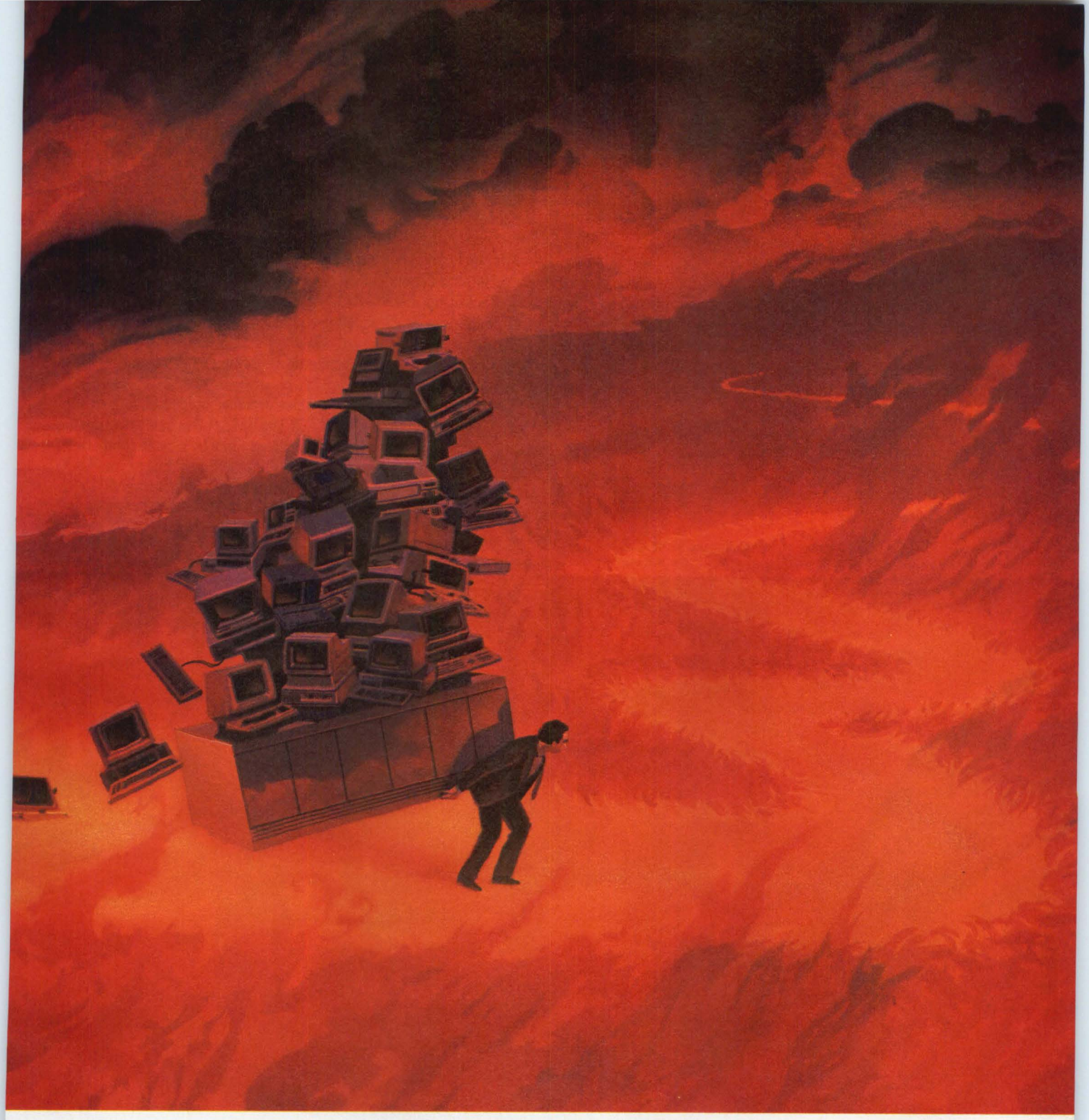

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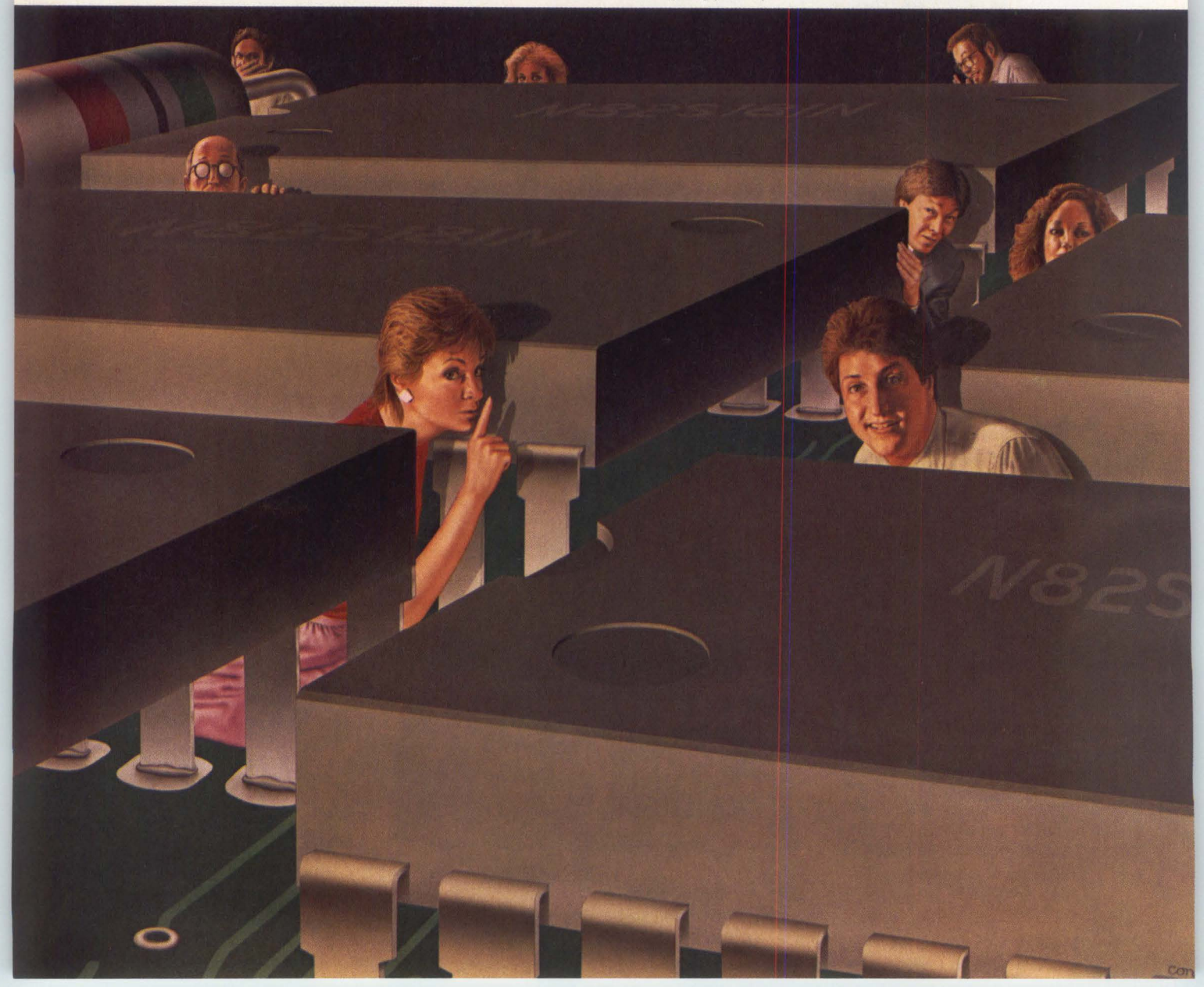
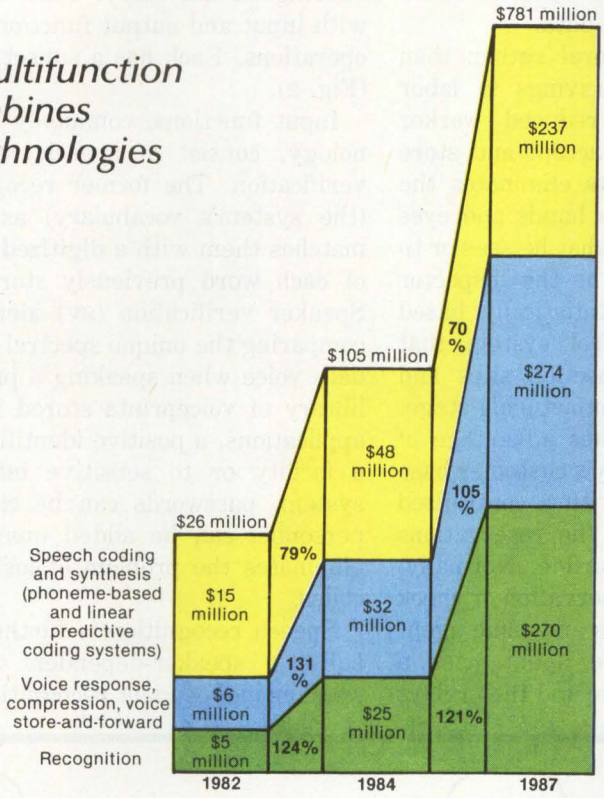


Implementation strategies for voice-processing terminals

JOE NANCE, Votan

Multichannel, multifunction voice utility combines major speech technologies



Source: International Resource Development Inc.

Fig. 1. Compound annual growth rates for the major categories of speech-processing products. *Speech-recognition system sales will increase more than 50-fold, while the total market is projected to increase 30-fold.*

The market for digital speech-processing products is projected to increase from $26 million in 1982 to more than $780 million in 1987. A key concern for speech-product vendors and system integrators is how to introduce and implement voice technology for end users. A system integrator can implement voice technology in a planned, three-stage approach that allows migration from a single-application system to one that encompasses both company-wide and external use.

Why voice terminals?

Human beings communicate with computers and other high-order machines in ways that usually require special training or skill. Voice technology addresses the need for a more "human" man/machine interface. The ability to use speech to command the activities of a computer or computer-controlled machine and to have that machine respond with speech output provides a terminal that truly lives up to the overused descriptor "user friendly."

The banking, retailing, manufacturing and transportation industries have recognized the benefits of using voice-processing terminals. Users of voice-based transaction systems require little training. The systems are convenient to use: speech allows a user to enter data faster and more accurately because it eliminates the use of transcription and intermediate processing steps. This translates into lower error rates, improved blue- and white-collar productivity and cost savings. As a result, the market for voice-technology products is projected to more than double each year for the next four to five years (Fig. 1).

The market for speech-processing terminals falls into two generic application areas: "busy hands/busy eyes" and remote transaction processing. Busy-hands/busy-

eyes situations are typically those in which an operator must interrupt a primary activity to enter or read other information. A prime example is the use of scientific instruments in manufacturing such products as semiconductor wafers. An inspector uses a high-power microscope to inspect chips for defects. The integrated-circuit (IC) inspector notes the type, nature and most likely source of the defect. The inspector or an associate must then compile and transcribe the data.

A voice-input terminal allowing oral rather than written notes provides significant savings in labor costs, increased productivity and reduced worker fatigue. A voice system tailored to accept and store verbal information about chip defects eliminates the need for the IC inspector to take his hands and eyes away from the microscope to record what he sees or to have another person to take notes as the inspector works. This allows creation of a statistically based real-time data-acquisition and control system that immediately flags problems at inspection sites and initiates corrections at an earlier manufacturing stage.

Remote transaction processing takes advantage of telephone terminals so that a company's customer base or mobile sales force can interact with a centralized information system. An example is the reservations and information system of a major airline. Normally, when a customer wants to make a reservation or check flight availability or air fares, he calls an airline agent and requests the information. The agent uses a computer terminal to query a database and then relays the information to the customer. By having a voice-processing terminal "answer" the phone, the caller can talk directly to the airline computer system, eliminating the intermediary. In the same fashion, a field salesperson can call the computer and place orders, check inventory status or confirm shipping dates 24 hours a day without interrupting office personnel and without concern for time differences.

Voice-processing comprises many technologies

To understand the implications of speech-processing terminals, familiarity with the basic technological offerings is necessary. Voice technology is concerned with input and output functions as are other terminal operations. Each has a subset of distinct technologies (Fig. 2).

Input functions, commonly called recognition technology, consist of speech recognition and speaker verification. The former recognizes particular words (the system's vocabulary) as they are spoken and matches them with a digitized "template," or pattern, of each word previously stored in system memory. Speaker verification (SV) identifies an individual by comparing the unique spectral qualities of that individual's voice when speaking a prescribed password to a library of voiceprints stored in memory. In security applications, a positive identification permits access to a facility or to sensitive information. With an SV system, passwords can be changed, and authorized personnel can be added quickly and easily. It also eliminates the problem of lost card keys and broken codes.

Speech recognition is further characterized by two subsets: speaker-dependent recognition (SDR) and speaker-independent recognition (SIR). SDR recognizes

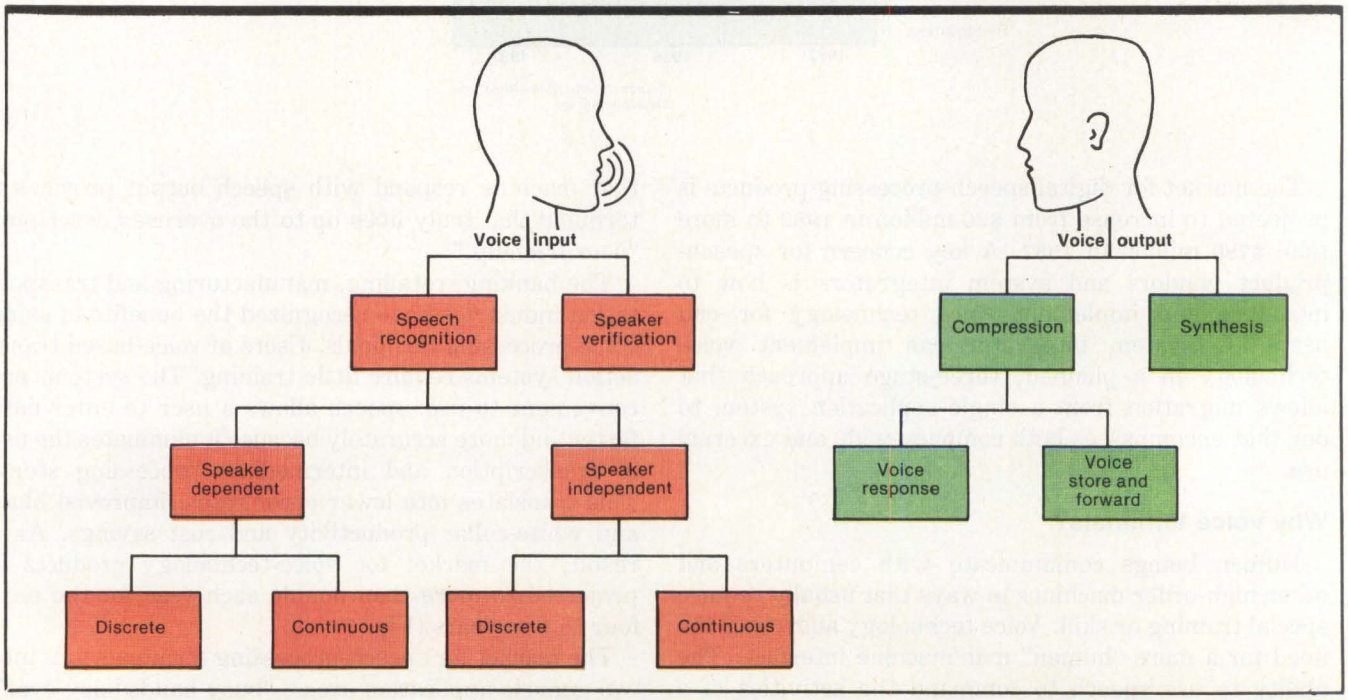
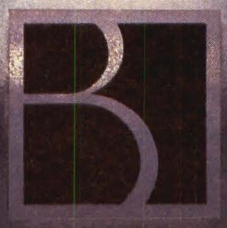


Fig. 2. Voice technology can be divided into two main areas: input and output. *Most current research is aimed at developing a system that combines speaker-independent, continuous-speech recognition and compressed voice response.*



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a word or phrase spoken by an individual who has trained the system by entering a set of vocabulary words. In training, the voice system digitizes and creates a template of each word and stores the templates in system memory. In operation, the voice system digitizes a spoken word and compares it to the stored templates. If they match, the word is recognized. SDR offers large vocabularies of as many as 255 user-selectable words and can be constructed in any language. On the other hand, SIR replaces user training with a set of representative templates created from a statistical sampling of a large population base, accounting for differences in speech accent, tonality and speed. In operation, a user can speak designated words and have them recognized without having trained the system. With SIR, however, the vocabularies are limited, preselected by the vendor and restricted to the language in which they were developed.

Another distinction in speech recognition is between discrete word and continuous recognition. Discrete-recognition systems, by far the more common and cost-effective of the two, recognize 1- to 2-second-long words or short phrases. Continuous-speech systems recognize long strings of words without pauses between the words. The ultimate objective of voice technology vendors is to develop speaker-independent, continuous-speech recognizers with unlimited vocabularies.

Voice output also is split into two approaches. Voice compression is based on the digital representation of actual human speech, which is compressed by coding redundant speech elements. Speech synthesis, on the other hand, constructs words from their building blocks, called phonemes. The system vocabulary is usually built around a tight set of phonemes, thereby significantly limiting the vocabulary size as well as introducing language dependencies. In operation, the reconstructed words are the direct product of a machine and typically sound robotic. Digital voice compression, on the other hand, is derived from a human source and retains the mood, emphasis and tone of the original speaker. Digital voice compression enables output messages to be easily modified in the field and to be created in any language.

Voice compression can be further distinguished as voice response (VR) or voice store and forward (VSF). VR is the audio output of a digitized and stored message of any length. It is used for operator prompting, feedback, information retrieval and interactive conversations using static messages. VSF is the real-time encoding and compression of a verbal message for temporary storage and subsequent retrieval as in voice mail or for immediate transmission to a listener's terminal, at which it is reconverted to audio output. VSF provides the technical basis for large multiuser telephone-answering and message-distribution centers.

Voice utility directs traffic

Voice-processing capabilities can be implemented in any terminal, computer or workstation. A board set that handles both recognition and compression provides

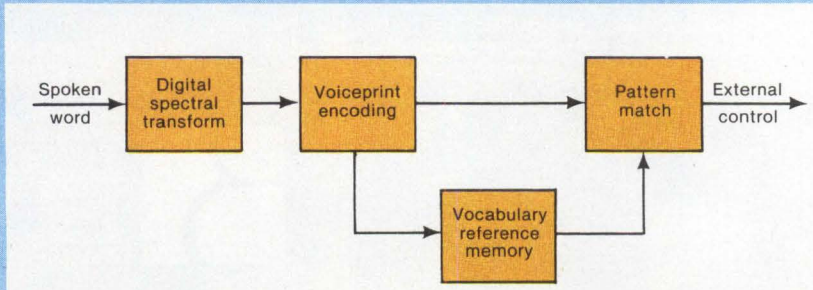
HOW SPEECH IS RECOGNIZED

Most speech-recognition techniques are either phoneme based or digital pattern-matching algorithms. Phoneme-based systems are algorithms designed to parse an incoming utterance into its smallest distinct sounds (phonemes) and compare the phonemes to those stored in a library of known words. Digital pattern-matching algorithms digitize incoming analog signals and compare the digital patterns of the incoming word to word patterns stored in system memory. If the incoming pattern matches a pattern on file within a specified tolerance, the incoming utterance is then "recognized."

To convert the analog signals to digital signals, the Votan system uses a proprietary algorithm that resembles a Fast Fourier Transform (FFT). A template is then made from the digitized frequency data and is stored in memory. This is called "voiceprint encoding."

To "recognize" a word, the voice processor constructs a "token" of the incoming utterance. The token-building algorithm is almost identical to the process used to build a template. The algorithm compensates for speech variances and matches the tokens to the templates by comparing the "distance" between the token and each of the templates on file. The distance scale goes from 0 (a perfect match) to 255. The template with the lowest distance is declared to match the token, provided the distance is below a pre-defined threshold. Setting a threshold prevents random noise, or words not on file, to be mistaken for words that are on file.

This technique applies to speaker-dependent recognition (SDR) as well as to speaker-independent recognition (SIR). The Votan system has a vocabulary of 255 words in SDR operation and 12 words in SIR mode.



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Attributes Req No Display Space	✓	✓		
Line Drawing Character Set	✓		✓	
Screen Tilt	✓		✓	✓
Buffered Printer Port	✓			
Separate Function Keys	10	0	4	11
Insert/Delete Line Key(s)	✓	✓	✓	✓
Erase End of Line/End of Page Key(s)	✓		✓	✓
Print Key	✓		✓	✓
Block Mode	✓	✓	✓	✓
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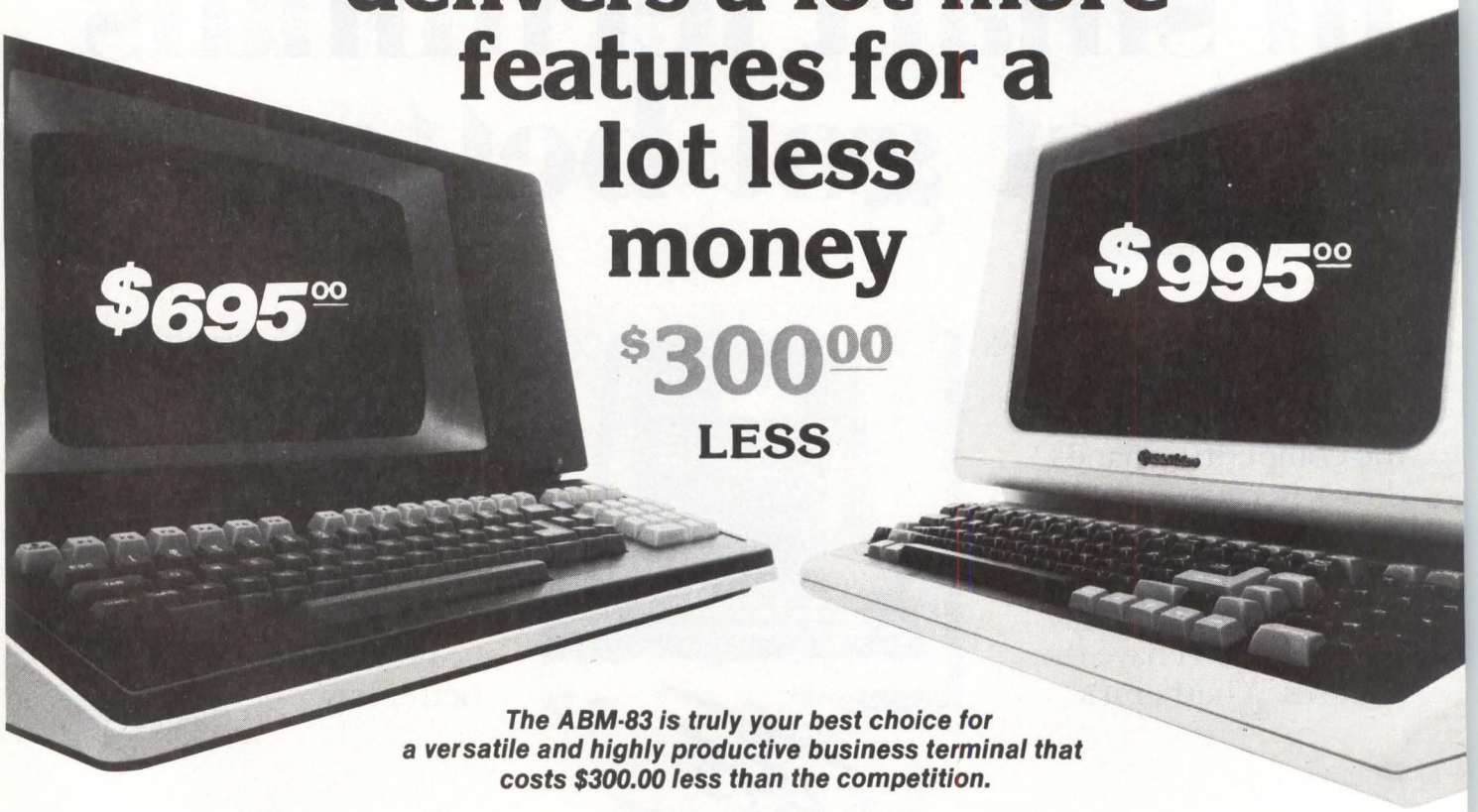

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a dedicated voice channel for each terminal. However, a more flexible and cost-effective approach is to use a central voice utility that concurrently manages the requirements of many users, serving as the link between a company's communications and information-processing systems. In this approach, a central voice utility, accessed through the PABX, links with the local-area network (LAN). Both local (internal) and remote (external) users can access the voice utility through any phone terminal (Fig. 3).

To handle a full range of applications, the voice utility offers all the major speech technologies (SDR, SIR, SV, VR, VSF) in an integrated configuration sharing hardware and software. Most applications benefit from the use of voice input and output in combination, which provides prompting, feedback and interactive conversations between users and computers. Applications such as voice mail, dictation, word processing, executive information inquiry, field sales-order entry, customer service and other functions can run concurrently.

In a typical sales organization, for example, a salesperson calls the computer system by phone. The call routes through the PABX, voice utility and LAN, establishing a two-way conversation with the computer system. Through the voice utility, the computer responds with *Hello. What can I help you with today? The following functions are available: order entry, inventory control and customer evaluations. At the sound of the tone, please select the desired function by name.* On choosing order entry, the salesperson then hears the options associated with that function and processes the customers' orders. With the multichannel voice utility, other sales personnel can access the system concurrently. Personnel at the home office or field staff can also place these calls. The voice utility accepts voice inputs, interprets their meaning and communicates with the host processor by using the protocol of the LAN and conforming to the data-message protocol of the host processor.

The voice processor converts speech signals from analog to digital and compares them to digitized word patterns stored in system memory. A proprietary digital spectral transform performs the conversion from the time domain to the frequency domain. The Votan transform is an algorithm that closely resembles a Fast Fourier Transform (FFT). Most of the mathematics involved in this transform are "reversible" for use in voice generation as well as voice recognition.

The voice utility also accepts the appropriate data from the host processor and converts it to an audio message that is output to the user. In all cases, the

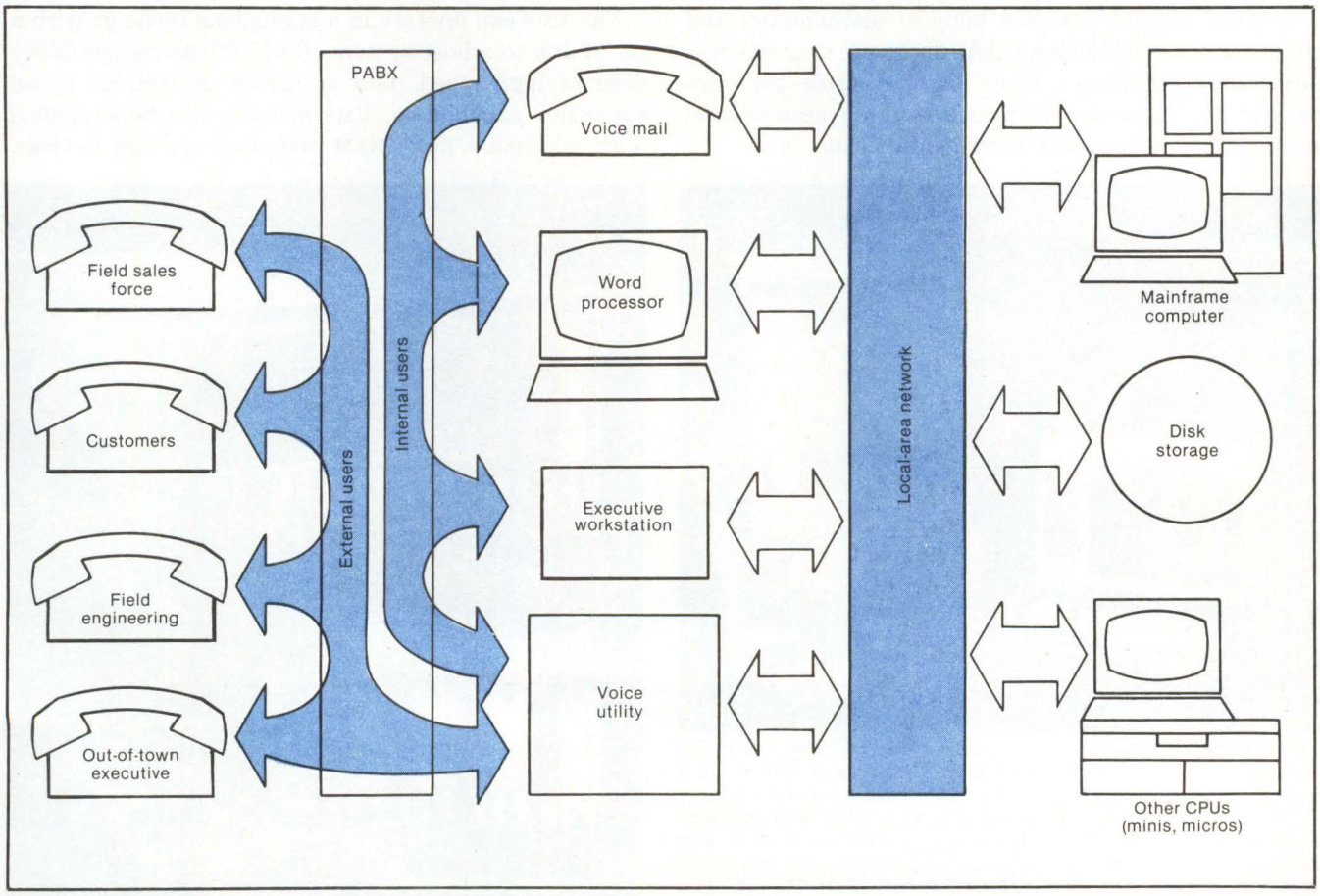


Fig. 3. The voice utility *serves as the interface for a company's communications and electronic data-processing network. Both internal (local) and external (remote) users can access the voice utility via the PABX.*

functions of the voice processor are transparent to the user.

VMS integrates multichannel configuration

Based on the voice-utility concept, Votan has developed a voice-management system (VMS) that provides the facilities for a complete shared-resource voice system. In multichannel configurations, Votan's VMS consists of a voice-control unit (VCU) and as many as four voice channels provided by VX series voice-processing and telephone-interface boards (Fig. 4).

The VCU serves as an intelligent controller in the multichannel system. The 8086-based VCU handles the real-time operation of VX series devices and telephone interfaces while communicating with a host processor through an LAN or a serial communications line. The VCU board is physically and electrically compatible with the industry-standard Multibus, and an RS232C line for monitoring or diagnostics is available to system developers. The 512K-byte system RAM is expandable to 1M byte.

Voice-processing capabilities are available on board-level VX series devices. This is the local processing ability of the voice utility containing Votan's proprietary technology, a complex body of mathematics and microcomputer technology that digitizes, extracts features and compresses voice data. Votan's software nucleus and hardware architecture integrates several voice technologies at low incremental cost.

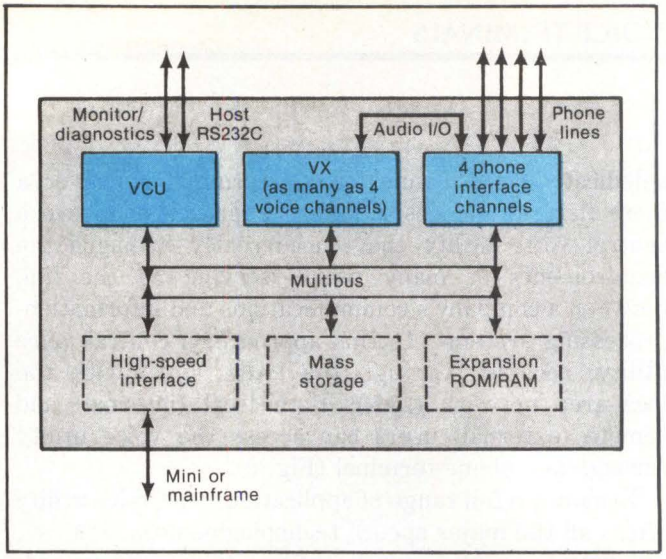
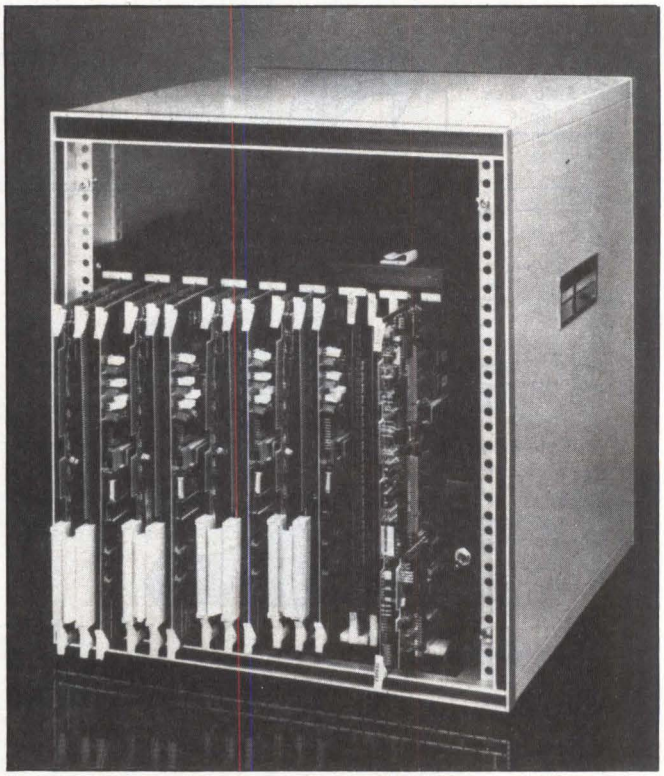


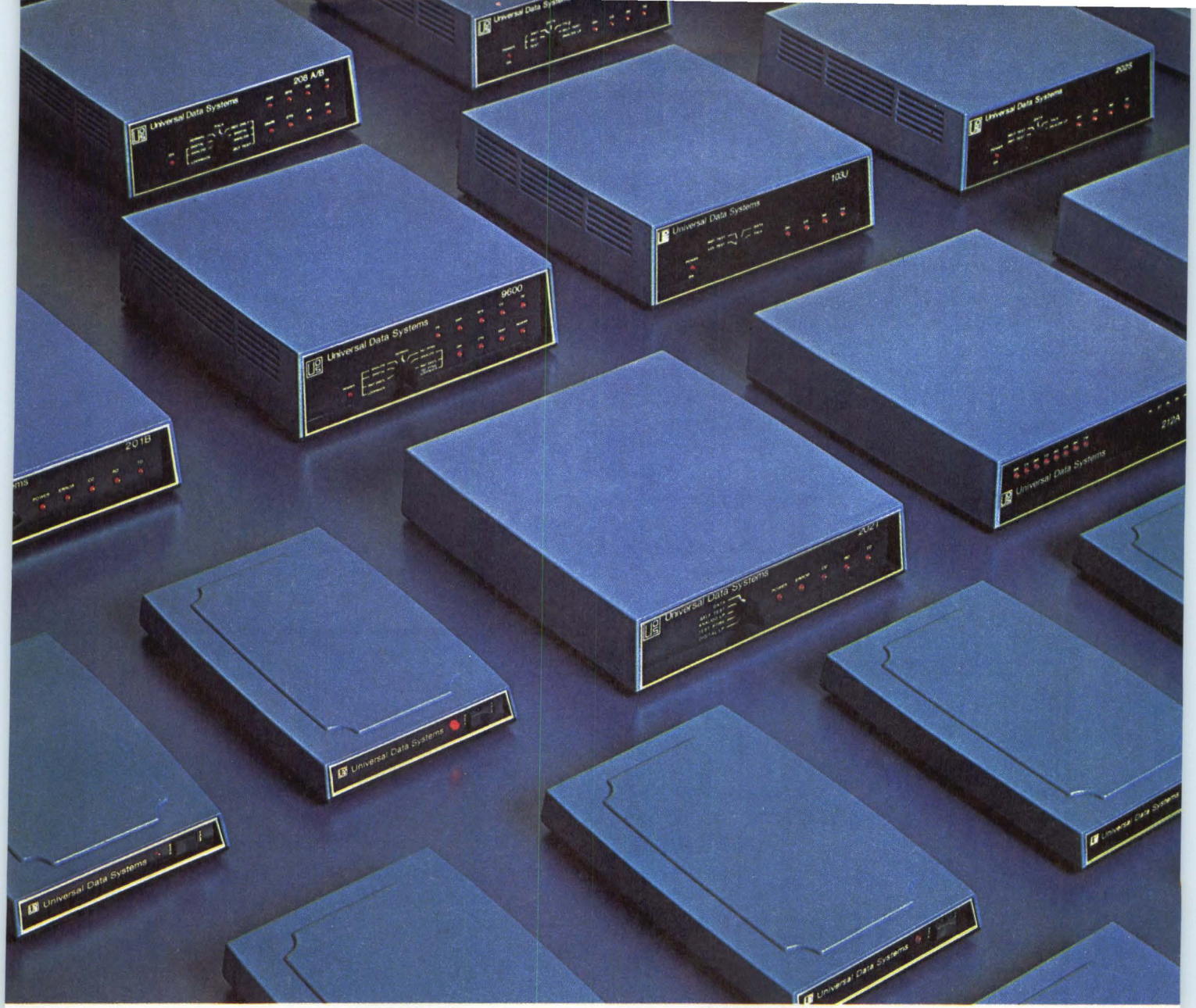
Fig. 4. Architecture of the voice-management system (VMS). *An RS232C serial port connects the VMS to external intelligence if required by the application. VX series voice-processing devices contain A/D-D/A converter boards. The telephone-interface boards interface Votan speech-processing products to standard telephone lines.*

A user can interface Votan's speech products to standard telephone lines via the telephone-interface board. Each microprocessor-controlled interface board can originate and answer calls through Federal Communications Commission-approved circuitry under VCU control.

The VMS can operate in a standalone mode or with a serial link to a host system. Its Multibus compatibility permits high-speed data transfers as well as broad expansion capabilities. VMS memory can be expanded with additional ROM, RAM and mass-storage devices.



Votan's voice-management system (VMS) *provides voice I/O support for various applications. The VMS includes as many as four voice channels, four telephone-interface boards, a voice-control unit (VCU) and a Multibus backplane. Price of VMS with speaker-dependent recognition (SDR), voice response (VR) and voice store and forward (VSF) is $22,650. With speaker-independent-recognition (SIR) capabilities, the system sells for $30,650. All models include a 16-slot card cage, the voice operating system (VOS) and 512K bytes of RAM.*



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For applications requiring more than four voice channels, multiple VMS systems can be linked.

Developing and running the programs

A major consideration for users is the effort required for application-software development. Votan addresses this concern by offering a high-level software-development tool that simplifies and accelerates the development of I/O routines for voice applications. The voice operating system (VOS) consists of a computer, an interpreter and a dialog builder that run with the PC-DOS or RMX-86 operating system. In a run-time environment, VOS executes voice applications and interacts with the VMS.

VOS supports the voice applications development language (VADL), a high-level programming language that requires fewer commands than do general programming languages. By isolating voice I/O functions from the application, VOS ensures high-level application integrity.

VOS programs are written in VADL, which is itself written in C. In a single-user system, VOS operates under PC-DOS on the IBM Personal Computer. In multiuser systems, VOS uses the Intel 8086 processor under the RMX-86 operating system. Because VOS produces an intermediate code that is executed by an interpreter in the run-time environment, the same VOS code can run without modification when transferred from the PC to the VMS environment. In concept, this is the same as P-code in Pascal systems. This allows the PC to be used as an inexpensive development environment with little additional effort to install the finished application in a VMS.

Four component programs provided with VOS to support VADL include a vocabulary-building utility, the VADL compiler, the executive and an interactive development aid for experimentation and immediate feedback when developing VADL code.

The VADL dialog source file (DSF) containing structured commands and definition statements is created using a text editor. This file is run through the compiler to produce a dialog-definition file (DDF), which specifies the voice elements of a dialog, and an executable-code file (ECF). The vocabulary builder is then used to enter voice data for each element specified by the DDF. The vocabulary builder is a menu-oriented, fill-in-the-blanks routine that allows the user to develop recognition templates, record messages and declare sets. Once defined, this information is stored in voice-data files (VDFs). In the run-time environment, the executive interprets the executable code and references the DDFs and VDFs to run the prescribed dialog while periodically exchanging information with a host system (Fig. 5). The "host" can be an operator's terminal, a remote computer connected to a VX series device or a coresident application program in a single-user or multitasking configuration.

The voice-management system provides a shared-resource voice system for virtually any voice application.

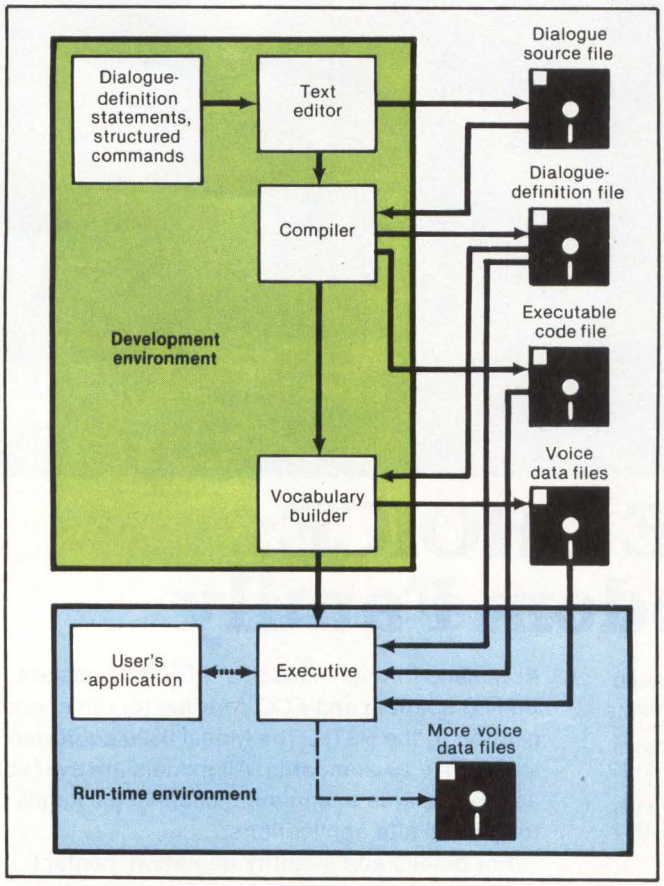

Fig. 5. The voice operating system (VOS) *is comprised of component programs that support the voice application development language (VADL). Dialog-definition statements and VADL commands are entered via a text editor creating a source file. The compiler creates a dialog-definition file (DDF) and an executable code file (ECF) from the source file. Using the vocabulary builder, the DDF is accessed and actual voice data are entered, creating voice-data files (VDFs). In the run-time environment, the DDF, ECF and VDFs feed into the executive. More VDFs can be created according to the user's application.*

Implementing voice-based systems

Building on the flexibility of the VMS and VOS, a system integrator can address the implementation of voice technology for the end-user environment in a planned, three-phase approach. As a prerequisite, the system designer must first select the most salable application as a starting point (such as factory floor data collection) and then select equipment that provides low

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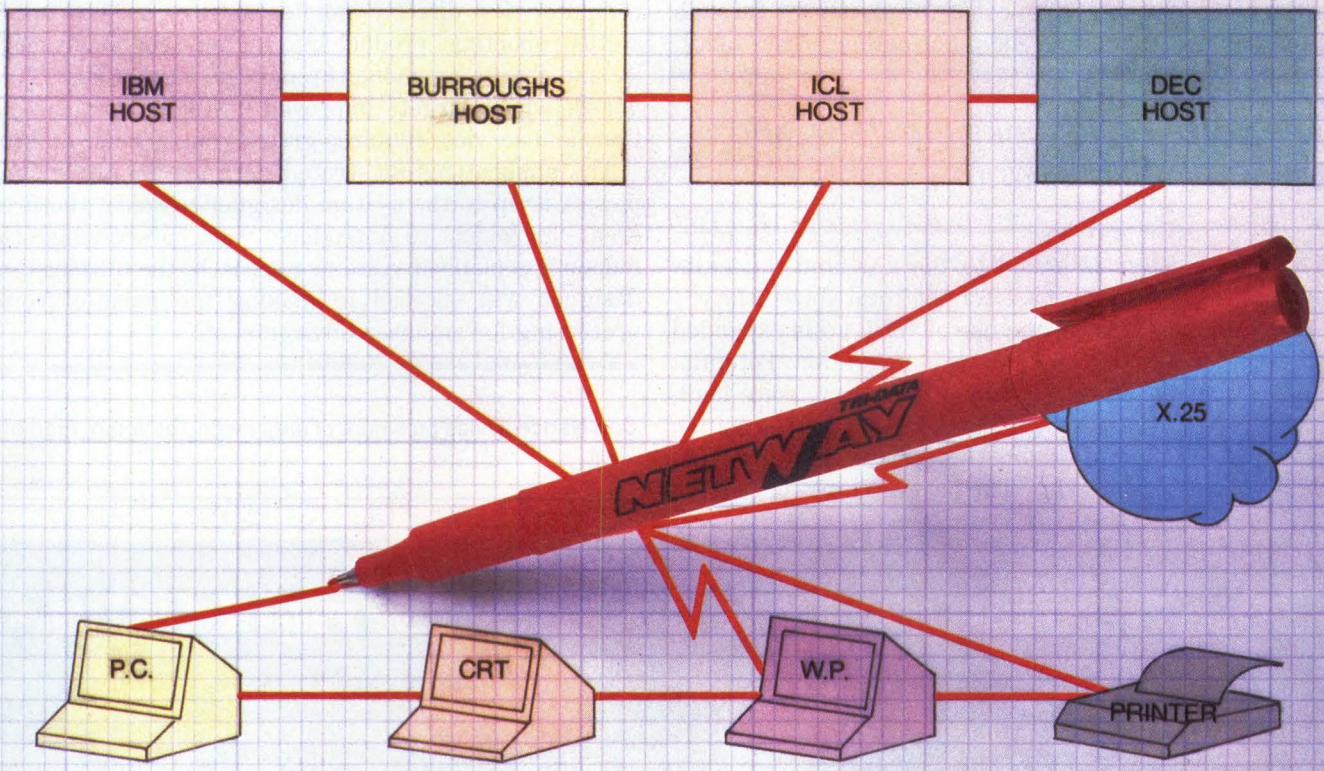

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cost per user through shared resources and integrated voice technologies that can address the needs of multiple applications. The first phase in the three-phase approach establishes an initial architecture that provides for migration to other applications. A typical entry point is manufacturing, with voice data entry implemented on a production line, a stockroom, shipping/receiving or quality control. The target in this phase is improving blue-collar productivity through time savings, accuracy and information accessibility.

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The voice system is linked to the LAN and the PABX system to provide the base for the total voice utility.

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The applications illustrated here are merely examples; it is up to the system designer to select the first areas in which to introduce voice processing. By following a planned systems approach, the OEM/system designer will succeed in making the most of voice processing for any user environment. □

Joe Nance is vice president of engineering at Votan, Fremont, Calif.

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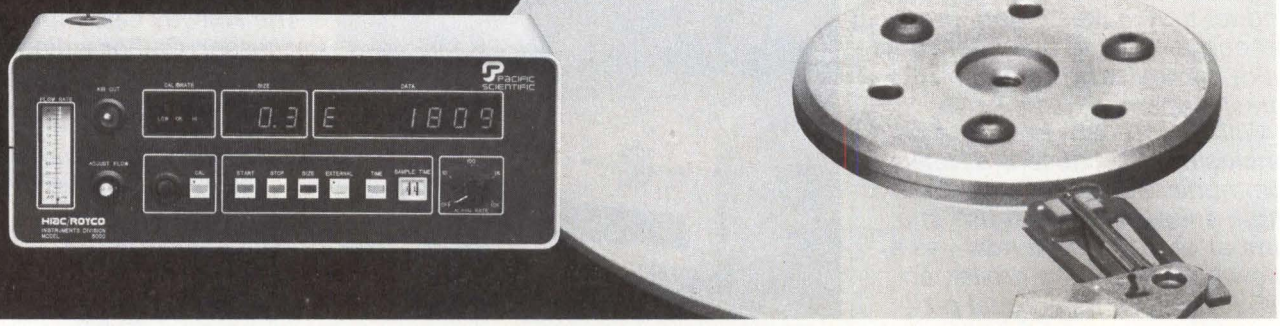

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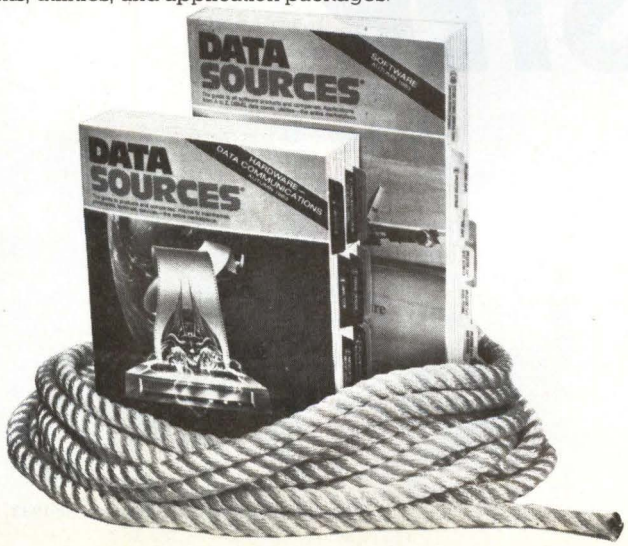

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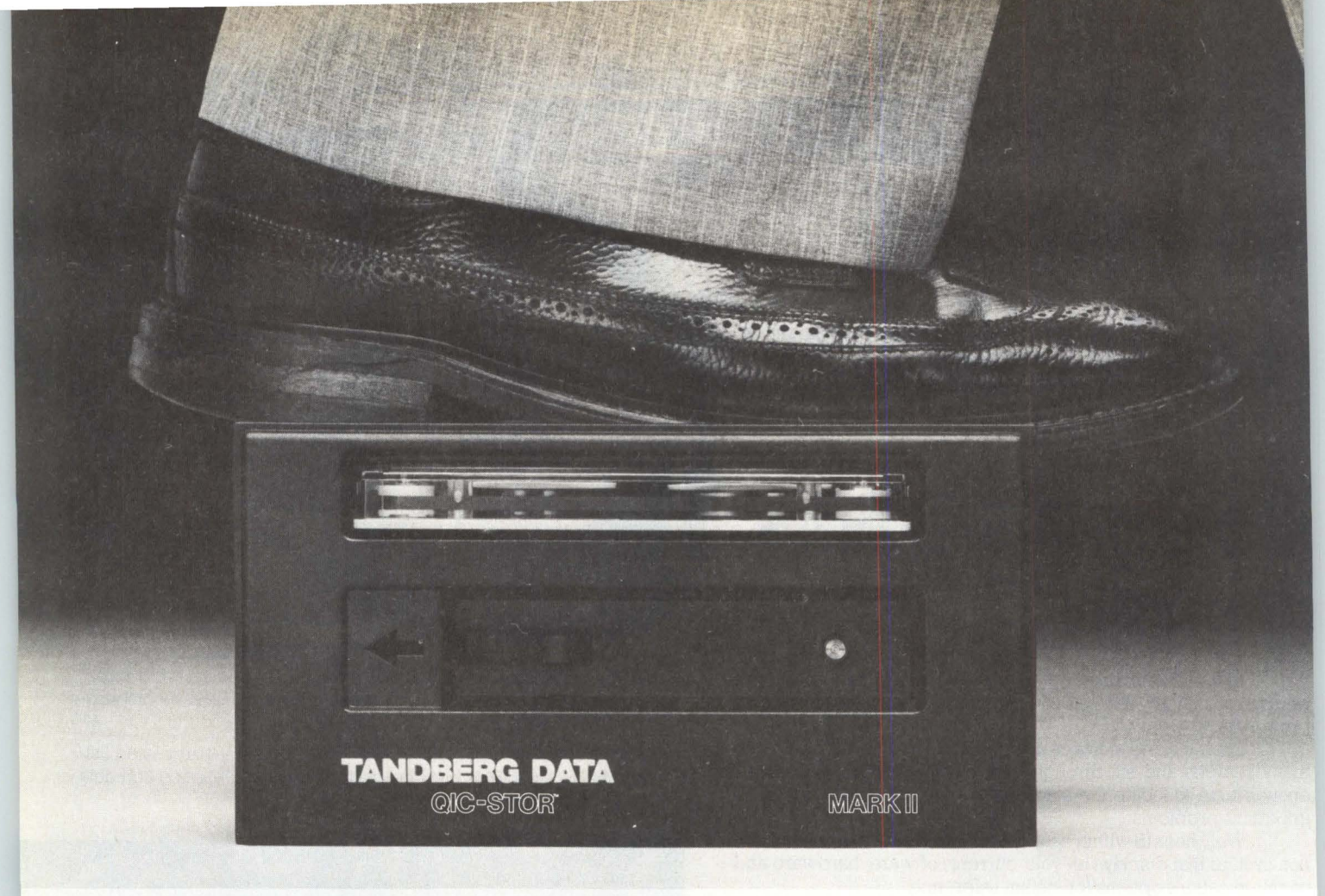

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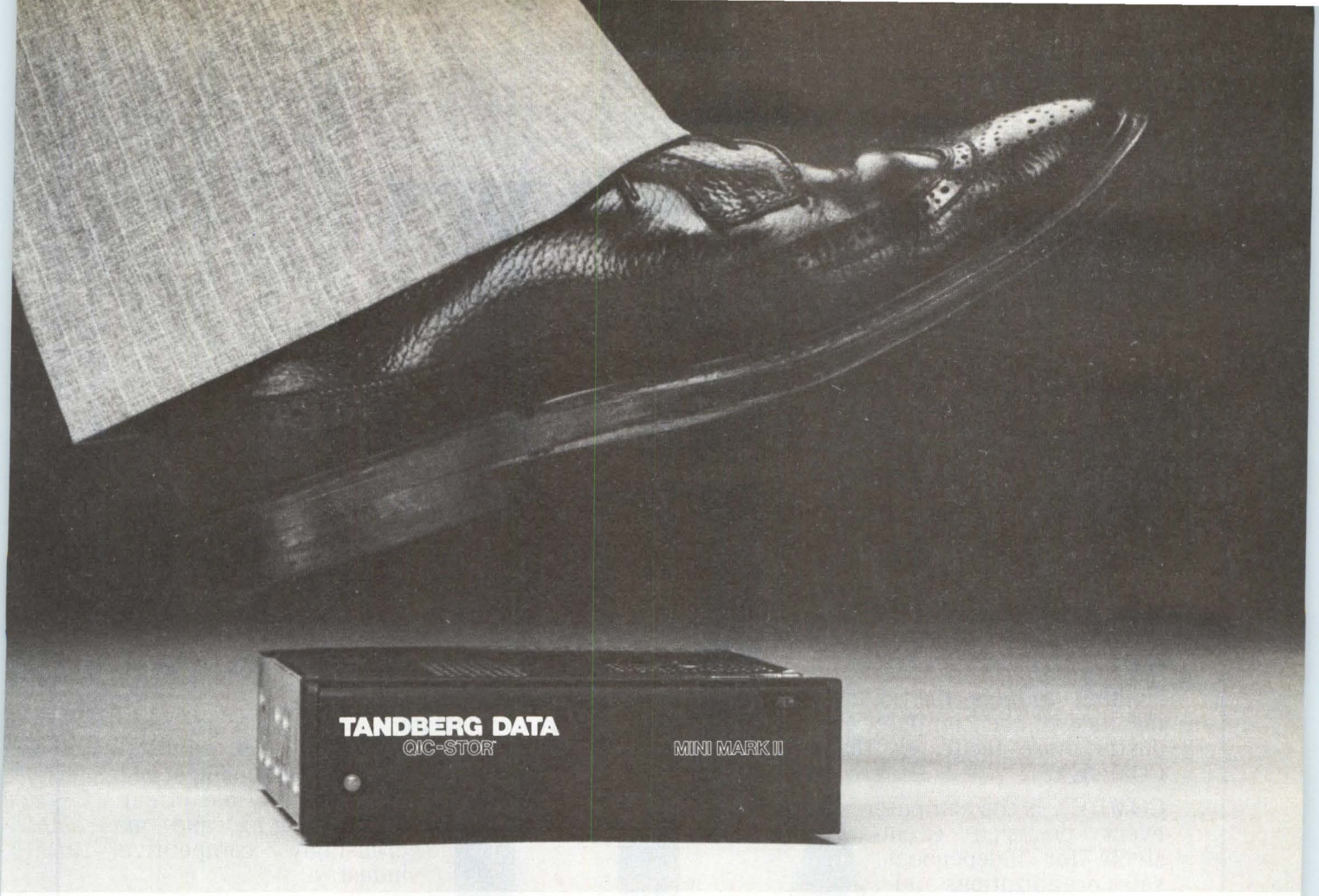

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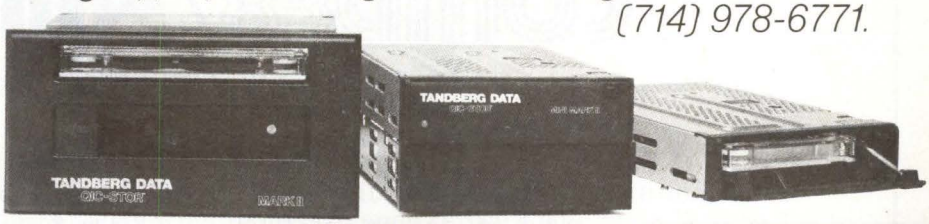

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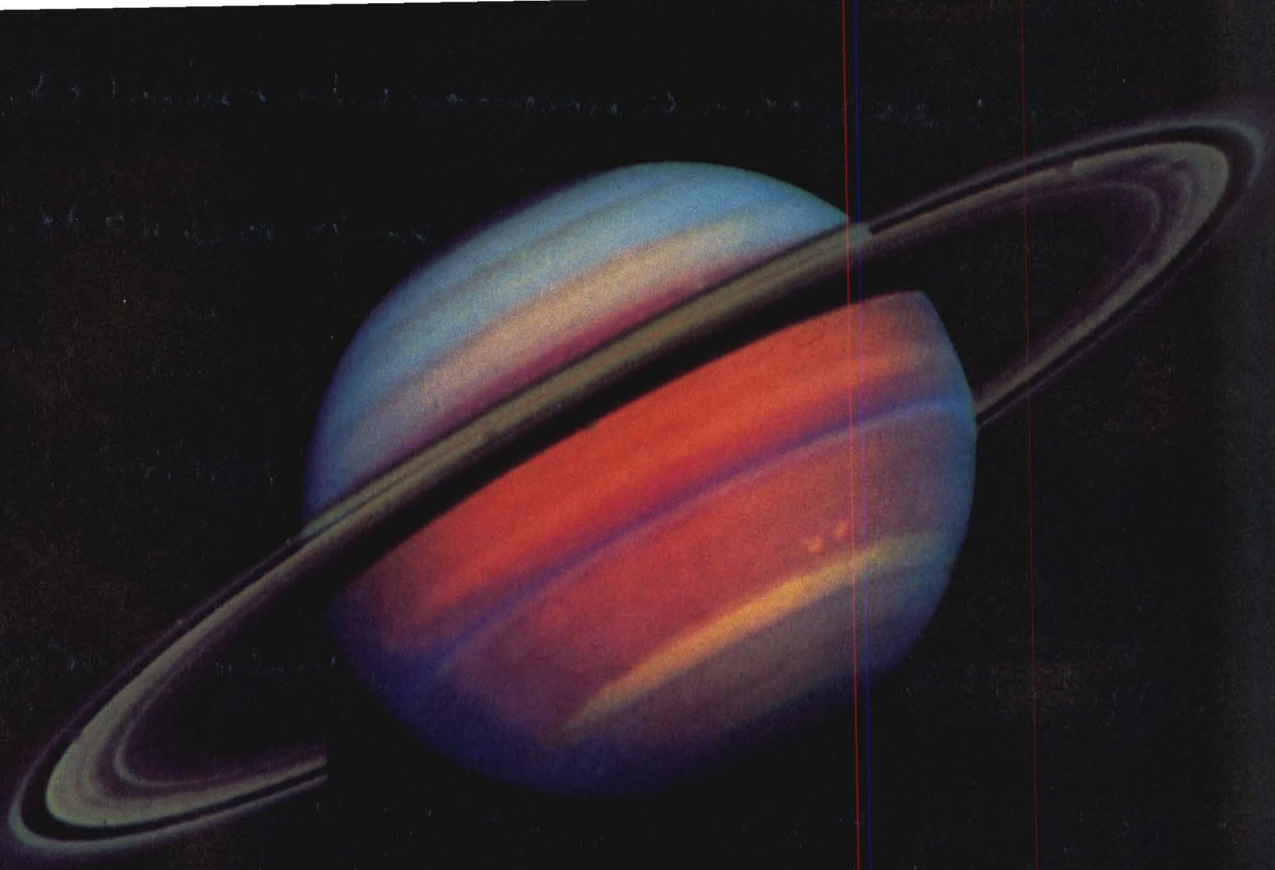

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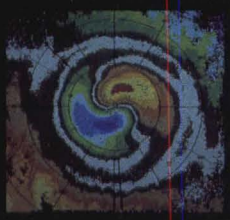

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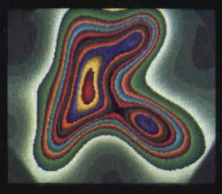

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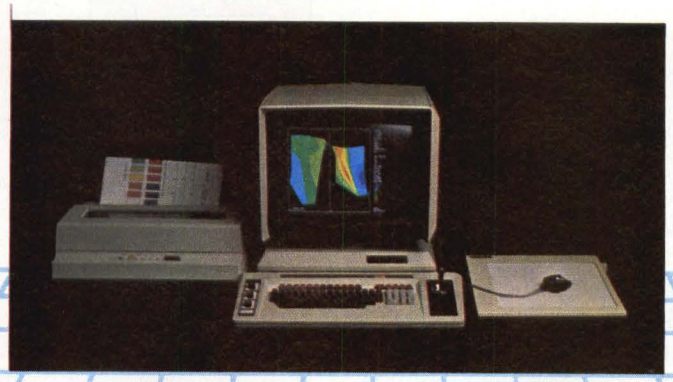

The Whizzard 1650 *combines color graphics and alphanumeric text. Base price of the keyboard and terminal is $15,900. The graphics digitizer is priced at $1400. A software interface for a Printacolor plotter is available for $1200.*

Design trade-offs in a multifunction graphics terminal

GARY I. WASHAM, Megatek Corp.

Engineering terminal combines text and color graphics

The Whizzard 1650 color graphics engineering terminal from Megatek Corp. is a low cost, versatile workstation with alphanumeric capabilities and a built-in line analyzer. Design trade-offs have resulted in a raster-scan terminal with an 8086 graphics processor, a hardware vector generator, a single-set raster plane buffer, a built-in VT100-emulating terminal for communications and text editing and a resident line analyzer for software debugging.

Resolution, refresh rates and flicker

Raster-scan resolution is a function of the number of individual pixels in the display field: the more pixels, the greater the resolution. However, as the number of pixels increases, so does the amount of processing time required to scan a line across the CRT screen, which decreases the number of frames that can be displayed each second. In addition, there is a minimum frame (refresh) rate below which some colors will appear to flicker more than others.

The goal is a display that provides an acceptable resolution with a frame rate that is high enough to ensure that all possible color combinations will appear flicker-free. Although a vector stroke display would have provided a higher resolution, it would have placed the 1650 out of its low-end price range. To meet cost requirements, Megatek Corp. uses a raster display with the best available resolution, which is user-selectable between 512 × 512 and 640 × 480 pixels. The display operates at 47 Hz, which Megatek found was the minimum frame rate ensuring flicker-free viewing of all possible colors.

Vector-to-raster conversion

In a display-list system like the 1650, information is entered as vector data that indicates the end points of lines. To be displayed on a raster terminal, it must be converted to pixel data. The first step is to convert data received from the host computer into an internal display list format. In the Whizzard 1650, data received from the host is loaded under the control of memory management resident in the firmware into a local

256K-byte display-list memory. Because the display-list memory is in the terminal, the host supplies the data required for a specific display only once, freeing it for other tasks while the display data is being processed locally.

Display-list data is in 32-bit words, the first four bits forming 16 instruction lookup codes. The first 14 of these lookup codes instruct the 8086 graphics processor to go to a list resident in the firmware containing the most commonly used graphics operating commands, such as "draw" or "move." When any of these 14 codes specifying vector location is used, the remaining 28 bits in the word contain two 12-bit fields representing the x and y coordinates, and a 4-bit field containing color information. When the instructions do not directly involve vector location, these 28 bits are used to provide other instructions, such as dynamic and static attributes, transformation and segmentation data and subroutining data. The graphics processor output consists of a stream of xy coordinate data and 4-bit color data fields, and is transmitted over an internal bus to the digital vector generator.

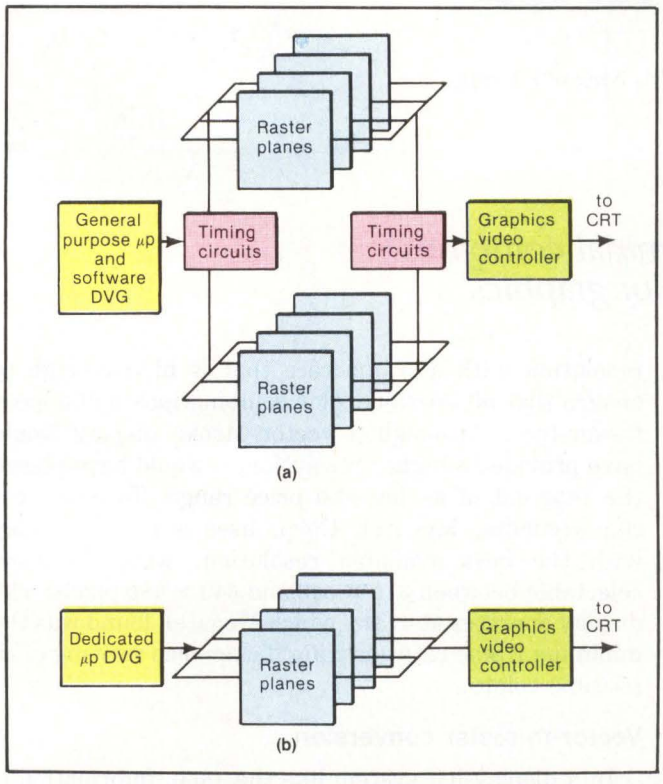

Fig. 1. A general-purpose microprocessor/software-based digital vector generator (DVG) *requires two sets of raster planes and timing circuits for relaying information to the graphics video controller (a), due to the relatively slow processing power of the chip/software combination. The timing circuits direct the data into one set of raster planes while feeding the video controller from the other set of planes. This approach requires twice the memory of a single-set buffer system (b), as well as additional control circuits. The dedicated DVG is faster and requires only one set of raster planes.*

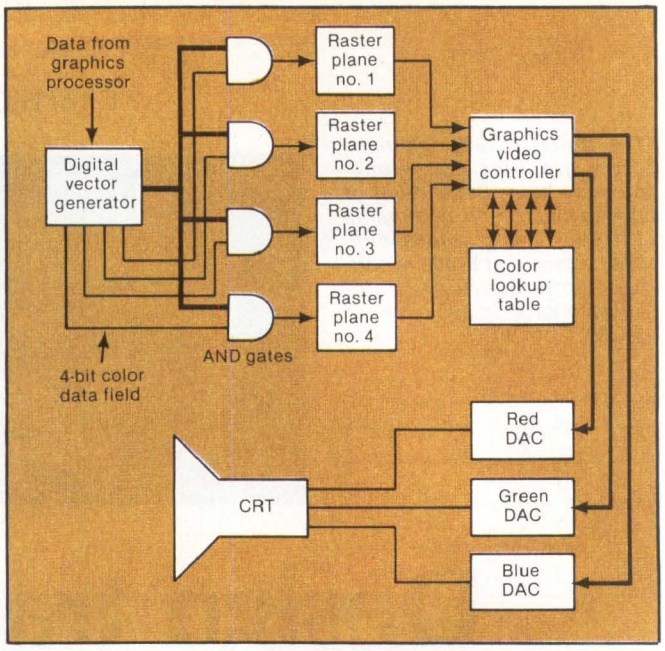

Fig. 2. Color generation in a graphics terminal *requires the use of multiple raster planes. Each plane represents one bit of the color data field supplied by the host computer. In the Whizzard 1650, a screen-on set bit for a vector is loaded into the required pixel addresses through four AND gates, each controlled by one of the color data bits in the 4-bit color field. A graphics video controller scans the four raster planes and reconstitutes a 4-bit color word for each pixel address. This 4-bit word is applied to a color lookup table that provides the video controller with the correct percentages of red, green and blue required to produce the desired color. The video controller then generates three corresponding digital words that are applied to three digital-to-analog converters. The digital-to-analog converters produce the analog signals that control the CRT.*

The DVG takes the xy coordinate data supplied by the 8086, calculates the length and direction of the vector and converts the vector to individual points to determine which pixels must be excited to produce a continuous line. The DVG uses Bresenham's algorithm to calculate the pixel data from the end points of the vectors (see "How Bresenham's algorithm draws lines quickly," p. 204).

One way to convert vector data to pixel data is to use a general-purpose microprocessor with instructions for Bresenham's algorithm in software. This approach minimizes hardware costs for the processor, although data conversion speed is relatively low.

Megatek chose an alternative for its 1600 Series terminals, designing a proprietary hardware DVG that executes Bresenham's algorithm in finite logic. Because the DVG processes the algorithm directly, without the intermediate interpretation of instructions required by a general-purpose chip and software, it can perform the required operations many times faster. The DVG in the 1650 can calculate raster data at the rate of 260 nsec. per pixel—approximately 10 times faster than most general-purpose microprocessors.

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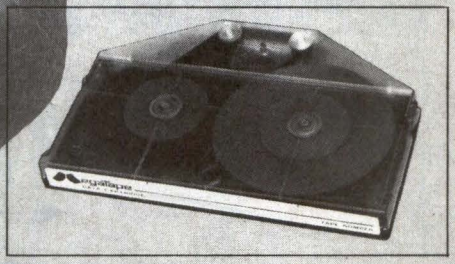

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The DVG generates data that specify the pixels that must be excited to paint a vector on the screen, and sends the data to an output buffer, or "raster plane." A raster plane is a large RAM buffer that is functionally a pixel map of the CRT screen; that is, there is a memory location in the plane for each pixel on the screen. The DVG's output is in the form of a memory address for a specific pixel and a bit that represents screen-on or screen-off. A video controller then reads out the contents of the plane and instructs the CRT beam to excite or to pass over the corresponding pixels on the screen (Fig. 1).

Color generation

The number of discrete colors needed in a graphics terminal depends on the intended application. Imaging systems, for example, must produce many colors to represent a variety of shading and color gradations. However, the number of discrete colors that can be displayed simultaneously is a function of the number of raster planes in the output buffer. Increasing the number of planes to increase color capacity also increases the memory costs and the amount of space required. Since the 1650 is primarily a CAD terminal, only a few colors normally need to be displayed at any one time. Thus, four raster planes—able to produce 16 discrete colors simultaneously from a palette of 4096 hues—suffice, again minimizing space and memory requirements.

A video controller scans the address location in each of the four planes representing a specific pixel and reconstitutes the 4-bit color field. Each of the 16

HOW BRESENHAM'S ALGORITHM DRAWS LINES QUICKLY

To represent a line in a raster-display system, the system must employ an algorithm that determines which set of x and y coordinates for pixels most closely approximates the line. In complex displays, the algorithm can be invoked hundreds or even thousands of times each time an image is created or modified, so the algorithm must be extremely fast to be useful in an interactive environment. This precludes the use of slow operations such as multiplication (except integer multiplication by 2), division and all floating-point arithmetic. One obvious line-drawing algorithm—repeatedly incrementing the pixel x coordinate by one, incrementing the y coordinate by the slope of the line and rounding the y coordinate to the nearest integer—is unacceptable because the slope and the rounding process involve floating-point arithmetic. Bresenham's algorithm uses only integer addition, subtraction and multiplication by 2—a special case of multiplication, fast because it can be implemented by a left-shift operation.

The inputs to Bresenham's algorithm are (x1,y1) and (x2,y2), the integer-valued line endpoints such that x1<x2. The outputs from the algorithm are coordinates of the pixels that "fill in" the line. The version of Bresenham's algorithm shown, which applies to lines in which (x2−x1)≥(y2−y1)≥0, increases the x coordinate of each successive fill-in pixel by one unit and increases the y coordinate by either zero or one. Moving left to right from endpoint (x1,y1) to endpoint (x2,y2), each pixel is either one unit to the right of the previous pixel (a horizontal segment) or one unit to the right and above the previous pixel (a diagonal segment). The apparent slope of the line comes from the relative number of horizontal and diagonal segments: the greater the proportion of diagonal segments, the steeper the line appears.

—Roy R. Friedman

```
BEGIN /* Line endpoints are (x1,y1) and (x2,y2) */
testvar = 2* (y2 - y1) - (x2 - x1)
a = 2* (y2 - y1)
b = 2* (y2 - y1 - x2 + x1)
y = y1
FOR x = (x1 + 1) TO (x2 - 1)
  IF testvar <0
    THEN testvar = testvar + a
    ELSE testvar = testvar + b
         y = y + 1
  ENDIF
  WritePixel (x,y)
NEXT x
END
```

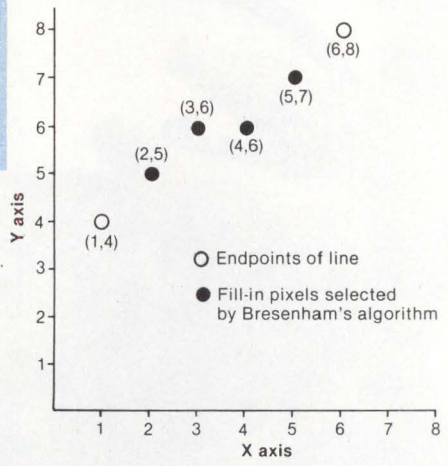
Initialization

Start of loop

Next pixel will be horizontal from previous pixel because y-coordinate is unchanged

Next pixel will be diagonal from previous pixel because y-coordinate is increased by one

Pseudocode for Bresenham's algorithm *contains a loop that selects x and y coordinates for each "fill-in" pixel by increasing the x coordinate by one and increasing the y coordinate by either zero or one relative to the previous pixel. This algorithm is extremely fast because the code within the loop uses only integer addition and subtraction.*



An example of the algorithm. *To represent a line from endpoint (1,4) to endpoint (6,8), Bresenham's algorithm selects fill-in pixels at locations (2,5), (3,6), (4,6) and (5,7). The line is approximated by a diagonal segment from (1,4) to (3,6), a horizontal segment from (3,6) to (4,6) and a diagonal segment from (4,6) to (6,8). In an actual display, a line typically would be represented by many more than the six pixels used in the example.*

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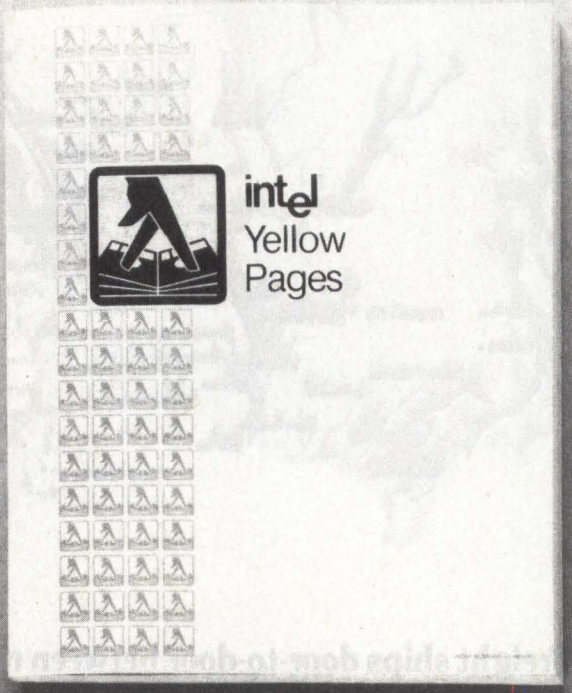

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possible 4-bit combinations represents a specific color. The color lookup table determines the correct percentages of the three primary CRT colors (red, green and blue) required to produce the desired display color and produces three corresponding digital words that are sent to the D/A converters that drive the CRT. As the CRT beam scans along a horizontal line pixel by pixel, it is instructed to excite the red, green and blue phosphors of each pixel to the required intensity (Fig. 2).

A potential shortcoming of a system with just one set of raster planes is the inability to provide multicolor blinking. Normally, a second set of raster planes is required to provide an alternate-color blink. Megatek circumvented the need for a second set of planes by using four independent color lookup tables—the primary display table and three blinking tables—and a control system that sequentially scans them when blinking is enabled. Through program control, additional sets of 16 color values can be loaded into one, two or three auxiliary lookup tables. The display can provide 16 possible blink-rate patterns.

Communications and text editing

The user of a graphics terminal usually requires a separate alphanumeric terminal for communications with the host computer and for text editing. To overcome the need for an expensive peripheral, the 1650 is equipped in firmware with a virtual emulation of Digital Equipment Corp.'s VT100 terminal.

To add alphanumerics to a graphics terminal, a separate output buffer must be provided. But, since all the alphanumerics can be displayed in the same color, only a single raster plane is needed. The color of the alphanumerics displayed on the 1650 is user-selectable from a palette of eight pre-set hues.

The final step in adding alphanumerics is to combine the information contained in the alphanumeric and graphics sets of raster planes. While it wouldn't be difficult to add a video mixer, a problem remains: what happens if a vector and an alphanumeric character

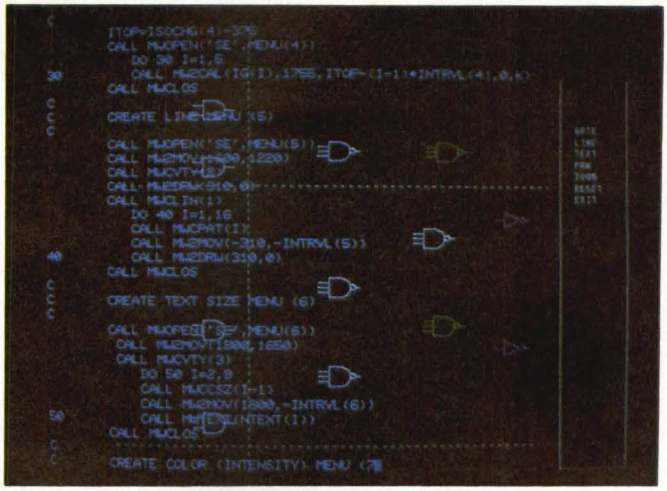

Fig. 4. The line analyzer generates an instruction-by-instruction program listing *for all data flowing into or out of the terminal. To speed debugging, graphics instructions can be displayed step by step as the CRT is painted, so users can observe changes in the design as each instruction is executed.*

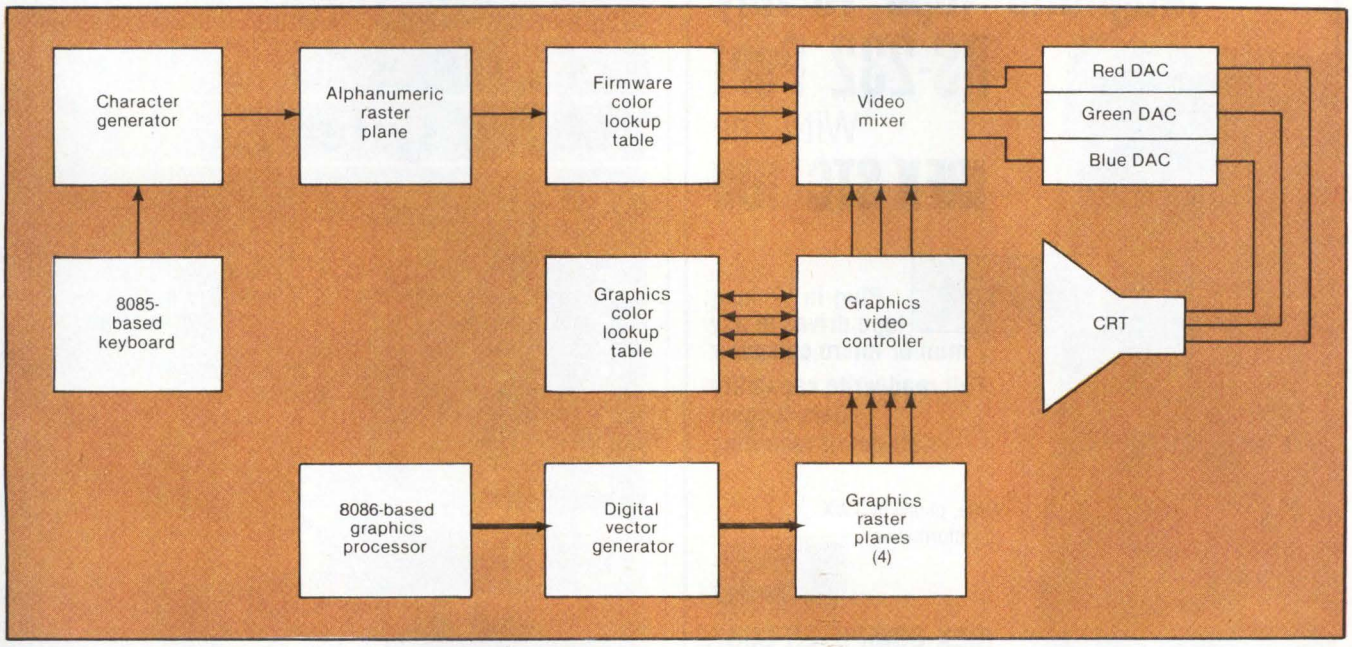

Fig. 3. Adding alphanumerics to a color graphics terminal *requires the addition of a character generator, an independent raster plane and a color lookup table. Outputs from the alphanumeric and graphics lookup tables are applied to a video mixer that overlays the two displays on the CRT via the digital-to-analog converters. In the Whizzard 1650, the alphanumeric input has priority so that its assigned color will be displayed even if a graphics vector intersects the same pixel.*

overlap in the display? When an overlap occurs in the Whizzard 1650, the pixels involved produce the color reserved for the alphanumerics. This is accomplished through the use of a controller that scans the alphanumeric raster plane and determines if the bit is set at a specific pixel address. If it is set, the alphanumeric color data for that address is applied to the video mixer, and the corresponding pixel is excited to produce the appropriate color. The color data contained in the graphics raster planes at that address are simply ignored. If the bit in the alphanumeric plane is not set, the controller scans the four graphics raster planes at that address and applies the resulting data to the video mixer (Fig. 3).

Software debugging

The Whizzard 1650 includes a firmware-resident line analyzer for software debugging. The analyzer, following instructions resident in the graphics processor firmware, generates an instruction-by-instruction program listing for all data flowing into or out of the terminal. When invoked, the listing is displayed along the bottom of the screen and the nature (graphic or alphanumeric) and direction of data flow are identified by the type and placement of enclosing brackets.

The instruction display ordinarily scrolls rapidly, but it can be stopped at any point through keyboard control, then advanced one instruction at a time in a step mode. The display being painted on the CRT screen also appears at the stepped rate, so the user can observe the changes on the CRT screen as each new instruction is executed (Fig. 4).

A "byte-trapping" characteristic of the line analyzer permits a user to set an interrupt at a specific instruction in the program. When this is invoked, the display operates at its normal speed until the designated instruction in the program is reached, at which point the analyzer stops the program. The user can then instruct the analyzer through keyboard control to display a given number of program instructions preceding or following the breakpoint. Thus, the user doesn't have to go through the time-consuming process of examining the listing, instruction by instruction, to find the particular code that programs the step in which the bug may exist. □

Gary I. Washam participated in the development of Megatek's Whizzard 1650. He holds a B.S. in systems engineering from the U.S. Naval Academy and an M.S. in systems management from the University of Southern California.

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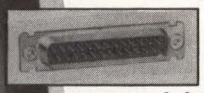

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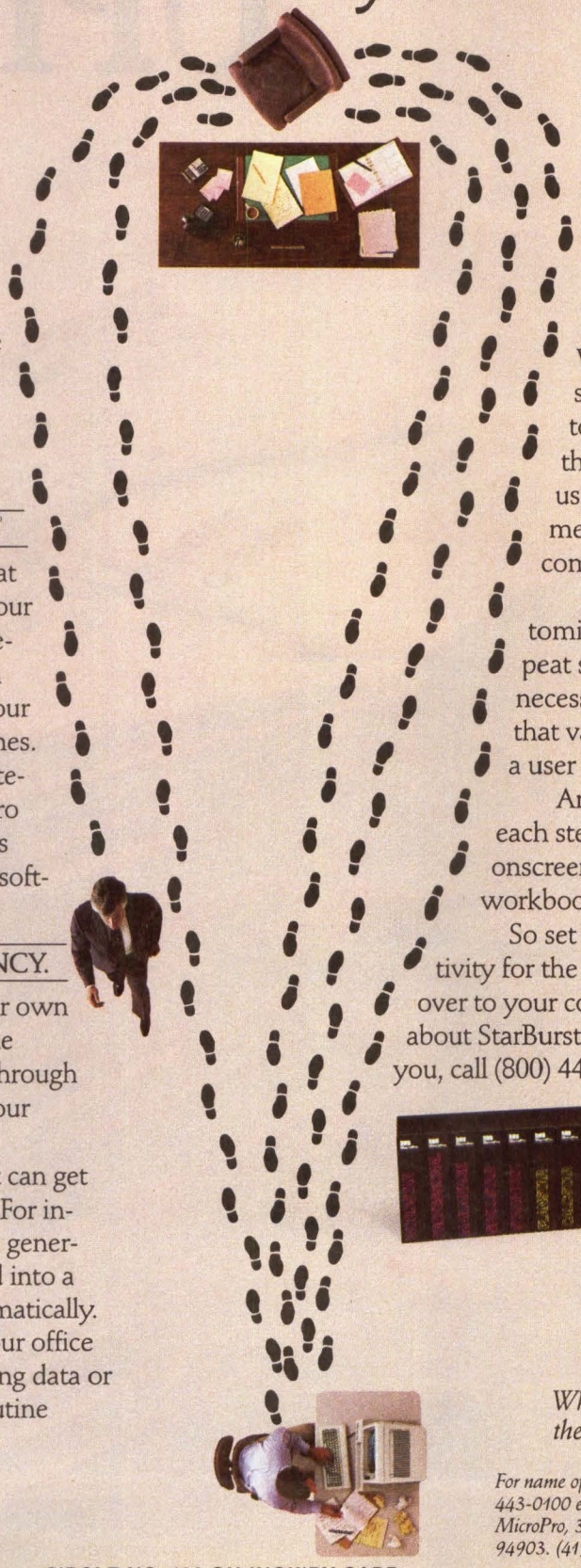

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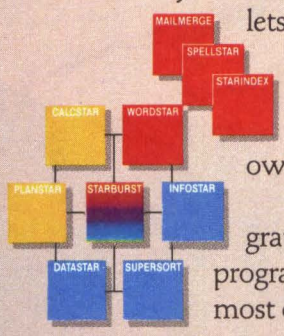

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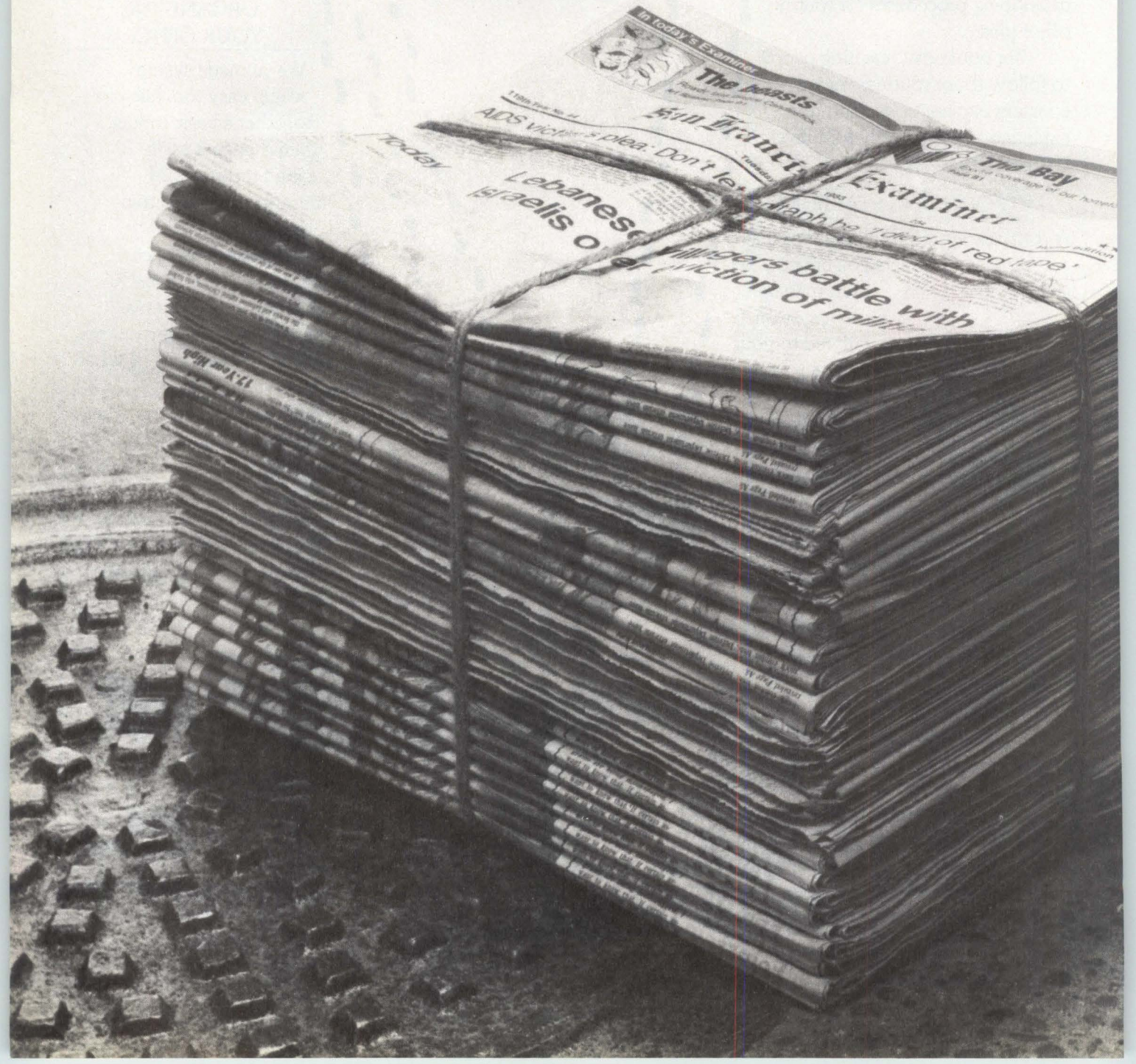

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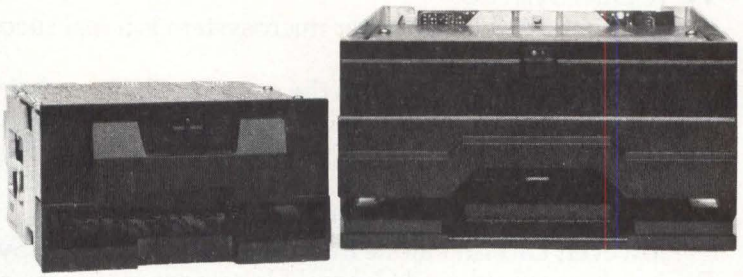

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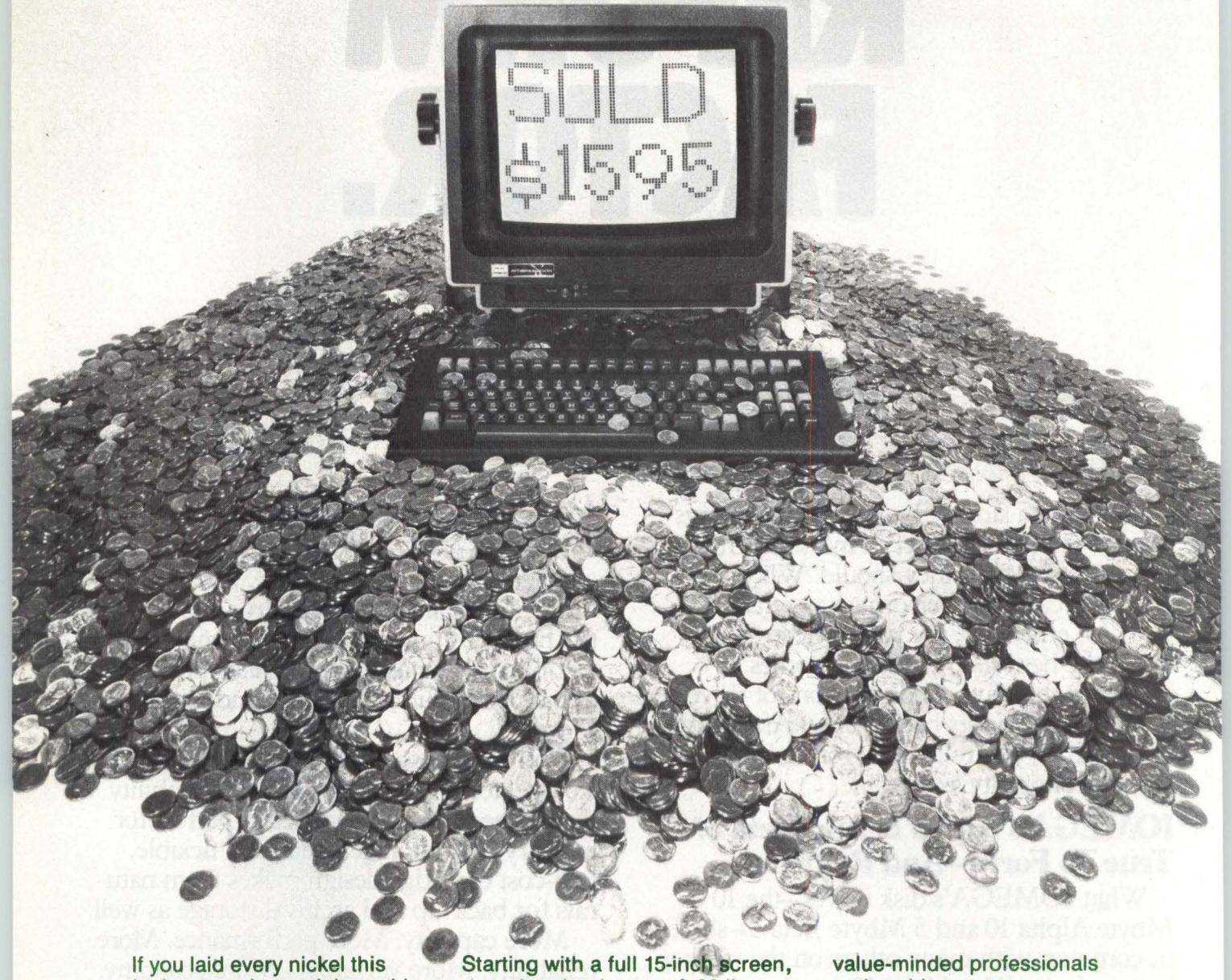

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Bit-mapping graphics board joins 16-bit CPU card to furnish near-photo-quality resolution

UNIX-based graphics system produces 1 million-pixel display

DENNIS DANIELS, Forward Technology Corp.

Supporting the refresh of a 1 million-pixel graphics display need not tie up the processing power of a 16-bit CPU. Graphics functions can instead be unloaded to a specialized graphics board with key raster-scan operations hard-wired into its graphics processor. By combining these raster operations with an on-board bit-mapped 1M-bit memory and a Multibus-compatible 16-bit processor, OEMs can implement a graphics system similar to Forward Technology Corp.'s FT-500 Gateway engineering workstation, which can update the frame of a near-photo-quality graphics display in only 64M sec. The FT-500 workstation is organized around an eight-slot Multibus card cage, holding the graphics board; a CPU board; plus optional Ethernet-, disk- and tape-controller boards.

The graphics workstation's 1M-pixel display (above) *highlights this configuration that includes a 20M-byte Winchester disk drive, a 20M-byte cartridge-tape drive, 256K bytes of RAM, a VT100-format detachable keyboard and a mouse for entry of graphics commands.*

Focusing on the graphics board

The heart of the graphics system is the FT-1024 graphics-controller board, containing the graphics processor, the bit-mapped 1M-bit memory, a 128K-byte

RAM and a Multibus interface. The memory can store the contents of a complete graphics-display frame, with 1 bit of memory representing 1 pixel of the frame. This bit-mapped approach works in conjunction with the novel architecture of the graphics processor. It performs Boolean operations on the contents of three 16-bit operand registers—source, mask and destination—updating a 1-by-1- to 1-by-16-pixel segment of display data in the frame buffer (Fig. 1). The graphics processor also contains a function unit, controlling the display data sent to the frame buffer; a set of command registers for function, width, control and interrupt; and four sets of X and Y address registers.

The 8-bit function register holds the results of Boolean operations performed in the function unit on data in the source, mask and destination registers. These include logical OR, NOR, XOR, AND and NAND operations, which, including permutations, create 256 possible raster operations. The function unit feeds the 16-bit result of the Boolean operations into the frame buffer at locations specified by the CPU via the graphics board's address logic. The frame buffer, in turn, serializes the data for driving a 50-MHz Ball HD series or Motorola M4408-type CRT.

A logical OR on the contents of the source and mask register is typical of the Boolean operations performed in the function unit. If the source register, for example, contains a right-slanting diagonal slash and the mask register contains a left-slanting diagonal slash, the resulting X pattern feeds into the frame buffer. A logical AND operation would produce the dot in the center of the X.

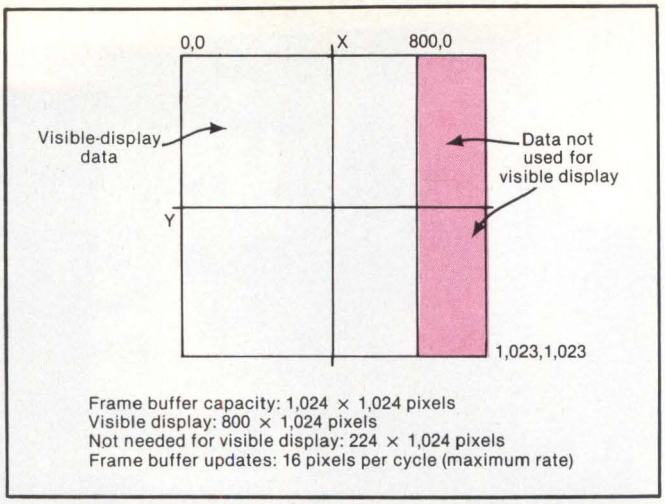

Fig. 2. Although the graphics board's frame buffer *can store information for a 1,024-by-1,024-pixel display, only an 800-by-1,024-pixel portion of it is needed to update the graphics system's CRT screen. The remaining locations can store often-used graphics symbols and objects, which can be quickly moved into the CRT's visible display. Each frame-buffer location, designated by coordinates 0,0 to 1,023, 1,023, represents an individually addressable pixel on the CRT screen.*

Although the frame buffer can store information for a 1,024-by-1,024-pixel display, the graphics system's display area measures 800 by 1,024 pixels. The remaining portion of the frame buffer not needed for visible-display data can store often-used graphics characters and other symbols (Fig. 2) as a library of cells that can be rapidly moved or duplicated in the visible display. (Moving and duplicating the cells in this

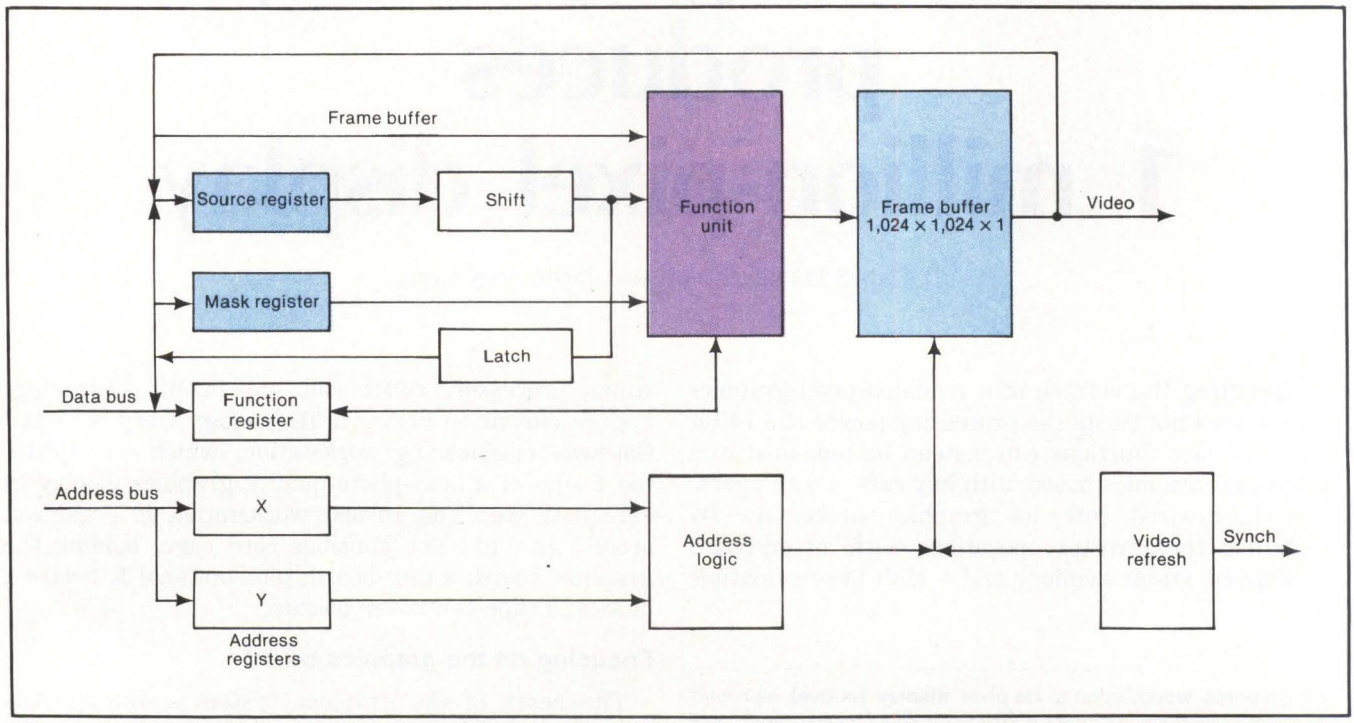

Fig. 1. The FT-1024's graphics processor *uses its function unit to perform Boolean operations on data in the source, mask and destination registers. The 16-bit result is sent into the frame buffer at locations specified by the CPU via the graphics board's address logic.*

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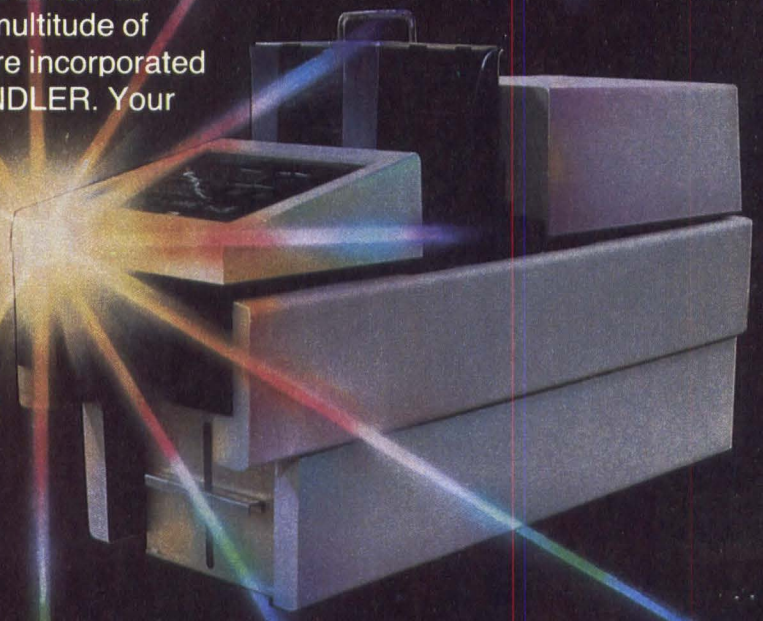

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manner proves much faster than recalculating them each time they are needed.)

The CPU board can access graphics objects in either the visible-display or remaining portion of the frame buffer via the graphics board's four pairs of X, Y registers, which permit immediate access to four objects. With only one reference to the graphics system, the processor can transfer a new operand via the data bus and a new X or Y address via the address

USING SIGGRAPH CORE PRIMITIVES TO SIMPLIFY GRAPHICS OPERATIONS

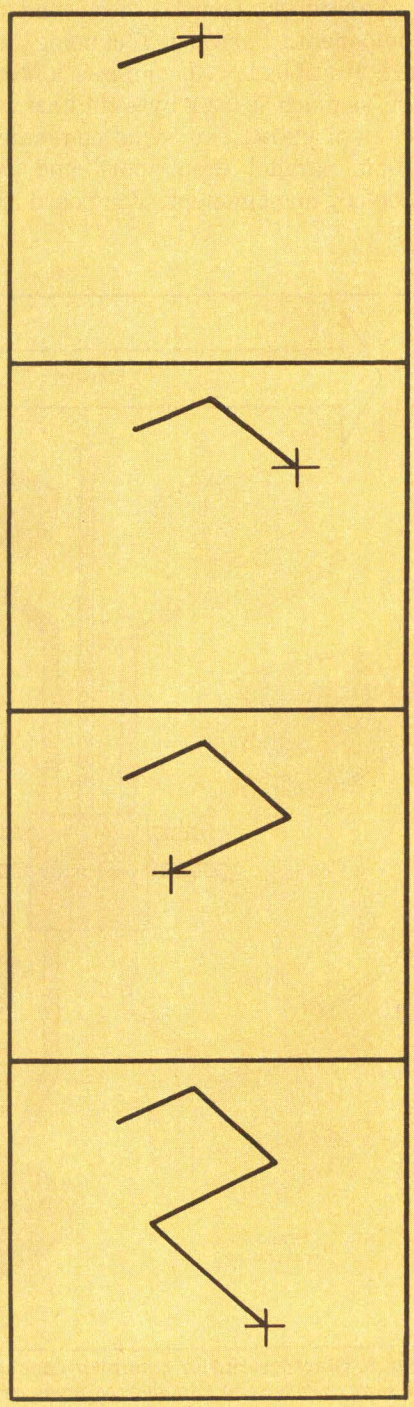
SIGGRAPH core primitives are higher level software commands that greatly simplify raster-scan graphics functions. As implemented on Forward Technology Corp.'s FT-1024 graphics board, commands similar to those shown in (A) can control a series of raster operations, speeding the generation of graphics symbols and objects. With a vector display, for example, implementing a command to rotate an object by 90 degrees requires manipulating mathematical functions using floating-point trigonometric calculations to produce the desired image. Using a core primitive command for a raster display, however, involves merely a shuffling operation that successively divides the picture in half—horizontally and vertically—interchanging the diagonal segments of the display until the rotation is completed. No mathematical algorithms are required, and the process itself is highly recursive, simplifying programming.

A "rubber-band" line display is another graphics function that can be implemented on the FT-1024 using the SIGGRAPH primitives. A user simply moves the cursor on the display screen from a starting point—usually with a mouse or data tablet—and the line is continually redrawn between the starting and endpoints (B). The operation is guided by a very simple algorithm that uses a logical OR operation on successive display data blocks to draw the line.

(A)

PLY2A.R	Draws a sequence of connected lines using absolute or relative coordinates.
PLY2A.R	Draws a defined number of current marker symbols at absolute or relative coordinates.
TEXT	Displays a string of alphanumeric text.
CHRSIZ [WIDTH, HEIGHT]	Specifies character size and space.
CHRSPC [SPACE]	
CLRMDL	Sets the model used for color.
DEFCLR	Associates colors with color indexes using the current color model.
FILIND [INDEX]	Specifies the polygon-fill index.
FONT [INDEX]	Sets the text-font index.
LINING [INDEX]	Sets the line-color index.
LINSTL [INDEX]	Sets the line-style index.
NDCWD2	Transforms a point on the screen to the 2D world space.
WINDOW	Specifies the portion of the coordinate system to be viewed.

(B)



bus. At the same time, the processor can select whether to load an operand from the data bus or from the frame buffer, whether to use the mask or the source register and whether or not to execute a frame-buffer-update operation.

Integrating the CPU board

A 16-bit CPU board is the second key graphics-system component. Forward Technology's FT-68X 6¾-by-12-inch Multibus board combines a Motorola 68000 processor, as much as 256K bytes of RAM with byte parity, 64K bytes of PROM, two serial communications channels, a 16-bit parallel input port and two-level page and memory management. The board runs under Microsoft Corp.'s XENIX-68 multiuser version of Bell Laboratories' UNIX operating system. Using XENIX-68, the board can run application programs written in C, FORTRAN, BASIC and Pascal high-level languages. Expansion encompassing Ada and Xerox Corp.'s Small Talk language is planned.

On-board RAM eliminates wait states

The inclusion of 256K bytes of RAM on the same board as the CPU has an important effect on system operation. It permits the 10-MHz 68000 to run programs at full speed without wait states, which would be needed if the RAM resided on a separate board and data had to be channeled through the Multibus interface's P1 connector. Using on-board memory, the 68000 can execute memory cycles, such as instruction fetches and read or write operations, every 500 nsec. Although it currently uses 64K RAMs, the board can accommodate future increases in RAM density. Memory can be further expanded by connecting a 768K-byte RAM board, which avoids wait states by linking through the P2 connector.

The Multibus, one of two buses on the FT-68X, references additional memory, the graphics processor and I/O devices. A second, internal synchronous bus communicates with on-board memory and other I/O devices. On-board accesses through the second bus free the Multibus to serve DMA devices or other CPUs, permitting true parallel processing in a multiprocessor environment.

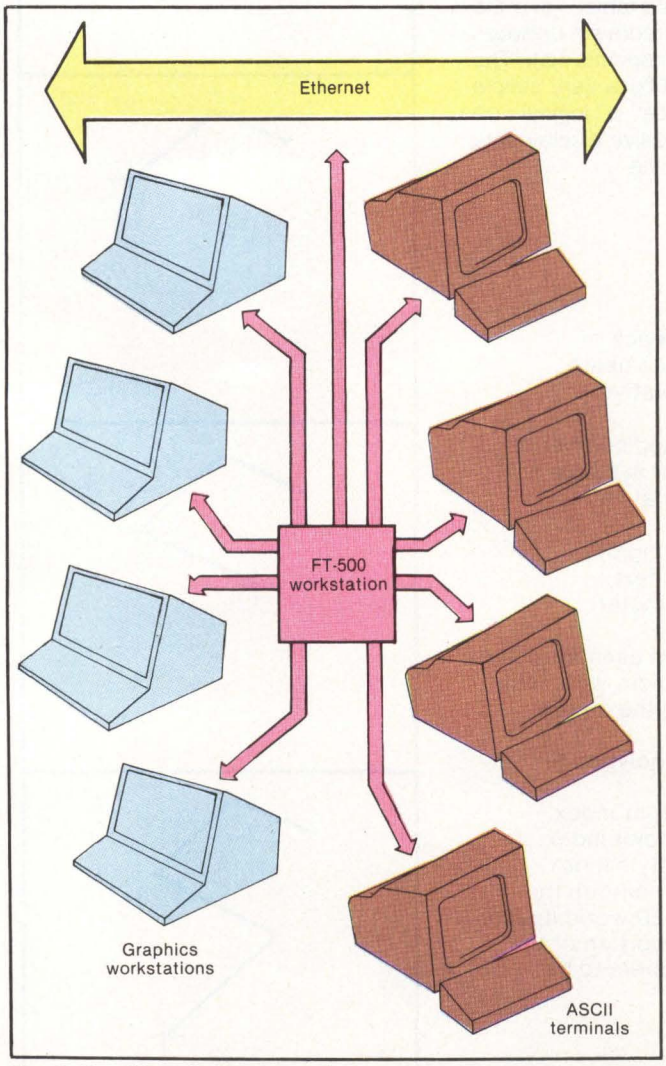


Fig. 3. Graphics cluster controller capability *permits one FT-500 Gateway workstation to control as many as four other workstations. The unit can also function as a standalone node on an Ethernet local-area network.*

HOW THE FT-68X MANAGES MEMORY

The FT-68X's memory-management unit (MMU) divides memory address space into 2K-byte pages. In the 24-bit addressing scheme, logical addresses are translated into physical addresses in a two-step process (see Figure). The first 11 address bits—A_0 to A_{10}—are within a page and therefore pass through the translation unmodified. The next 10 address bits—A_{11} to A_{20}—are subject to translation. Three bits—A_{21} to A_{23}—are reserved for special system functions and do not take part in the address translation.

In the first translation step, 10 bits of the logical address from the 68000 are combined with the 4-bit status information from the context register and translated via the segment map into a 6-bit virtual page address. The context register permits a system running multiple processes to switch between them without reloading state information relating to the translation of a particular process. The memory-management scheme can therefore

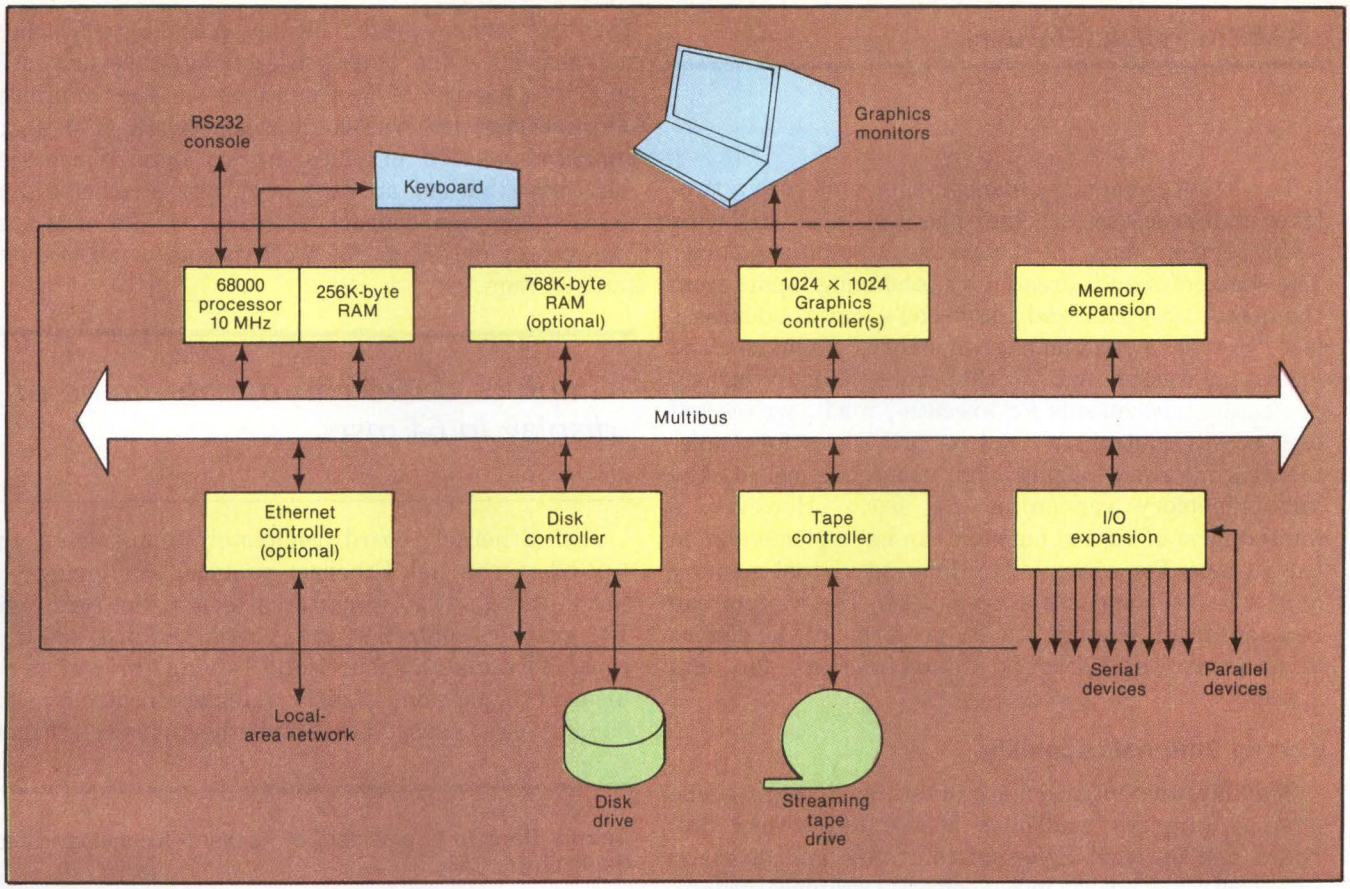
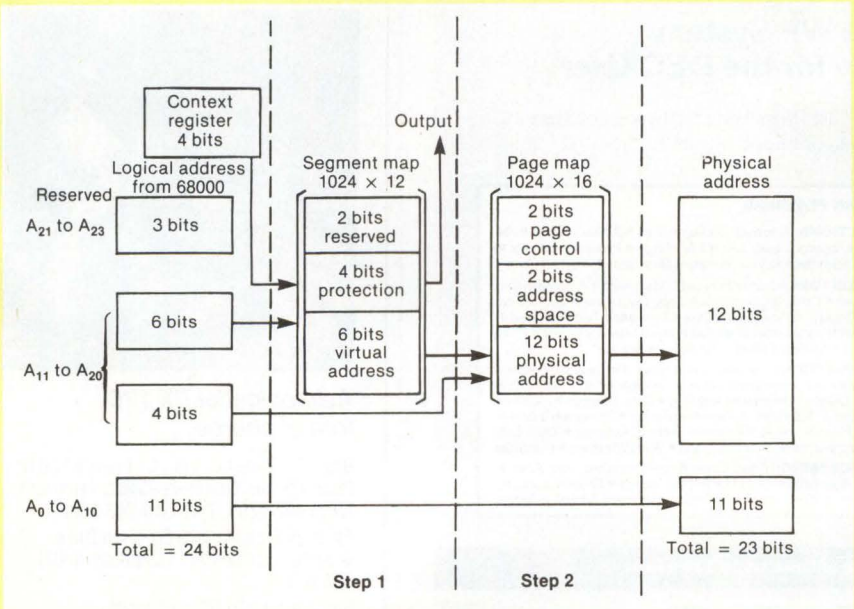


Fig. 4. An eight-slot card cage *permits the workstation to accommodate optional Ethernet and interface controller boards as well as additional memory and other I/O devices.*

map 16 distinct process translations simultaneously and access them by switching between the 16 portions of the segment map.

The 12-bit segment map reserves 2 bits. The other 10 bits (4 protection bits and the 6 most significant bits of the logical address) form a 1,024-entry table. The segment map outputs 6 virtual address bits and 4 protection bits. The 6 virtual address bits can then create as many as 64 segments for the 1,024-by-16 page map, each with its own protection attributes. These segments can be shared by assigning them a common virtual address or kept private by giving each segment a unique virtual address. A logical segment can thus be as large as 2M bytes or as small as a 2,048-byte page.



In the second of the memory-management steps, the 6-bit virtual address and 4 protection bits per segment from the segment map combine with the 4 logical address bits from the 68000 in the page map. The page map translates these inputs—along with 2 bits of page-control information—into a 12-bit physical page address. The 12-bit page address joins with the 68000's 11 unmodified intra-page bits (A_0 to A_{10}) to form a 23-bit physical address. The MMU can designate each page of physical address as one of four types of address space—on-board memory space, Multibus memory space, Multibus I/O space or as representing a non-existing page.

The FT-68X's memory-management unit uses a two-level multiprocessor scheme. The first level employs a 12-bit segment map; the second uses a 16-bit page map. The segment map is created by combining inputs from the context register and the 68000's logical addresses (see "How the FT-68X manages memory," Page 220). The logical addresses fed to the segment map include protection mechanisms for execute-, read-, write- and user-access control, as well as provisions for implementing demand paging and using the 68010, the virtual-memory version of the 68000. However, a limited form of virtual memory can be implemented on the FT-68X. For example, by limiting virtual-memory access to load and store operations, the system can recover from a page fault, a form of load/store architecture that permits virtual memory for data spaces.

Adding Ethernet capability

The Gateway engineering workstation integrates the FT-1024 graphics controller board, the FT-68X CPU board and optional Ethernet-controller and disk and tape-controller boards into a powerful graphics system. The basic turnkey system includes a 20M-byte Winchester disk drive and 20M-byte cartridge-tape drive. To support clusters of workstations or the multiuser demands of an Ethernet local-area network, (Fig. 3), an enhanced version provides an 80M-byte Winchester disk drive backed up by a 45M-byte streaming-tape drive. OEMs can connect as many as four 80M-byte Winchester drives to one workstation for 320M bytes total storage.

Graphics board can update frame of display in 64 msec.

The Ethernet board completely implements the 10M-bit-per-second Ethernet protocol, occupying one slot in the Gateway workstation's eight-slot card cage. The graphics controller, CPU board, and disk and tape controllers take up four slots, leaving three slots for memory expansion, a serial interface controller that handles eight RS232C ports and other functions (Fig. 4). □

Dennis Daniels is president of Forward Technology Corp., Santa Clara, Calif.

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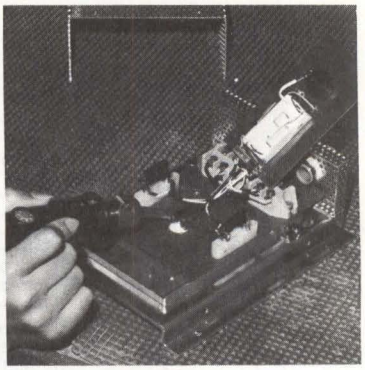

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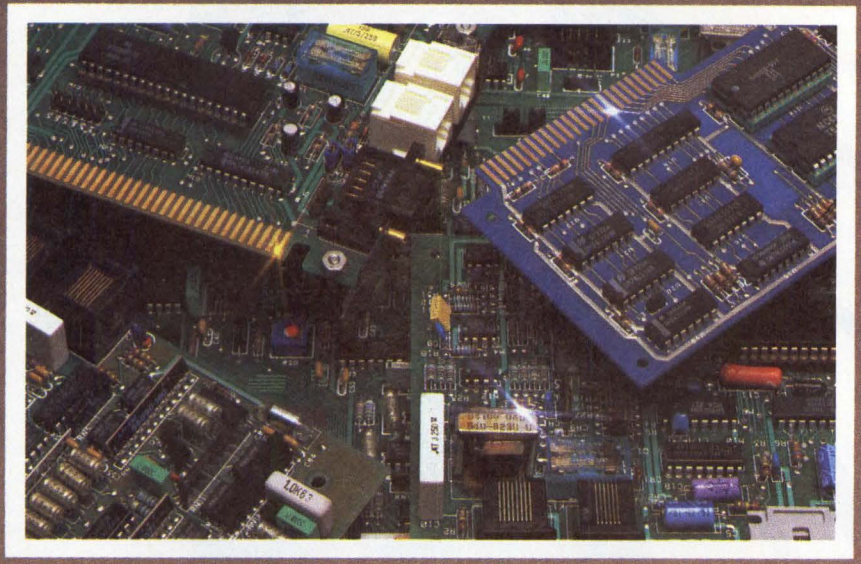

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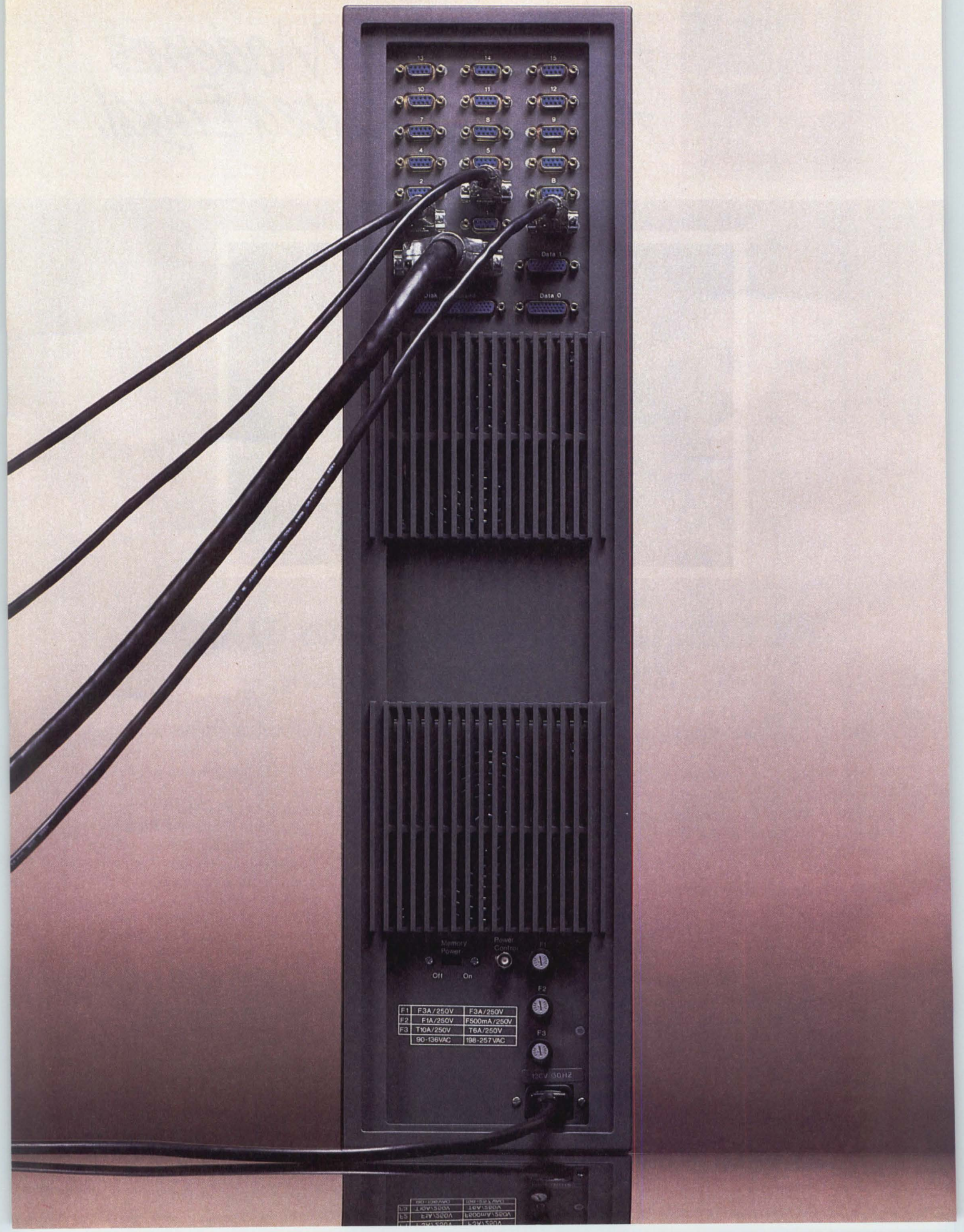
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Power Control
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Off
On
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F3
F1 F3A/250V F3A/250V
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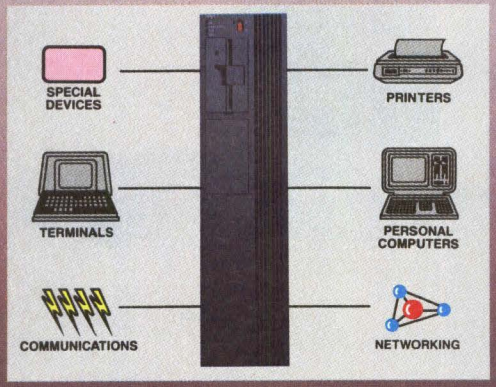

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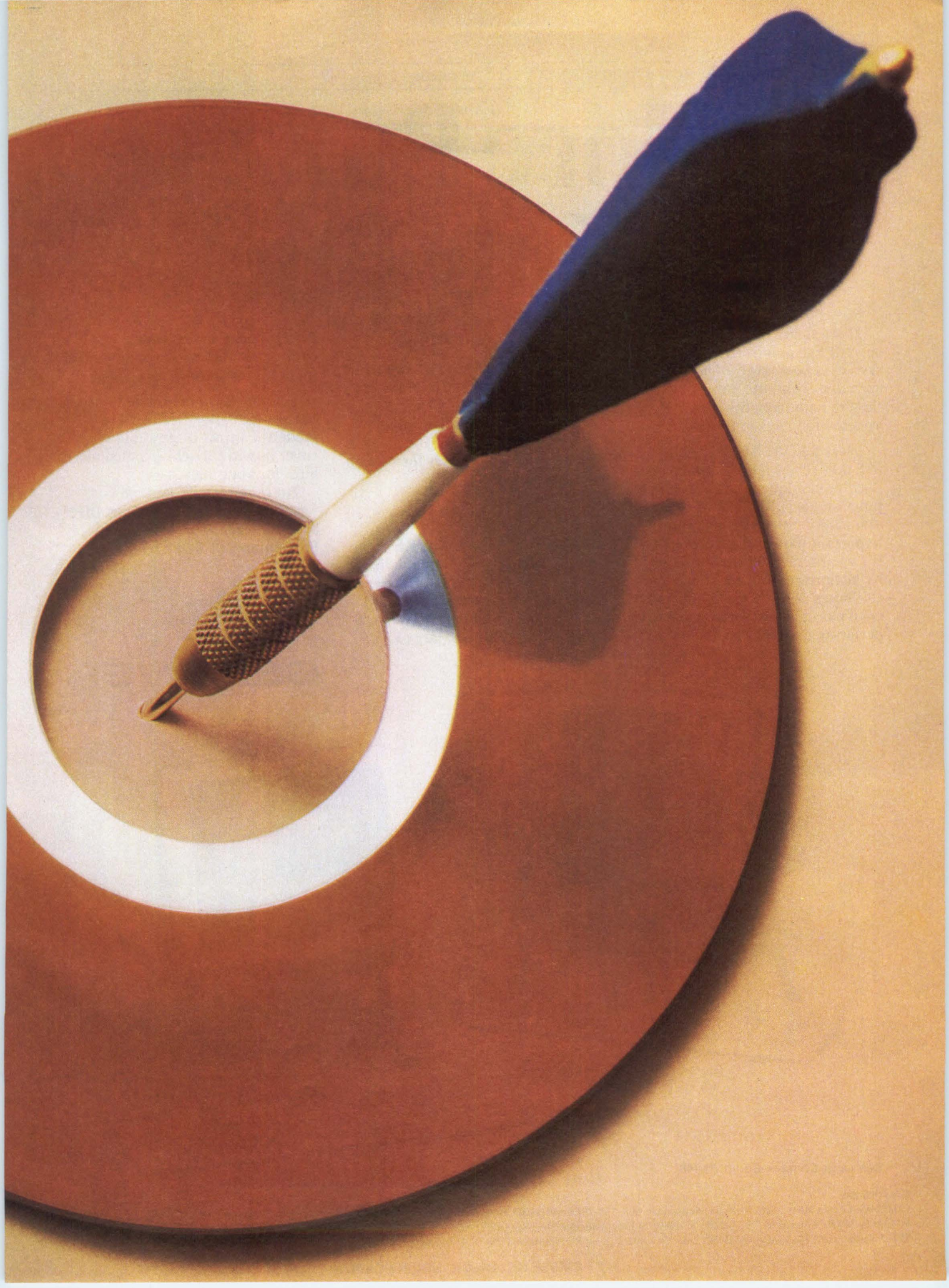

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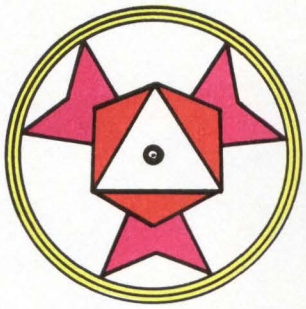


COMDEX™ Fall '83... spotlights software products and trends

JESSE VICTOR, Associate Editor

Fifth annual small systems conference and exposition emphasizes major operating systems, key languages, systems and application packages

Software will hold the limelight when Comdex/Fall '83 convenes in Las Vegas, Nev., Nov. 28 through Dec. 2. More than 250 of the show's 1,500 exhibitors will be software or software-related companies. Many of the conference's 52 professional sessions will focus on key operating system (OS) trends, integrated microcomputer software packages, major and emerging languages, developments in local-area-network (LAN), database software and software interfaces for microcomputer-to-minicomputer or -to-mainframe connections.

A Monday afternoon session—"Operating System Trends: Ultimately UNIX?"—will track operating systems such as MS-DOS, CP/M, Bell Laboratories' UNIX, XENIX and "some other things that may come out by that time," says session leader Jean Yates, president of Yates Ventures, Los Altos, Calif. "We will look at where the overall winners are going to be in terms of market share, unit shipments and dollars."

Tracking OS standards

Yates does not see UNIX becoming the de facto standard for 16-bit systems. "Obviously, IBM's MS-DOS/PC-DOS products are the de facto 16-bit standard," she asserts. "MS-DOS/PC-DOS is very much the OS of the single-user workstation. UNIX is a vehicle for making 16-bit minicomputer-type computers and applications available to microcomputer purchasers." What does Yates see as the main role for UNIX? "It's going to be very important for microcomputers-through-mainframes as a multiuser standard OS that vendors will offer in conjunction with a proprietary OS on the high end to give the end user access to the UNIX application-software library."

The session will explore the advantages and disadvantages of CP/M relative to MS-DOS and look into "ways to differentiate the product from PC-DOS," Yates adds. Yates does not agree with those who see a steadily declining role for CP/M in the next few years. "I think CP/M has a very viable position," she claims. But there is "some question as to where its niche will be. With more than 800 OEMs using it, it's not going away. You can be compatible with PC-DOS, offer CP/M and get some significant advantages that differentiate your product from the 8 zillion running on MS-DOS."

A significantly less sanguine view of available software will be offered by Rodney Zaks, president of Sybex Computer Books, Berkeley, Calif., in "Defacto Standards in the Micro Jungle." The Tuesday afternoon session will delve into the "demise of CP/M, the rise of IBM-enforced standards for operating systems, the significant demise of Pascal and the unlikely emergence of UNIX," according to Zaks. "It is very likely that we will see CP/M taper off and possibly slow drastically," Zaks asserts. "It is unlikely that any significant new computers will be introduced that will have CP/M compatibility."

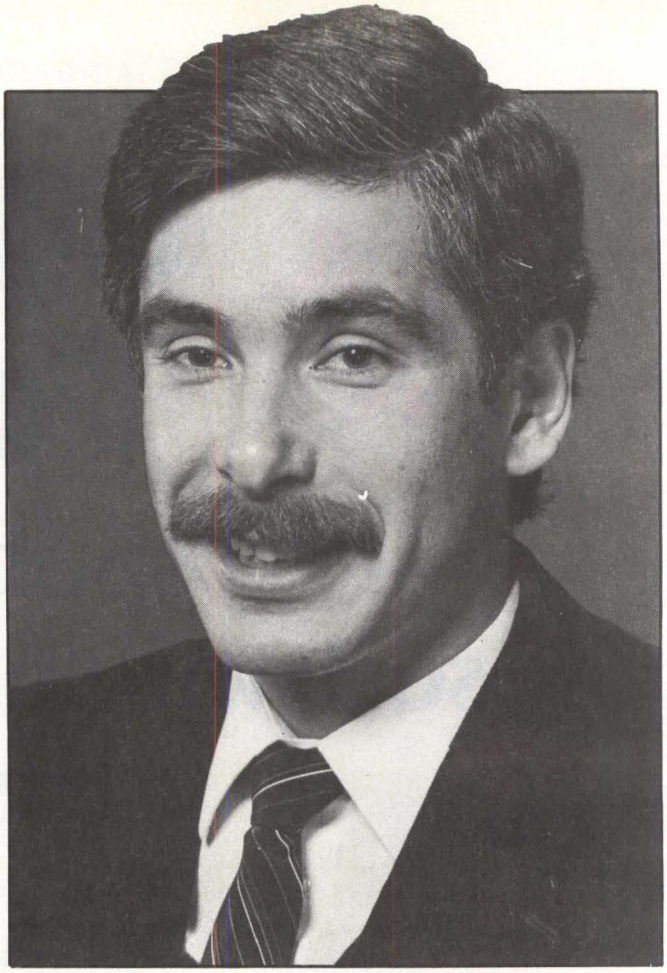
Zaks sees PC-DOS or "possibly a proprietary OS that IBM might be introducing later on" as taking over CP/M's role. As for Pascal, "nobody is creating the programs that would have made it easy to use, effective or convenient," he insists. "Pascal at this point remains a development tool for engineers and an educational tool for universities. The growth phase of Pascal is also now terminated."

Questions of survival

As for highly-touted languages, Zaks views Ada primarily as a "long-range" tool for the military that also may "become quite well-used by development circles over the next five to 10 years." However, he does not foresee significant commercial applications within the next few years.

Zaks is also not optimistic about the prospects for UNIX. "UNIX so far has not made it," he contends. "And the hardware that would truly support the OS's capabilities is not truly available at this point. The large-scale use of UNIX as an operating system is very unlikely in the short term. UNIX remains very much wishful thinking in its admirers' eyes." Zaks thus expects MS-DOS and PC-DOS to capture the lion's share of the OS market, with UNIX emerging perhaps sometime down the road on faster machines that can more effectively use its capabilities.

In related session coverage, James Dow, president of Microcom Inc., Norwood, Mass., will discuss the recently-introduced Microcom Networking Protocol (MNP) and the general role of communications standards and protocols. Following the International Standards Organization (ISO) model, MNP serves file transfer among microcomputers, minicomputers, mainframes and computer networks. "I see it becoming the de facto standard for dial-up communications," Dow says. He expects VisiCorp, Microcom, Apple Computer Inc., Lotus Development Corp. and several other companies to standardize on the protocol soon. He thus sees the use of three sets of communications protocols serving different kinds of end-user requirements, with



"It is unlikely *that any significant computers will be introduced that will have CP/M compatibility," says Rodney Zaks, president of Sybex Computer Books.*

MNP supplementing IBM Corp.'s System Network Architecture (SNA) and a LAN protocol. "Whatever IBM announces as its LAN will become one of the LAN standards," Dow says, "with possibly Ethernet as the other."

Focusing on integrated software

Integrated software packages will not be neglected by Comdex/Fall '83. Another Tuesday afternoon session—"Integrated Microsoftware Packages: Do They Deliver?"—will zero in on innovative products such as VisiCorp's Visi^{On}, Lotus 1-2-3, and Apple Lisa-type packages, says session chairman Brant Corenson. President of Enlon Associates, Cupertino, Calif., Corenson expects the coverage to delve into current and future products in two categories: first, lower-level systems that do not require a hard disk and don't offer features such as multiwindowing, graphics and a pointing device and, second, higher-end packages that include these capabilities.

Corenson, however, sees some obstacles to widespread use of integrated software products by middle- and higher-level managers in Fortune 500 companies. They will "probably not use Lisa- or Visi^{On}-type systems on a personal computer in an individual office,"

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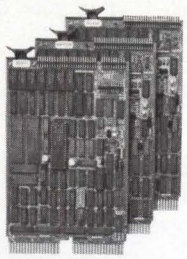

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he says, but might use them on the departmental level. "The main problem right now is the price. It's too high. The other problem is that IBM hasn't introduced anything yet. And, until they do, corporate acceptance of these products will not be that rapid." Corenson expects IBM, as in many other markets, eventually to call the tune for integrated software products.

The session will also focus on the three levels of integration these packages offer. The lowest-level products integrate and translate file formats; the next-level products, which include packages such as Context Management Systems' MBA and Lotus' 1-2-3, have common instructions from one package to another. The top-line products provide several levels of software with a high-level user interface, graphics and a mouse for data entry. The highest-level products, Corenson says, are "object-oriented systems," such as Xerox Corp.'s Small Talk, in which the "operating system and applications are in one common area, and you add additional applications by adding objects to the system."

Databases and LANs also considered

Developments in database software and the role IBM and AT&T will play in the small computer systems market will be tracked by two Comdex/Fall '83 sessions. Wednesday morning, "Doing More Database Business" will consider the role of database software in multiuser systems, the split between menu-driven and procedural packages and the use of database software in multiuser LANs. This application, however, remains problematic, contends session participant Adam Green, president of Softwarebanc Inc., Arlington, Mass. "LANs don't really exist as far as I am concerned,"

"We will look *at where the overall winners are going to be in terms of market share, unit shipments and dollars," says Jean Yates, president of Yates Ventures.*

Green says. "There are a lot of people advertising them. There are some people who have them. But they are a hardware solution. The software is not there yet."

In this regard, file access can be a problem on multiuser systems, Green cautions. "Right now, you can get 10 different personal computers on one hard disk and call that an LAN. But you'd better make sure they don't try to get the same file at the same time. That would be a big problem." An even bigger problem,

Comdex/Fall '83 is expected *to attract 1,500 exhibitors.*

Many of the 52 professional sessions *at Comdex/Fall '83 will focus on software matters.*

he contends, is that network capabilities are not being fully used. "Networks are treated as a shared hard disk, but they are not sharing files, which is the key point to networks. There is no application software available that will let users share files." A user could write it in assembly language or C, Green says, but "there is no way an end user can just pick up a database program and take advantage of a network."

Despite these problems, Green predicts a "tremendous growth" for the database market over the next few years. "The number of people who will want databases is going to be huge," he says. "The number of people who can use spreadsheets is limited to maybe half a million. But people who need databases include anyone who deals with information—which is what most of the country is doing right now."

Predicting small systems trends

Computer system developments and peripherals coverage, the core of most industry trade shows, will also be in the spotlight at Comdex. A Thursday morning session, for example, will predict the shape of tomorrow's microcomputer and minicomputer markets. Tuesday afternoon coverage, "Tracking Disk Developments," will follow significant trends, as will a related Thursday morning session. Another session, "Small Systems Markets," will track "the most recent trends and price/performance ratios, rapid price degradations and the use of added value to differentiate one small system from another," reports session co-chairman Jean Yates. "We will look at the key players, who is winning in terms of units shipped and the general impact IBM and AT&T are having on the market" for computer systems selling for less than $150,000. The Tuesday afternoon session will also focus on developments in office automation.

Yates foresees IBM's entry into the small systems market as having a devastating impact, forcing many of the weaker contenders to drop out over the next few years. "As the hockey-stick growth curve levels out," Yates says, "I see a precipitous trend toward mergers, acquisitions and bankruptcies." Yates expects AT&T, for its part, to come on strong in the office-automation market. "They will certainly be a major contender because they will try to sell computers to the phone-purchasing people in the big Fortune 100 companies and thereby combat IBM. In office automation, there is going to be a knock-down, drag-out fight between IBM and AT&T for control of the office." □

IMPROVING SOFTWARE RELIABILITY

Jack Scanlon, vice president, processor and software systems division, Western Electric Co., looks at computer and communications software from a telephone professional's perspective and doesn't like what he sees. "Downtime due to software problems will have to be reduced by two orders of magnitude to be acceptable. Hardware today is sufficiently reliable, but software is not. Reliability is becoming more of a software than a hardware issue."

Comparing computer systems to the dial-up telephone network, Scanlon notes that a computer system running 24 hours a day with an average uptime of 99 percent will be down for several hours a week. That's "actually very poor reliability" when important business processing or Defense Department decisions may hang in the balance. "Ninety-nine percent uptime is totally unacceptable. Ninety-nine percent is only as good as Ivory soap. We need 99.99 percent or better." The dial-up phone system, Scanlon contends, has achieved a downtime of only 2 minutes a year.

Co-keynoter for the Comdex/Fall '83 show with William Gates, president of Microsoft Corp., Scanlon sees serious problems with software reusability and programmer productivity. "Half of all the time spent by programmers is spent redoing things that have already been done for a new environment," he asserts. "That is totally unacceptable." The solution? Portable operating systems such as UNIX and portable compilers such as C.

However, Scanlon points out that languages such as Ada with strong typing and other requirements in regard to program structure will reduce programming and debugging and thus serve to boost programmer productivity.

Computer systems that can talk to any other system without a performance penalty are also a necessity, Scanlon says. In most systems, the use of networking can cut performance by 25 percent, compared to no loss of performance for the telephone system. "When you call someone over the dial-up phone network, you don't have to worry about what kind of equipment they have or over what path the signals can travel." Scanlon says. "For computers to become ubiquitous, the same kind of network integration is required." There are also too many protocols in use, and the ones being used are inefficient. The solution? Reduce the number of protocols and put the protocols themselves into silicon.

Scanlon foresees a "continuing marriage of software designers and silicon designers" as more and more software, including high-level languages, becomes embedded in silicon. To use all the components on tomorrow's chips fully and efficiently, Scanlon says, software designers will have to become involved in chip design. If they don't, manufacturers will turn out very dense chips that "don't do what the software designer wants them to do." Putting software in silicon is also "the only way to get costs down to acceptable levels," he says.

Finally, Scanlon sees "environmental robustness" as a major issue for computer systems—and a major shortcoming when they are compared to the telephone network. The phone network, he notes, continues to function in the face of power outages, major storms and lightning and other environmental extremes. In contrast, Scanlon points out, computers still require narrow humidity and temperature ranges.

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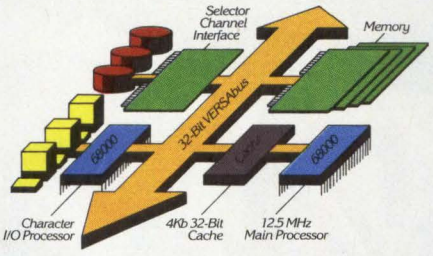

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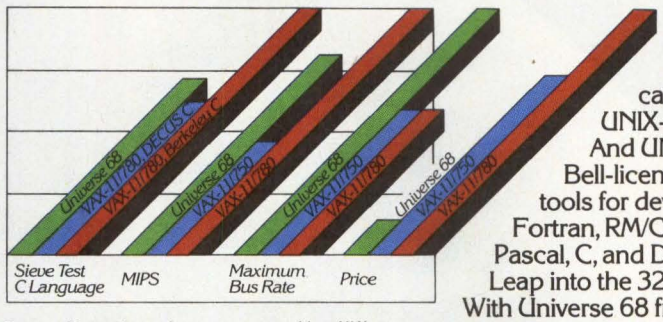

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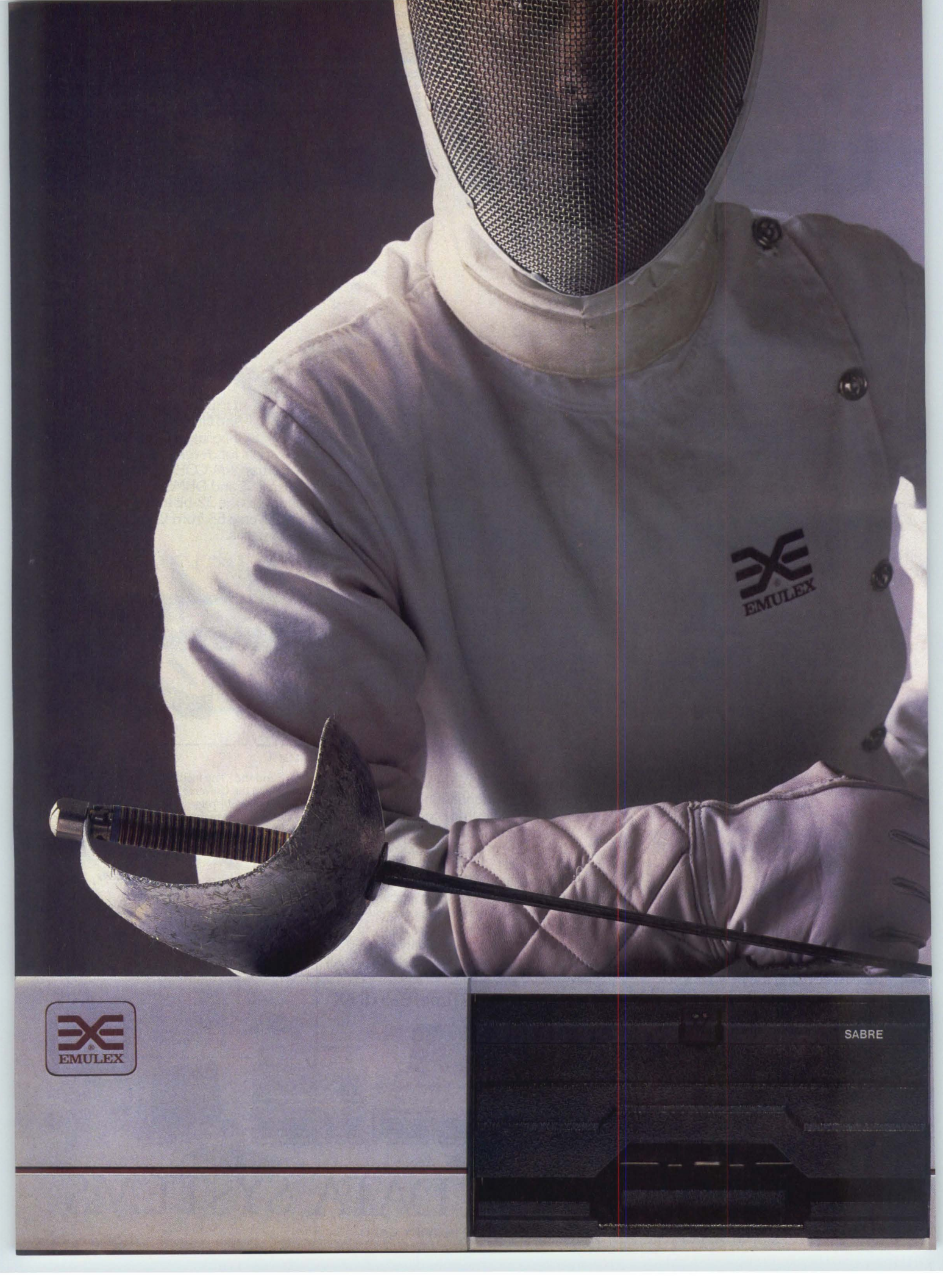
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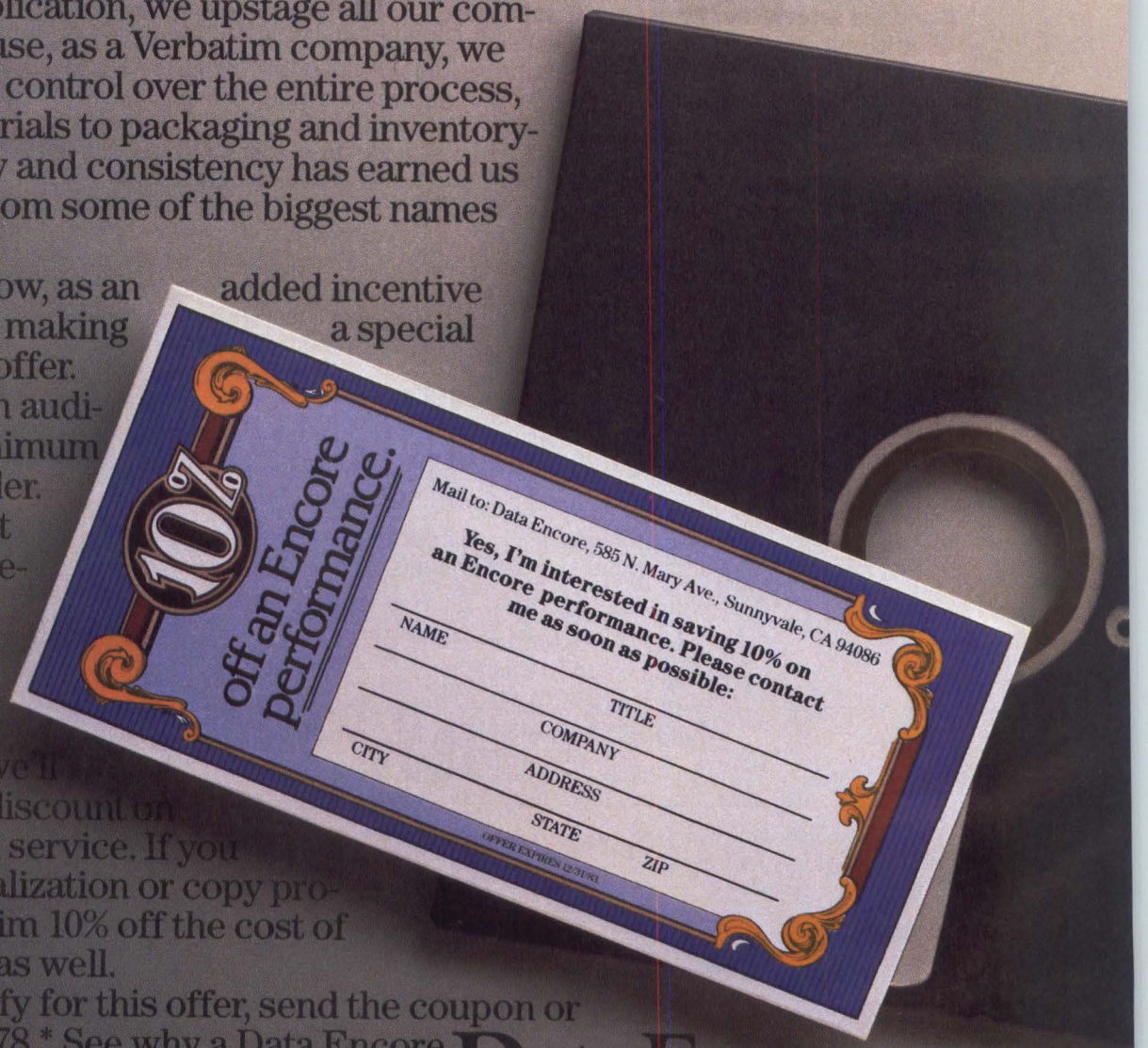

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10M-bps LAN combines benefits of CSMA/CD and token passing

ASHRAF M. DAHOD, Applitek Corp.

LAN factors	Access method: CSMA/CD	Access method: Token passing
Maximum device-to-device distance:		
Less than 5 miles	✓	✓
Greater than 5 miles		✓
Types of devices:		
Intelligent		✓
Non-intelligent	✓	
Asynchronous	✓	
Synchronous		✓
Short bursty messages	✓	
Long bursty messages	✓	
Fixed-length bursty messages	✓	
Short regular messages		✓
Long regular messages (file transfers)		✓
Fixed length regular messages		✓
System requirements:		
No central controller		✓
Known transmission delay	✓	
Unbounded, highly variable transmission delay is acceptable		✓
Tightly synchronized operations needed	✓	
Digitized voice support needed		✓
Ratio of peak system load* to system capacity:		
Less than 40%	✓	✓
Less than 60%	✓	✓
More than 60%		✓

*(Number of devices × data bit rate per device × message frequency per device)

Different access methods address different local-area network (LAN) requirements. *While carrier sense multiple access/collision detection (CSMA/CD) and token passing are well-suited to particular LAN environments, Applitek's UniLINK access method accommodates all LAN requirements in each of the above categories by combining the benefits of CSMA/CD and token passing.*

Choosing a local-area network (LAN) for a multivendor, multitasking computer environment presents a dilemma: two common access methods are available. They are carrier sense multiple access/collision detection (CSMA/CD), most effective in networks with non-intelligent devices generating infrequent, or "bursty," messages, and token passing, in networks with synchronous, intelligent devices transmitting frequent or regular messages. Applitek Corp.'s universal LAN (UniLAN) uses the UniLINK access method to combine the advantages of both access methods on one 10 M bit-per-second network. UniLAN uses either broadband or baseband coaxial cable or fiber-optic cable and has modular software.

Common access methods offer advantages

An access method is a protocol that defines the rules granting a user-device entry to a data channel. CSMA/CD is a distributed contention technique that uses random access and variable message lengths. If two devices try to transmit at about the same time, they stop and wait a random amount of time before trying to send again. (Retransmission delays vary, depending on network load.) As more devices attempt to transmit, the number of collisions increases, and more network time is spent resolving them. Long or frequent messages, such as file transfers, could overload the network and cause serious delays. Therefore, CSMA/CD is more efficient on lightly-loaded networks with intermittent traffic and applications that require only short delays rather than guaranteed access. Guaran-

UniLINK access methods serve multitasking, multivendor environments

teed access means that, within a specified period of time, the system ensures that a device will be able to transmit.

Some applications, such as real-time digitized voice, require guaranteed access to the network. Token passing is the preferred method for these applications. The network passes a token from node to node. Because the node holding the token controls the medium for a pre-defined period of time, token-passing systems are effective for applications involving frequent or regular traffic and become inefficient if traffic is infrequent or irregular. Moreover, they sometimes require special administrative nodes to control traffic.

UniLINK combines advantages

UniLINK automatically adjusts to accommodate different types of devices and traffic loads. The network implicitly assigns a different number to each message. (A message is defined as the period during which a packet of information can be transmitted.) The messages can be of variable length. All devices on the network "know" the current message number and can transmit only during the message number assigned.

A message-number allocation process assigns numbers to the network interfaces on a dedicated or contention basis. A message number is dedicated if only one interface can use the number to send information through the network. A contention message number can be assigned to more than one interface; interfaces must "contend" for its use. As in CSMA/CD, when the sender detects a collision, it stops and waits a random length of time before trying to send again in a contention message number. However, if a sender's dedicated message number comes up before the random wait period is over, the sender uses that message number to transmit. Thus, if a node encounters a relatively large number of collisions, the message-number allocation process assigns a dedicated message number to that node. This procedure reduces the delays in conventional CSMA/CD systems. Also, a node can be given priority by assigning it more message numbers, depending on the amount of traffic generated at the node.

Allocation of message numbers to the network interfaces determines how UniLINK functions. If all message numbers are assigned on a contention basis, the network functions like a CSMA/CD network; if interfaces are assigned only dedicated message numbers, UniLINK functions like a token-passing network, the numbers acting as tokens. And, similarly, if both dedicated and contention numbers are used, UniLINK functions as a combination of the two. By assigning dedicated message numbers for synchronous and voice devices and contention message numbers for asynchro-

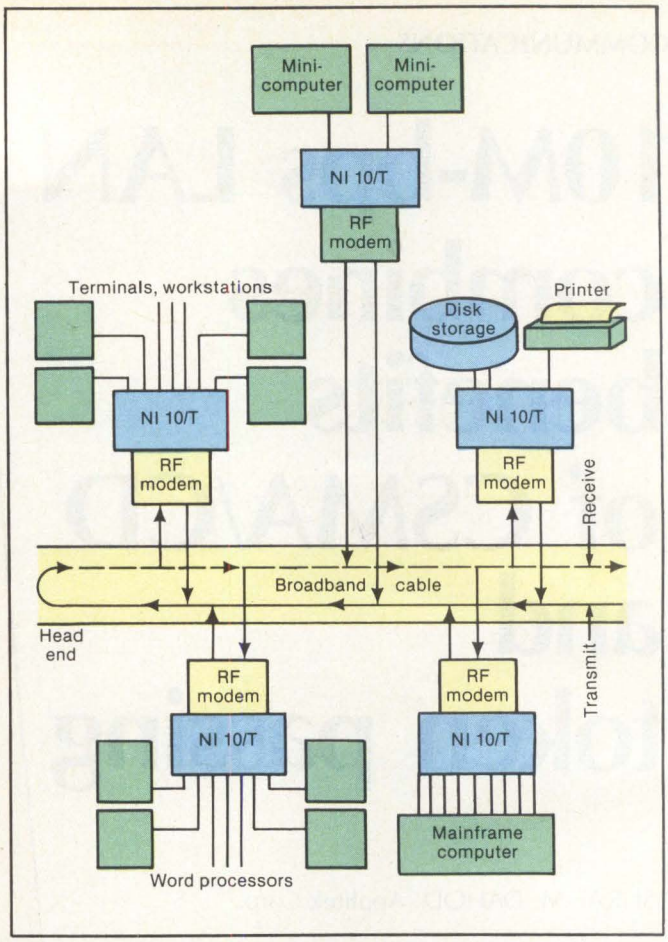


Fig. 1. UniLAN configuration with broadband cable. *The network interface (NI 10/T) connects user devices to the cable via the Applitek RF modem. In a baseband system, a transceiver connects the network interface to the coaxial cable.*

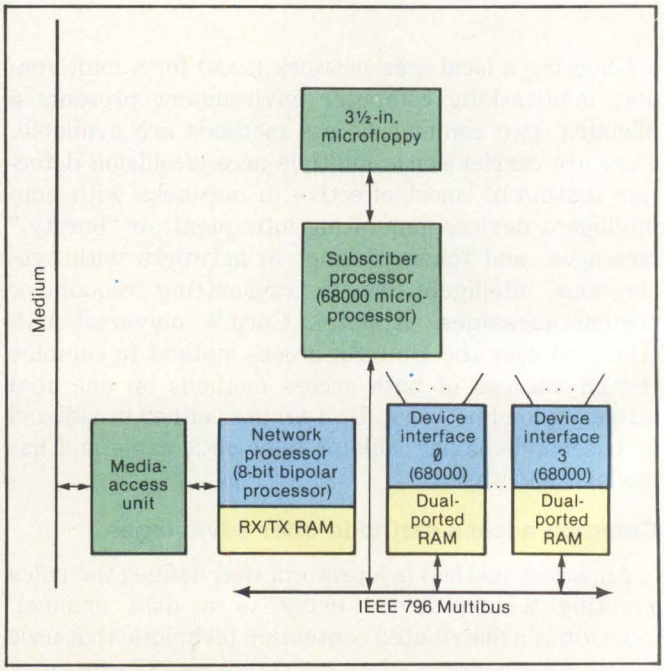
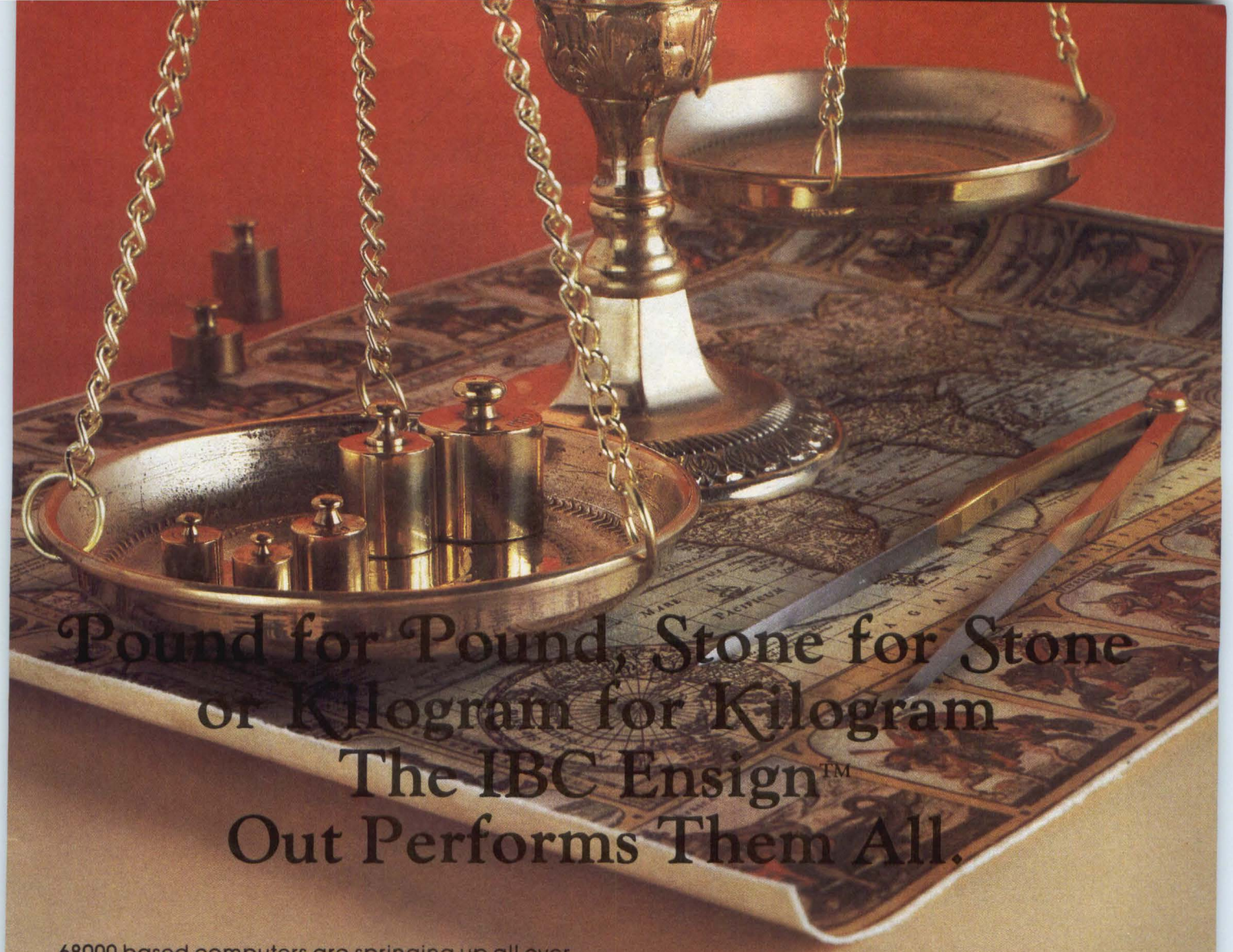


Fig. 2. The network interface *consists of the media access unit; a network processor with firmware that implements the UniLINK access method, a receive/transmit (RX/TX) buffer with 8K bytes of RAM to receive packets and 4K bytes of RAM to store packets to be transmitted, a subscriber processor that checks message headers and as many as four device interfaces.*



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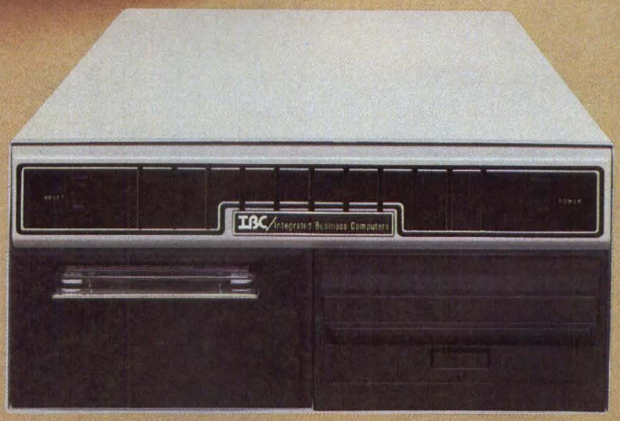

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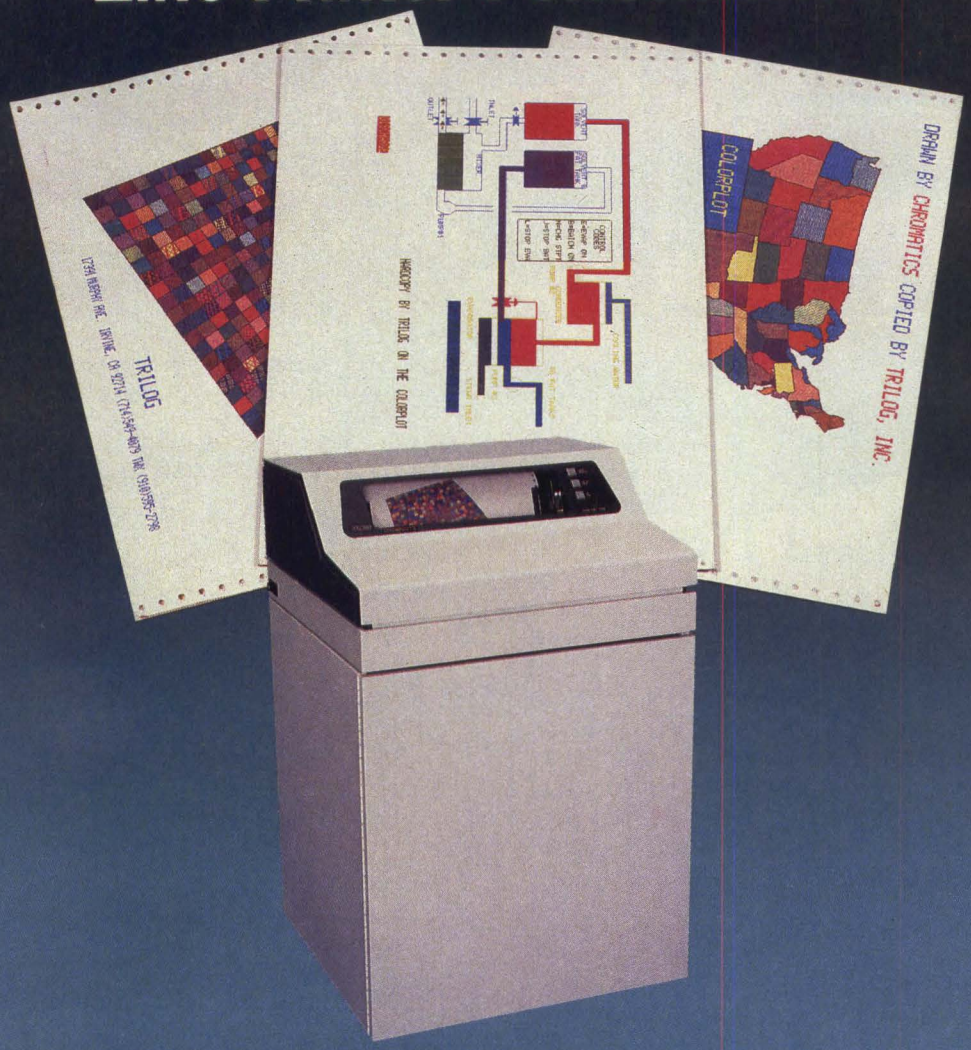

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nous and bursty devices, the network concurrently provides guaranteed and shared access.

Message numbers are assigned either by the user or by an automatic allocation algorithm in each interface. In a large network, a network monitor unit can automatically perform message-number allocation and other network-management functions.

Network interfaces synchronize and keep track of message numbers as they pass by on the network, a process called "pacing." Any of the network interfaces can handle system pacing. When an interface comes on-line, it "listens" to the network. If no activity is detected, that node automatically assumes the pacer role. If two or more interfaces attempt to be the network pacer at once, collision occurs, and the interfaces shut off and wait a random period of time before trying again.

Each network interface has 16-bit message-number counter incremented at each message boundary. To ensure that the value of the counter is the same from device to device, the network pacer sends a message carrying the current message number. These block-synchronization messages are sent once every 1,024 messages.

Time delay is used when interfaces transmit, allowing messages to line up end to end with no idle time between them. In a broadband system, each device computes its own time-delay parameter because each interface is at a different distance from the cable head end. The time-delay parameter establishes different loop delays for each node, depending on the distance from the cable head end.

Connecting the configuration

The media-access unit (MAU) connects the network interface to the network. In baseband systems, the MAU is an IEEE 802 baseband transceiver; in fiber-optic systems, the MAU is a baseband optical fiber tap. For broadband systems (Fig. 1), Applitek Corp. has developed a custom RF modem to act as the MAU. The modem follows IEEE 802 guidelines and offers 10M-bps operation in one 6-MHz TV channel.

UniLAN can support more than 10,000 network interfaces, depending on the cable used. Each network interface (Fig. 2) consists of the MAU, a network processor, a subscriber processor and the device interface(s).

The network processor has an 8-bit bipolar processor with firmware to implement the UniLINK access method. A receive/transmit buffer has 8K bytes of odd-parity RAM to receive packets from the network and 4K bytes of odd-parity RAM to store packets to be transmitted. Its resettable first-in, first-out (FIFO) memory increases data throughput. The network processor Manchester encodes and decodes data in

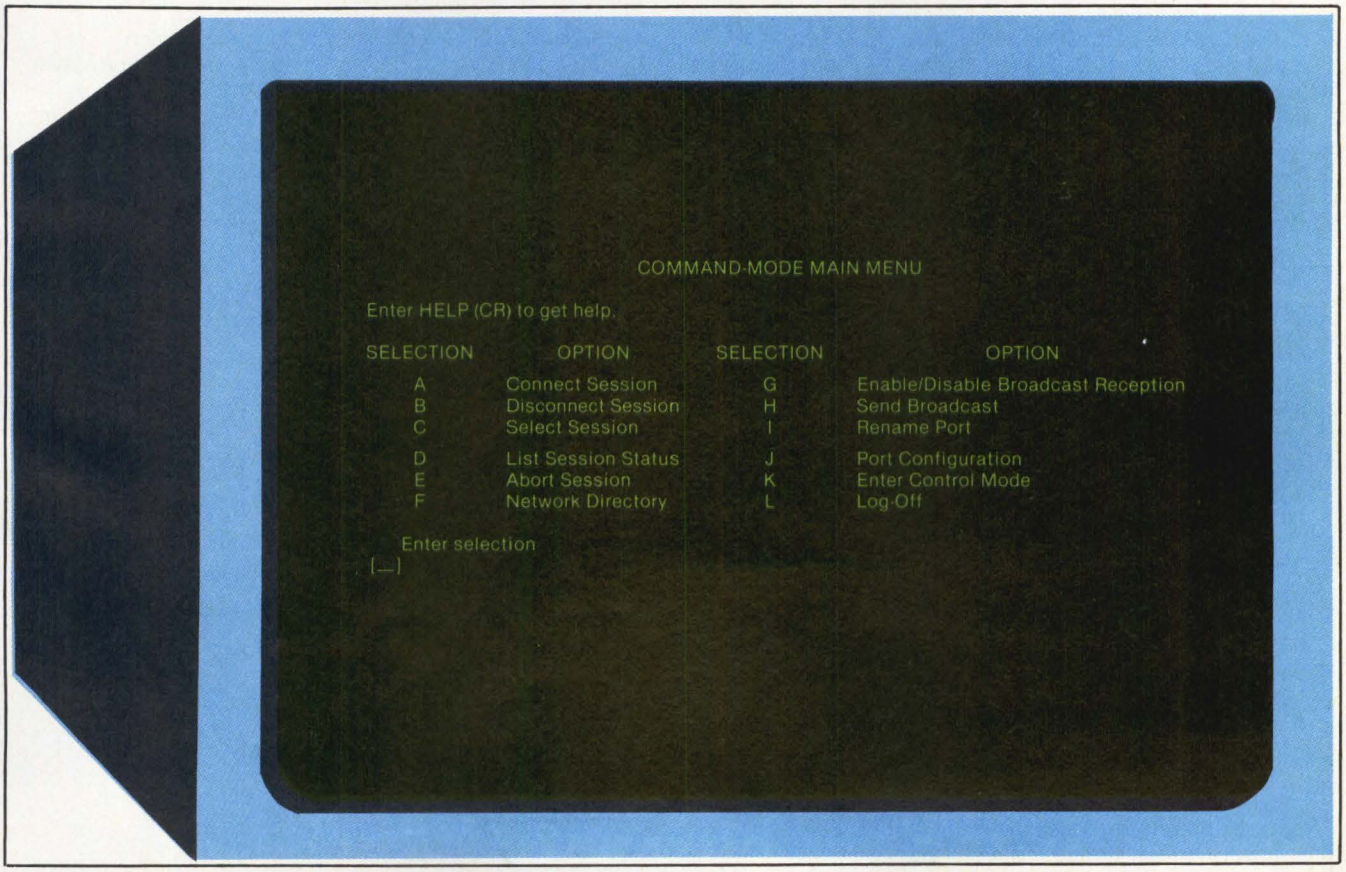


Fig. 3. The command mode main menu *provides commands for configuring system devices.*

baseband and optical fiber networks.

The subscriber processor is based on the Motorola 68000 microprocessor and handles as many as four device interfaces. A 3½-inch microfloppy drive connected to the subscriber processor stores programs and configuration parameters.

Connecting the 68000-based device interfaces to the subscriber processor is an IEEE-796 Multibus. Each device interface comes with 32K bytes of dual-ported RAM to store inbound and outbound packets, so that, while one packet is being assembled, another can be transmitted. Each device interface supports as many as eight RS232/449 asynchronous, bisynchronous or synchronous data-link-control (SDLC) devices. The network interface currently has eight ports for connecting user devices.

Tracking the data flow

The dual-ported RAM on the device interface stores data from a user. When a packet (message) is ready to be transmitted, the device interface informs the subscriber processor, which sets up direct memory access (DMA) between the RAM and the transmit buffer. The network processor then sends the packet to the network through the MAU.

In "receive" direction, the MAU receives data from the network and stores it in a "receive" buffer. The subscriber processor checks the header and processes the data. If the packet is addressed to a device connected to the network interface, it sets up a DMA to move the packet into dual-ported RAM. The 68000 then takes the packet from RAM and ships it to the user.

Each component of the network interface runs its own diagnostics at power-up. The device interfaces put their local ports in loop-around mode. The subscriber processor checks them and sends test-pattern packets through the network processor and MAU and over the cable. If all diagnostics pass, the network processor becomes operational.

Modular software provides flexibility

UniLAN'S software has an English-language command structure presented in menu form, and a HELP facility provides on-line support. Software creates virtual circuits, called "sessions," between devices, while error detection and control procedures assure the integrity of the data.

PLAYING BY THE RULES

The Open Systems Interconnection (OSI) reference model, defined by the International Standards Organization (ISO) in collaboration with Comité Consultatif International Télégraphique et Téléphonique (CCITT), is designed to establish a data-communications protocol model for local-area networks (LANS). The purpose of the ISO model is to facilitate compatibility between the various protocols in a multivendor network, as well as to increase the software modularity of network systems via a modular, seven-layer organization. Applitek Corp.'s Universal LAN (UniLAN) implements the layers via network interface components.

The first (physical) layer refers to how user devices are connected and how data travels over a transmission medium or cable. The data-link layer defines the communications path between network nodes and the transfer of data over the shared cable. It also detects and corrects errors occurring on the physical layer. UniLAN implements these layers in the media-access unit (MAU) and in the network processor, respectively.

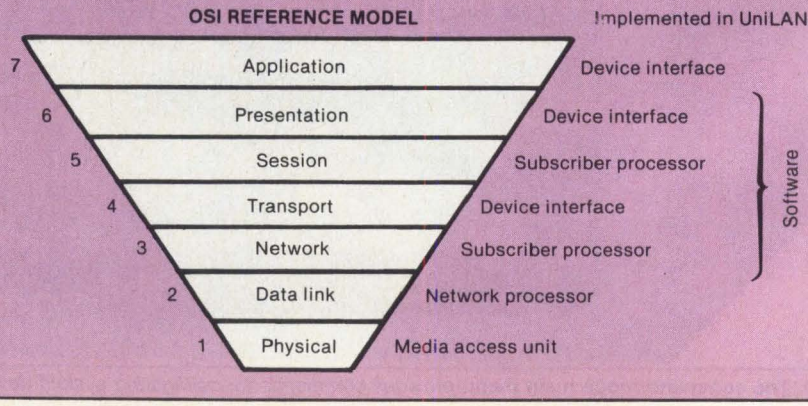
Layers three through seven are implemented in network software. The third transparently routes network packets. The transport layer, implemented in the device interface, assures end-to-end data integrity and data sequencing.

The fifth, or session, layer defines procedures to make, manage and break connections between users. These connections are called sessions and include such functions as auto dialing and load sharing.

The sixth layer converts data from a sending device into a format recognizable by a receiving device. Functions include code and character-set conversions, data formatting, message compression and encryption.

The seventh, or application, layer enables application processes to operate within the network environment, and their content depends on the application supported. The layer provides transparent network-wide resource sharing, file transfers, remote file access and database management.

The OSI model defines the logical functions of each layer, although it is not a network-design requirement. The hope is that, by adhering to these guidelines, more compatible protocols will emerge. □



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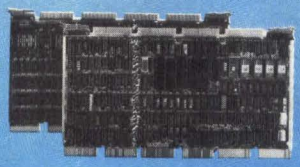

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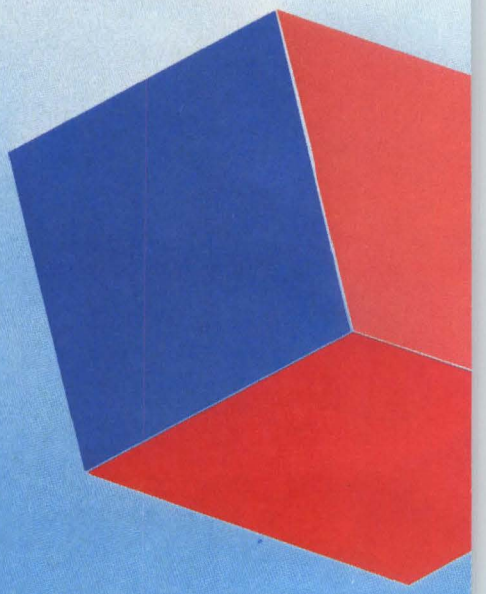

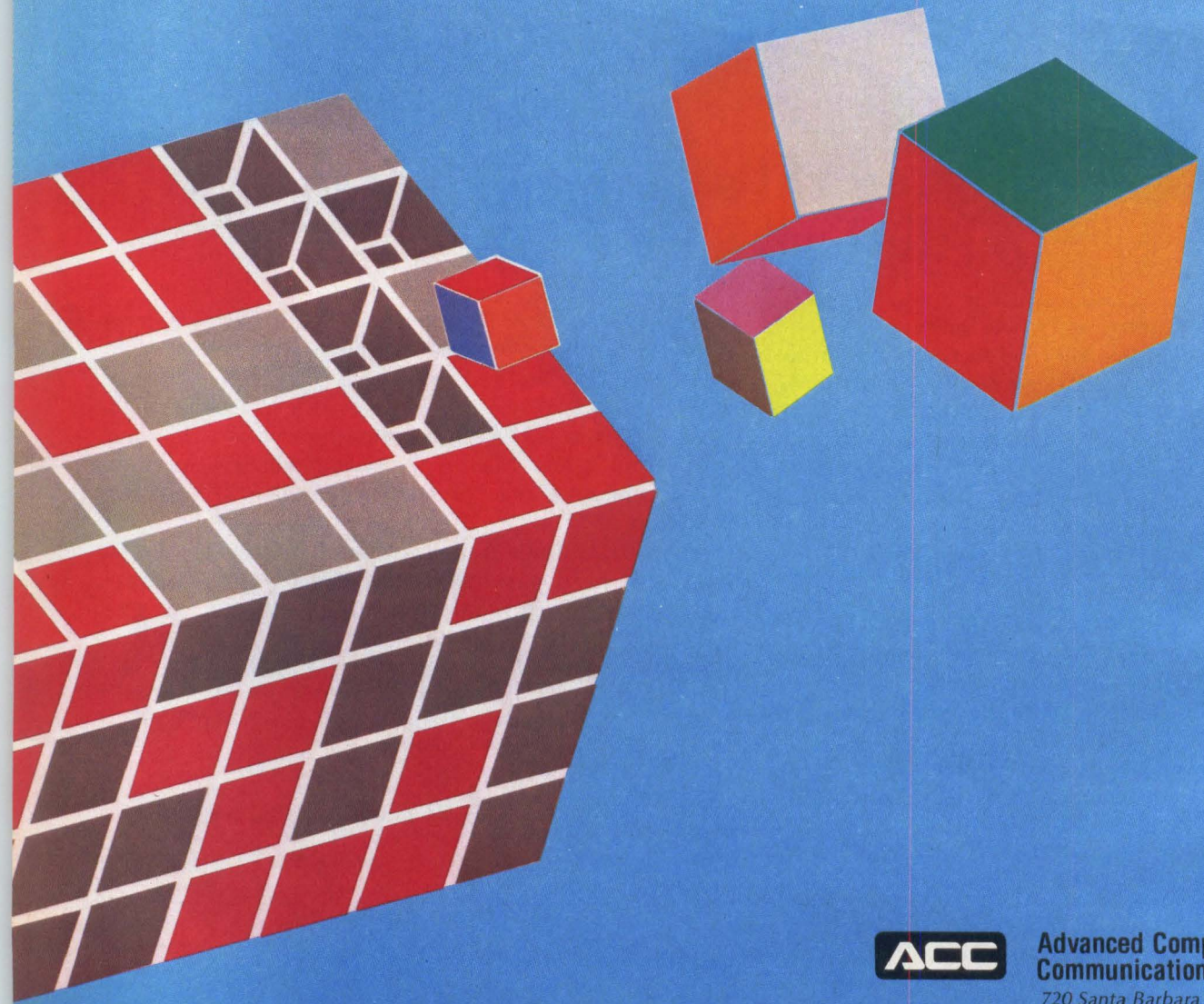

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CIRCLE NO. 120 ON INQUIRY CARD

Three modes of operation are available to the user: command, data and control. Command mode provides commands to connect and disconnect sessions, use a network directory, configure port parameters and send messages to other users on the network (Fig. 3). It is limited to local operations.

Data mode expedites the passing of data between devices once a session has been established. For devices that always communicate with only one destination, the network manager defines permanent sessions. Once established, the device always remains in data mode and network operation involving that device is transparent to the user.

The password-protected control mode allows remote connection and disconnection of sessions, port configuration and renaming, network control and diagnostic functions (Fig. 4). Diagnostic functions include access to an error-history log that is maintained automatically by the system and the ability to put devices into several different types of loop-back mode to pinpoint the location of problems.

Independent copies of the Software Components Group Inc.'s pSOS operating system run on both the device interface and the subscriber processor. Application software is divided into two groups of processes. One group is supported by the operating system on the subscriber processor; the other is supported by the operating system on each device interface. The layers of software adhere to the guidelines established by the Open Systems Interconnection (OSI) reference model (see "Playing by the rules," Page 246).

The RAM-based system is loaded with software code from the local floppy disk. The floppies can be down-loaded from one subscriber processor to another, facilitating updating of software. The floppy disk also holds the HELP files, port-configuration parameters, the local network directory and the field-engineering error log file.

Device-specific parameters such as baud rate, parity, flow control and other port-configuration parameters can be changed through software commands so that devices can be moved from port to port. The user can revise the software according to application requirements at any of the layers corresponding to the OSI model. The software supports asynchronous devices with data-transfer rates up to 19.2K bps. Future versions will support synchronous devices with data rates up to 56K bps. □

Ashraf M. Dahod is chairman of Applitek Corp., Wakefield, Mass.

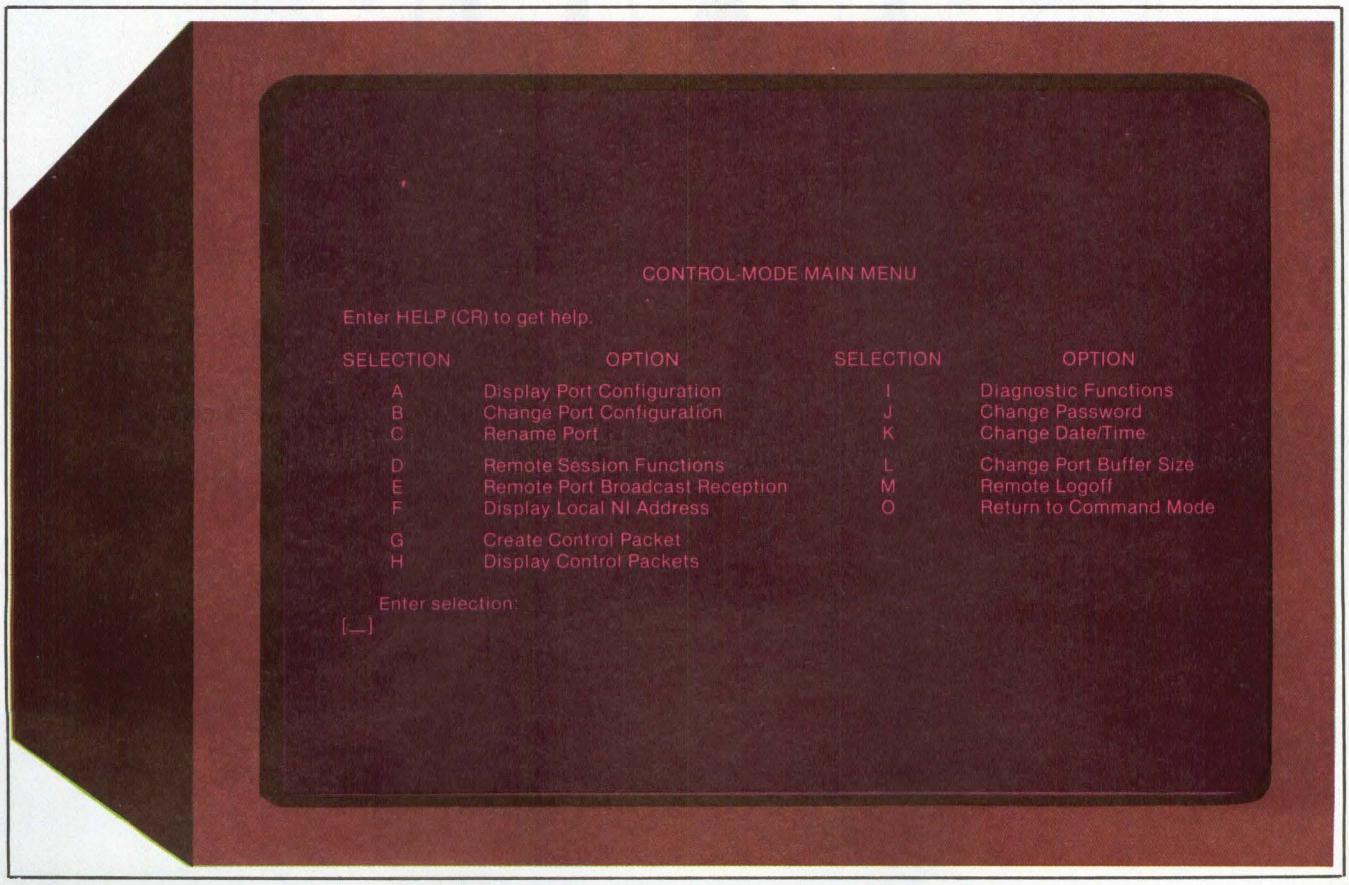

Fig. 4. The password-protected control mode main menu *provides commands to connect and disconnect sessions, configure and rename ports and perform diagnostic functions.*

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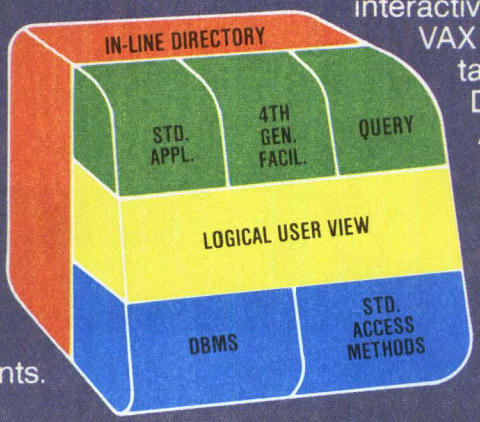

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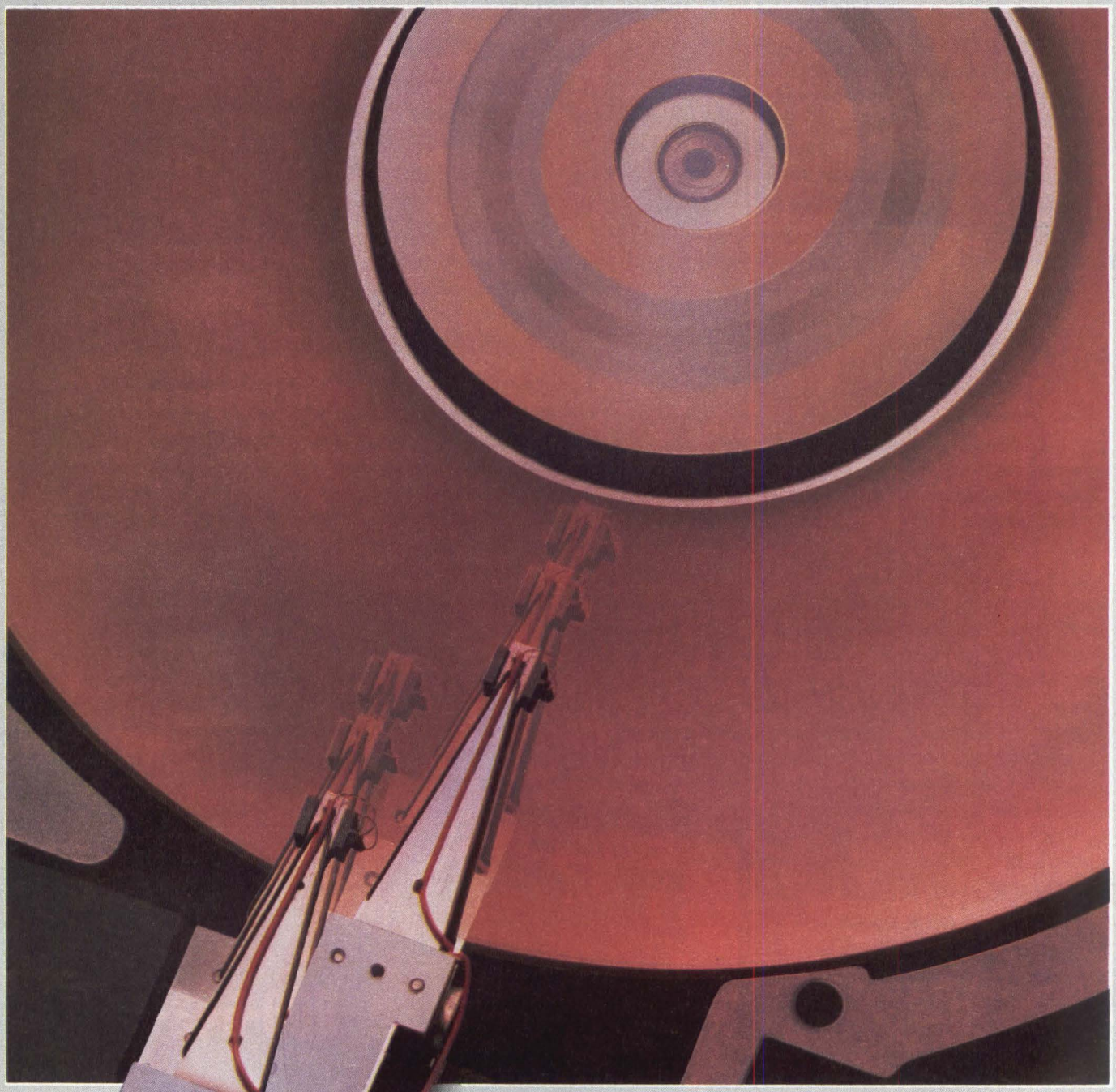

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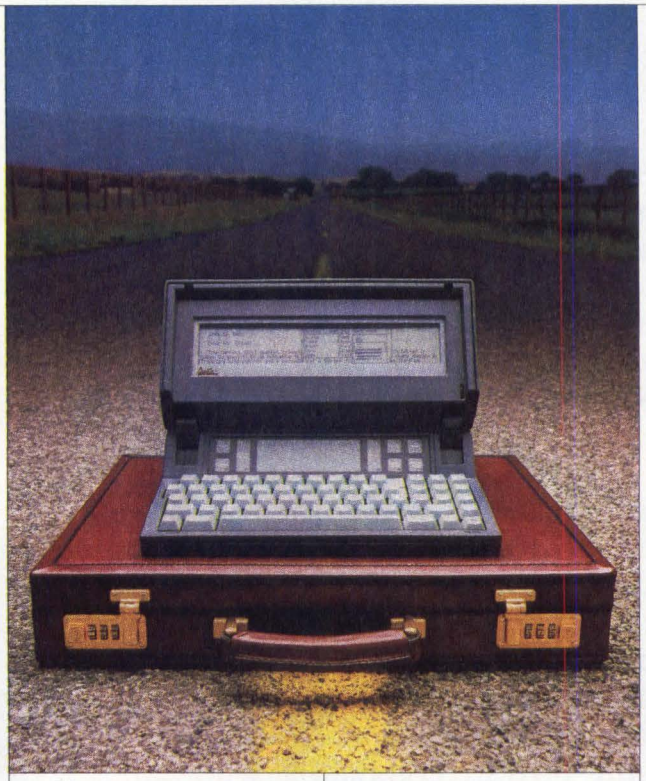

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Tailoring UNIX for the supermicro business environment

PAUL REILLY,
Momentum Computer Systems International

MC68000-based micro incorporates Unify DBMS and enhances UNIX's data communications and user interface

UNIX is more than 10 years old and showing its age. Consequently, several microcomputer manufacturers have introduced enhanced systems that retain UNIX's strongest features while bringing it more into line with higher performance hardware developed since UNIX's inception. One such manufacturer is Momentum Computer Systems International, which has adopted the Unify database manager to overcome UNIX's slow access to large databases. Momentum has also redesigned portions of the UNIX kernel, tuning it to the architecture of the MC68000 used in the company's 32/E microcomputer.

Improving the UNIX file system

The minicomputer systems of the early 1970s had relatively little disk storage. This led to the development of UNIX's complex and awkward file system, which was designed to use every available block of disk space by scattering file blocks throughout the disk with little regard to ease and speed of access (Fig. 1). Reading a file sequentially as UNIX does requires many disk head movements because blocks of the same file can be located on different tracks or cylinders.

Momentum alleviated this problem by tuning file-system parameters so that related file blocks are usually located on the same or adjacent cylinders (Fig. 2). Although the individual blocks can still be scattered, they are organized to minimize disk head movement.

Another disadvantage of a scattered file structure is that a mechanism is needed to keep track of where each file block is on the disk. The mechanism UNIX uses is based on the text-processing environment for which it was developed. In this environment, numerous small text files, each only a few thousand bytes, must be accessed sequentially and updated frequently. To accomplish this, UNIX uses the *i-node* indexing scheme to address most of the blocks in a large file (Fig. 3). The i-node contains 13 pointers to physical disk blocks, the first 10 of which point directly to the first 10 blocks of a file. If a block is 512 bytes, as is usually the case in a UNIX system, the first 5,120 bytes of the file can be directly addressed using the i-node. Blocks 11 through 138 are indirectly addressed via a disk block of 128 pointers pointed to by the 11th entry of the i-node. Thereafter, the process becomes progressively more complex. The 12th word of the i-node points to a block containing 128 pointers to 128 additional blocks of

pointers. Finally, the 13th entry of the i-node points to the start of a three-level index structure. This arrangement expands a UNIX file to more than 1G byte. However, the price a user pays for this design is the large number of disk accesses required to read a single file block. The larger the file, the more overhead required. Added to this overhead is data movement from the disk to a UNIX system buffer and eventually to the requesting program. Although not important in text processing, in which most files are small, this overhead is critically important in a business environment, in which megabyte-sized databases are the rule.

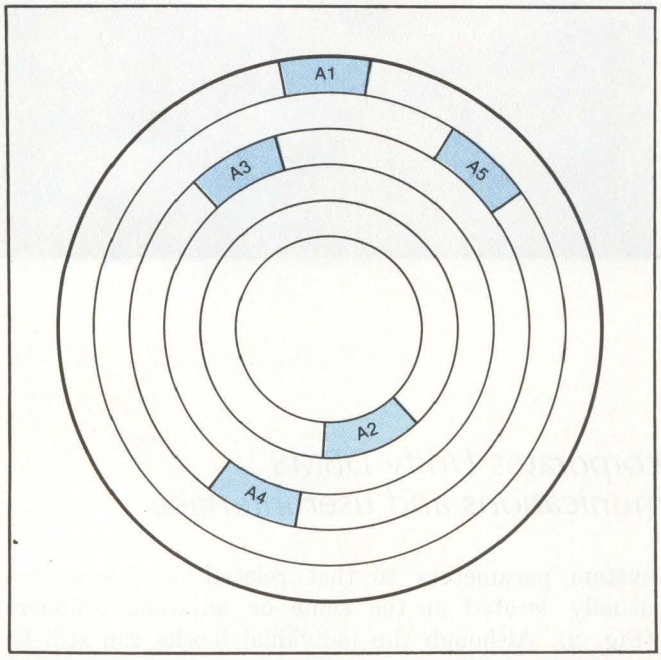

Fig. 1. UNIX scatters file blocks *throughout the disk, allowing every available space to be used but at the expense of speed and ease of access. Because related file blocks can be located on widely separated tracks or cylinders, reading a file sequentially requires much head movement.*

Nothing less than a complete rewrite of the UNIX file system can solve the disk-access problem. However, its effects can be minimized. Momentum has designed the disk subsystem driver so that a physical disk can be subdivided into several logical disks, permitting an application program to use a file system other than UNIX on a partition of the physical disk (Fig. 4). An example is Unify, the database-management system selected by Momentum, whose "raw mode" file system is superior to UNIX's file system for large database applications (Table 1). Unify dispenses with the multiple disk accesses of i-node addressing and uses contiguous physical blocks within a logical partition. It gains access to data by specifying a block offset from the start of the logical partition. Momentum's disk

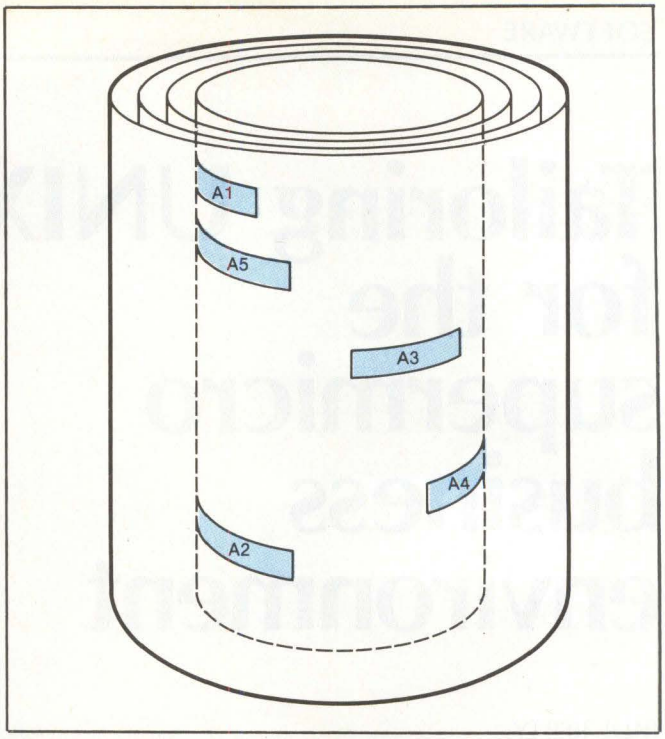

Fig. 2. To minimize the excessive disk head movement *caused by UNIX's scattered file placement, Momentum groups blocks of the same file on the same or adjacent cylinders of a multiplatter disk. In the diagram, the five individual file blocks, although scattered, are all on the same cylinder.*

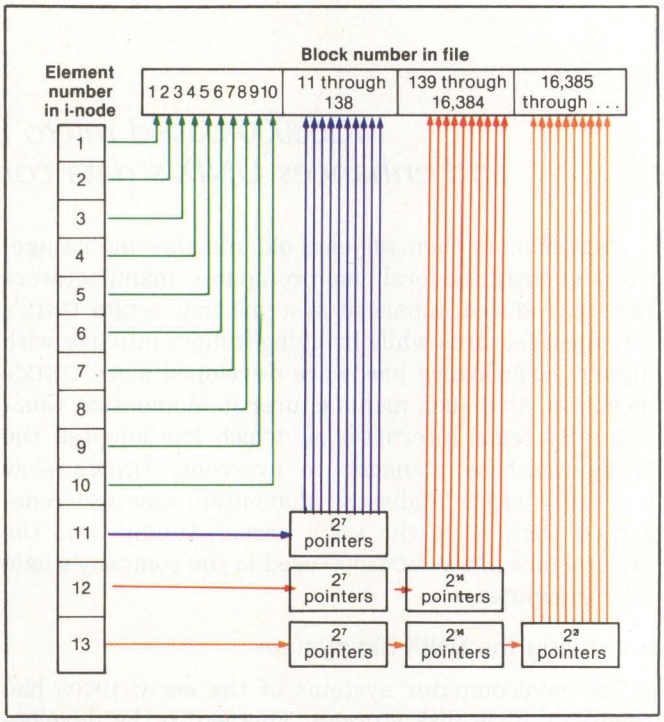

Fig. 3. UNIX i-nodes *permit direct access to the first 10 blocks or approximately 5K bytes of a file (green). The i-nodes also give the addresses of three overflow pointer blocks that point—through increasing levels of indirection—to the remainder of a file. One level of indirection (purple) is required for files between 5K and 70K bytes, two levels (red) for files between 70K and 8M bytes and three levels (orange) for larger files. The i-node technique works well on small files but becomes progressively more cumbersome on files requiring indirect addressing. For example, a 110K-byte file, which needs two levels of indirection, involves three disk accesses to store or retrieve data.*

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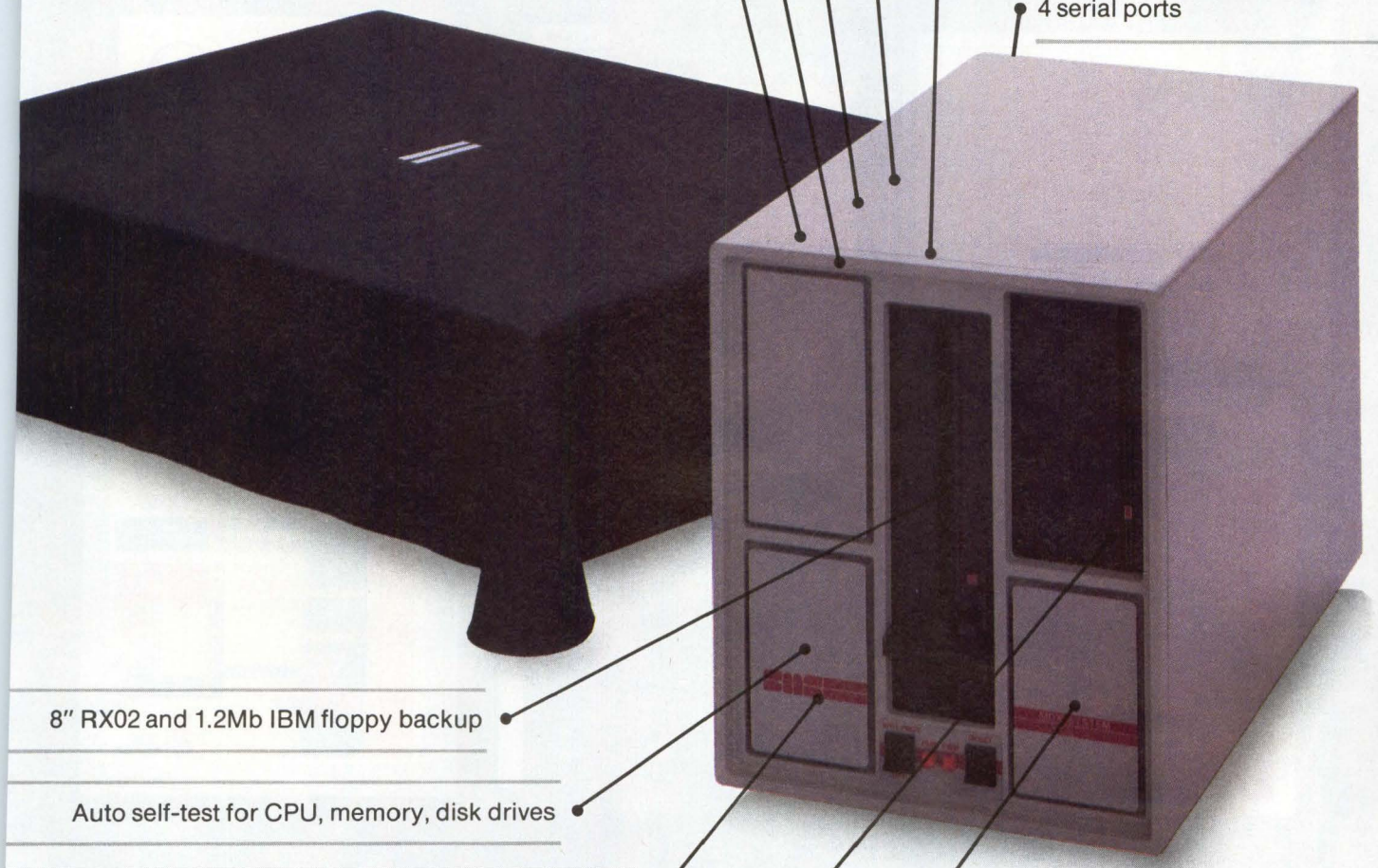

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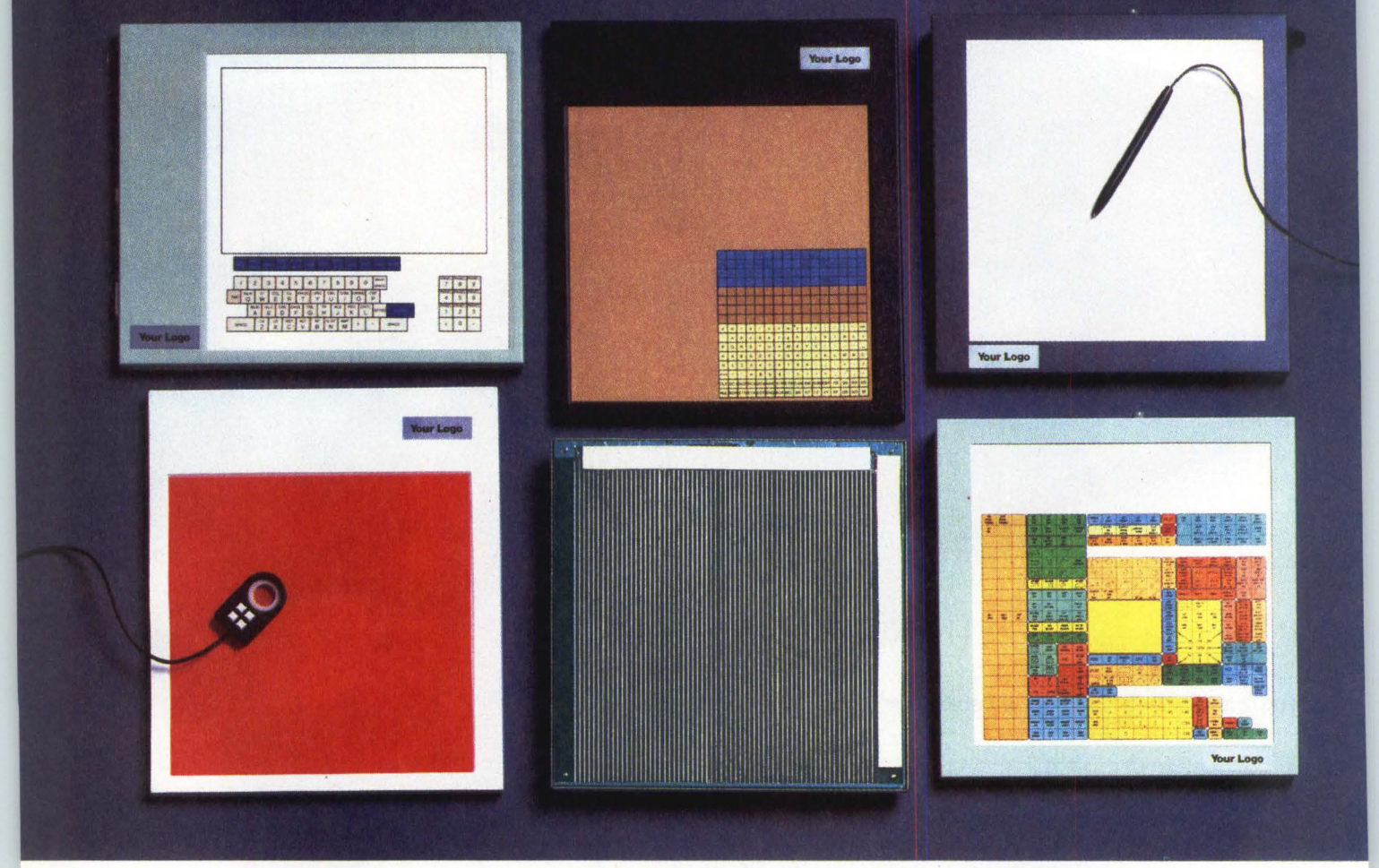

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driver converts these logical addresses into physical sectors on the disk and transfers data to and from user memory without system buffering.

	Real time (min. : sec.)	Machine time (min. : sec.)	Records per sec.
System unloaded:			
Unify DBMS using "raw mode" file accessing	3:15	2:34.9	2.84
DBMS using UNIX file system	4:47	4:18.9	1.93
System loaded:			
Unify DBMS using "raw mode" file accessing	9:30	2:41.3	0.97
DBMS using UNIX file system	12:55	4.39	0.71

Table 1. In file-access timing comparisons, *the Unify DBMS using raw-mode file access was benchmarked against a comparable DBMS using the standard UNIX file system. In a loaded (DBMS and other file-intensive tasks) and unloaded (DBMS-only) environment, 553 records were added to a 10M-byte database. In both tests, the raw-mode technique used about 40 percent less machine time.*

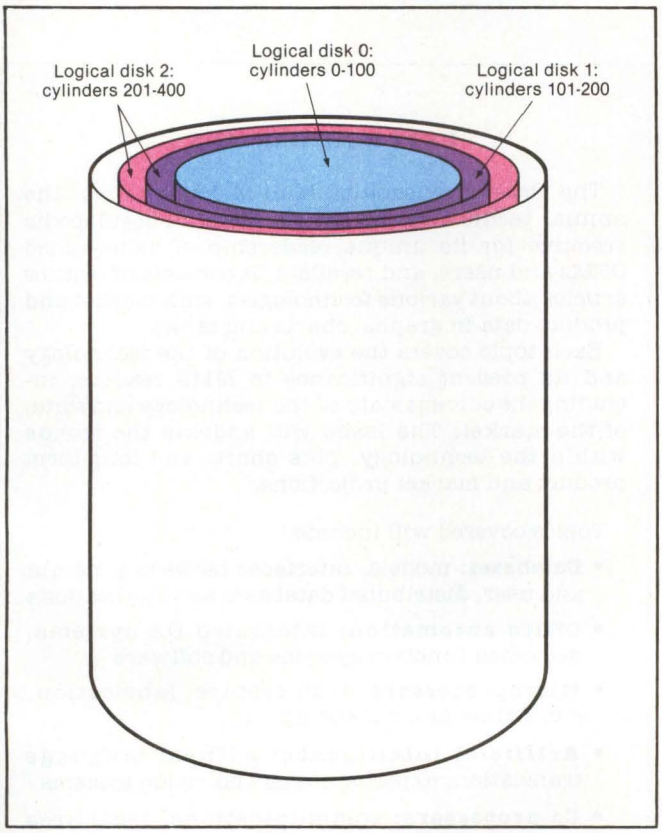

Fig. 4. Subdividing a physical disk *into several logical disks offers a choice of file-access methods. For example, logical disks 0 and 1 might contain standard UNIX files, while logical disk 2 might hold "raw-mode" files used by the Unify database-management system (DBMS).*

Another limitation of the UNIX file system is that it is designed for sequential access, which is inflexible for most business applications. Momentum allows application programs random access to file blocks via Unify instead of UNIX. This provides a double benefit: Unify's random access capabilities can be incorporated into high-level languages such as COBOL, and application programmers can employ the facilities of Unify to implement complex tasks.

Correcting UNIX's teleprinter, user interfaces

During the early 1970s, when UNIX was originally implemented, the ASR-33 Teletype was the only reasonably priced interface to a minicomputer system. It was inexpensive, easily maintained and widely available.

Fig. 5. Momentum's "shell" menu *simplifies the UNIX interface for business users. Menu items can be varied according to user needs. The display shown is invoked automatically whenever a user logs in or exits an application.*

But it also was slow—10 characters per second (cps)—and required approximately 10 pounds of pressure to depress one of its keys. Because the ASR-33 ran at a slow 110 baud, little attempt was made to streamline UNIX's terminal interface. The aggregate throughput for terminals on a typical UNIX system today is barely 1,200 baud, fast enough for 10 ASR-33 terminals but only one-eighth the rate of a modern 9,600-baud CRT terminal. To provide a communications rate consistent with today's business system requirements, Momentum has rewritten major portions of the UNIX terminal driver and handling code. The result is a 3,000 percent increase in aggregate terminal throughput, the equivalent of four 9,600-baud terminals running continuously at maximum speed. Moreover, because CRT terminals rarely run at maximum rates for more than a few moments at a time, Momentum's

terminal driver can serve as many as 16 users per system with no visible degradation in response time.

Another consequence of using the ASR-33 is UNIX's terse and arcane command syntax. Because the ASR-33 was very slow and required heavy key pressure to depress its mechanical linkages, early UNIX users soon learned to print only what was necessary and to type the absolute minimum number of keystrokes. Thus, user commands were usually only two or three characters, and they did not print status information unless an error occurred. Even error messages were brief, some containing only a character or two. Although this is fine for a knowledgeable user, a neophyte is left in the dark.

Model	Benchmark time (sec.)	Price ($)
Momentum 32/E	106	34,000
Perkin-Elmer PE 3210	93	75,000
DEC VAX-11/750	85	115,000
DEC VAX-11/780	83	196,000

Table 2. In a comparison of four systems, each system shown performed three tasks in UNIX Version 7: sorting a small file, sending a file to two terminals and reading an entire logical disk. Benchmark times are total real time for all tasks. Package includes eight I/O ports, a disk drive, a tape drive, a console and an operating system. (Source: Momentum Computer Systems International)

For example, the command ls -R|sort|uniq -c|pr -3|tee copl|lpr lists recursively the entire file-system directory, sorts it alphabetically, removes—but keeps count of—redundant entries, displays the list in three-column format, writes a copy of it to a file named *copl* and prints it on the line printer—an impressive array of tasks relative to the number of characters in the command line. However, the command syntax is far removed from English and certainly not user friendly. All keystrokes, including blank spaces, must appear exactly as shown or the command will not function.

Fortunately, UNIX is unique among operating systems in that its user interface is not part of the system kernel, but merely an application program. The interface, or shell, is easily replaced. Momentum has designed a menu shell for business computer users looking for a friendly environment (Fig. 5). Menu selection can easily be varied according to a user's needs and is automatically called by simply logging in. All a user needs to do is type in the account's name and password and select the program from the menu.

Fine-tuning for the MC68000

UNIX was the first practical portable operating system, but it often suffers in performance when ported to a different machine. For example, several benchmarks show that UNIX Version 7 is faster on the PDP-11/70 than any of the VAX-11 systems. The PDP-11/70 is certainly not faster than the VAX-11/780, but UNIX is better tuned to the PDP-11/70, making it difficult to run UNIX efficiently on a different set of hardware without much effort. For example, Momentum has increased the number of register variables in the most frequently used UNIX kernel routines from the PDP-11's three to the MC68000's seven, increasing throughput on its MC68000-based systems by 10 to 20 percent. Adding hardware such as linear voice-coil Winchesters and smart serial I/O boards can further increase performance. A recent benchmark (Table 2) shows that the Momentum 32/E microcomputer with linear voice-coil Winchesters produces 80 percent of the throughput at less than 20 percent of the price of the VAX-11/780. □

Paul Reilly is technical services manager with Momentum Computer Systems International, Sunnyvale, Calif.

NEXT MONTH IN MMS

The December issue of Mini-Micro Systems, the annual technology review, is MMS's encyclopedic resource for its unique readership of value-added OEMs and users, and resellers. It consists of feature articles about various technologies, with market and product data in graphs, charts and tables.

Each topic covers the evolution of the technology and its present significance to MMS readers, including the current state-of-the-technology and state-of-the-market. The issue will address the trends within the technology, plus short- and long-term product and market projections.

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- **Databases:** models, interfaces between program and user, distributed databases and applications
- **Office automation:** integrated OA systems, dedicated function systems and software
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- **Artificial intelligence:** natural language translation, expert systems and vision systems
- **Co-processors:** communications, local area networks and floating point arithmetic

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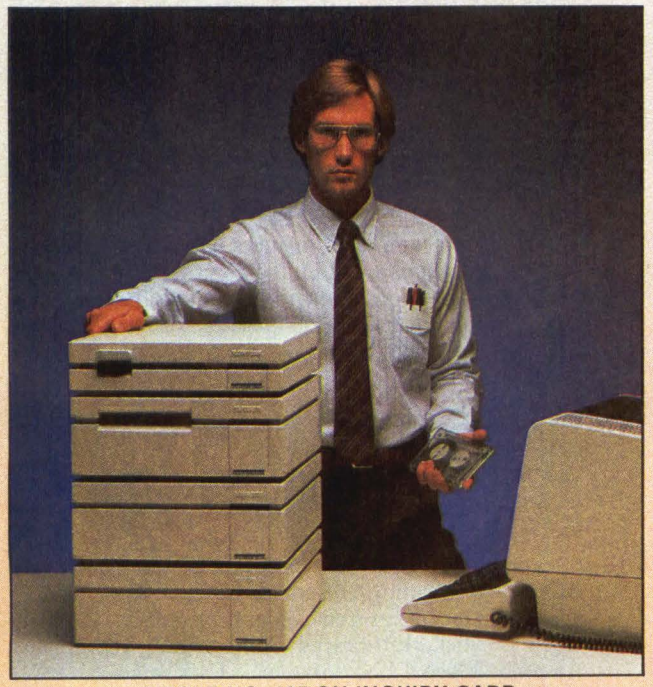

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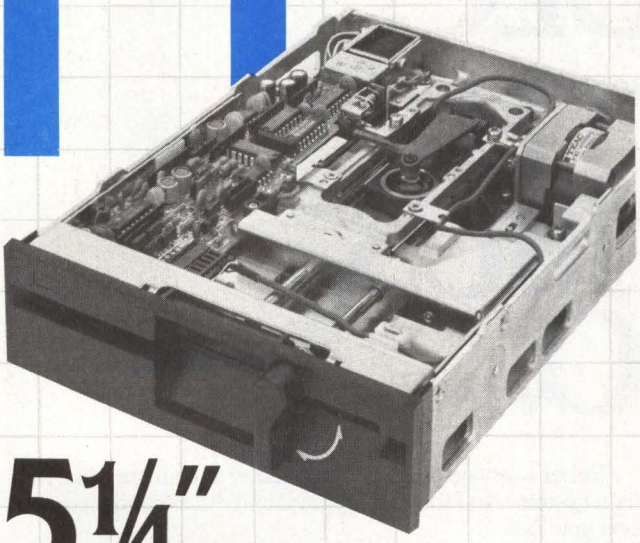

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NOVEMBER

1-3 **Federal Office Automation Conference,** Washington, sponsored by the National Council for Education on Information Strategies. Contact: National Council for Education on Information Strategies, P.O. Box N, Wayland, Mass. 01778, (617) 358-5356 or (800) 343-6944.

1-3 **INTECH '83 Integrated Office Technology Conference and Exposition,** Chicago. Contact: Jacqueline Voigt, National Trade Productions Inc., 9418 Annapolis Rd., Lanham, Md. 20706, (301) 459-8383 or (800) 638-8510.

2-4 **Edmonton Computer & Office Automation Show,** Edmonton, Canada, sponsored by Industrial Trade Shows of Canada. Contact: Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, (416) 252-7791.

7-9 **Satellite Communications Symposium,** Atlanta, sponsored by Scientific-Atlanta Inc. Contact: Betsy Crawley, Symposium Coordinator, 3845 Pleasantdale Rd., Atlanta, Ga. 30340, (404) 449-2274.

8-10 **CAM-I's 12th Annual Meeting and Technical Conference,** Dallas, sponsored by Computer Aided Manufacturing-International Inc. Contact: Rhonda Gerganess, Manager, Conference Services, or John R. Forton, Marketing Manager, CAM-I Conference Services, 611 Ryan Plaza Dr., Suite 1107, Arlington, Texas 76011, (817) 860-1654.

8-10 **The Hammer/Seybold Executive Forum: "Directions in Office and Professional Computing,"** New York, sponsored by Hammer and Co. Inc. Contact: Cheryl McManamy, Seybold Publications Inc., 44 Bromfield St., Suite 801, Boston, Mass. 02108, (617) 542-2261.

8-10 **Third Annual Software Expo,** London. Contact: SOFTWARE/Expo, 22 W. Adams St., Suite 400, Chicago, Ill. 60606, (312) 263-3131.

14-16 **"Applied Interactive Computer Graphics" Course,** Los Angeles, sponsored by the Continuing Education Institute and Computer Graphics Consultants. Contact: Continuing Education Institute, 10889 Wilshire Blvd., Suite 1000, Los Angeles, Calif. 90024, (213) 824-9545.

14-17 **Canadian Computer Show & Conference,** Toronto, sponsored by Industrial Trade Shows of Canada. Contact: Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, (416) 252-7791.

15-18 **"Practical Structured Techniques for Software Design & Coding" Seminar,** Palo Alto, Calif., sponsored by Integrated Computer Systems. Contact: Ruth Dordick, Integrated Computer Systems, 6305 Arizona Place, Los Angeles, Calif. 90045, (213) 450-2060. Also to be held on Dec. 6-9 in Boston, Dec. 13-16 in Washington, Jan. 17-20 in Los Angeles and Feb. 7-10 in Phoenix, Ariz.

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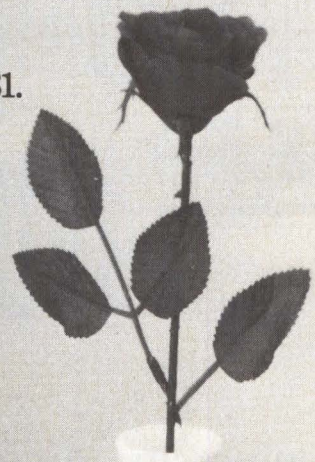

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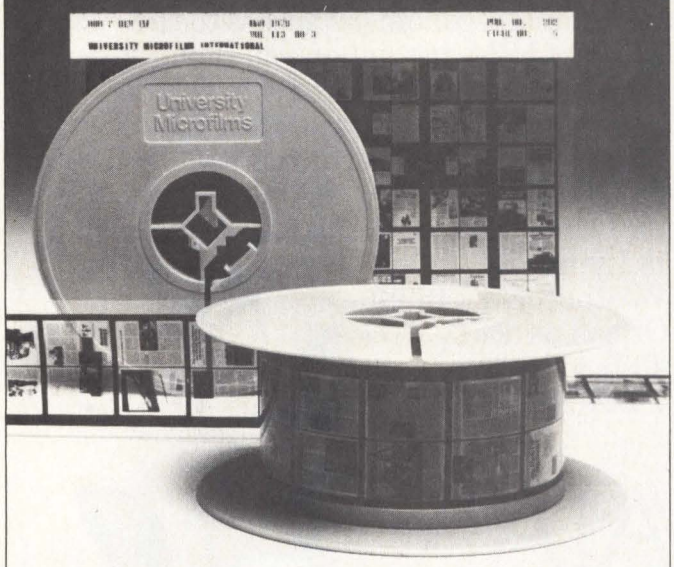

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Calendar

16-18 **"MVS/SP Internals Overview" Seminar,** Atlanta, sponsored by ACTS Corp. Contact: Jeff Carico, ACTS Corp., 11910 Gate Way, Austin, Texas 78727, (512) 258-7869.

17-18 **"Voice-Data Integration and the Digital PBX" Symposium,** Washington, sponsored by Phillips Publishing Inc. Contact: Diane Pontisso, Seminar Coordinator, 7315 Wisconsin Ave., Suite 1200N, Bethesda, Md. 20814, (301) 986-0666.

17-19 **Fifth Annual Northeast Computer Show and Software Exposition,** Boston, sponsored by Northeast Expositions. Contact: Northeast Expositions, 822 Boylston St., Chestnut Hill, Mass. 02167, (617) 739-2000.

17-20 **Computer Showcase Expo,** Washington and Chicago, presented by The Interface Group Inc. Contact: Linda Yogel or Peter B. Young, The Interface Group Inc., 300 First Ave., Needham, Mass. 02194, (617) 449-6600 or (800) 325-3330.

20-22 **Third Annual On-Farm Computer Use Conference and Trade Show,** West Lafayette, Indiana, sponsored by School of Agriculture, Purdue University. Contact: Division of Conferences, Purdue University, West Lafayette, Ind. 47907, (317) 494-1177.

NOVEMBER 28 - DECEMBER 1

North American Telecommunications Association (NATA) Showcase, Washington, sponsored by NATA. Contact: Karen Palermo, NATA, 511 Second St. N.E., Washington, D.C. 20002, (202) 547-4450.

NOVEMBER 29 - DECEMBER 2

"Defining Software Requirements, Specifications & Tests" Course, Boston, sponsored by Integrated Computer Systems. Contact: Ruth Dordick, Integrated Computer Systems, 6305 Arizona Place, Los Angeles, Calif. 90045, (213) 450-2060. Also to be held on Dec. 6-9 in Washington, Dec. 13-16 in Los Angeles and Feb. 28 - March 2 in Washington.

"Database Management Systems—Mini, Micro & Distributed Applications" Course, Boston, sponsored by Integrated Computer Systems. Contact: Ruth Dordick, Integrated Computer Systems, 6305 Arizona Place, Los Angeles, Calif. 90045, (213) 450-2060. Also to be held Dec. 6-9 in Washington, Dec. 13-16 in San Diego, Jan. 17-20 in Palo Alto, Calif., Feb. 14-17 in Anaheim, Calif. and Feb. 28 - March 2 in Baltimore.

COMDEX/Fall '83, Las Vegas, Nev., produced by The Interface Group. Contact: The Interface Group, COMDEX/Fall '83, 160 Speen St.,P.O. Box 927, Framingham, Mass. 01701, (617) 449-6600.

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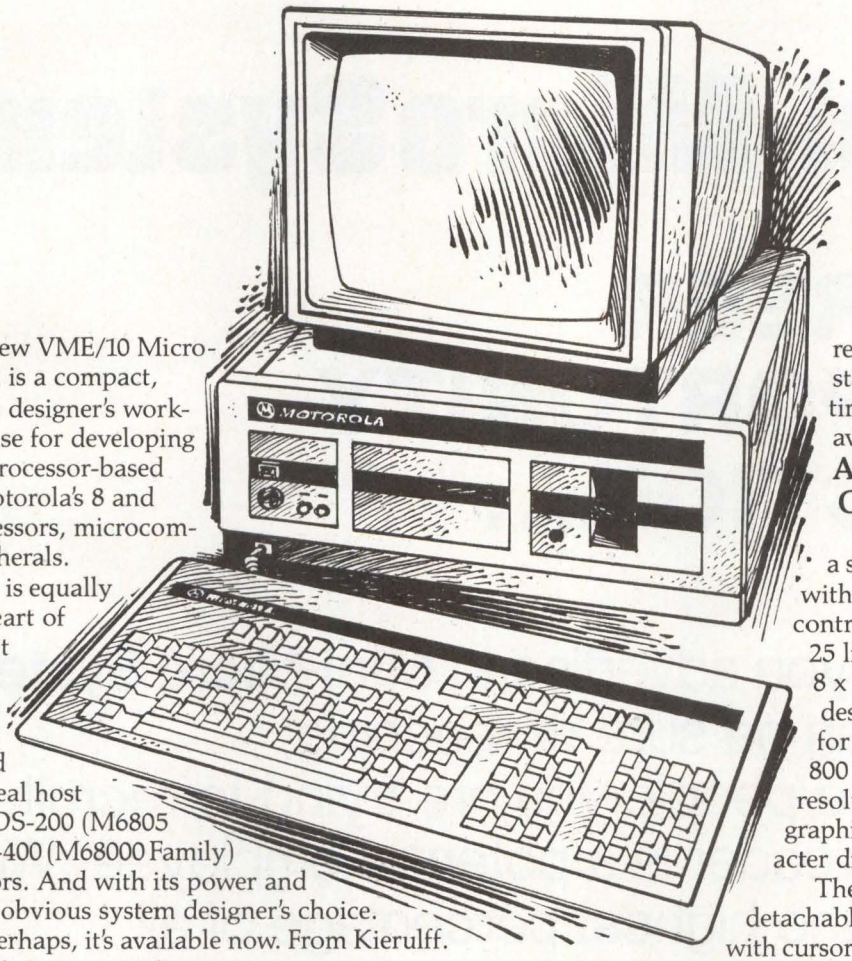

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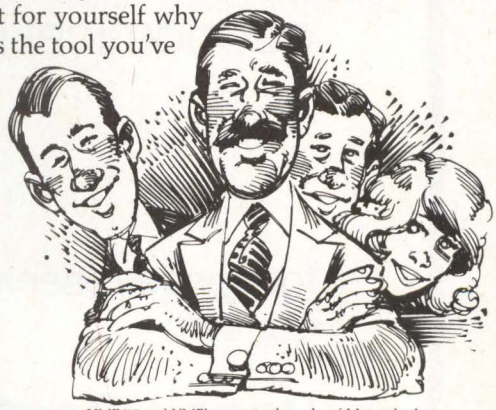

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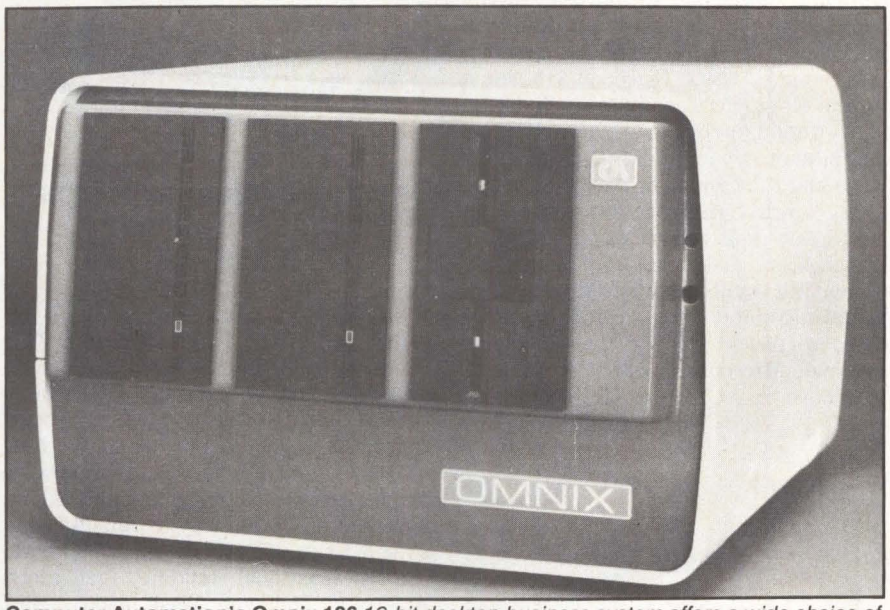
Multiuser system runs industry-standard software

The Omnix 186 multiuser, 16-bit desktop business system uses the 80186 microprocessor to run industry-standard operating systems, programming languages and commercial application programs for users with heavy data- and word-processing work loads.

The system supports four to 16 terminals and printers in concurrent processing operations. It uses a user-transparent, 16-bit I/O processor for disk and terminal management that lets the 80186 deal exclusively with its multiple application tasks. An optional 8087 numeric processor extension provides a high-speed number-crunching capability for floating-point operations.

System integrators can choose from the CP/M-86, MP/M-86, Concurrent CP/M and OPUS-1 operating systems. Languages include CBASIC-86, COBOL, FORTRAN, Pascal and Trans-BASIC, the vendor's business language compiler with multikey ISAM file manager.

Omnix 186 systems offer a combination of 1M-byte, 5¼-inch floppy disk and one or two 5¼-inch Winchester disk drives, or a Winchester disk drive and a ¼-inch streaming-tape drive. Winchester drives are available in 5M-, 10M-, 15M- and 20M-byte (formatted) capacities. All systems include 384K bytes of RAM and four serial ports, expandable to 16 in groups of four.

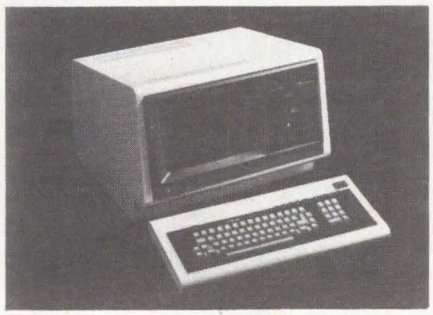


Computer Automation's Omnix 186 *16-bit desktop business system offers a wide choice of operating systems and languages and various combinations of floppy and Winchester disk drives or Winchester disk and streaming-tape drives.*

Prices begin at $8,990 for the smallest Omnix 186 with a 5M-byte Winchester disk drive and a 1M-byte floppy disk drive. **Computer Automation Inc.,** 18651 Von Karman Ave., Irvine, Calif. 92713, (714) 833-8830. **Circle No 300**

UNIX workstation aimed at scientific markets

The Unistar 100 single-user and Unistar 200 multi-user workstations are 68000-based microcomputers designed to provide speed and versatility for the scientific, industrial and commercial markets. The systems include an intelligent video terminal, integrated disk storage, a microprocessor CPU and the UNIX operating system. The Unistar's Multibus architecture, optional Tektronix 4010-compatible graphics controller and wide array of programming languages, including a C compiler, FORTRAN 77, Pascal, COBOL, Ada and BASIC, are keys to its flexibility. Hardware features include a 12-in. green CRT screen, a detached keyboard, a 5¼-in., 600K-byte floppy disk drive and a 5¼-in. Winchester disk drive that stores 10M bytes on the Unistar 100 and 21M bytes on the Unistar 200. Main memory sizes are 256K bytes on the Unistar 100 and 512K bytes on the Unistar 200, and both are expandable to 1M byte. Single-unit prices are $9950 for the Unistar 100 and $13,950 for the Unistar 200. **Callan Data Systems,** 2645 Townsgate Rd., Westlake Village, Calif. 91361. **Circle No 301**



Virtual-memory computers run UNITY

The Mega series 32-bit, virtual-memory microcomputers incorporate National Semiconductor Corp.'s NS16032 CPU with true 32-bit internal logic, an internal data path configured on the Multibus (IEEE 796) 16-bit interface and demand-paged virtual memory and 64-bit double-precision, floating-point arithmetic implemented in hardware. MegaMicro computers can perform 161,000 64-bit, double-precision multiplications per sec. The virtual-memory feature allows each user to compute as if he had 16M bytes of both program and data space. Mega series computers support as many as 32 simultaneous users per processor, and multiple processors can be linked so that an unlimited number of users can share resources. Because the NS16032 instruc-

New Products

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tion set is symmetrical, the processor is suited to high-level languages such as FORTRAN, C and Pascal and to structured, modular programming. The MegaMicro 16032 computer runs Human Computing Resources' UNITY operating system that implements Berkeley's 4.1 enhancements of Bell Laboratories' UNIX. Priced at $15,000, a typical MegaMicro computer includes an LMC 16032 processor board with virtual-memory and floating-point hardware and 512K bytes of parity-checking RAM, eight RS232 I/O ports, an intelligent disk controller, a 20M-byte Winchester disk drive, the UNITY operating system with supporting utilities, C and FORTRAN compilers and a case, a power supply and manuals. **Logical Microcomputer Co.,** 140 S. Dearborn St., Chicago, Ill. 60603.

Circle No 302

Portable computer expands Commodore's 64 line

The Executive 64 portable computer comprises a 6510 CPU, 64K bytes of RAM, a low-profile, detachable keyboard, a 6-inch color monitor and a 170K-byte floppy disk drive. The unit weighs 27.6 pounds and measures 5 by 14½ by 14½ inches. External ports allow full-sized monitor and graphic printer hookups. Using a Z80 cartridge, the computer accommodates the CP/M operating system. BASIC V2 is resident in the unit's ROM. $995. **Commodore Business Machines Inc., Computer Systems Division,** 1200 Wilson Dr., West Chester, Pa. 19380, (215) 431-9100.

Circle No 303

Desktop system supports 8-, 16-bit environments

The SuperSystem II model 8/16 desktop computer runs in 8- and 16-bit environments using Intel's 80186 microprocessor. The unit supports the CP/M-86 operating system, Microsoft products, CBASIC II, FORTRAN, COBOL, Pascal and PL/1-80. Mass storage capacities range from 700K to 52M bytes. Other features include a parallel printer port, an RS232 communications port and an optional synchronous port. $3,995 to $7,995. **CMC International,** CMC International Building, 1720 130th Ave. N.E., Bellevue, Wash. 98005, (206) 885-1600.

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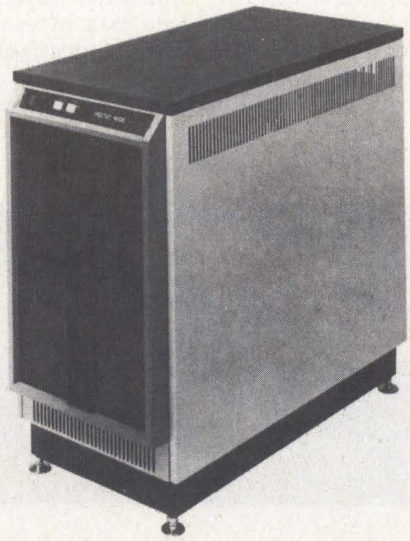
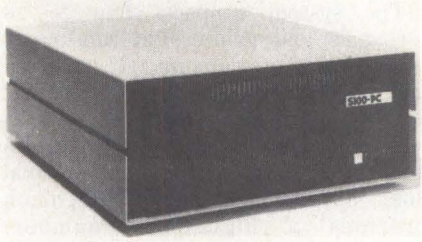


Business computers run Pick operating system

The 10-MHz MC68000-based system 4200 product line supports as many as 35 terminals, running under the Pick operating system. The desktop model 4220, accommodates three to 11 terminals/printers linked to the host via RS232C interfaces; the floor-cabinet model 4240 accommodates 11 to 35 terminals/printers. Both models have 256K bytes of RAM, Winchester disk drives and a ¼-inch cartridge-tape drive. A seven-slot chassis on the 4220 and an 11-slot chassis on the 4240 allow expansion. $13,000. **Pertec Computer Corp.** 17112 Armstrong Ave., Irvine, Calif. 92714, (714) 540-8340.

Circle No 305



8088-based microcomputer runs MS-DOS

Housed in a 15-slot desktop enclosure, the S100-PC computer system comprises an 8-MHz 8088 microprocessor, 128K bytes of RAM, two RS232 ports, two parallel ports, a battery-protected clock/calendar, an EPROM monitor with built-in diagnostics, the MS-DOS operating system and two double-sided, 5¼-inch floppy disk drives that store 640K bytes. Options include memory expansion to 1M byte, battery-protected CMOS RAM and an 8089 I/O coprocessor. CP/M-86, MP/M-86 or Concurrent CP/M-86 can be substituted for the MS-DOS operating system at additional cost. $1,895 (100 units). **Lomas Data Products Inc.,** 66 Hopkinton Rd., Westboro, Mass. 01581, (617) 366-6434.

Circle No 306

Supermicrocomputer runs virtual-memory UNIX

The Pixel 80 supermicrocomputer system uses Motorola Inc.'s 68010 processor with a separate I/O processor to run a virtual-memory version of UNIX System III with Berkeley enhancements. In its maximum configuration, the Pixel 80 offers 16-terminal capability, 6M bytes of RAM and 720M bytes of Winchester disk storage. Targeted to OEMs and system integrators, the Pixel 80 is supported by a large selection of third-party software, including the MicroINGRES and UNIFY relational database-management systems, MDBS

III, SMC IDOL, five word-processing packages, general accounting packages and BASIC 5 financial applications. High-level programming languages including C, Pascal, Ada, APL.68000, FORTRAN 77 and several versions of COBOL and BASIC, are available. The Pixel 80 supermicrocomputer, including UNIX System III, a 10-MHz 68010 processor, 512K bytes of RAM, a 38M-byte hard disk drive and a selection of backup devices, is priced at $13,900 in single-unit quantities. **Instrumentation Laboratory Inc., Pixel Division,** One Burtt Rd., Andover, Mass. 01810.

Circle No 307

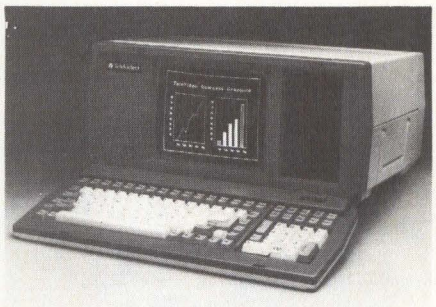
Computer incorporates Fairchild microprocessor

Using a 16-bit Fairchild 9445 microprocessor with 128K bytes of RAM, the M1 series desktop computer supports as many as five users. It is available in three models—the M1/10, M1/34 and M1/68—with 10M, 34M and 68M bytes of Winchester disk storage, respectively. All models have a 20M-byte, ¼-inch streaming-tape drive that operates at 90 ips. They also offer the IRIS or BITS operating system, five serial ports, one parallel printer interface and a real-time clock. Prices start at $12,000 for the model M1/10, with quantity discounts available. **Microtech Business Systems,** 3180 Pullman St., Costa Mesa, Calif. 92626, (714) 557-8640.

Circle No 308

Portable computer has networking capability

The TeleTote I portable computer weighs 25 pounds and has a 9-inch video display screen with 640-by-240 graphics resolution. The screen displays 24 lines of text with 80 characters per line. An optional RS422 network port links the TeleTote I to a TeleVideo network for access to shared files, printers and



electronic mail. Hardware highlights encompass a Z80A CPU; 64K bytes of RAM, expandable to 128K bytes; a 368.6K-byte (formatted) 5¼-inch floppy disk drive; a SuperMouse port and two RS232 printer/modem ports. CP/M, GSX-80 graphics extension, word-processing, spreadsheet and graphics software are included. $1,499, one disk drive; $1,899, two disk drives. **TeleVideo Systems Inc.,** 1170 Morse Ave., Sunnyvale, Calif. 94086, (408) 745-7760.

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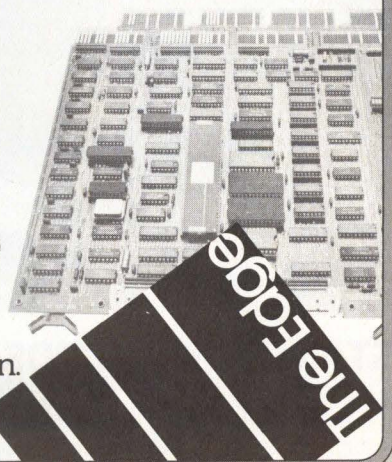

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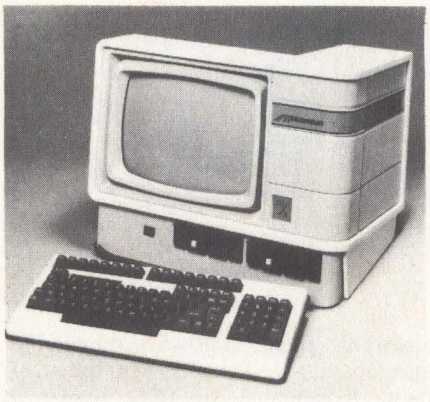

Microcomputer features UNIX

The model 32/4 MC68000/UNIX-based microcomputer workstation offers direct-memory access, a proprietary memory-management unit and 0.5M bytes of 150-nsec. main memory. The four-board system also includes an alphanumeric display controller board, a 12-inch green phosphor screen, a keyboard and two 5M-byte, 3.9-inch Winchester disk cartridge drives. Four serial ports, as well as an SASI interface, provide support for three additional user terminals and a printer. UNIX, C, word-processing and spreadsheet software are supplied. $4,495 (OEM quantities). **Momentum Computer Systems International,** 965 W. Maude Ave., Sunnyvale, Calif. 94086, (408) 245-4033.

Circle No 310

Single-board computer employs R6511Q micro

The CmC SBC6511 single-board computer uses Rockwell International's R6511Q microprocessor. It incorporates an enhanced version of the standard 6502 instruction set and has an on-chip clock, an asynchronous serial port, an event counter, a timer and 192 bytes of RAM. The board carries the R6511Q CPU, power supply, address decoders, a 1.8432-MHz crystal, serial-port operation to 19.2K baud, an eight-position CPU-readable DIP switch, expansion ports and sockets for 2K bytes of RAM and as much as 8K bytes of ROM. An IEEE-488 (GPIB) interface, an RS232 interface and a development board with monitor, trace and disassembler are optional. $189. **Connecticut microComputer Inc.,** 36 Del Mar Ave., Brookfield, Conn. 06804, (203) 775-4595.

Circle No 311

Portable microcomputer runs IBM PC software

The AJ Passport portable personal computer runs application software written for the IBM PC. It weighs 20 pounds and occupies 18 inches of desk space. It has 256K bytes of internal RAM, two 320K-byte floppy disk drives and a 7-inch amber screen. The product uses an 8088 microprocessor and comes with MS-DOS and an Advanced Disk BASIC interpreter with graphics support. With two floppy disk drives, a parallel printer

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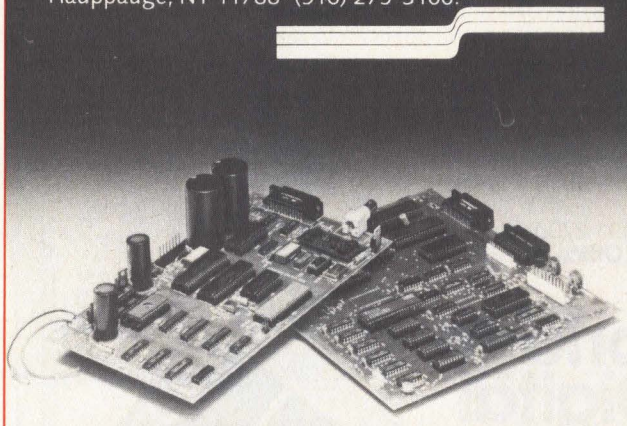

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port, a serial communications port, a time and date clock with battery backup, a 300-baud auto-dial/auto-answer modem and operating and application software, it sells for approximately $4,500. **Anderson Jacobson Inc.,** 521 Charcot Ave., San Jose, Calif. 95131, (408) 286-7960.

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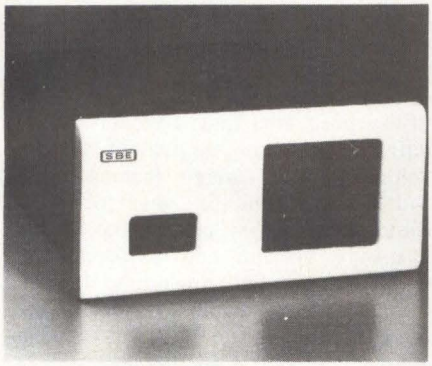

16-/32-bit microcomputer works on Multibus

Available in a rack-mount enclosure, the SBE 200 16-/32-bit microcomputer contains 256K bytes of dual-ported RAM, a 5¼-inch, 320K-byte floppy disk drive and a 5¼-inch, 10M-byte Winchester disk drive. Its ModulasTen M68K10 board offers a 10-MHz MC68000 microprocessor, a 24-bit parallel I/O, two RS232C ports, an SBEX-SASI board for connection to disk controllers and Multibus compatibility. Regulus (UNIX-like), CP/M-68K and pFORTH 32 are available. $4,695 (25 units). **SBE Inc.,** 4700 San Pablo Ave., Emeryville, Calif. 94608, (415) 652-1805.

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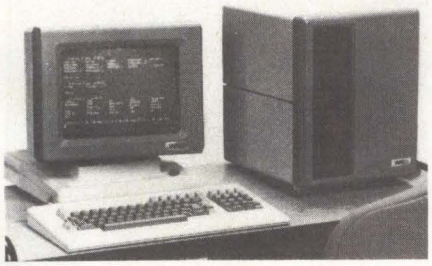

Microcomputers target system integrators

Suited for value-added resellers, the VAR/68 series computers include a 6809 CPU, 128K bytes of RAM, eight serial ports, one parallel port and an ergonomic video display and keyboard. The computers come with various combinations of 750K-byte floppy disk drives and 5M- or 20M-byte Winchester disk drives. Software offerings include a structured BASIC with Pascal-type data structures as well as COBOL, Pascal and C compilers. The computers run OS9-Level 2, a UNIX-like multiuser, multitasking operating system featuring password protection, record-level lock out and dynamic memory allocation. $4,325 to $10,585. **Smoke Signal Broadcasting,** 31336 Via Colinas, Westlake Village, Calif. 91362, (213) 889-9340.

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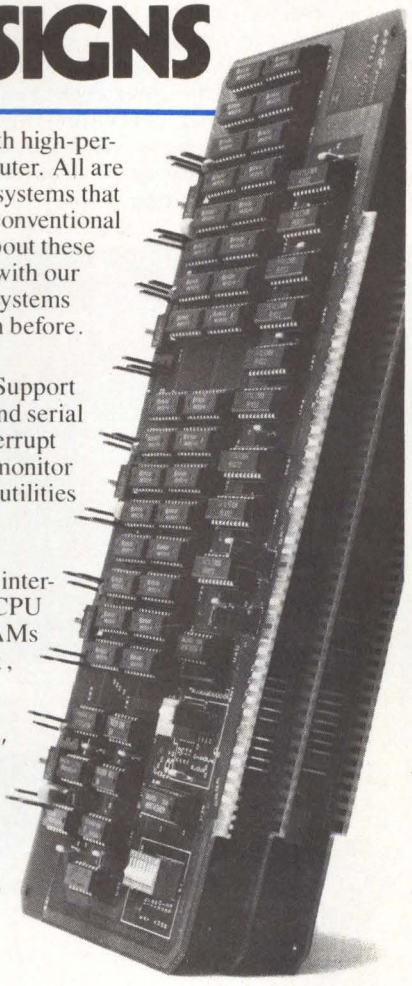

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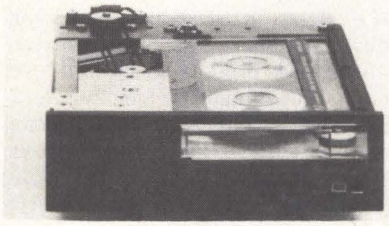
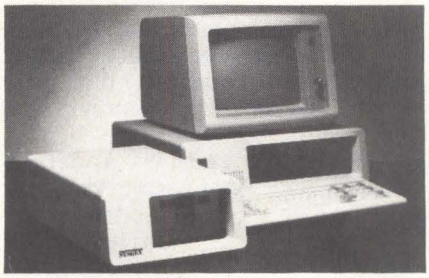


Streaming tape drives are half-height

The Scorpion family of half-height ¼-in. streaming cartridge-tape drives enables designers to integrate streaming tape with half-height Winchester drives or with floppy disk drives in 5¼-in. cabinets. Featuring LSI electronics technology, the drive's controller and motor-drive circuitry are contained on a 5- × 7-in. board that can be packaged separately from the drive mechanics. Like the company's 8-in. family of streaming cartridge-tape drives, the Scorpion series can back up 5M- to 50M-byte capacity Winchester disk drives at transfer rates of 5M bytes per min. The series is available in two models that have formatted storage capacities of 20M or 45M bytes. Drives use the industry-standard Archive (QIC II) Sidewinder interface and are interface compatible with other products from the vendor. Prices start at $800 in OEM quantities. **Archive Corp.,** 3540 Cadillac Ave., Costa Mesa, Calif. 92626. **Circle No 315**

Winchester systems for PC include cassette backup

The Sysgen II series of mass-storage memories for the IBM Personal Computer features streaming-tape cassette backup. The two Winchester-type drives in the series provide formatted storage capacities of 10M or 20M bytes. The streaming-tape cassette subsystem performs backup operations at rates as high as 2.5M bytes per min. The Sysgen II series is compatible with PC-DOS or CP/M-86 operating systems. Its hard disk systems can be configured in as



many as 10 logical volumes under PC-DOS and as many as 14 logical volumes under CP/M-86. The number and size of these logical drives are user selectable. Sysgen II systems include utility programs that save and restore data on volumes equivalent to disk volumes in an image fashion or as individual files or sets of files. Single-unit prices are $2995 for the 10M-byte version and $3795 for the 20M-byte version, including IBM PC interface card, cables and software. **Sysgen Inc.,** 47853 Warm Springs Blvd., Fremont, Calif. 94539. **Circle No 316**

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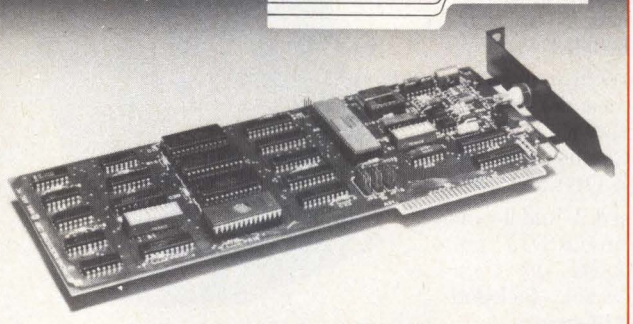

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CIRCLE NO. 135 ON INQUIRY CARD

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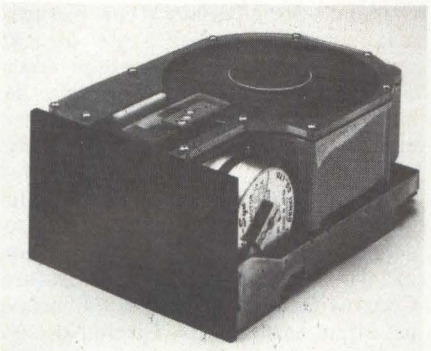
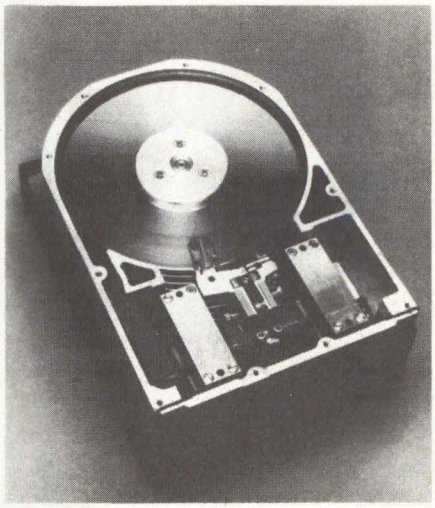


Winchesters take aim at small-business computers

The D5200 family of 5¼-inch Winchester disk drives comprises four models with unformatted storage capacities of 6.4M, 12.9M, 19.3M and 25.8M bytes. The drives have 85-msec. average access times and 5M-bit-per-second data-transfer rates. They are available with an industry-standard interface. Features include a direct-drive DC spindle motor, microprocessor controls and LSI circuits and an MTBF rating of 12,000 power-on hours. $915 to $1,410 each (100 units). **NEC Information Systems Inc.,** 5 Militia Dr., Lexington, Mass. 02173, (617) 862-3120. **Circle No** 317

Winchesters boast 32-msec. access times

The 500 series of 5¼-inch Winchester disk drives includes four models with unformatted storage capacities ranging from 55M to 111M bytes. Model 502 stores 55M bytes on four disks; model 504 stores 86M bytes on six disks. Both drives are compatible with the ST412/506 interface. Models 503 and 505 have higher recording densities to get 71M and 111M bytes of storage capacity on four and six disks, respectively. These drives feature on-board data separation and are available with Priam and ANSI interfaces. The 502 and 504 offer 625K-byte-per-second data-transfer rates, and the 503 and 505 offer



806K-byte-per-second transfer rates. All units have 32-msec. average access times. $1,550 to $2,500 (500 units). Delivery: second quarter, 1984. **Priam Corp.,** 20 W. Montague Expressway, San Jose, Calif. 95134, (408) 946-4600. **Circle No** 318

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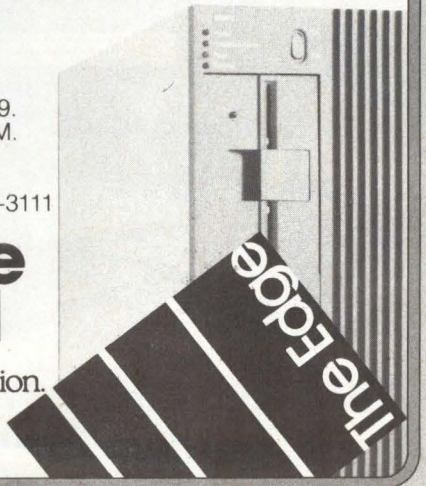

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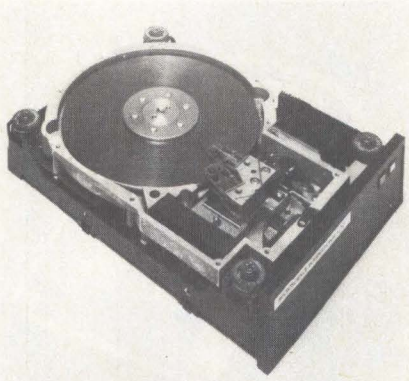
New Products

DISK/TAPE



Half-height Winchester stores 10M bytes

The HH-612 half-height 5¼-inch Winchester disk drive stores 10M bytes of formatted data. Measuring 1.63 by 5.75 by 8 inches, weighing 3 pounds and requiring 0.9A DC, the HH-612 suits small-business systems and personal and portable computers. It features thin-film-plated disks, microprocessor-controlled spindle motor and servo positioning, a thermally isolated stepper motor with a patented band actuator, embedded guard bands and on-board self-diagnostics. $999. **Microscience International Corp.,** 575 E. Middlefield Rd., Mountain View, Calif. 94043, (415) 961-2212. **Circle No** 319

Disk systems for Series/1 store 126.4M bytes

The Certainty 231 and 241 Series are families of sealed-module, random-access disk storage systems that attach to the IBM Series/1 minicomputer. The systems store 63.2M or 126.4M bytes of data. Each system consists of a disk storage device, an attachment controller and all hardware for installation in the Series/1 4997 rack enclosure. The attachment controller operates in the Series/1 cycle-steal mode, allowing multiple-sector disk transfers and has initial program-load capability. Both Certainty Series disk systems feature a maximum data-transfer rate of 1.2M bytes per sec. and an average access time of 30 msec. The Certainty 241 models also feature 0.6M bytes of double-sided floppy-disk storage. Prices of the Certainty 231 and 241 disk systems, in quantities of five through nine, range from $12,325 to $19,200 depending on storage capacities and inclusion of the floppy disk feature. **Control Data Corp.,** Box 0, Minneapolis, Minn. 55440. **Circle No** 320

Cartridge-tape streamer stores 45M bytes

The model DSC 50X ¼-inch streaming cartridge-tape subsystem for the IBM Series/1 computer consists of a single-board Datum tape controller, an Archive ¼-inch cartridge streaming-tape transport, a power supply, software and cables. The controller board mounts directly in the Series/1's

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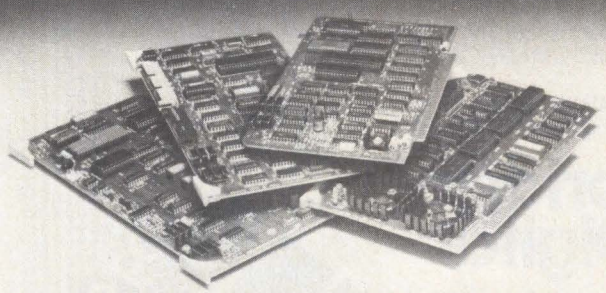

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CIRCLE NO. 137 ON INQUIRY CARD

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A. Total No. Copies Printed (Net Press Run)	121,456	124,373
B. Paid Circulation		
1. Sales through dealers & carriers, street vendors and counter sales	None	None
2. Mail Subscriptions	2,320	2,515
C. Total Paid Circulation	2,320	2,515
D. Free distribution by mail, carrier, or other means samples, complimentary, and other free copies	118,188	120,796
E. Total Distribution (Sum of C & D)	120,508	123,311
F. Copies not distributed		
1. Office use, left over, unaccounted, spoiled after printing	948	1,062
2. Returns from news agencies	None	None
G. Total	121,456	124,373

I certify that the statements made by me above are correct and complete. Robert LaFemina, (signed) Manager, Administrative Services.

processor chassis, and a separate 5¼-inch-high enclosure houses the remaining components. The tape drive stores 45M bytes of formatted data on nine tracks. Recording density is 8,000 bpi; data-transfer rate is 5M bytes per minute. $5,000. **Datum Inc.,** 1363 S. State College Blvd., Anaheim, Calif. 92806, (714) 533-6333. **Circle No** 321

Winchester stores 190M bytes on eight disks

The XT-2000 family of 5¼-inch Winchester disk drives includes models with unformatted storage capacities of 85M bytes (four disks), 140M bytes (six disks) and 190M bytes (eight disks). The drives incorporate the ST506/412 interface and have data-transfer rates of 5M bits per second. Average access time is 30 msec. The drives also feature a 3380 Whitney-type ceramic mini-composite head slider. Using a ferrite read/write element, the slider records 1,224 tracks per disk surface. Track density is 980 tpi. $1,670 to $2,995 (1,000 units). Delivery: first quarter, 1984. **Maxtor Corp.,** 61 E. Dagget Dr., San Jose, Calif. 95134, (408) 942-1700.

Circle No 322

Tape subsystem stores 40M bytes

Designed for use with the IBM PC and the IBM PC XT, the TD-1012/PC-STR ½-inch tape subsystem operates in start/stop (12.5 ips) and streaming modes (100 ips) and supports industry-standard IBM/ANSI/ECMA tape formats. The recording mode is standard phase encoded PE at 1600 bpi. Data-transfer rate is 20K bytes per second in start/stop mode and 160K bytes per second in streaming mode. The unit accepts 7- to 10½-inch-wide industry-standard tape reels and stores approximately 40M bytes of formatted data (depending on block size) on a 2,400-foot reel of tape. The system includes a tape controller board and a software-driver package for read/write/control. $4,995. **Innovative Data Technology,** 4060 Morena Blvd., San Diego, Calif. 92117, (619) 270-3990.

Circle No 323

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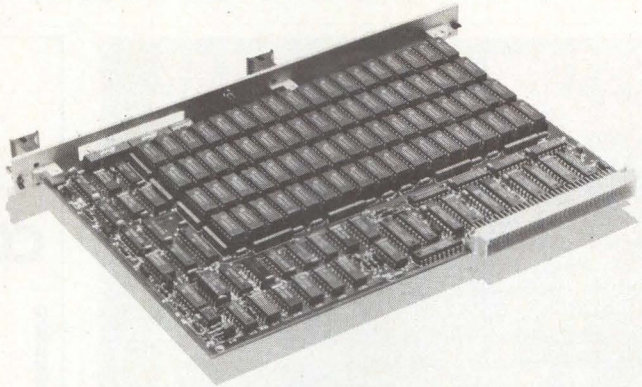

Compatible with the VME/10 microcomputer system and MVME210 memory board, the MM-6000D is a high density memory that can employ either 64K or 256K DRAMs. A jumper option selects either 64K or 256K DRAM operation.

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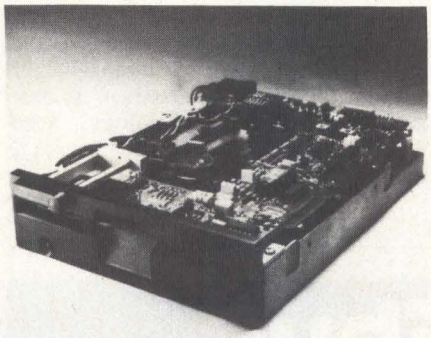
New Products

DISK/TAPE



Floppy drives feature ball-bearing carriage

The Echo 500 family of 5¼-inch, half-height floppy disk drives employs a ball-bearing coupled carriage to achieve precision track-to-track positioning and low-noise drive stepping. Storage capacities range from 1.6M bytes (unformatted) for the double-sided, double-density, 96-tpi model to 125K bytes (unformatted) for the single-sided, single-density 48-tpi model. Track-to-track access times are 3 msec. for the 96-tpi models and 6 msec. for the 48-tpi models. Data-transfer rates range from 500K to 125K bits per second. Prices start at $95 to $225 (large OEM quantities). **Hi-Tech Peripherals Corp.,** 15192 Triton Lane, Huntington Beach, Calif. 92641, (714) 891-0027. **Circle No** 324

Half-height Winchester stores 10.5M bytes

The CM4000 half-height, 5¼-inch Winchester disk drive stores 10.5M bytes (formatted) using a single platter of standard oxide media. Recording density is 9,275 bpi. The drive also features 750-tpi track density with 640 data cylinders per disk and 1,280 tracks per disk. Data-transfer rate is 5M bits per second; average access time is 75 msec. The drive measures 1.65 by 5.75 by 8 inches, weighs 3 pounds and consumes 15.5W. Approximately $600 (OEM quantities). **Computer Memories Inc.,** 9216 Eton Ave., Chatsworth, Calif. 91311, (213) 709-6445. **Circle No** 325

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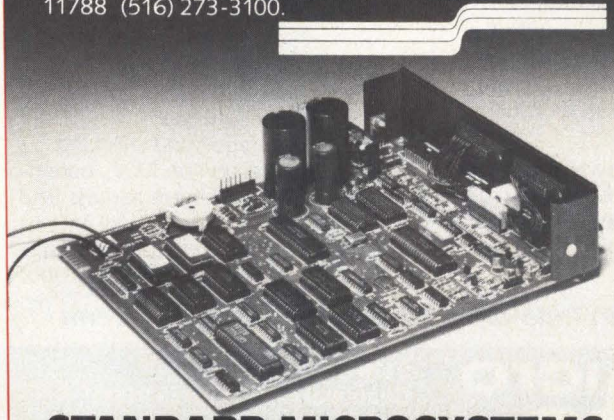

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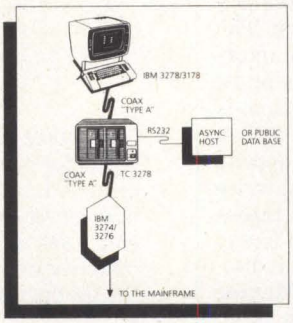

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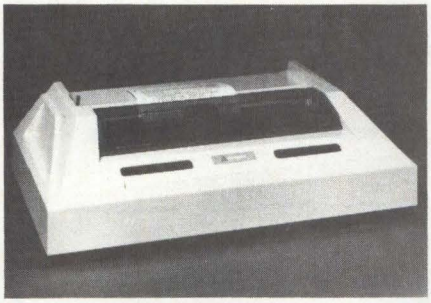
CIRCLE NO. 144 ON INQUIRY CARD

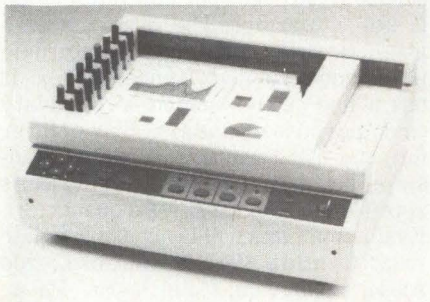
New Products

PRINTERS



Dot-matrix printer achieves 500 cps

The DP-6500 data-processing printer achieves speeds of 500 cps at 10 cpi. For 132-column printing, the DP-6500's speed is higher than 200 lpm. Key to the DP-6500's speed is an 18-needle print head consisting of two vertical columns of nine needles each. Other DP-6500 features include selectable ranges of 10, 12, 15 and 16.4 cpi, seven ISO character sets that include Swedish, Danish-Norwegian, German, French, Spanish, Italian and standard USASCII and font down-loading from the host computer. $2995. **Anadex Inc.,** 9825 De Soto Ave., Chatsworth, Calif. 91311. Phone (213) 998-8010. **Circle No** 326



Digital plotter suited for presentation graphics

The model XY/749 eight-pen digital plotter generates vectors, circles and arcs, axes and point-marks with 0.1-mm. resolution. It can also print all 96 ASCII characters at any angle with user control of height, width and slant. Plotting speed is 450 mm. per sec., and printing speed is 3 cps. The plotter is compatible with most mainframes, minicomputers and personal computers. RS232C and IEEE 488 interfaces are available. Prices start at $1995. **IBM Instruments Inc.,** P.O. Box 332, Danbury, Conn. 06810. Phone (800) 243-7054. **Circle No** 327

Printer line includes high-speed, color models

The enhanced "B," the two-speed "S" and the two-speed/seven-color "SC" are new versions of C. Itoh Electronics' 8510A and 1550A serial dot-matrix printers. The "B" models have additional dip-switch settings of 6 or 8 lines per in., increased throughput of 68 lpm versus 63 lpm and enlarged overrun and receive buffers. The "S" models have a 180-cps draft-quality printing mode as well as the "A" models' standard 120-cps printing speeds. The "SC" models feature 120- and 180-cps printing speeds

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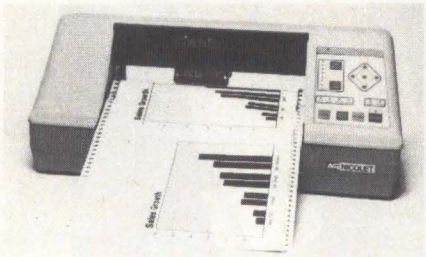
and a three-color ribbon that provides users with a seven-color printing palette. The basic difference between the 8510 family of printers and the 1550 family is in carriage width: 8510 models have an 80-character-per-line format for forms 4½ to 10 in. wide, while the 1550's 136-character-per-line format accepts forms 4½ to 15½ in. wide. The 8510 has a standard 1K-byte buffer, and the 1550 has a standard 3K-byte buffer. Both printers have a 9 × 9 matrix and a built-in graphics mode with 144 × 160 dot-per-sq.-in. resolution. Centronics and RS232C interfaces are available. Single-unit prices are $745 for the 8510B, $995 for the 1550B, $825 for the 8510S, $1225 for the 1550S, $925 for the 8510SC and $1325 for the 1550SC. **C. Itoh Electronics Inc.,** 5301 Beethoven St., Los Angeles, Calif. 90066.

Circle No 328



Color plotter operates in SNA/SDLC environment

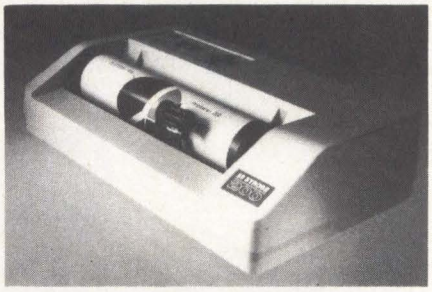
The Zeta 887, an eight-color pen plotter, connects directly to an IBM 3274 or 3276 cluster controller providing high-resolution, hard-copy output directly from an IBM 3274 or 3276. Plotting speed is 20 ips. Various media types (translucent bond, glossy bond, vellum or clear inking film) and media widths (ISO A3, A4 and ANSI A, B size drawings) are supported. The commands required to drive the Zeta 887 can be generated by any application program that uses industry-standard plotting routines. The plotter is also supported by ISSCO's DISSPLA and TELL-A-GRAF, Precision Visuals, DI3000 and the SAS/GRAPH software packages. $7950. **Nicolet Zeta Corp.,** P.O. Box 4003, Concord, Calif. 94524. Phone (415) 671-0600.

Circle No 329

Color printer produces more than 4900 hues

The TC1040 color ink-jet printer/plotter can produce 4913 hues on various pin-fed media. Printing resolution is 84 or 120 dpi horizontally and 85 dpi vertically. A maximum of 12.1 in. of printing surface is provided, allowing as many as 1300 individually addressable pixels. Print speed averages 27 ips, and the average printing time for a 512- × 512-pixel image at 85 dpi is less than 1 min. The TC1040 interfaces via an RS232C or Centronics-type I/O port employing an 8-bit ASCII data format. English, Spanish, German, French, Swedish, Dutch and ASCII character sets are available. $5495. **PrintaColor Corp.,** 5965 Peachtree Corners E., Norcross, Ga. 30071. Phone (404) 448-2675.

Circle No 330



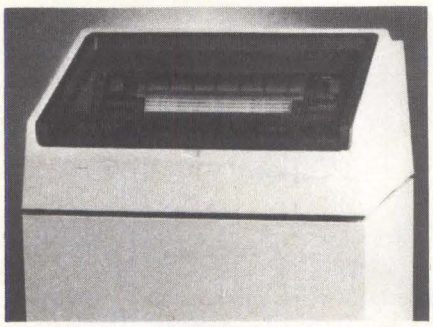
Color graphics plotter changes pens automatically

The model 260 graphics plotter produces plot graphs and charts using as many as six colors with automatic pen changes. The individually replaceable pens are held in a cartridge. Menu-driven software lets users preselect colors before initiating plots and generate bar charts, pie charts and line graphs with a resolution of 500 steps per inch on both the x and y axes. The plotter can also label charts and create text pages. It has an RS232C interface and is compatible with computers that run the CP/M-80, PC-DOS and MS-DOS operating systems. $995. **Strobe Inc.,** 897-5A Independence Ave., Mountain View, Calif. 94043, (415) 969-5130.

Circle No 331

Matrix line printers operate at 600 lpm

The GE 4030 and GE 4060 shuttle matrix line printers operate at 300 and 600 lpm, respectively. Standard character spacing is 5 cpi, 10 cpi and 13.3 cpi. Line spacing is 6 or 8 lines per in. Both printers have graphics capabilities featuring a resolution of 60 × 72 dpi or 120 × 144 dpi. Both printers use



continuous, fanfold, margin-punched paper and can print six-part forms. Full 94-character ASCII sets are standard, with space provided for national character sets or special symbols. Industry-recognized, plug-compatible interfaces are available. Prices range from $5500 to $8500 with delivery scheduled for mid-1984. **General Electric Co., Data Communication Products Department,** Waynesboro, Va. 22980. Phone (703) 949-1000.

Circle No 332

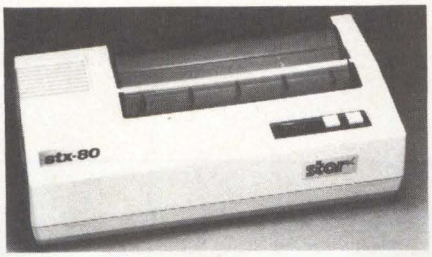
Magnetic printer uses perpendicular recording

The MP6090 high-speed magnetic printer for the OEM market prints at 6000 lpm (88 pages per min.) Resolution is 240 × 240 dpi. The printer uses a magnetic drum, pependicular recording heads and a single-component toner. It has a line-printer emulation capability that permits standard line-printer formats using multiple fonts in landscape and portrait directions. Price is approximately $25,000 (OEM quantities). Evaluation units will be available in late 1983. **Cynthia Peripheral Corp.,** 766 Aleso, Sunnyvale, Calif. 94086. Phone (408) 745-0855.

Circle No 333

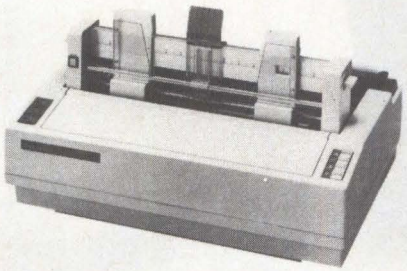
Low-cost thermal printer serves pc systems

The STX-80 thermal printer provides bidirectional logic-seeking printing of 80 characters per line, or 40 cpl in expanded print mode, at 60 cps. It furnishes 96 standard ASCII characters and 51 European characters using a 5-by-9 dot matrix, 64 block graphic characters using a 6-by-6 dot matrix and bit image graphics using an 8-by-480 dot matrix. A standard Centronics-compatible 8-bit parallel interface permits use with most personal computers. The printer employs standard



8½-inch-wide, friction-feed, thermal-roll paper. $200. **Star Micronics Inc.,** 1120 Empire Central Place, Dallas, Texas 75247, (214) 631-8560.

Circle No 334



Impact printers offer high speed, graphics

Logic-seeking bidirectional units featuring bit-image graphics, the KX-P1160 and KX-P1090 impact dot-matrix printers provide a seamless cartridge-type ribbon designed for long life and easy replacement. Both models can print 96 standard ASCII characters with true descenders, and the KX-P1090 also offers three international character sets. The 136-column KX-P1160 prints at 165 cps with 9-by-13 resolution and handles fanfold paper 4 to 15 inches wide. The 80-column KX-P1090 prints at 80 cps with 9-by-9 resolution and accommodates fanfold or single sheet paper from 4 to 10 inches wide or 8½-inch-wide roll paper. Each printer offers standard parallel interface and optional RS232C interfaces. KX-P1160: $1,750, KX-P1090: $550. **Panasonic Industrial Co.,** 1 Panasonic Way, Secaucus, N.J. 07094, (201) 348-7183. **Circle No** 335

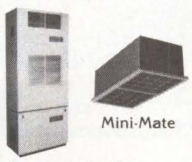
Printer provides range of character sizes

The Gemini 10 impact dot-matrix printer provides 100-cps logic-seeking bidirectional printing and true descenders in 17, 12, 10, 8.5, 6 and 5 cpi sizes. Italic, subscript and superscript are available as well as emphasized, double-strike and underline options. The unit offers 96 standard ASCII characters, 96 italic characters, 64 special characters and 32 block graphic characters using a 6-by-6 dot matrix. Users can program additional characters into 2K bytes of PROM. Both 60-by-72 low-resolution and 120-by-144 high-resolution bit-image graphics are available. A Centronics-compatible parallel interface is standard, and an RS232/20-mA current-loop serial interface is optional. $399. **Star Micronics Inc., Computer Peripherals Division,** 1120 Empire Central Place, Dallas, Texas 75247, (214) 631-8560.

Circle No 336

Are your computers getting the "shock treatment"?

Static electricity, humidity and other environmental problems can cause all kinds of annoying disruptions to your computer or word processing work flow. And it's totally unnecessary! Liebert offers affordable solutions to all small computer environmental and power problems. Call **614/888-0246.** We help make your computer investment pay off!



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Liebert Corporation, 1050 Dearborn Drive, P.O. Box 29186, Columbus, Ohio 43229, 614/888-0246 Telex: 246655 LIEBERT WOGN

CIRCLE NO. 146 ON INQUIRY CARD

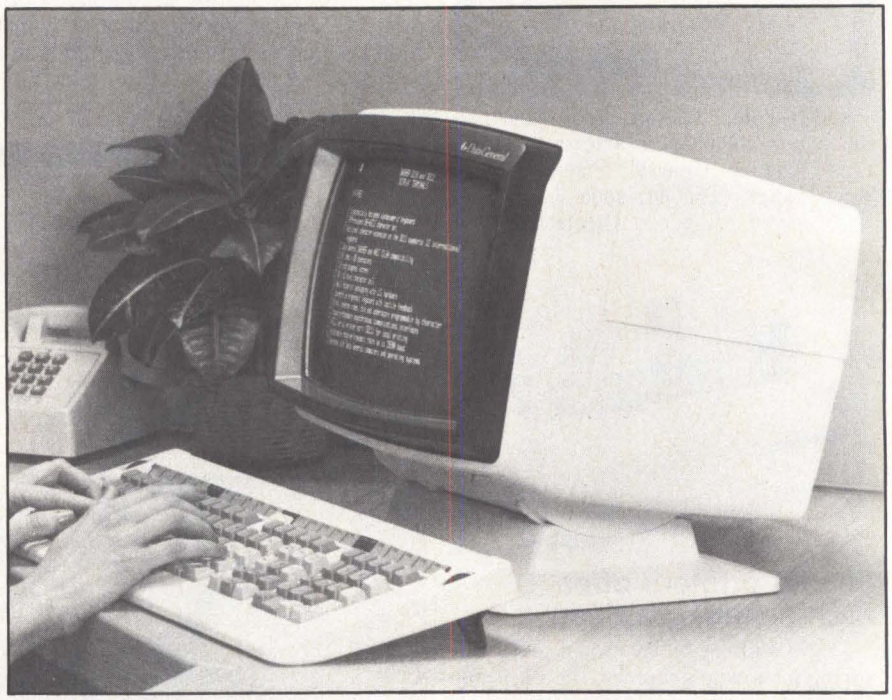
DG expands Dasher terminal line

Data General Corp. has introduced four ergonomically designed Dasher terminals. The D210 and D211 are low-cost replacements for the Dasher D200 terminal, while the D410 and D460 terminals feature higher functionality including windowing and screen-management capabilities. The D460 also offers graphics capabilities intermixed with alphanumeric text. The terminals are compatible with earlier Dasher models and can be used with existing applications.

Each terminal has a 12-inch tiltable display housing and a low-profile keyboard. The D410/460 displays 24 lines of 81 columns in a 10-by-12 dot matrix or 135 columns in a 12-by-12 dot matrix. Users can define as many as 24 windows. Bidirectional vertical scrolling and 162-column horizontal scrolling are available.

The terminals support a complete set of editing commands including erase screen, window, unprotected text, end of line, insert/delete character, line, margin commands and change attributes.

The D410/460 Dasher family provides 512 pre-defined characters including 95 ASCII, 68 foreign-language characters, a subset of the Greek alphabet, extended math symbols, forms ruling, word-processing symbols, superscripts and subscripts. D460 users can also define as many as 3,752 additional characters that can be down-line loaded from the host computer.



DG's new Dasher *terminals are designed for use with Eclipse, Nova and CS small-business systems.*

The terminals support ANSI command formats X3.41/X3.54, DG command codes, 20-mA current loop (except the D210) and RS232C interfaces and local printing. The terminals are supported by the AOS, AOS/VS and AOS/RT32 operating systems as well as DG's CEO (comprehensive electronic office) and systems software. The D210 and D211 models are also supported by the DOS, RDOS, RTOS, MP/OSO and MP/AOS operating systems.

Prices range from $995 for the D210 to $1,785 for the D460. Delivery is 60 days. **Data General Corp., Information Systems Division,** 440 Computer Dr., Westboro, Mass. 01581, (617) 366-8911.
Circle No 337

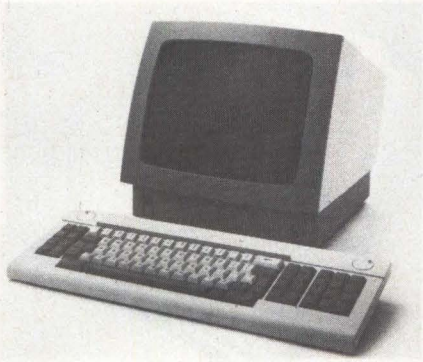
Conversational terminal shows 128 characters

The model ADM 11 video display terminal comprises a 12-inch, non-glare green screen with tilt-and-swivel adjustments and a detachable, low-profile keyboard with Selectric-type layout, a numeric keypad, a tilt mechanism and three-key rollover. The screen can display 128 characters including control codes, block graphics, wide-point graphics and line-drawing characters in an 80-column-by-24-line format. Other highlights include non-embedded reduced intensity, blink, blank and

reverse video, line and page erase, two non-volatile setup modes, four print modes and four programmable and optionally non-volatile function keys. $695. **Lear Siegler Inc., Data Products Division,** 714 N. Brookhurst St., Anaheim, Calif. 92803, (714) 774-1010.
Circle No 338

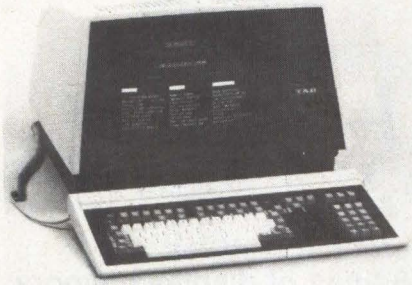
Ergonomic terminal is IBM plug compatible

C. Itoh Electronics' CIE-7800 video display terminal is plug-compatible with IBM 3278 and 3178 terminals. It has a tiltable 14-inch, non-glare green or amber screen, a 12-inch-by-12-inch footprint and an 87-key keyboard. The terminal displays 12 to 43 lines of 80



characters or 27 lines of 132 characters. Standard character sets are EBCDIC and ASCII. Other features include a printer interface and a bi-level, software-activated security lock. Concurrent alternate personalities such as DEC VT100, Burroughs TD 830/983/986, IBM 3101-3104 and IBM 3275/76-2 (bisynchronous) are available. Contact the vendor for price information. **ACM Inc.,** Suite 540, 3857 Birch St., Newport Beach, Calif. 92660, (800) 854-5959.

Circle No 339



Terminal operates in three modes

The model 132/15H Honeywell-compatible smart terminal operates in one of three standard operational modes—character, text or form. The terminal has an internal clock, and provides keyboard-selectable asynchronous and synchronous communications rates. Its 15-inch non-glare screen displays 80 or 132 columns. In addition to 95 ASCII keys (including 11 Honeywell business graphics characters), a 14-key numeric pad and 26 control keys, the 132/15H has 14 user-programmable function keys. $2,200. **Tab Products Co.,** 1451 California Ave., Palo Alto, Calif. 94304, (415) 858-2500.

Circle No 340

Terminal suits graphics applications

Intended for graphics applications, the J-1014 monochromatic, microprocessor-based terminal features 1024-by-780 resolution, an 880-nsec.-per-dot drawing rate and compatibility with Tektronix 4010 and 4014 commands and with DEC VT100 terminals. The terminal can run many software packages including Plot 10. The J-1014 performs scrolling and selective-erase functions and can generate circles and multiple line styles.

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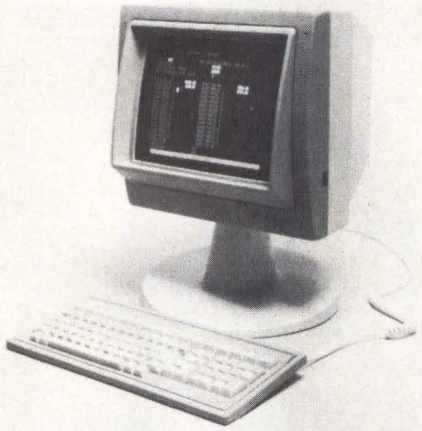
CIRCLE NO. 147 ON INQUIRY CARD

New Products

TERMINALS

A color version is available. $3,995. Delivery is 60 days. **KEL Inc.,** 1 World Trade Center, Suite 4811, New York, N.Y. 10048, (212) 524-8350.

Circle No 341



Display terminal exhibits ergonomic design

The model C-300 microprocessor-controlled, conversational video display terminal features a movable keyboard and a 14-inch screen that displays green characters on a black background in an 80-column-by-24-line format. Shielded on four sides, the screen can tilt and swivel. Five video attributes—normal, reverse, blink, half-intensity and security (no display)—are selectable. A portion of the display can be protected, while an operator enters or receives data in the unprotected portion. An RS423 interface is standard. $1,495. **Cado Systems Corp.,** 2055 W. 190th St., Torrance, Calif. 90504, (213) 323-8170.

Circle No 342

Terminal addresses block-mode applications

Compatible with DEC VT100 units, the ATL-004 microprocessor-based, buffered display terminal operates in conversational or block modes. It features a 14-inch screen, a 9-by-13 character cell, 80- and 132-column display formats, 27 display lines, programmable smooth scrolling and eight soft function keys. Applications include message communications, forms-oriented data entry, inquiry/retrieval, transaction processing, distributed data processing and system and process control. $995. **Beehive International,** 4910 Amelia Earhart Dr., Box 25668, Salt Lake City, Utah 84125, (801) 355-6000.

Circle No 343

DEC-compatible terminal features English setup

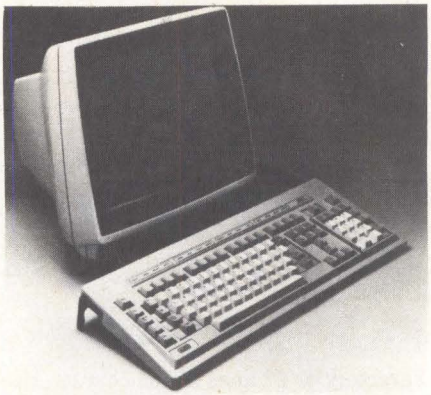
The Excel 60 Plus DEC VT131-/132-compatible display terminal features English-prompted setup menus, 15 programmable function keys and a printer port for DEC and non-DEC

printers and video capabilities such as reverse video, underlining and bold and blinking characters. The terminal displays 24 lines of 80 or 132 characters with reverse, underlined, bold or blinking attributes. It operates in character and block transmission modes. A bidirectional RS232C port is standard. A choice of 12- or 14-inch monitors with green, gray or amber phosphors is offered. $1,250. **Datamedia Corp.,** 7401 Central Highway, Pennsauken, N.J. 08109, (609) 665-5400.

Circle No 344

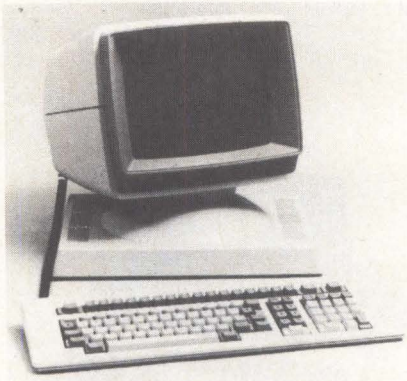
Terminal displays 132 columns

Tailored for business applications, the Altos II smart terminal contains a 14-inch tiltable screen with an 80- or 132-column display and smooth vertical scrolling. It also offers horizontal and vertical split screens, three character sizes and six hidden attributes. The terminal's detachable keyboard has an 18-key numeric keypad whose keys can double as special-function keys. Other



features include DEC VT100 emulation, 16 programmable function keys, two pages of memory, four communications modes (full and half duplex, local and block) and power on self test. $1,195. **Altos Computer Systems,** 2641 Orchard Parkway, San Jose, Calif. 95134, (408) 946-6700.

Circle No 345



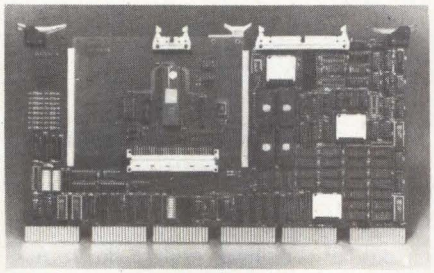
Terminal features 48 lines of display memory

The model ADM 24E video display terminal has a low-profile, tilt-adjustable, detached keyboard and a 12-inch, non-glare green CRT monitor contained in a tilt-and-swivel adjustable housing. The 80-column terminal provides a standard 48-line display memory with a 24-line scan. Non-embedded visual attributes include reverse video, reduced intensity, underline, blink, blank and double-width characters and business graphics. Standard features encompass 16 programmable function keys, selectable international character sets, non-volatile terminal setup from the keyboard and full editing functions. $1,250. **Lear Siegler Inc./Data Products Division,** 714 N. Brookhurst St., Anaheim, Calif. 92803, (714) 774-1010.

Circle No 346

New Products

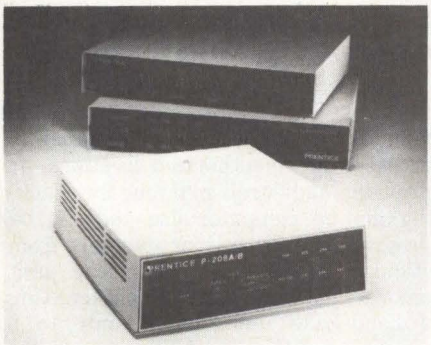
DATACOMM



Unibus controller connects computers to Ethernet

The Easyway Ethernet port controller connects PDP-11 and VAX computer systems to an Ethernet network. The board supports layers 1 through 4 of the network architecture. A companion product, Connect software, handles the session level, layer 5. Easyway combines two modules on a single hex-width board. The host protocol processor contains the Unibus interface and the transport protocols. The communications adapter board plug-in module provides the link and the physical protocol to the Ethernet network. A transceiver interface cable connects to the user-supplied transceiver cable. Easyway can be installed in any hex-width slot in a DDLL Unibus backplane configured for DMA operation. It meets Xerox/Intel/DEC Ethernet specification 1.0 and supports a 10M-bit-per-second data rate. $5,000. **Able Computer,** 1732 Reynolds Ave., Irvine, Calif. 92714, (714) 979-7030.

Circle No 347



Standalone modem operates at 4,800 bps

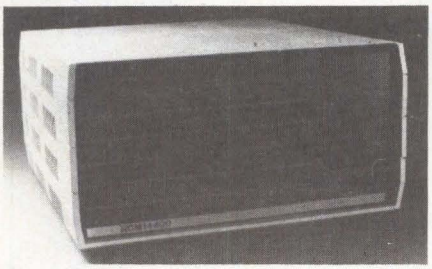
The P-208A/B 4,800-bps synchronous modem is Bell 208A and 208B compatible. It operates in half-duplex mode over public switched telephone networks and two-wire leased circuits and in full-duplex mode over four-wire leased circuits. This auto-answer, direct-connect modem features automatic adaptive equalization. Transmission levels and timing are strap selectable. Remote and local analog and digital loopback tests can be monitored from front-panel indicators. $1,750. **Prentice Corp.,** 266 Caspian Dr., P.O. Box 3544, Sunnyvale, Calif. 94088, (408) 734-9810.

Circle No 348

Multiport modem reduces telephone-line requirements

The Micro4000 model 4096/4+ multiport modem combines a time division multiplexer with a 9,600-bps modem in a compact package to support as many as four synchronous terminals or channels on one unconditioned telephone line. As many as four input channels operating at 2,400, 4,800, 7,200 or 9,600 bps can be supported as long as the aggregate composite data rate does not exceed 9,600 bps. The modem complies with CCITT Recommendation V.29 and features down-line channel loading and composite link parameters (such as operating speed), front-panel status indicators, independent local and remote loop-back tests for the selected channel or the composite link and individual channel buffering and control signal passing for linking to other communications equipment. $3,695. **Micom Systems Inc.,** 20151 Nordhoff St., Chatsworth, Calif. 91311, (213) 998-8844.

Circle No 349



Modem multiplexes six data channels

The NCM14400 modem consolidates data traffic from multiple medium-speed lines, multiplexing as many as six data channels on a single circuit and supporting 11 data-rate/channel combinations. It operates at 14,400 bps over domestic and international private lines and offers 12,000- or 9,600-bps fallback speeds. An all-digital automatic/adaptive equalizer senses the characteristics of a given telephone line and automatically trains itself to compensate for amplitude and delay distortion introduced by the channel. Initialization time is 225 msec. Other features include a 150-bps side channel and dial backup. $7,650. **Intertel Inc.,** 6 Shattuck Rd., Andover, Mass. 01810, (617) 681-0600.

Circle No 350

Modem features remote-boot capability

The BytCom 212AD is a Bell 212A-compatible modem with a microprocessor-based auto-dial circuit. The modem provides 0 to 300-baud and 1,200-baud transmission over the switched telephone network. The modem can store as many as nine phone numbers and associated names in non-volatile memory. Other features include remote-boot capability, software disconnect, a 16-character answerback capability and an integral voice/data switch. Tone, pulse and blind dialing are interchangeable within a stored-number sequence to allow users on pulse circuits to dial over MCI and Sprint lines. $695. **BytCom,** 2169 Francisco Blvd., Suite H, San Rafael, Calif. 94901, (415) 485-0700.

Circle No 351

Answer-only modem operates in three modes

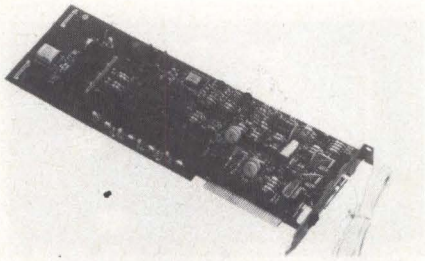
The DSM/Triple rack-mounted modem automatically responds to Bell 212A-, Bell 103- and Vadic VA3400-originating modems. This answer-only unit handles serial binary data at low synchronous (1,200 bps) and asynchronous (0- to 300- and 1,200-bps) speeds. Character lengths run from 8 to 11 bits, depending on the mode. A modem-detect algorithm determines the type of modem originat-

ing the call and automatically switches the unit into the compatible mode. Diagnostics include local and end-to-end tests as well as analog and digital loopbacks. $850. **Infotron Systems Corp.**, Cherry Hill Industrial Center, Cherry Hill, N.J. 08003, (609) 424-9400.

Circle No 352

Modem for IBM PC has asynch communications

The Signalman Mark VI modem for the IBM Personal Computer features a data-transmission rate of 300 baud, Bell 103 compatibility, tone and pulse dialing and auto-answer/auto-dial programmability. The Mark VI connects directly to a modular telephone wall jack. It fits directly into any of the PC's expansion slots and eliminates the need for an asynchronous communications card. The AnComm communications program provided with the Mark VI allows a user to send and receive text files, provides an automatic text-capture buffer, stores a directory of frequently dialed telephone numbers and allows single-key dialing of phone numbers in the directory and unattended answering. $279 including a subscription to the Source. **Anchor Automation Inc.**, 6624 Valjean Ave., Van Nuys, Calif. 91406, (213) 997-6493.



Circle No 353

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. . . and Quietly enjoy it next year.

Give the gift of quiet to your office work environment. Give QUIETPRINT.

The year end is nearing. Nothing has changed. Your office is still noisy. And at this time of year employees have so many holiday thoughts that any additional distractions, such as noise, make productive work difficult. It's time for a generous change . . . QUIETPRINT.

A QUIETPRINT Acoustical Cabinet will silence your word processor, data printer or teleprinter. Give your office the quiet it deserves and enjoy the benefits all next year. Not only can the productive quiet be a joy, but **you** will enjoy a tax break, too! But don't let the office know; your quiet generosity may lose some of its mystery.

With models available for more than 300 business machines your gift selection is assured to be easy. Call us today and we can discuss your needs, or write for a brochure showing our line of quality quiet cabinets.

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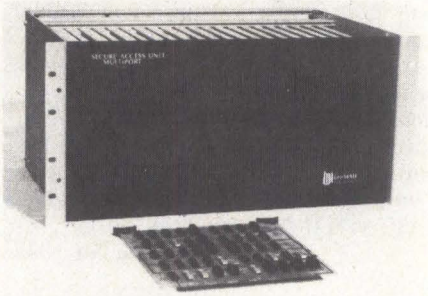
CIRCLE NO. 148 ON INQUIRY CARD



Security device uses call-back to limit access

The Secure Access Multiport (SAM) security device uses programmable memory and call-back to prevent dial-up access from unauthorized locations. It provides audit-trail printout for tracking dial-up computer use and can be programmed directly or remotely from standard ASCII terminals. The unit answers incoming calls without emitting a handshake tone, reacts only to a six-digit location identification number (LIN) and disconnects the call, preventing line tie-up. A programmable LIN directory handles 256 telephone numbers. Unauthorized incoming calls are thwarted, and the intrusion attempt is noted. $570 to $1,400 per port. **LeeMAH**, 729 Filbert St., San Francisco, Calif. 94133, (415) 434-3780.

Circle No 354

New Products

SOFTWARE

Language support for DEC, TI computers

Digital Research progamming languages are available now through the CP/M Library in disk formats for the DEC Rainbow 100 and TI Professional Computer. The CP/M Library is a set of software packages for popular computers in attractive, uniform packages for retail distribution. Initial languages in the new formats include Pascal/MT+, PL/I, Level II COBOL, CIS COBOL, CBASIC and the CBASIC Compiler. Utilities such as the Speed Programming Package for use with Pascal/MT+, a symbolic instructive debugger and a set of programmers' utilities including a relocating assembler, linkers and a librarian are also available in the new format. Prices range from $150 for the symbolic instructive debugger to $1600 for Level II COBOL. **Digital Research Inc.,** P.O. Box 579, 160 Central Ave., Pacific Grove, Calif. 93950. Phone (408) 649-3896. **Circle No 355**

Pascal compiler runs on IBM PC

SBB Pascal is a two-pass, locally optimizing Pascal compiler for the IBM Personal Computer that runs under PC-DOS. A CP/M-86 version is planned. Based on the Pascal/Z compiler, SBB Pascal closely follows the Jensen and Wirth definition of the language with extensions designed to aid the professional programmer in software development. Extensions include variable-length strings, direct file access, arbitrary precision BCD numbers for business arithmetic, functions returning structured values, separate compilation, external routines, include files, symbolic I/O of enumeration types, an ELSE clause for the CASE statement, overlays and chaining. The compiler package also includes an interactive Pascal debugger written in SBB Pascal and a screen editor provided in SBB Pascal source. $350. **Software Building Blocks Inc.,** P.O. Box 119, Ithaca, N.Y. 14851. Phone (607) 272-2807. **Circle No 356**

FORTH system runs on MC68000-based micros

IoForth, a FORTH system for MC68000-based microcomputers with disk drives, features a 32-bit parameter stack and background tasks. The package includes a kernel, an assembler, a FORTH interpreter, a job swapper, 32-bit floating-point operations, virtual-memory capability, first-in-first-out data structures and a screen editor. Disk-file structure and graphics software are optional. Interface to a user's system is through user-supplied subroutines that perform primitive input/output functions such as printing a character on a terminal or reading a sector from disk. All source code except the kernel and the assembler is priced at $1990; the complete package is priced at $5000. **Io Inc.,** 1842 W. Grant Rd., Tucson, Ariz. 85745. Phone (602) 792-0969. **Circle No 357**

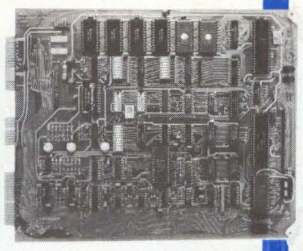
Program simulates CP/M on VAX-11 computers

With CP/Sim, programs written to run under the CP/M operating system on an 8080 microprocessor with 64K bytes of memory can execute on a DEC VAX-11 computer running under the VMS operating system. CP/Sim provides conversion between CP/M and VAX file formats. Features include file protection, availability of date/time stamps and use of version numbers. The package includes a utility for exchanging files between a CP/M-formatted disk and the host VAX $2,400. **Proto Systems,** 1238 Josephine St., Berkeley, Calif. 94703, (415) 525-9340. **Circle No 358**

Statistics database works on Apple II

Statpro, a set of integrated statistics, graphics and data-management programs, turns an Apple II, II+, or IIe computer into a menu-driven research and management workstation. With the database component, a user can enter, edit, manipulate, transform, store, copy and print data. Descriptive, regression, analysis of variance, time series and multivariate statistical functions are provided. They enable users to prepare

Hey Printronix!



IBM 2770
IBM 2780/3780
IBM 3270
IBM 2946 (PARS)
HASP
UNIVAC DCT 1000
UNIVAC 1004
UNIVAC U-100/U-200/U-400
UNIVAC NTR
Honeywell VIP 7700
Burroughs Poll and Select
NCR Poll and Select

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For example, our MPC-79 (photo) is specifically designed for PRINTRONIX printers. Some of the currently available protocols are listed at left.

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An Association Dedicated to Addressing the Marketing Concerns of Manufacturers of Computer Peripherals and Related Products.

OVER 20 COMPANIES HAVE JOINED THE NEWLY-FORMED **PMA.** THEY HAVE RECOGNIZED THAT A TRADE ASSOCIATION CAN BE AN EFFECTIVE TOOL IN RESPONDING TO **COMMON** MARKETING INTERESTS SUCH AS:

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A panel discussion

A HIGHLIGHT OF THE PMA MEMBERSHIP MEETING DURING THE LAS VEGAS COMDEX SHOW WILL BE A PANEL DISCUSSION ON PERPHERALS STANDARDS. IT WILL INCLUDE THE FOLLOWING SPEAKERS:

- **William Burr, National Bureau of Standards**
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☐ Membership Application Form
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CIRCLE NO. 155 ON INQUIRY CARD

graphs in scatter, regression, triangle and box plots, as well as pie charts, histograms and dendograms. Users can alter margins, tick marks and color highlights and edit titles, labels and legends. $1,995. **Wadsworth Electronic Publishing Co.**, 20 Park Plaza, Boston, Mass. 02116, (617) 423-0420.

Circle No 382

Concurrent Pascal suits real-time applications

Intended for programming real-time embedded systems, Micro Concurrent Pascal (mCP) provides process, monitor and class constructs for Concurrent Pascal. A device-monitor construct permits hardware interaction from mCP. The package runs on a host computer that supports sequential Pascal. Compiled output is in P-code or assembly language for Z80, Z8000, 8080/8085, 8086/8088, 6809, 68000 or 1802 target microprocessors or LSI-11 microcomputers. P-code output is reentrant, relocatable and PROMable. Features include interrupt handling, language constructs for writing device drivers, absolute hardware addressing, separate compilation, and calls to assembly-language routines. Contact the vendor for price information. **Enertec, Inc.**, 19 Jenkins Ave., Lansdale, Pa. 19446, (215) 362-0966.

Circle No 359

GRAPHICS WORKSTATIONS

To the editor:

Concerning "Graphics workstation vendors (MMS, July, Page 174), two items need to be corrected. The listed Aydin Controls system should be spelled AYCON 16, and the resolution range should be 256 by 256 to 1024 by 1024.

Johanna M. Manning
Product Promotion Specialist
Aydin Controls
Fort Washington, Pa.

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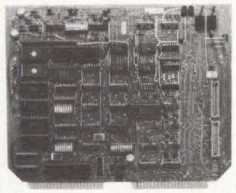
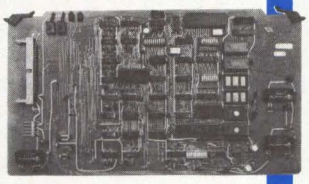
Hey Centronics!





IBM 2770
IBM 2780/3780
IBM 3270
IBM 2946 (PARS)
HASP
UNIVAC DCT 1000
UNIVAC 1004
UNIVAC U-100/U-200/U-400
UNIVAC NTR
Honeywell VIP 7700
Burroughs Poll and Select
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For example, our MPC-81 and MPC-85 (photos at left) are specifically designed for CENTRONICS 6000 and Linewriter printers. Some of the currently available protocols are listed at left.

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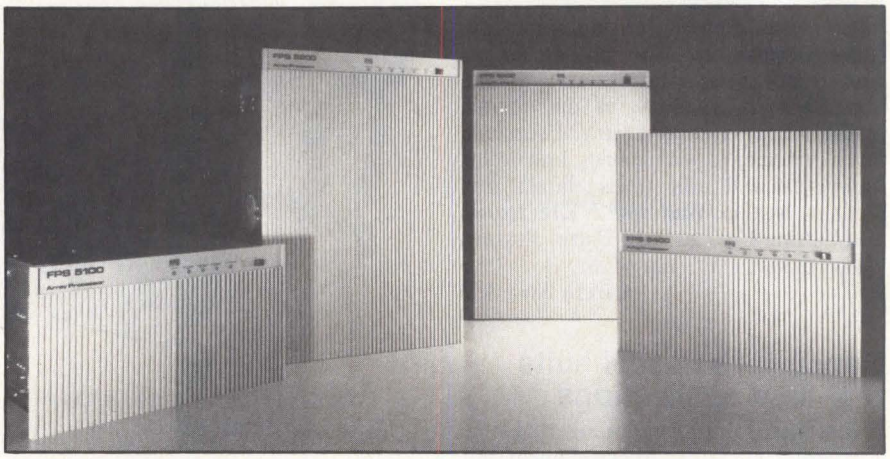
Array processor offers increased performance



Floating Point Systems Inc. has introduced an advanced series of 38-bit array processors offering as much as 62-million-floating-point-operations-per-second (MFLOPS) performance while reducing the per-MFLOPS price of the average processor to less than $2,000.

The new FPS-5000 series is expected to replace Floating Point's 100 and 120 series of array processors providing as much as 26 MFLOPS, says Paul Wiley, product line manager for the series. The company expects to ship the processors in February 1984.

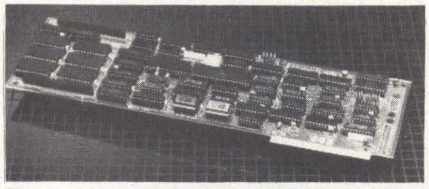
The series aims at the signal-image-processing market, including such instrument products as medical imagers, seismic recorders and flight simulators. It encompasses four basic product groups, the 5100, 5200, 5300 and 5400. The basic model, the 5100, sells for $60,000 and comes with 16K bytes of memory, which can be upgraded to 32K bytes, and has a performance of 26 MFLOPS. At the high end of the line is the 5400, with 32K bytes of program memory, 1M words of data memory and 62-MFLOPS performance. Price of the 5400 is less than $100,000.

The 5000 series is compatible with interfaces on other 38-bit Floating Point array processors. In addition, it will be software compatible with previous series. The series features a coprocessor with its own local memory and control capability.

The 5200 series has two coprocessors, the 5300 has an optional third coprocessor containing two floating-point adders and a floating-point multiplier with a 6-MHz internal-instruction-cycle time and yielding a 1,024-point complex-fast Fourier transform (FFT) time of 2.7 msec. Independent local memories and multiple addressing processors in each unit constantly monitor performance.

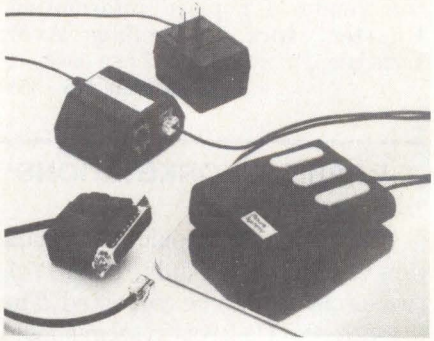
Floating Point officials expect that, in addition to new installations, older array processors will require servicing, and a large replacement market will develop for the price-competitive new series. *—Robert A. Sehr*

Floating Point Systems Inc., P.O. Box 23489, Portland, Ore. 97223, (503) 641-3151. **Circle No 360**



Boards add graphics, CP/M 2.2 to IBM PC

The SuperVision video interface board and the Z/Plus Z80 processor board plugs into the IBM Personal Computer. SuperVision allows a user to display 132 columns by as many as 44 rows on a standard IBM PC video monitor. When used with the vendor's graphics adapter, SuperVision generates dot-addressable graphics with 720-by-348-dot resolution. It includes a parallel port that is compatible with IBM's monochrome video board, and the asynchronous communications port can be configured as COM1 or COM2. The Z/Plus board enables the IBM PC to execute CP/M 2.2 or CP/M 3.0 programs and has a 6-MHz Z80B microprocessor, as much as 192K bytes of dual-ported memory and an asynchronous communications interface. Using CP/M 2.2, SuperVision can support 64K bytes of memory; using CP/M 3.0, 192K bytes of memory are available. SuperVision $720; Z/Plus, $860. **California Computer Systems,** 250 Caribbean Dr., Sunnyvale, Calif. 94086, (408) 734-5811. **Circle No 361**



Optical mouse works with IBM PC software

The PC Mouse works with virtually all software packages on the IBM PC. It allows users to issue as many as nine commands by clicking one of the mouse's three buttons one to three times. PC Mouse translates mouse motion and button clicks into user-defined key sequences. As many as 15 key sequences can be assigned to each button code. An internal microprocessor transmits position data at 1200 baud via a three-wire RJ11C connector. An interface box allows direct connection to

an RS232 port. The package also includes the source and executable code for a Draw program with pop-up menus. $332. **Mouse Systems Corp.,** 2336H Walsh Ave., Santa Clara, Calif. 95051, (408) 988-0211. **Circle No 362**

Color display monitor suits personal computers

The model SC-100 CRT color display monitor is compatible with Apple II, Apple III, Atari 800, Commodore 64, IBM PC, NEC PC, Osborne and TI-99 personal computers. This 13-inch diagonal monitor displays eight colors in a 230-mm. horizontal by 175-mm. vertical area. It features a 40-column-by-24-line format and external front and back controls for sound, contrast, power, vertical hold, color, tint and brightness. The monitor consumes 65W of power and comes in a neutral-colored, polystyrene cabinet. $329. **Sakata U.S.A. Corp.,** 651 Bonnie Lane, Elk Grove Village, Ill. 60007, (312) 593-3211.
Circle No 363

Plug-in card provides shared database access

A plug-in card for the IBM PC, the Database Machine provides shared database access in multiuser PC networks by incorporating an intelligent LSI hard disk controller and built-in database functions in silicon. The product also features a parallel processor, an 8-MHz Intel 80186 coprocessor, a 64K-byte, triple-ported buffer and 128K bytes of multitask RAM. Only one Database Machine card is required for each hard disk in the PC network. An additional card allows a Database Machine-equipped PC to drive a multiple terminal cluster through the card's serial I/O ports. The product supports as many as 128 users and is compatible with ST-506 Winchester disk drives and the Omninet, PCnet, Etherlink, Plan 4000 and Sharenet local-area networks. $1,300 to $1,500. **Cogent Data Technologies Inc.,** P.O. Box 3902, Bellevue, Wash. 98009, (206) 455-3343.
Circle No 364

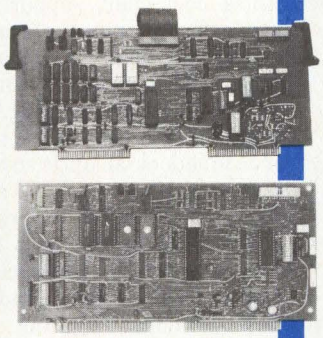
Controller supports eight asynchronous lines

Designed for use in Multibus systems, the UB2012 multiline asynchronous controller supports as many as eight asynchronous terminals or lines. It controls all character-by-character processing done by the host CPU in most UNIX systems. The device includes a National Semiconductor NS16008 microprocessor, 64K bytes of buffer memory, 16K bytes of PROM and eight full-duplex lines with programmable baud rates as high as 38,400 bps. The product provides an RS232C or RS422 interface by a rack-mount panel and connectors. UB2012 AMAC, $1,995; RS232 interface panel, $210; RS422 interface panel, $240. **Unidot Inc.,** 602 Park Point Dr. Suite 231, Golden, Colo. 80401, (303) 526-9263. **Circle No 365**

OCR scanners serve single-application market

The three models in the AlphaWord Series 80 family of optical-character-recognition page readers offer a selection of scanning speeds and a variety of resident type styles such as Courier 10, Courier 12, Prestige elite, Prestige pica, Letter gothic and OCR-B. Models A and B scan 145 pages per hour; model C scans 250 pages per hour. One resident font is standard in all three models, and two optional fonts can be supplied for models B and C. Each scanner supports one RS232-compatible, asynchronous or synchronous interface. They have a control panel, a numeric

Hey Dataproducts!



IBM 2770
IBM 2780/3780
IBM 3270
IBM 2946 (PARS)
HASP
UNIVAC DCT 1000
UNIVAC 1004
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Call Air Land Systems. And find out about our full line of microprocessor-based protocol converters and other data communications interfaces for line printers and other peripherals. We've already developed both hardware and software for most major communications protocols, and we're anxious to discuss your specific needs.
For example, our MPC-51 and MPC-73 (photos at left) are specifically designed for DATAPRODUCTS B300/B600 and M200 printers. Some of the currently available protocols are listed at left.

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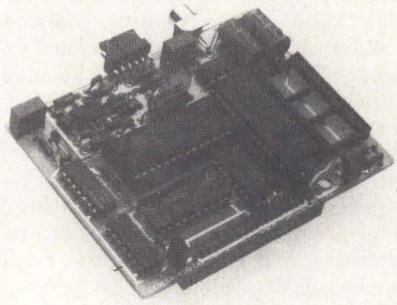
keypad and a 16-character LCD for altering the scannable area of documents that contain unscannable letterhead or embedded graphics. $12,990 to $14,990. Delivery is 45 days after receipt of order. **CompuScan Inc.**, 81 Two Bridges Rd., Fairfield, N.J. 07006, (201) 575-500. **Circle No 366**



Module produces natural-sounding speech

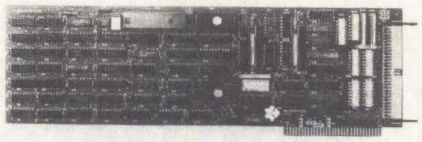
Compatible with all 8- and 16-bit systems equipped with expansion sockets, the GDX-SPEECH-TI speech-synthesizer module generates a natural-sounding voice using a standard, on-board 206-word industrial vocabulary. An additional on-board vocabulary socket or unlimited speech using CPU-provided LPC-10 data expands the applications. The self-contained module features on-board LPF, 2W audio amplifier, phone jack and volume control. It accepts an 8-ohm speaker and external volume control. The module can also mix low-level audio from an external source with synthesized speech before passing through the internal amplifier. $285. **General Digital Corp.,** 700 Burnside Ave., E. Hartford, Conn. 06108, (203) 528-9041.

Circle No 367

Control unit establishes IEEE-488 bus

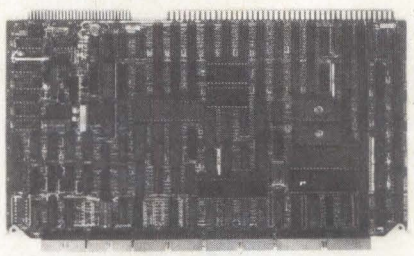
The model 4835 bus controller makes the RS232 or RS422 serial data port of a computer appear and function as an IEEE-488 bus controller. Connected into the serial link between a central computer and a terminal, the 4835 establishes an IEEE-488 bus wherever situated along the serial link. Software control of the IEEE-488 bus established

by the 4835 resides in the central computer, allowing a user to write control programs in the language used by the central computer. This stand-alone controller is independent of the central computer's architecture, software operating system and language. $1,450. Delivery is 45 days after receipt of order. **ICS Electronics Corp.,** 1620 Zanker Rd., San Jose, Calif. 95112, (408) 298-4844. **Circle No 368**



Controller supports SMD interface

The Maverick SMD PC-80, a high-capacity disk controller, supports the SMD disk interface on personal computers. The controller connects as many as two fixed and/or removable SMD disk drives, with capacities ranging from 16M to 800M bytes for each drive, to any IBM PC or IBM PC look-alike. It supports dual porting and programmable sector sizes as large as 960 bytes. It provides automatic error correction with 32-bit ECC, bad-track and -sector replacement and overlapped seeks. Using a buffered architecture with a bipolar state machine managing the data stream, the controller accommodates disk data rates as high as 20M bits per second. A CMOS processor external to the data stream regulates on-board activity. Transfer across the bus can be supported through DMA or programmed I/O. The unit occupies a single slot in the PC and can be installed without modification to hardware. Software drivers are available for MS-DOS 2.0 and uNETiX. $1,200 (100 units). **Interphase Corp.,** 2925 Merrel Rd., Dallas, Texas 75229, (214) 350-9000. **Circle No 369**

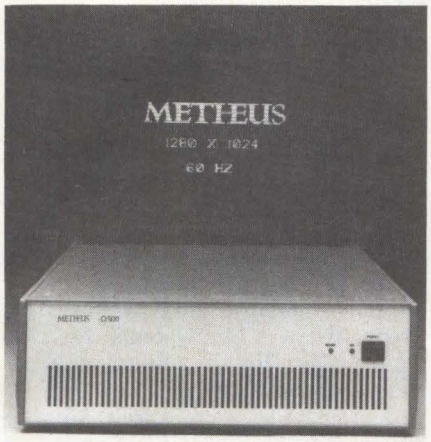


Controller supports file-oriented tape backup

The X217 family of three multifunction Multibus controller boards allows file-oriented transfers and image backup using a QIC-02-compatible ¼-inch streaming tape. Each board occupies only one Multibus card slot. Model 5217 handles two ST-506-type 5¼-inch floppy disk drives and one ¼-inch tape drive. Model 7217 handles two SA1000-type 8-inch Winchester disk drives, two SA800-/SA850-type 8-inch floppy disk drives and one ¼-inch tape drive. Model 6217 interfaces to two 5¼-inch Winchester disk drives, two 8-inch floppy disk drives and one ¼-inch tape drive. These boards feature non-interleaved data transfer, on-board data separation, 32-bit error-correction code and self diagnostics. They incorporate microcode command primitives that emulate the streaming-tape subset of Intel's iSBX 217 controller. $1,020 (100 units). **Data Systems Design Inc.,** 2241 Lundy Ave., San Jose, Calif. 95128, (408) 946-5800. **Circle No 370**

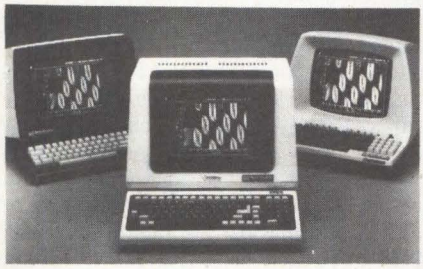
Display controller features 1,280-by-1,024 resolution

The Ω500 display controller supports 1,280-by-1,024-pixel screen resolution and provides a 60-Hz non-interlaced refresh rate. Its bit-slice processor, with a 167-nsec. cycle time, can display random vectors at 1.5 million pixels per second and can flash-fill rectangles at 35 million pixels per second. An eight-by-24-color lookup table allows display of 256 colors from a palette of more than 16 million. For applications requiring more depth of color than resolution, the Ω500 is available in a 640-by-512-by-32 folded configuration also capable of 60-Hz operation. In this mode, a software-settable crossbar switch allows a user to configure bit-plane use of the color lookup table. The unit comes with an



RS232C or a GPIB tablet and DEC or HP 16-bit parallel host communications interface options. $16,950. **Metheus Corp.**, P.O. Box 1049, Hillsboro, Ore. 97123, (503) 640-8000.

Circle No 371



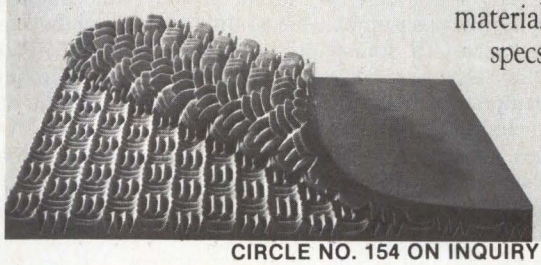
Enhancements emulate Tektronix 4010, 4014

The 512-Series Retro-Graphics, a line of bit-map graphics upgrade products, provides Tektronix 4010 and 4014 graphics terminal emulation and Tektronix Plot 10 graphics software compatibility on TeleVideo, ADDS and Lear Siegler terminals. Based on 4010/4014 protocol, the units provide business, scientific and engineering users with incremental point plotting, multistyle vector drawing (dotted, dashed and solid), four graphics character sets, selective erase and cross-hair cursor capabilities. In addition, special function keys can clear the screen or enter various function modes. The models are compatible with such applications and utility graphics software programs as DISSPLA, TELLAGRAF, Plot 10, Template, DI-3000, SAS/GRAF and ILS. $749. **Digital Engineering,** 630 Bercut Dr., Sacramento, Calif. 95814, (916) 447-7600.

Circle No 372

SONEX kills disk drive hum.

SONEX acoustical foam's absorption coefficient is four times that of conventional materials. Send for the tests, charts, specs, and color examples from 3800 Washington Ave. N., Minneapolis, MN 55412, or call 612/521-3555.



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techniques with foams

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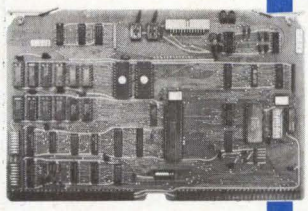
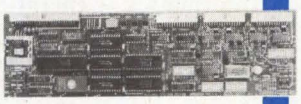
Hey General Electric!*





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IBM 2780/3780
IBM 3270
IBM 2946 (PARS)
HASP
UNIVAC DCT 1000
UNIVAC 1004
UNIVAC U-100/U-200/U-400
UNIVAC NTR
Honeywell VIP 7700
Burroughs Poll and Select
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For example, our MPC-29 and PCU-62 (photos at left) are specifically designed for GE 200 and 3000 printers. Some of the currently available protocols are listed at left.

* GE Data Communications Products recently acquired by Genicom Corp.

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New Products

LITERATURE

Brochure summarizes product line

This product summary brochure covers the vendor's line of communications, disk and tape controllers for DEC computer systems. It provides company background information and technical descriptions with product photos. The listed products feature microprocessor-based architecture, allowing configuration/reconfiguration to standard or custom peripheral requirements by setting on-board switches or replacing microcode PROMs. **Emulex Corp.,** P.O. Box 6725, 3545 Harbor Blvd., Costa Mesa, Calif. 92626, (714) 662-5600 or (800) 854-7112.

Circle No 373

Data sheet details silent ink-jet printer

A six-page, fold-out data sheet outlines the standard features, printing technique, unit weight, dimensions and technical data of the model 2712 silent ink-jet printer. This non-impact printer outputs data and graphics at 270 cps. **Siemens Communications Systems Inc., Office Terminals Division,** 186 Wood Ave. S., Iselin, N.J. 08830, (201) 321-3400.

Circle No 374

Telephone directory lists industry numbers

This directory provides telephone numbers of manufacturers and distributors of computers and peripheral equipment. The directory lists the companies alphabetically and by product category. $35. **EITD, Harris Publishing Co.,** 2057-2 Aurora Rd., Twinsburg, Ohio 44087, (216) 425-9143.

Circle No 375

Study documents corporate practices

"Management Assessment of User-Driven Technologies," a 122-page study, describes the results of a recent survey of 71 major corporations on their use of personal computers, information centers and fourth-generation technologies. $90. **FTP,** 492 Old Town Rd., Port Jefferson Station, N.Y. 11776. Phone (516) 473-1110. **Circle No** 376

Brochure presents terminal, traffic concentrator

The Dynapac Multi-Pad (packet assembler/disassembler) is described in a four-page brochure. The Multi-Pad concentrates terminal traffic onto an X.25 link, providing access to public or private packet switched networks. As many as 16 asynchronous devices can be supported, and each port can handle a different speed and parity. **Dynatech Packet Technology Inc.,** 6464-G General Green Way, Alexandria, Va. 22312, (703) 642-9391. **Circle No** 377

Brochure describes PC-to-mainframe link

VisiAnswer and Answer/DB, two cooperating software products that provide an intelligent connection between personal computers and large databases on IBM mainframe computers, are described in an illustrated, six-page brochure. The brochure describes how the two products bring computing power and central databases to users of VisiCalc and other Visi series packages. VisiAnswer runs on the IBM PC; Answer/DB operates on an IBM mainframe. **Informatics General Corp.,** P.O. Box 1452, Canoga Park, Calif. 91304, (213) 716-1616. **Circle No** 378

Brochure highlights ¼-inch tape drive

A six-page color brochure highlights the Qic-Stor Mark II ¼-inch streaming-tape drive's operation and design, including tape-edge sensing, self-locking cartridge mechanism, QIC-02/04 compatibility, 20M- to 60M-byte storage capacity and broad applications. **Tandberg Data Inc., Data Storage Division,** 571 N. Poplar, Suite H, Orange, Calif. 92668, (714) 978-6771. **Circle No** 379

Brochure outlines graphics systems

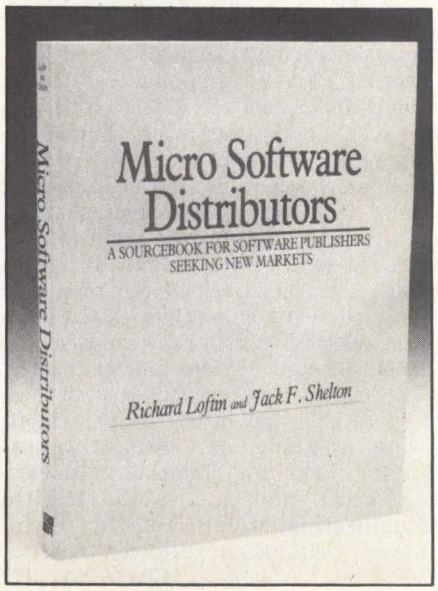
A six-page, color brochure details features and benefits of the VIA Series 100 family of interactive graphics systems. The brochure discusses systems hardware, graphics software—including logic and schematic capture and design verification for gate arrays and standard cells—distributed communications, pattern generation, user support, design aids and system productivity. **VIA Systems Inc.,** 76 Treble Cove Rd., N. Billerica, Mass. 01862, (617) 667-8574.

Circle No 380

Micro software directory profiles distributors

Micro Software Distributors: A Sourcebook for Publishers Seeking New Markets focuses on middlemen. Edited by Richard Loftin, it contains profiles of 167 companies seeking programs for resale. Full-page listings describe the companies, the software they seek, how much they pay, the marketing rights they obtain, to whom they sell and the support they provide. The directory covers hardware and software manufacturers and distributors, publishers, retailers and those that license or purchase software for quantity resale. $95, **Software Research Co.,** Drawer N, P.O. Box 9524, Washington, D.C. 20016, (202) 364-8700.

Circle No 381



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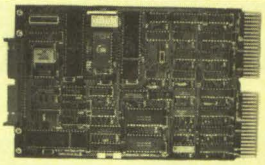

TDL-11SA HOST ADAPTER INTERFACES SCSI/SASI CONTROLLERS TO THE DEC LSI-11 BUS

The TDL-11SA is a dual-wide Host Adapter that interfaces SCSI (SASI) disk controllers to the LSI-11 bus.

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Also available: the TDL-11WD interfaces Western Digital disk controllers to the LSI-11 bus.

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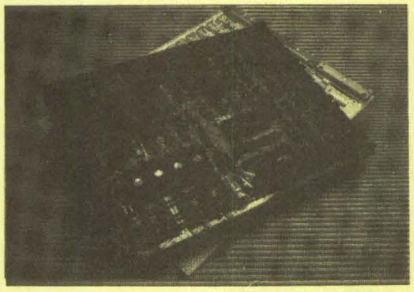

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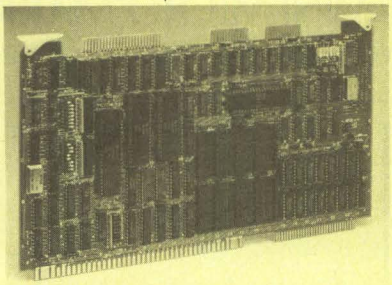

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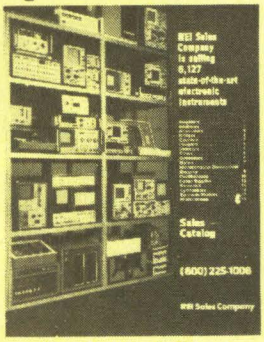

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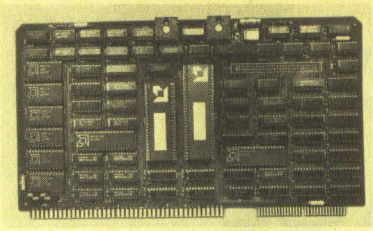

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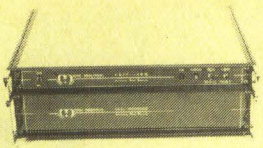

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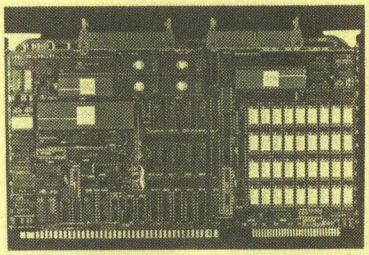

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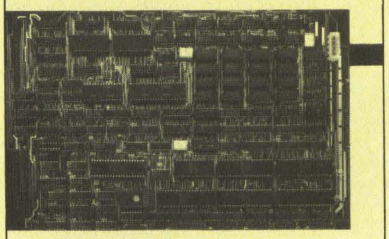

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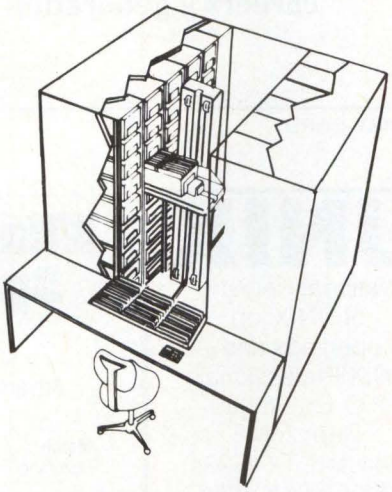

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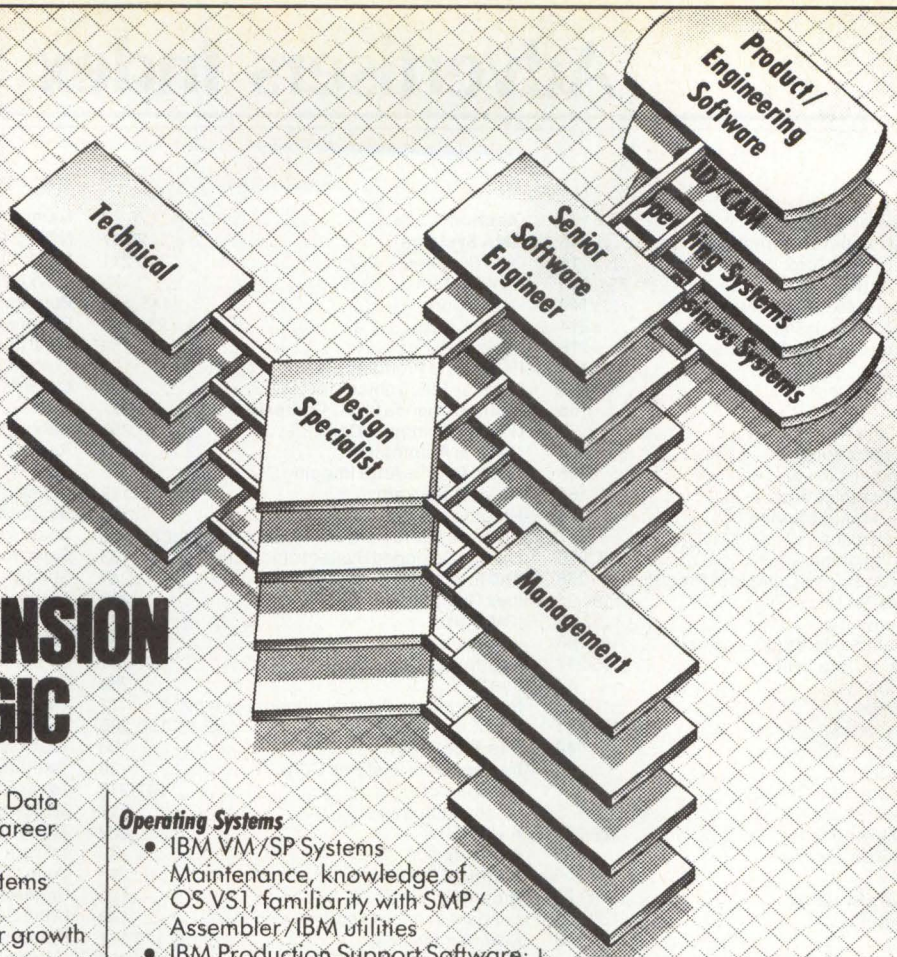

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