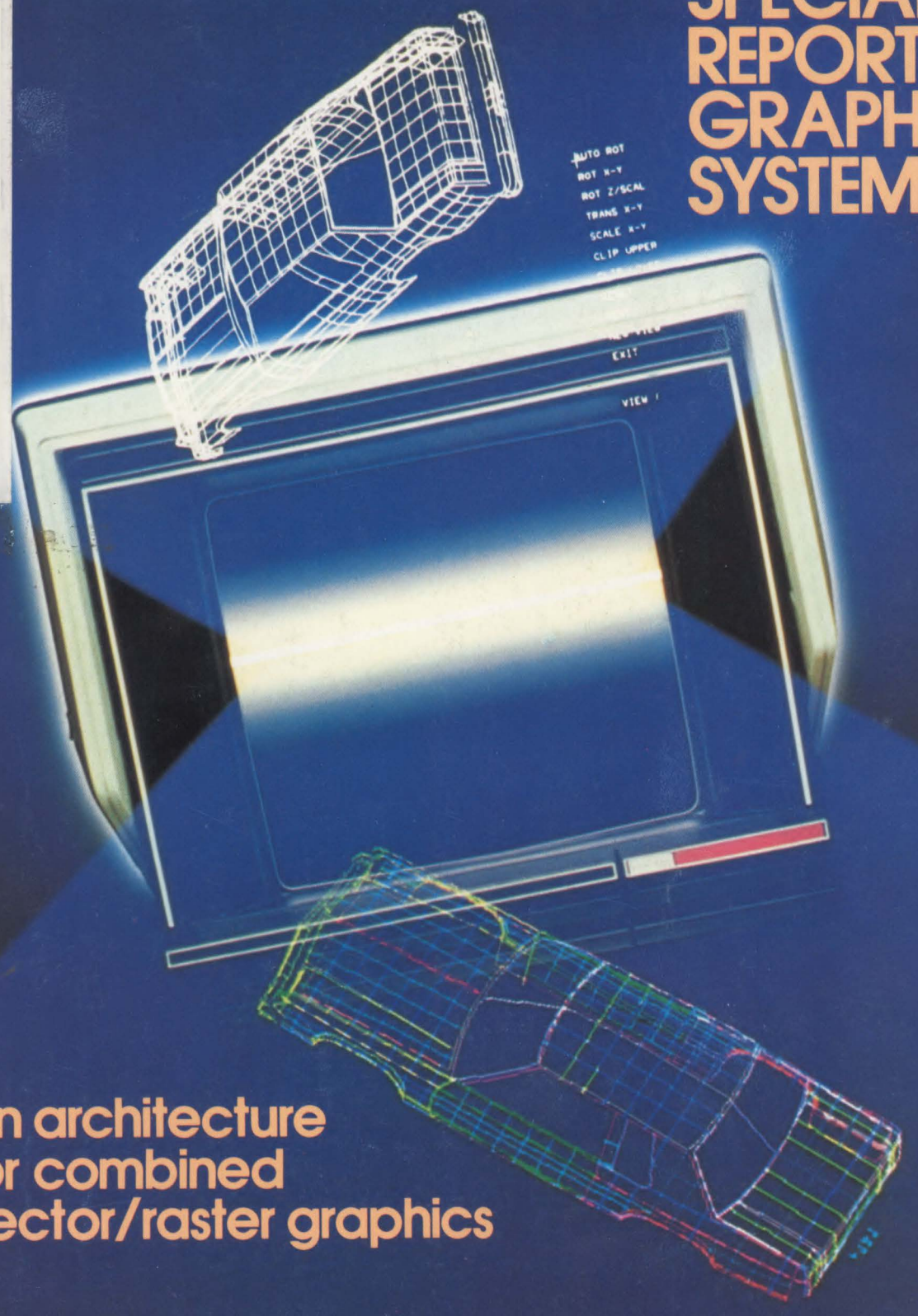
Mini-Micro Systems

A CAHNERS PUBLICATION

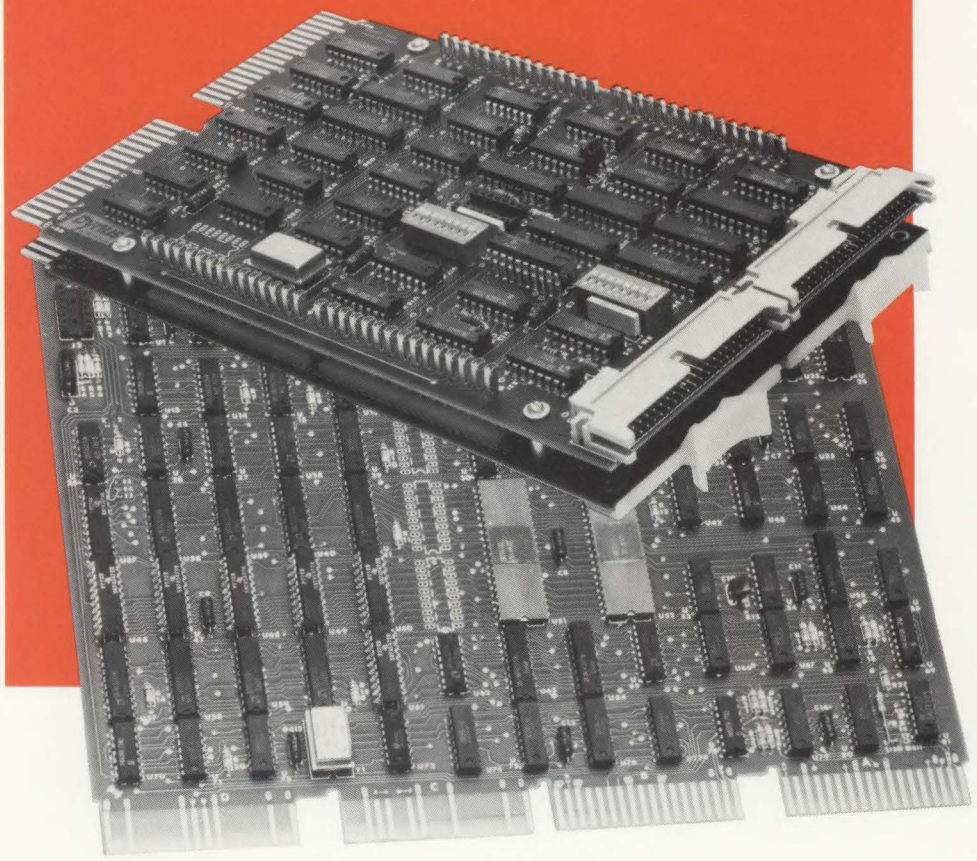
DECEMBER 1980

SPECIAL REPORT: GRAPHIC SYSTEMS



An architecture for combined vector/raster graphics

DEC®-COMPATIBLE PERIPHERAL CONTROLLERS



Now, from the company that delivers the industry's widest range of DEC-compatible memory products, a family of peripheral controllers that's second to none. From comparatively simple cartridge disk controllers to complex 300MB storage module drive (SMD) controllers.

An impressive array of state-of-the-art controllers, all built around high-speed bipolar microprocessors. All software compatible with the host LSI-11® or PDP®-11 minicomputer...and all available now.

And Dataram's controllers are designed to save you money, and a lot more. Like space — our controllers typically occupy half the space required for the comparable controller from DEC. Doing it with a level of performance that makes any member of this family worth looking at.

Look at the chart of our current family of peripheral controllers, growing every day. If you don't see the controller you need, we're probably working on it right now. Call us and discuss your requirements.

DATARAM CORPORATION

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

DATARAM CONTROLLER	T03	T04	T34	C03	C33	S03/A	S03/B	S03/C	S33/A	S33/B	S33/C
	Magnetic Tape Controller			Cartridge Disk Controller		SMD Controller					
MINI	LSI-11	LSI-11	PDP-11	LSI-11	PDP-11	LSI-11	LSI-11	LSI-11	PDP-11	PDP-11	PDP-11
COMPATIBILITY	TM11/TU10			RK05		RM02	RK07	RP06	RM02	RK07	RP06

CIRCLE NO. 1 ON INQUIRY CARD

IMMEDIATE DELIVERY

Energy Auditors.

Utility companies increase audit efficiency with TI's 745 and 765.

A number of utilities, using energy services companies, are finding TI's *Silent 700** Models 745 and 765 Portable Data Terminals a cost-efficient means for improving energy audit productivity.

TI's Portable Data Terminals allow utility representatives to effectively perform complex on-site audits by accurately and quickly collecting audit information via prompts from the data terminal. Energy data can be corrected, updated and verified during the audit, either on-line with the Model 745 or off-line with the Model 765.

The Model 745 allows representatives to access the full capabilities of the host computer with its interactive communication features for reliable, responsive results. With the Model 765, utility auditors can speed up the audit process using the data terminal's editing feature, built-in bubble memory data storage, and Data Entry Validation Option capabilities.

Once the data has been collected, these Portable Data Terminals can calculate the various energy parameters, and supply customers with a required hardcopy printout of the results and suggestions for energy-saving improvements. Additional on-site reports can be generated for customers that request recalculated summaries utilizing varied energy rating factors.

Both the Model 745 and the Model 765 offer virtually silent 30 characters-per-second thermal printing, an easy-to-use typewriter-like keyboard, and a built-in acoustic coupler for transmission to the host computer. These, and other features on the Models 745 and 765 can eliminate handling and postage costs as well as time delays incurred with other audit methods, and reduces communications costs and time.

TI is dedicated to producing quality, innovative products like the Models 745 and 765 Portable Data Terminals. And, TI's hundreds of thousands of data terminals shipped worldwide are backed by the technology and reliability that come from 50 years of experience.

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

For more information on TI's Model 745 and Model 765 Portable Data Terminals, contact the TI sales office nearest you, or write Texas Instruments Incorporated, P.O. Box 1444, M/S 7884, Houston, Texas 77001, or phone (713) 373-1050. In Europe, write Texas Instruments, M/S 74, B.P. 5, Villeneuve-Loubet, 06270, France.

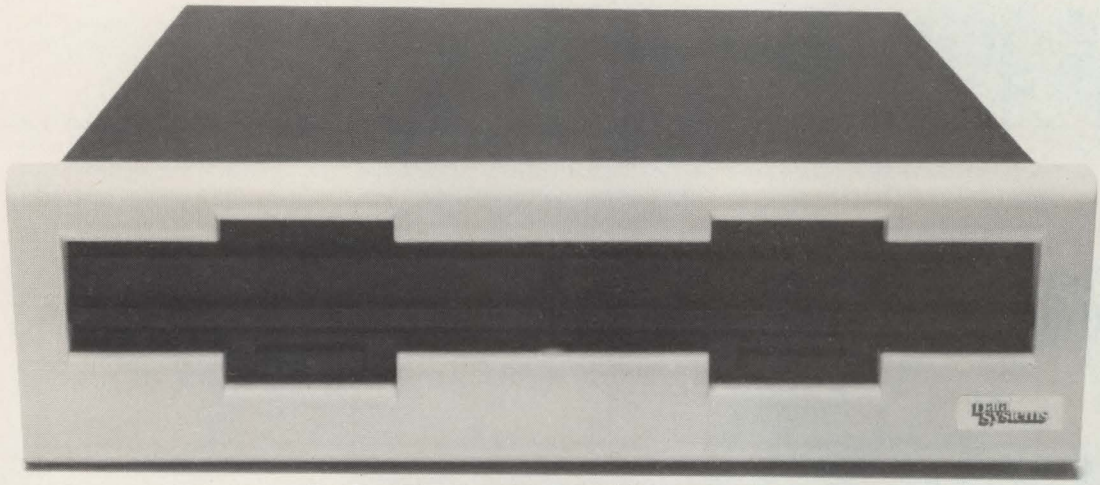
Fifty Years of Innovation

*Trademark of Texas Instruments †Service Mark of Texas Instruments

TEXAS INSTRUMENTS
INCORPORATED

CIRCLE NO. 2 ON INQUIRY CARD

THE DSD 440. TOTAL DEC® RX02 COMPATIBILITY,



AND MORE.

The DSD 440 is the only alternative to the DEC RX02 that's 100% software, hardware and media compatible with LSI-11, PDP®-11 and PDP-8 computers, including those with extended memory. It can be configured as an RX02 for DEC double density or IBM 3740 single density recording, or as an RX01 for backward operating system compatibility.

MORE

A 512-byte hardware bootstrap is built into all PDP-11 and LSI-11 interfaces. It loads system software automatically from either single or double density diskettes. Extensive self-testing is DIP-switch selectable with the "Hyperdiagnostics" that run without being connected to a computer. The low profile 5¼-inch DSD 440 features write protection and diskette formatting.

FASTER

The optimized DSD 440 microcode increases system throughput when using the RT-11 foreground/background monitor. In particular, the DSD 440 with an LSI-11 runs fill and empty buffer operations 20% faster than an RX02.

FOR LESS

The DSD 440 is the RX02 compatible flexible disk system that combines high performance and advanced features with fast delivery... at a lower price. For further information, call or write Data Systems Design today. A data sheet and price list will be forwarded to you immediately.

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Data Systems Design, Inc.
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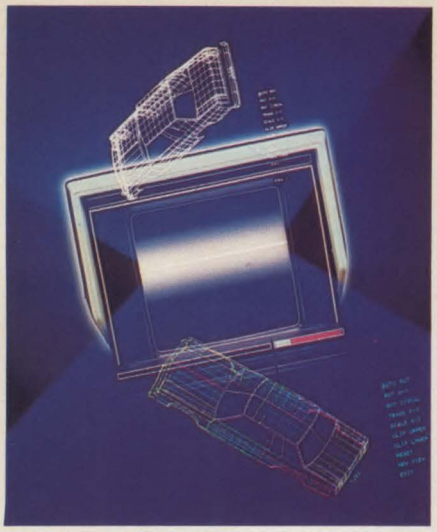
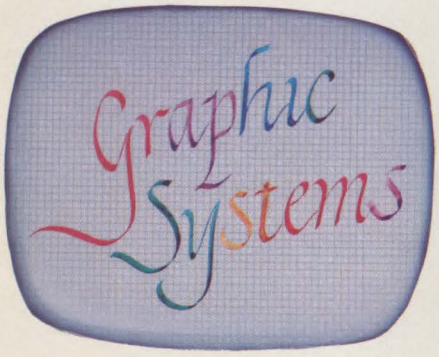
CORPORATE HEADQUARTERS: Data Systems Design, 3130 Coronado Drive, Santa Clara, CA 95051
Tel: (408) 727-9353 TWX: 910-338-0249

CIRCLE NO. 3 ON INQUIRY CARD



Megatek Corp.'s Whizzard 7290 dual-output graphics system operates with both vector refresh and color raster work stations. See p. 105. Photo by Frank Lee, courtesy of Megatek Corp.



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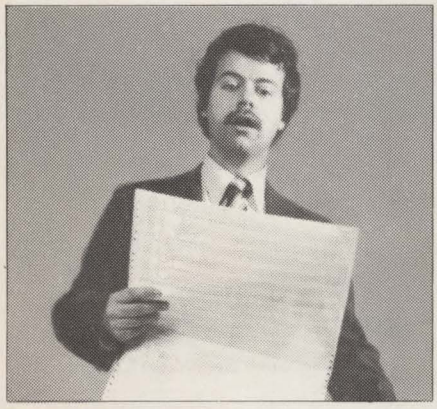

Page 142 . . . . . Avoiding Pascal's pitfalls

VBPA ABP

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Mini-Micro Systems

A Cahners Publication Vol. XIII No. 12 December 1980

FEATURES

MINI-MICRO WORLD

DEPARTMENTS

A Marriage of Convenience— for PDP and LSI users!

It's a marriage made in heaven—for DEC PDP-11 and LSI-11 owners who would like a low-cost, quick-to-install, high-density data storage system.
The union consists of Kennedys' Series 5300 fixed media, Winchester technology disk drives and Kennedy emulation controllers. The controllers; which use standard DEC PDP-11 operating systems and diagnostic software, are embedded inside the computer, allowing the Series 5300 to be easily attached to both PDP-11 and LSI-11 minis! In one sweet, short ceremony, Series 5300, with its' one, two or three platter versions and unformatted data capacity of 70M bytes and track density of 300 TPI can be joined with the KSC11 unibus disk controller for the PDP-11; and the KSCO1, for use with the LSI-11; And no software changes or other alterations are required.
Kennedy Series 5300, controllers and your PDP-11 or LSI-11—put them together, plug them in and you have a winning system.

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Breakpoints

CENTRONICS PRINTER FAMILY SET FOR NCC INTRODUCTION

With its miniprinter troubles seemingly under control, Centronics Data Computer Corp. is turning its attention to its aging industrial printer line, the 700 series. Centronics president Michael Kaufman says the 700 series—the mainstay of the company's business—will be replaced eventually by a new matrix-impact printer family now under development at headquarters in Hudson, N.H. While refusing to discuss specifics, Kaufman says the as-yet-unnamed printer family will offer higher performance and more versatile forms-handling than the present line. "Our aim is to allow a user to slip any form into the printer, with no further setup required," Kaufman says. Industry sources speculate that the first member of the new printer family will be a replacement for Centronics' model 703 132-column, 180-cps printer. One source expects the new printer to offer similar performance, but at a substantially lower price—$1500 to $1800 compared to $2100 to $2300 for the 703. The source also speculates that the new printer may contain a friction-feed mechanism, instead of a tractor feed, to allow the use of pre-cut forms. The new printer family, Kaufman says, will first be shown in April at the Hanover Fair in West Germany, and will be introduced to U.S. customers a month later at the National Computer Conference in Chicago.

Meanwhile, Kaufman reports that the company's Quietwriter program is progressing, with soft-tooled versions of the innovative letter-quality printer slated to be delivered to major OEM customers in March for evaluation.

JAPANESE COMPANY MIRRORS LIFEBOAT SOFTWARE

A clone of Lifeboat Associates may have turned up in Japan. The company's CP/M operating system for Northstar computers and disk subsystems has surfaced in Japan under the label of Kohjinsha Company, Ltd. "It's almost as though we have a subsidiary in Japan," says Tony Gold, president of the New York publishing house for μc software. "They're using our name and reputation to make sales in Japan." Gold claims he has copies of a reproduced product sporting his company's disk label, and copyrighted ads that appeared in Japanese magazines. Those ads use Lifeboat's name, Kohjinsha's name in parenthesis, the Lifeboat trademark logo and a list of other Lifeboat products. Gold says Kohjinsha translated Digital Research (the company that licenses that CP/M) documentation into Japanese. Additionally, the Japanese company sent letters to other Lifeboat software authors to inquire about licensing their products. Gold traced his copy of the product, via a program serial number, to a December, 1979, sale to an Anchorage, Alaska, company. No updates were incorporated into the software in that year. Gold says he has filed no protest letter, but he prefers "to bring public opinion to bear to stop the company." A Digital Research spokeswoman says the company did not know of Kohjinsha's activities, but Digital Research did not authorize the Japanese to sell the software.

WANG PLANS IN-HOUSE DRIVE EFFORT, BROADBAND LINKS

Look for upcoming "office-of-the-future" systems from Wang Laboratories to be linked via broadband (100-MHz) cable links. "The decision to go with broadband has already been made," reports one industry observer. "This will be Wang's answer to the baseband (10-MHz) Ethernet system announced by Xerox" (MMS, July, p. 17). Also planned for future Wang systems are high-end, 8-in. Winchester-disk drives built in-house. The Lowell, Mass., systems vendor is moving to create an R & D group to lay the foundation for a captive drive effort in the Boston area, says one industry source, with hardware at least three to five years away.

SMALL WINCHESTERS GET DISK-CARTRIDGE BACKUP

Backup for low-end Winchesters has taken another twist with the development of a controller that can interface Shugart Associates' 10M-byte SA1000 8-in. fixed-disk device to the Lynx 8-in. disk-cartridge drive announced recently by Data Peripherals, Sunnyvale, Calif. (MMS, October, p. 132). Called the DP 900, the controller could be available from Data Peripherals as early as next March, and will permit users to daisy-chain four Lynx drives,

SA1000s or Quantum Q2000 fixed Winchesters in any combination. Data Peripherals will sell the DP 900 in small quantities only, referring customers with large orders to the company that designed it, Data Technology Corp., Santa Clara, Calif.

NEW COMPANY WILL FOCUS ON ½-IN. TAPE-CARTRIDGE DRIVES

Next year could be the year of the ½-in. IBM-compatible tape-cartridge drive for Winchester backup. Following close on the heels of Newell Research Corp., Saratoga, Calif. (MMS, November, p. 6), is a yet-to-be named Sunnyvale, Calif., start-up that intends to build both a high-speed, high-capacity cartridge and the drive to go with it. Look for a formal corporate unveiling as well as a product announcement sometime next quarter.

R & D FIRM SEEKS TO BOOST DISK DENSITIES

Two engineers on partial leaves of absence from Dastek Corp., Los Gatos, Calif., have set up an R & D effort to develop the technology needed to boost the areal densities of disk drives incorporating thin-film read/write heads and oxide-coated Winchester-disk media. Called OMAC, the new venture is now operating in nearby Santa Clara and comprises Dastek co-founder and engineering chief Jim Money, servo expert Dick Oswald and some part-time help. Funding for the new venture has come from media vendor Dysan Corp., Santa Clara, which has also supplied capital to Dastek. One source says the technology could result in a five-fold increase in the storage capacities of thin-film drives and could obviate the need for drive makers to move to thin-film media. What OMAC will do with the technology has not been determined, but that question could be answered by a mid-1981 announcement.

FLORIDA DATA WILL OFFER WORD-PROCESSING PRINTER

Florida Data Corp. will enter its bid in the high-quality dot-matrix printer market in April, with the first in a series of office systems printers geared for word-processor and small-business system users. The printer uses multiple passes of the print head to obtain the same quality as the Sanders Technology, Inc., Media 12/7, says James Adkisson, president of the West Melbourne, Fla., company (MMS, November, p. 31). The printer can operate at either of two speeds under control of an 8-bit μp: 600 cps with resolution as high as 120 dots per in. and more than 100 cps in a high-quality mode at 360 dpi. A virtually unlimited number of fonts and signatures can be loaded down-line onto diskette. Price is less than $2500 in OEM quantities of 100, and end-user price is $4000. That includes a patented triple-paper-path sheet feeder for automatic-, hand- and tractor-sheet-fed forms.

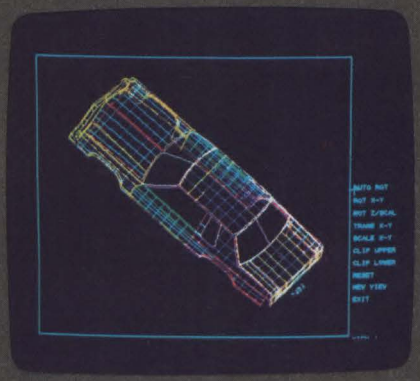
WANG RACES IBM TO SHIP FIRST LOW-END WORD PROCESSOR

With the introduction this month of its expected low-end word processor to rival IBM's Displaywriter, Wang Laboratories intends to be the first of the two companies to ship its product. Company spokesmen say the new Wangwriter is not yet installed at a user site, and they will not comment on whether there are orders. But industry observers say the product was available to large users at the end of November (MMS, October, p. 7). IBM is scheduled to begin shipping the Displaywriter in January against a 42-week delivery schedule. Priced at $7500, the Wangwriter consists of Wang's standard "dumb" word-processing work station mounted on a pedestal, a detachable keyboard, a printer console that includes dual-density 5¼-in. minidiskettes that hold 65 pages of information, a 20-cps daisy-wheel printer developed by the company, a Z80 μp and internal electronics. Communications include 2780, 3870, 2741 and teletypewriter. Included are a glossary and merging functions, but no language dictionary.

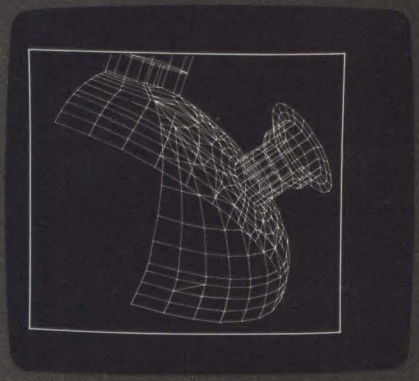
SPERRY-UNIVAC MINIS WILL DEBUT

Look for Sperry-Univac's minicomputer operation, Irvine, Calif., to announce two additions to its line of V77 16-bit processors this month. The new machines, called the V77-500 and -700, will be field-upgradeable to the V77-800 high-end processor simply by switching CPU boards. The CPUs will hold 2M bytes of main memory. Shipments will begin in the first quarter of next year, but prices have not been set.

Freedom of Expression.

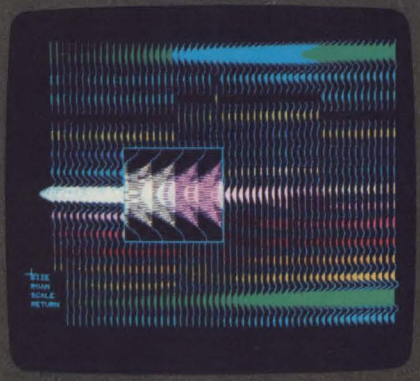


Only Megatek gives you all three, the excitement of dynamic raster color...

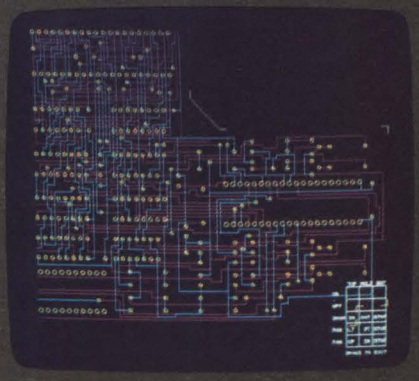


...the precision of 4096 x 4096 high resolution calligraphic Whizzard systems...

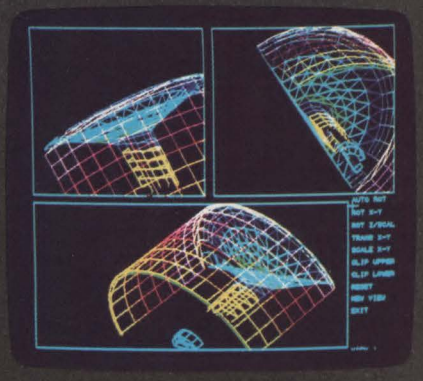
...and user-oriented software to make it easy to implement your application.



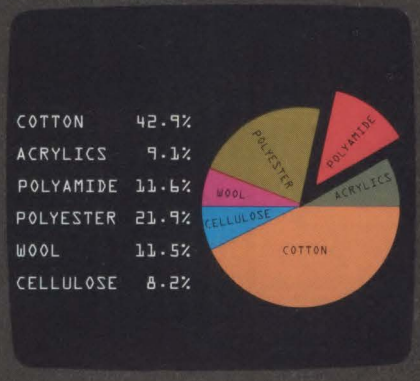
Powerful, real-time dynamics enable you to scan the display then zoom in for added detail.



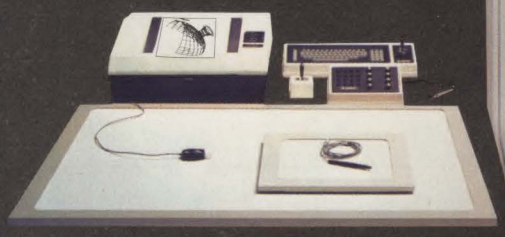
A large virtual display gives you the full picture, with the added information of up to 16 colors at a time.



Rotations mean you can view models from any angle and segment the display into multi-viewports.



It all adds up to the capabilities you need to put your ideas into pictures.



And you get freedom of choice, too, with intelligent interactive peripherals and modular design for easy expansion.

The Megatek Whizzard. It will set you free.

Express yourself with a Whizzard computer graphics system and take advantage of our technological innovations. You get system flexibility. Easy to use, ever-expanding software support. Installation, training and service world-wide. And an inside track on the future.

We're earning our reputation in computer graphics. Count on us. For advanced hardware compatible software. And added value.

Find out more about how Megatek can give you freedom of expression. Write for up-to-the-minute details on our complete line of computer graphics products.

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MEGATEK

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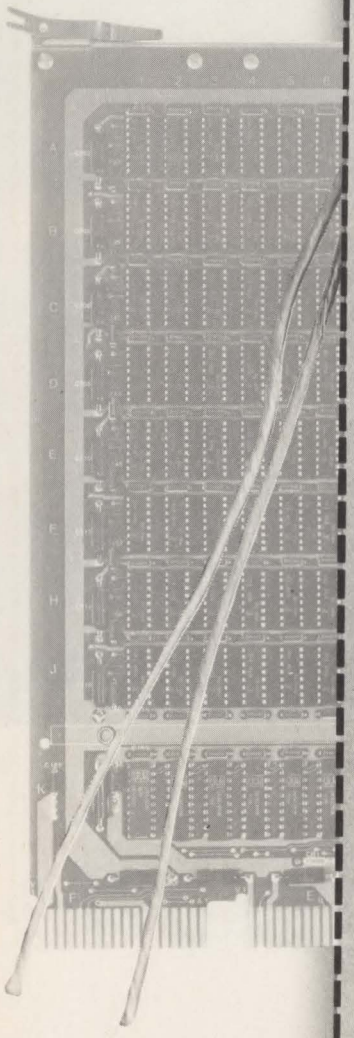
CIRCLE NO. 5 ON INQUIRY CARD

WRITE YOUR OWN TICKET for VAX, PDP-11 and Q-Bus Memory



We have VAX, PDP11 and Q-Bus Memory boards available for immediate delivery from shelf stock. To see if we can deal on your terms, fill out the ticket and fire it off to us. Or, better yet, pick up the phone and ask to talk to one of our memory sales crew. Either way, we'll respond immediately.

And, our involvement won't stop at competitive pricing and on-time deliveries. We'll back up our boards with the best warrantee program in the industry.

Tell us how you want to deal. We'll do the rest. Call us at **408-734-4300**

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COMPANY _____

ADDRESS _____

PHONE _____

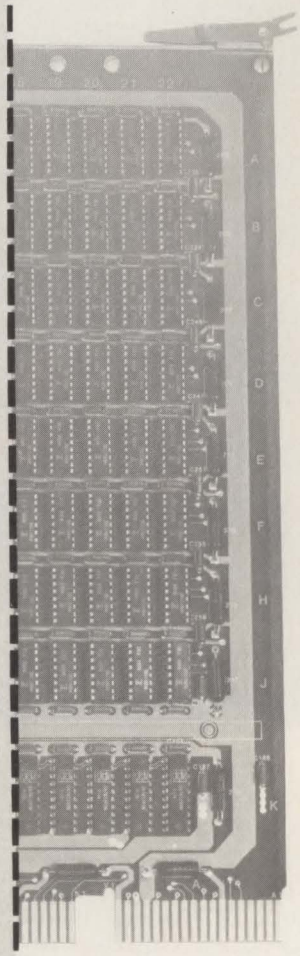
MEMORY REQUIRED _____

EVALUATION UNIT REQUIRED BY _____

APPLICATION _____

12-MONTH QTY REQUIRED _____ BEGINNING _____

PRICE _____ PRESENT SOURCE _____



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CIRCLE NO. 6 ON INQUIRY CARD

PDP-11® and LSI-11®
TAPE and DISK CONTROLLERS

EMULEX®

AUTHORIZED EMULEX DISTRIBUTOR
First Computer Corporation, the world's leading DEC computer system integrator now distributes the complete spectrum of EMULEX Tape and Disk controllers for the PDP-11 and LSI-11 family of computers.

HARDWARE/SOFTWARE TRANSPARENCY
These microprogrammed, emulating Tape and Disk Controllers are fully software transparent to both the PDP-11 hardware and software. The use of these controllers protects you from the impact of future versions of the operating system software. They are so compatible you can plug them into your system and be up and running the standard DEC diagnostics and operating systems in minutes.

ADDED FEATURES
These controllers provide you with added features such as automatic self-testing, onboard pack formatting, and programmable bandwidth control at no additional cost.

BROAD RANGE OF DEVICES SUPPORTED
It makes no difference which of the DEC PDP-11 or LSI-11 family you are using or which type of storage device is required for your application. We can support 59 different drives from 13 different manufacturers.

HIGHEST QUALITY AND SUPER RELIABILITY
You can be assured of the quality and reliability of these Tape and Disk Controllers because First Computer Corporation specializes in PDP-11 and LSI-11 computer systems, components, and peripherials. Over the years our reputation was built on the quality and reliability of the products we sell. We continue to protect this reputation by selling only the very best.

SUPER FAST SERVICE
Because we are the largest system integrator specializing in PDP-11 and LSI-11 systems, components, and peripherials, First Computer Corporation can satisfy most of your Tape and Disk Controller requirements directly from our stock.

GUARANTEED SATISFACTION
Your satisfaction is fully guaranteed by First Computer Corporation. We believe in every product we sell. If for any reason these Tape and Disk Controllers do not meet your expectations, simply return them freight prepaid and insured, within 10 days of receipt and we will refund your money in full. First Computer Corporation backs each of these products with a full one year warranty.

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CIRCLE NO. 7 ON INQUIRY CARD

Technological leadership.

One board, one bus, one way environment for the '80s.

With Motorola MC68000 VERSAmodules, a single board offers all the functional versatility of competitive 16-bit systems at a fraction of the cost.

With VERSAmodules and the powerful VERSAbus™ interconnect, there's maximum utility, expandability, reliability and maintainability for a wide range of industrial, communication, lab automation and general business applications in one optimized system.

With the complete VERSAmodule family of circuit boards, system software, packaging and accessories the microcomputer system engineer can apply the power and versatility of the MC68000 MPU at a high level of system integration.

With VERSAmodules, you're into the '80s and beyond.

Most Powerful Microcomputer

The VERSAmodule Monoboard Microcomputer flagships the VERSAmodule family. Combining an MC68000 MPU, full VERSAbus interface, multiprocessor capability, substantial ROM/RAM, serial and parallel I/O and timer/counter functions, it's easily the most powerful single-board microcomputer yet offered. For designs requiring up to 128K bytes of ROM and RAM, plus two high-speed serial channels (up to 19.2K baud) and 40 lines of parallel I/O, this single board meets all system needs. Competitive approaches require two to four boards for the same capability, and, inevitably, more cost.

Total Software Environment

Many 16-bit applications, particularly in higher-performance, control-oriented areas, require a realtime, multitasking environment for efficient operation. By combining the ready-made RMS68K™ multitasking system software package with your VERSAmodule-based system, you can save the man-months of effort necessary to develop a system capable of managing resources efficiently in real time. Time and money saved can be used to apply your expertise to development of application programs.

to a total, 16-bit system VERSAmodules.™

New Generation Bus.

Supporting a mixture of 8- to 32-bit MPU architectures with high-speed transfer rates, VERSAbus offers a flexible, economical system bus ideal for industrial automation, communications or general business applications. VERSAbus is incorporated in the VERSAmodule chassis/card cage backplanes and willingly accomodates multiple processors. Designed-in ease-of-use for tomorrow's upgraded systems saves money by obviating major hardware and software redesign.

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VERSAmodule products support an unmatched level of system integrity. This includes reliability of the MC68000 with its advanced architectural features such as exception-processing and interrupt handling. These allow for graceful handling of common system problems such as bus error, illegal instruction, divide-by-zero, privilege violation, spurious interrupt, etc. This "soft-failure" capability alerts operating personnel and, in many cases, allows recovery before critical failure.

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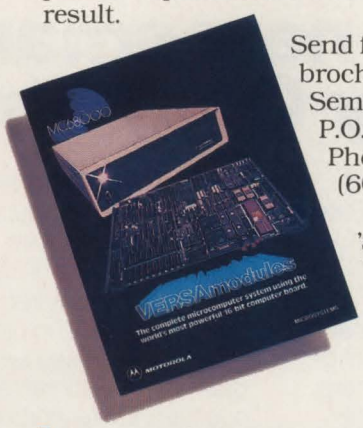

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CIRCLE NO. 8 ON INQUIRY CARD

DEC fleshes out VAX line with 750, a scaled-down 780

When Digital Equipment Corp. introduced the VAX-11/780 in 1977, industry observers felt the system might suffer in the market because it lacked software. Instead, the new supermini—DEC's first 32-bit machine—proved successful beyond even its maker's expectations. DEC has sold 2000 of the $250,000 systems in three years and now has a year's backlog on order. Meanwhile, the VAX's software repertoire—initially comprising only an operating system and FORTRAN—has grown to include five additional languages and network and data-management software.

Now DEC has strengthened its supermini line still further, with the announcement of the VAX-11/750, a scaled-down version of the 780 based on semi-custom integrated circuits, which offers 60 percent of the 780's performance at 40 percent of its price. In addition, DEC has introduced two other VAX-related products:

- The RM80 14-in. Winchester-disk drive—a medium-capacity (124M-byte) unit claimed to have superior performance and reliability characteristics. For example, DEC claims that the RM80's average access time—25 msec.—is faster than that of similar-sized disks. The new Winchester drive—the first to be developed and built by DEC—sells for $29,900 with controller, and will be available in January.
- The Datasystem 700 series—the first DEC commercial systems to be based on VAX processors. The new systems—the most powerful in DEC's commercial arsenal—are based respectively on the VAX-11/750 and the 780. The 750 carries a $110,000 starting price tag and will be available in April, 1981. The 780 starts at $250,000 and will be available next month.

But the product highlight remains the VAX-11/750 processor. The new machine has the same 32-bit architecture, 244-instruction set and 4.3G-byte address space as its 780 predecessor. Yet it is one-third the earlier machine's physical size, and sells for 40 percent of the 780 CPU price (about $120,000).

The lower price does entail a performance penalty, however. The 750 is only 60 percent as fast as the 780, and it has only one-fourth its real memory capacity—2M bytes versus 8M bytes. Nevertheless, the 750 is a powerful machine in its own right, DEC officials point out. For example, they claim that the 750 is comparable in power to an IBM 4031-2—the smallest member of IBM's 4300 series large-scale computers.

Moreover, the 750 offers such power at an attractive price. For example, a bare-bones OEM configuration comprising a processor, 512K bytes of memory and a printing terminal sells for $47,000 in volume. System prices begin at $89,000 for a processor, 512K bytes of memory, a printing terminal, two 28K-byte disks and the VAX/VMS operating

Digital Equipment Corp. *has strengthened its supermini hand with the VAX-11/750, a scaled-down version of the 780.*

system. In contrast, the model 780 carries a $100,000 to $500,000 price.

Because of its substantially lower price, DEC president Kenneth H. Olsen expects the 750 to expand the company's markets to include users that it could not previously reach with the high-priced 780. "The 750 will broaden the gateway into distributed computing for large numbers of new users," Olsen says. Moreover, he suggests that even smaller VAX systems will be forthcoming. For example, a single-board VAX, code-named Nebula, is reported to be waiting in the wings at DEC.

Such sudden aggressiveness in the low-end of the 32-bit minicomputer market could spell trouble for such competitors as Prime Computers, Inc., Perkin-Elmer Data Systems and Systems Engineering Laboratories. These companies—all of which offer 32-bit machines in the $40,000 to $100,000 range—have not had to face the industry giant in the low end of the market until now.

DEC attributes its ability to squeeze the VAX architecture into a drastically smaller and less costly machine to its use of a little-known but increasingly popular type of integrated circuit called the gate array. The device essentially is a form of semi-custom logic. It consists of a partially finished integrated circuit on which circuit elements, called gates, have been deposited in rows, but not yet connected to perform a particular function; that function is tailored in the final processing steps. Gate arrays offer the advantages of full-custom circuits—high density and low cost—while drastically reducing the time and cost to develop such a circuit from scratch.

The VAX-11/750 contains 55 of these semi-custom circuits, which were developed at DEC's new semiconductor facility in Hudson, Mass., and together they comprise about 90 percent of the processor's logic.

Because the new chips do as much work as 25 of the standard TTL circuits used in the VAX-11/780, DEC was able to squeeze the new machine onto five boards instead of 12, lowering manufacturing costs and power consumption while increasing reliability because of the reduced number of elements.

But while DEC attributes the 750's attractive 40/60 price and performance ratio to a new circuit technology, industry sources suggest another contributing factor. They point out that DEC quietly raised prices on the model 780 by as much as 19 percent in October. One source speculates that the price adjustment was made because DEC had been pricing the 780 low to stay competitive with manufacturers such as Prime that were offering lower-priced machines. Now, with the 750, DEC has a competitive machine; hence, the price rise.

Volume deliveries of the model 750 are slated to begin in April, 1981. Deliveries of 750 systems with the new RM80 disk drive will begin a month later. *—Paul Kinnucan*

IBM enhances Displaywriter before deliveries begin

Even though IBM has not yet shipped its recently introduced Displaywriter word-processing system (MMS, August, p. 35), the Office Products Division enhanced the product in October with two software packages that add a mathematics capability, more word-processing functions and an international spelling dictionary. There's also additional mass storage in the form of two diskette units.

Adding features before a product is delivered may seem unusual, but some industry observers say the additions—especially the mathematics and word-processing functions—complete the initial Displaywriter offering with features available on competitive word processors.

The new programs, Textpack 3 and Languagepack, are available under license on prerecorded diskettes. Textpack 3 includes automatic or manual global search of words in a document, merging files of standard and variable information, automatic rearrangement of columnar information and mathematics and statistics for the four basic mathematical functions.

Languagepack extends the available 50,000-word dictionary to include six foreign languages and forms of U.S. and U.K. English. Monthly license fees for Textpack 3 and Languagepack are $25 and $15, respectively. Textpack 3 will be available in September, and Languagepack in May.

To facilitate the new functions, two diskette units were added to triple information storage to 2 million characters. The single-drive IBM 6360 model 20 is priced at $1700, while the dual-drive model 22 sells for $3300. Deliveries will begin in June. Electronic storage was increased to 1 million characters with a new Diskette 20, a dual-sided, double-density diskette that is used in conjunction with the models 20 and 22. A Displaywriter incorporating the hardware and software enhancements sells for $11,490, plus $40 a month for both licensed programs.

When asked why IBM did not offer mathematics, globals and file merges initially, an IBM spokesman would say only that the company is

demonstrating its commitment to expanding systems for customers' needs.

However, the reasons for the introduction appear to be two-fold, says Amy Wohl, principal at Advanced Office Concepts Corp., a Bala Cynwyd, Pa., consulting firm. "IBM either thought its backlog was not totally solid—meaning half of the orders were letters of intent from those not sure they wanted the system—or perhaps IBM is gearing up additional production facilities."

An IBM spokesman admits that Displaywriter deliveries have stretched out to 42 weeks, with first shipments scheduled for January.

Wohl says IBM has come close to a complete product offering, and the question is how much the market for that product extends beyond the 30,000-unit backlog IBM is believed to have. She says that about 10 percent, or 600,000, installed typewriter work stations are candidates for upgrades to Displaywriter devices.

Yet one significant feature—records-processing—will not be available on the Displaywriter until next year, says Patricia Seybold, editor of *The Seybold Report on Word Processing*. She explains that IBM intentionally overlooked this function, which allows fields of information to be set up. IBM apparently did not want to hurt sales of its OS/6 word processor. Seybold says that the announcement of this function will be delayed until the Displaywriter is manufactured in volume so that there will be no problems in meeting customer demand. *—Lori Valigra*

C/70 development system executes C language, UNIX

A software development system claimed to run software written in the C language faster than other systems in its price class has been introduced by BBN Computer Corp. The new system, designated the C/70, derives its efficiency from its special-purpose instruction set, says Martin Oakes, director of marketing at the Cambridge, Mass., data-communications equipment supplier.

Oakes explains that most other minicomputers have general-purpose instruction sets that are not geared to any particular language. The C/70's instruction set, on the other hand, was designed specifically to execute C language statements. The result, Oakes says, is an "enormous" increase in efficiency. For example, he estimates that a C program translates into half as many C/70 machine instructions as would be required on a minicomputer with a general-purpose instruction set.

Because programs are smaller, Oakes says, the C/70 can run C software faster than more expensive machines. For example, he claims that the C/70 is as powerful, when running C programs, as the PDP-11/70—Digital Equipment Corp.'s most powerful 16-bit minicomputer. Yet, the system costs less than DEC's mid-range PDP-11/44 machine. For example, a typical C/70 system that includes 256K bytes of memory, 32 asynchronous communications lines, two 80M-byte disk drives, a console terminal and a cabinet costs $74,000. That's about 14 percent less than the price on a similar PDP-11/44 configuration with 67M-byte disks, Oakes claims.

The C/70 software development system *from BBN Computer Corp. is designed to execute the C language and the UNIX operating system.*

Because of its C orientation, Oakes expects the C/70 to find a ready market among users of UNIX—a popular operating system for DEC computers that is written in C. Originally developed at Bell Laboratories, UNIX has gained a wide following—particularly among government and university users. Oakes estimates that there are several thousand UNIX installations.

Because the Bell-supplied version of UNIX is partially written in DEC assembly language, it will not run on the C/70 system as is. However, BBN Computer offers a modified UNIX version, with the assembly language rewritten in C. The BBN Computer version sells for $6000 for an initial license, plus $2000 for each additional license.

Although the C/70 is primarily aimed at software-development applications, Oakes also sees the system being used as a nodal processor in data-communications networks. For these applications, BBN Computer offers a stripped-down operating system, called C/MOS, that resides entirely in main memory. *—Paul Kinnucan*

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CIRCLE NO. 9 ON INQUIRY CARD

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Winchester drive capacities will double every three years

OEM systems designers now eyeing a wide array of 14-, 8- and 5¼-in. Winchesters can expect higher capacity drives on a regular basis through the 1980s, says the head of one Bay Area hardware house.

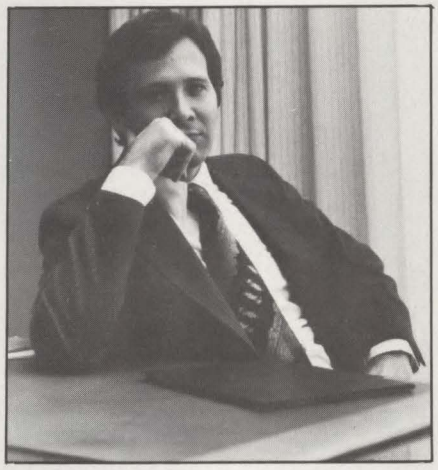
"Double-density 3350 technology Winchester read/write heads have already doubled track densities to the 1000-tpi range," says Bill Schroeder, president and co-founder of San Jose-based Priam Corp. "Thin-film read/write heads will show up on a large-scale basis in the OEM market in about two years." IBM is already shipping drives with thin-film heads, he goes on, referring to the 3370 announced in early 1979. In about one and a half years, vendors such as Memorex and Storage Technology will announce plug-compatible hardware. Dastek Corp., Los Gatos, Calif., plans to ship its new 4835 400M-byte OEM drive early next year (MMS, February, p. 19).

The impact of thin-film head technology on the OEM market will be two-fold, Schroeder goes on. First, storage capacities will soar, compared to existing double-density Winchester drives, and to the thin-film drives now on the market or announced. "Within three years," he says, "Drives with bit densities ranging from 10,000 to 15,000 bpi will be commonplace."

Second, Schroeder contends that thin-film heads will prolong the useful life of the oxide disks developed for Winchester hardware nearly 10 years ago, at the expense of higher capacity thin-film media now available.

Schroeder cites production problems as the main hang-up preventing large-scale acceptance of thin-film media, particularly problems related to the corrosion of the permalloy layer where magnetic impulses are registered. One prime cause of corrosion can be chlorine from the nickel-based salts dissolved in the plating solutions. "Chlorine levels as low as 200 parts per million are sufficient to contaminate a thin-film disk, or for that matter, a wafer of thin-film heads," says one chemist.

David Johnston, president of Poly Disc Systems, Inc., Torrance, Calif., feels that the drive industry's fears about thin-film media are unwarranted, however, and that contamination-free production quantities are available. "We've heard about chlorine contamination for five years," he says, "and we've never seen it." According to Johnston, the chlorine problem goes away when the disks are baked at 500°F. "This causes any contaminants to bubble up," he explains. "If there are bubbles, the disk is bad: if not, the disk is good."



Priam Corp.'s Schroeder: *"The industry won't get excited about thin-film media until large-scale production runs are made."*

Furthermore, he goes on, Poly Disc artifically ages each platter by creating what Johnston calls a "controlled contamination" of the disk during the baking process. "We turn the thin-film layer from nickel-cobalt to a nickel-cobalt oxide," he says. "After that, it won't chemically change."

Schroeder remains unimpressed: "The industry won't get excited about thin-film media until large-scale production runs are made," he says. "But we anticipate that thin-film media combined with thin-film heads will come into use on a large-scale basis before the end of the 1980s." Bit densities on the drives could hit 25,000 bpi as a result, he notes.

Johnston, however, feels that things could happen faster, and that more drive makers should consider thin-film media before thin-film heads. He notes that two companies already are using Poly Disc thin-film media—Computer Peripherie Technik GmbH, Berlin, and Irwin International, Inc., Ann Arbor, Mich. (MMS, November, p. 45).

Vertical data storage may possibly appear at the same time as drives with thin-film heads and media, Schroeder goes on. This recording technique, he says, will significantly reduce bit-cell size, permitting more data to be stored per track. "Vertical data storage will show up later in this decade," he says. "IBM is only now fooling around with it." The advantages of this recording technique appear impressive at first: Bit densities could range from 25,000 to 100,000 bpi, Schroeder says, compared to the 6400-bpi densities found on 3350-technology hardware.

Schroeder also sees a number of other advances coming to the OEM Winchester market. All these advances are aimed at further increasing hardware capacities. He sees the use of microsteppers at the low end of the drive spectrum. These microsteppers will be tied to some form of feedback system to double track densities of drives in the SA1000 class.

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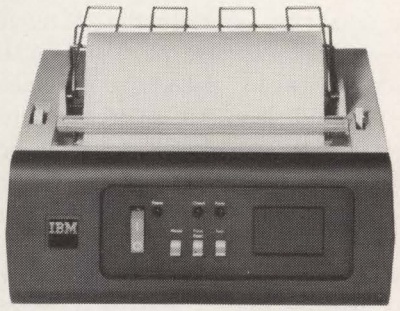

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CIRCLE NO. 10 ON INQUIRY CARD

Schroeder foresees the widespread use of dual actuators to cut arm contention at the high end of the spectrum. Also in the offing is the widespread use of "run-length limited" (RLL) encoding schemes that could lead to a 50 percent increase in bit densities with no increases in flux changes.

Despite the bright outlook for Winchester hardware capacities, however, Schroeder does see some problems ahead. "Unfortunately for systems designers, interfacing standards will diverge," he says. "The industry has waited with bated breath too long for ANSI to develop a Winchester drive standard, and now it's too late." Drive vendors are moving in too many different directions on the question of interfacing, he goes on, with some Winchester suppliers choosing the older storage module drive (SMD) standard.

Users also can expect to continue to pay a hardware premium if they choose to incorporate 8-in. Winchesters rather than 14-in. hardware into their systems, Schroeder says, even though a 14-in. disk costs about 20 percent more than an 8-in. platter. "Right now, to get the same capacity as a 14-in. disk, the user has to stack up three 8-in. platters," he explains. "In media costs alone, the user is paying 140 percent more if he goes with the smaller drive."

Moreover, he says, stacking up platters means additional heads and arm assemblies (a 50-percent penalty), plus the added costs (as much as 40 percent more) that occur when the electronics common to both drives are compressed to fit into an 8-in. form factor.

As examples of the price differentials between the two types of drives, he cites Shugart Associates' 10M-byte 8-in. SA100 and 14M-byte SA4000. Price for the former (adjusted to include a data separator) is $130 per megabyte, Schroeder says. Price for the SA4000 is $90 a megabyte. The

MINIBITS

SOLID STATE INKS TWO CONTRACTS TOTALING $54 MILLION

Solid State Technology, Inc., Woburn, Mass., has signed two contracts for its 8100 series of small business computers. It signed an international distributor agreement worth $4 million with Hawke-Cramer of the United Kingdom for 650 computers over the next three years, and it signed a $50 million agreement over three years for 10,000 systems to be distributed by Alanthus Data Communications Corp., Rockville, Md. Alanthus will also maintain and support SST's OEMs nationwide. The 8100 computer has a 64K-byte memory, two standard interfaces, an integrated text-editing system and a 150-cps printer. Both a single- and a dual-floppy-disk drive with a capacity as high as 644K bytes can be configured into the system.

EXXON ENTERPRISES FORMS NEW OFFICE-SYSTEMS COMPANY

Exxon Enterprises, Inc., the venture development arm of Exxon Corp., has established the Exxon Office Systems Co. to manage business operations serving the office-products market (MMS, August, p. 5). The company consists of Qwip, Qyx and Vydec; the office systems marketing division for domestic marketing, sales and service operations; the international division; certain Exxon Enterprises staff functions; and advanced product-development activities. Robert A. Contino, a former IBM executive, has been named president. Headquarters for the new company will be in Stamford, Conn. Manufacturing and product development facilities of the three major product areas will remain at their respective sites.

USED WORD-PROCESSING EQUIPMENT IS FOR SALE

While the rapidly growing word-processing market continues to receive new products and companies, at least one company is taking advantage of a phenomenon that already exists in the data-processing industry: selling used equipment. Word Systems, Inc., Minneapolis, sells previously owned IBM, Xerox, Lanier and other word-processing equipment. Word Systems will buy from users who want to replace current word-processing equipment and sell to those who want word processors but can't afford new equipment. The used equipment will be available for prices substantially lower than manufacturers' list prices, says company officer H. Clifford Walker.

CANADA DEVELOPMENT CORP. BUYS LANIER DEBENTURES

In an effort to erase its short-term debt and raise capital, Lanier Business Products, Inc., Atlanta, has offered $30 million in debentures, all of which will be bought by Canada Development Corp., Vancouver. The debentures are convertible into 625,000 shares of Lanier stock, or 7.8 percent of that company's common equity. CDC is a holding company formed by the Canadian government that invests in natural resources, manufacturing and high technology. CDC also owns AES Data, Ltd., Canada, which manufactures Lanier's "No Problem" line of electronic typewriters. Lanier will use the money for general purposes, supporting capital requirements, increasing R & D and possible acquisitions and expanding its manufacturing facility by 20,000 sq. ft.

TELEPRINTER SHIPMENTS ARE DOWN THIS YEAR

Despite increasing demand, teleprinter shipments will be lower this year than last, notes a recent study by Venture Development Corp. (VDC), Wellesley, Mass. The reason: While most of the teleprinter industry is seeing flat or negative growth rates, industry leaders DEC and Teletype cannot manufacture hardware fast enough. VDC says the downward trend will not continue and that shipments in 1981 will more than make up 1980's losses. Sales are estimated to hit $2 billion by 1985, but there will be some casualties along the way. VDC forecasts a shake-out in the teleprinter industry in the near future, noting that of the 32 U.S. suppliers, three (Digital Equipment Corp., Teletype Corp. and Texas Instruments Inc.) accounted for more than 60 percent of shipments this year. The report states that these companies, as well as 15 others, will show a good growth potential over the next five years, but the remaining manufacturers will continue to lose market share.

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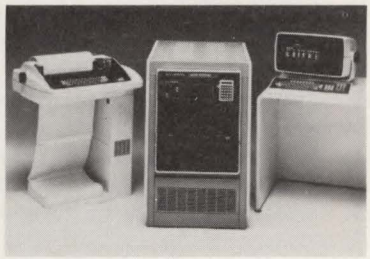

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More Advanced Image Processing

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TWIN DISPLAY is designed to fill the missing link in computerized pre-printing processes. It eliminates time-consuming conventional film stripping and retouching, and allows the operator to utilize digital computer equipment without the usual delays. Full page composition and make-up is quick and easy. Linked to any color scanning device, the basic information containing original art, transparencies and keyline material is the input source for Comtal's Twin Display System. All routine operations are done at a rate faster than traditional studio crafts can achieve. Page assembly is done at the operator's convenience. Color matching and masking by the stylus method gains time of a new order compared to conventional handling, thanks to the exclusive Reference Screen built-in to Comtal's Twin Display. Errors are caught and quickly erased without the "original" being lost. After approval, the completed page is returned to the output scanner unit and converted into film separations or gravure cylinders to suit the particular printing operation required. Comtal's Twin Display is the new dimension in image information providing a display screen showing an exact replica of a finished page without the need for chemical, mechanical or photo-optical procedures.

DIGITAL VIDEO INPUT PROCESSOR by Comtal is a system that digitizes original film imagery as seen on an illuminated light table by a video camera. The DVIP adjusts for variations to provide very high quality digital images on a B&W monitor as an adjunct for the Vision One/20. Its applications include military or telecommunications use as well as non-destructive testing procedures. A further Comtal choice allows transfer of the image to a host computer.

8000-R, a newly redesigned, random real-time peripheral device, provides a superior image when used in conjunction with a data base host or applied to a Vision One/20. Ideal for pipeline processing and color image enhancement, the 8000-R solid state processor is a standard in the industry.

MAPPER, Comtal's interactive spatial warp system, provides point by point image registration under the control of the operator via an interactive procedure. Often applied to Landsat imagery or graphic arts, the Mapper is typically linked to a Vision One/20 and has 6 or 12 degrees of freedom — applicable to a broad range of imaging and cartographic projections. The concept includes simple linear effects that achieve translation, rotation and scaling as well as more advanced warping characteristics of "rubber sheet" distortion such as in second order warp or advanced cubic warp visuals.

COZO (Continuous Zoom) by Comtal gives the convenience of magnification from same size to macro imagery (up to 512 times) as a tool for medical, graphic or industrial fields. Its key features include replication, bi-linear and cubic interpolation, with zoom in steps of .002 magnification.

HIGH RESOLUTION PROCESSOR is special-purpose Comtal hardware used in conjunction with the Twin Display to produce high spatial and color brightness resolution output such as that essential for pre-printing operations. The HRP aids in page make-up allowing interactive composition to be achieved by the operator at relatively high speed.

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CIRCLE NO. 12 ON INQUIRY CARD

figures apply equally to Priam's hardware line, he says. Per-megabyte prices are $65 for the 8-in., 35M-byte 3450 drive, and $50 for the 14-in., 33M-byte 3350 device.

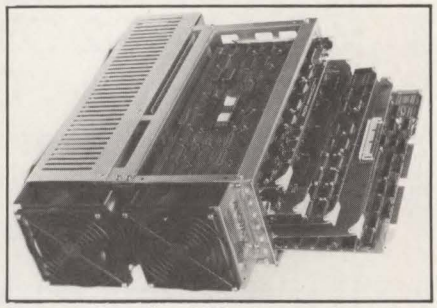
The figures for 8-in. hardware will decline, however, as data capacities increase, Schroeder goes on, noting that the crossover point between 8- and 14-in. hardware is now at the 10M-byte level. Three years from now, the crossover will be at the 20M-byte point. "We can anticipate that Winchester storage capacities will double every three years," he says, adding that there's no competition for these drives in sight, even from bubble memories, the hardware many have long espoused as the inevitable replacement for rotating devices. "People say bubble memories are just around the corner," Schroeder says, "but it's like waiting for Godot—they just never show up. The Winchester-disk drive will not be obsoleted." —*John Trifari*

Anova Corp.'s new emulator runs on Intel Multibus

An Oakland, Calif., company is the latest firm to introduce a processor that emulates Data General Corp.'s Nova minicomputer family—a business that was risky until a judge ruled against Data General last spring (see "Suits and non-suits," p. 23). But Anova Corp.'s model 2/10 is a Nova emulator with a twist. The processor runs on Intel Corp.'s backplane bus, the Multibus, while remaining fully compatible with Nova software.

The 2/10 is a microprogrammed CPU board based on 2901A bit-slice technology. The instruction set is Nova-compatible. The board contains processor logic, Multibus control logic, direct addressing to 128K bytes, 8K bytes of EPROM that provide a virtual operator's panel, 2K bytes of RAM, a monitor with self-diagnostics and a real-time system clock.

Anova president David Wyland says that all peripherals designed for the Multibus can be used with the 2/10. All device codes, register addresses and busy/done logic addresses of the 2/10's I/O instructions are mapped into the I/O device addresses of the Multibus via Multibus control logic. Appropriately configured Multibus peripherals



Anova Corp.'s 2/10 *is another Nova emulator, but one with a twist: The processor runs on an Intel Multibus while remaining fully compatible with Nova software.*

NOVA-COMPATIBLE MARKET: SUITS AND NONSUITS

Anova Corp. may have chosen the right time to enter the Data General-compatible market. A long-standing antitrust suit against DG that has kept the market from rolling was settled last spring. Some observers think the decision is the boost the DG-compatible equipment makers need. For others, including one of the plaintiffs, it makes little difference.

In the suit filed in San Francisco district court by plaintiffs Fairchild, Ampex, Digidyne, Bytronix, Data Compass and SCI Systems, Data General was accused of anti-competitive practices by tying the sale of its operating systems to the sale of its CPUs, and by tying the sale of its CPUs to the sale of memory. The Sherman Antitrust Act, under which DG was sued, clearly makes such bundling arrangements illegal. At issue, however, was whether or not DG could refuse to sell CPUs, operating systems and memories separately.

Fairchild and its co-plaintiffs wanted to make it possible for customers to lease or purchase DG operating systems for use with their Nova emulators.

Presiding judge William Orrick ruled that the tie-in sales arrangements were illegal. He also determined that DG had no real justification for forcing such sales arrangements on its customers. This opened the door for the independents. All that's left now is a determination of financial damages to be paid by Data General to the co-plaintiffs. The case should go to the jury next month.

But for plaintiff Bytronix Corp., the financial remunerations will be icing on the cake. The three-year-old Fullerton, Calif., company manufactures a family of Nova-compatible minicomputers, and last May introduced a single-board Nova emulator, the B500.

According to company president and founder Norman Clark, the DG-compatible market is large and quite strong, mostly because of the amount of independent software and operating systems available for DG and DG-like hardware. "We don't have to tie ourselves to Data General anymore to make a sale," he says.

Anova's president David Wyland agrees. "There's plenty of independent software available for Nova-compatible systems," he points out. "We don't expect to sell to users of DG software."

Nonetheless, would Data General come after Anova with a lawsuit? And what about the name Anova? Isn't that pushing things? Wyland smiles. "There's always a possibility of a lawsuit—even just to find things out," he says. "But it's not likely. Any action would just be an aggravation suit."

Data General has no comment on the antitrust suit or on Anova Corp.

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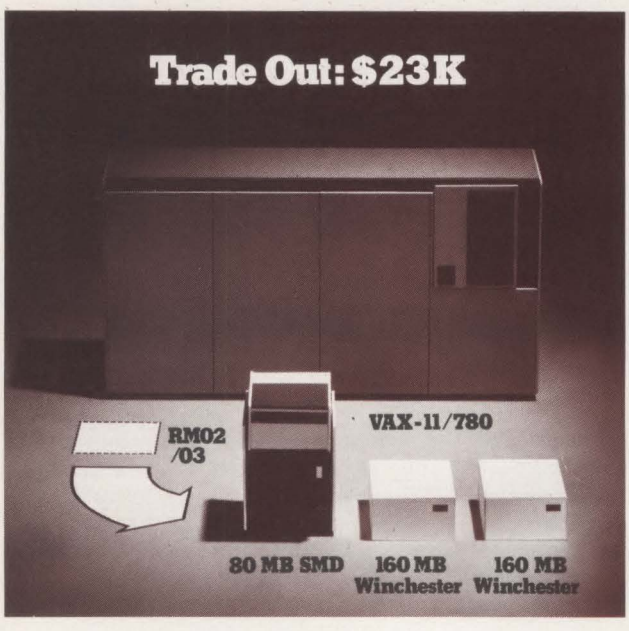

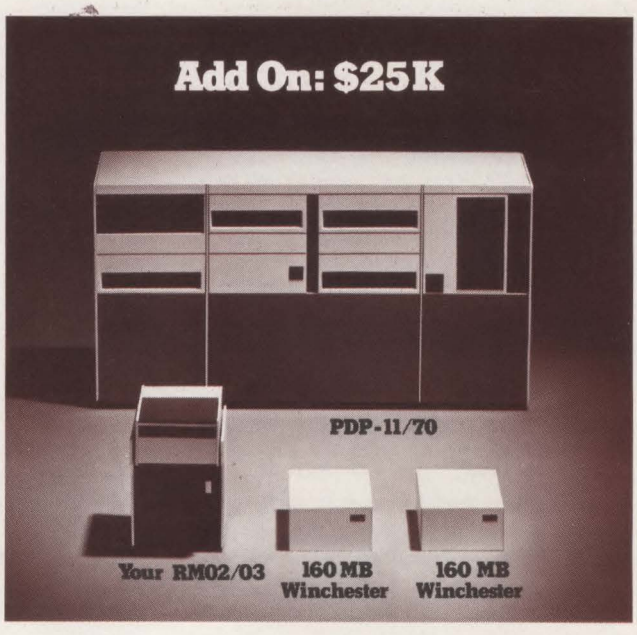

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or memories are, therefore, software transparent to the CPU. Says Wyland, "The microprocessor bus brings down system costs by allowing the use of the low-cost peripherals for the Multibus."

The 2/10 can emulate Data General's Nova 1200 or the Nova 2, which are functionally equivalent CPUs. Minimum instruction execution time is 600 nsec., Wyland says. "The 2/10 performs at about the level of a Nova 2. But we can boost the speed to bring performance to above that of a Nova 3," claims Wyland. The 2/10 will run DG's RDOS operating system, Wyland says, as well as several other independent operating systems, including Point 4 Corp.'s IRIS.

The 2/10 is the initial product in a series of board-level products Anova expects to introduce over the coming year. These include an RS232 serial I/O card, a 64K-byte RAM card and a dual floppy-disk controller, all Nova and Multibus compatible. Wyland says that about 15 evaluation units of the 2/10 will have been shipped by the end of this year. Volume production and deliveries of the CPU may start soon after the first of the year.

Wyland has priced the Anova 2/10 at $5600, making it, he says, 15 percent less expensive than a microNova with comparable peripherals and 40 percent less expensive than a Nova 3 or 4. He's targeted the processor at the high end of the Multibus-compatible single-board computer market, in which he claims there is a gap between performance requirements and available hardware, especially for 16-bit applications. Though no benchmarks have been taken, Wyland believes the 2/10 will perform as well as, and perhaps better than, Intel's 8086-based 16-bit board-level products.

The first 2/10s to be sold will be equipped with floppy disks, printers and video terminals. Later models, Wyland says, will include hard-disk storage as well.

He expects to find interest for the 2/10 from existing Nova OEMs and from "customers needing the power of a 16-bit processor and software." He says the 2/10 is ideal for data collection and compaction applications, as well as in data communications networks as multiplexers.

—Larry Lettieri

Decision Data pioneers in IBM-compatible peripherals

Pioneering plug-compatibility for IBM peripheral equipment in a relatively new market niche is a risky business. Users who are unfamiliar with new equipment may hesitate to change to a new supplier for system peripherals, despite incentives such as lower cost or higher performance.

But Decision Data Computer Corp., Horsham, Pa., is gearing up to be a major worldwide independent supplier of IBM System/34 and /38 small computer peripherals. The company is best known for its IBM System/3-compatible card-punch peripherals and for System/34 and /38-compatible printers. Memorex Business Systems division is the only other vendor besides IBM to have introduced an IBM 5251-11 CRT terminal replacement.

As an addition to its line of IBM-compatible printers, Decision Data's 3751-11 CRT terminal replacement for System/34 and /38 5251-11 terminals rounds out the company's line of peripheral subsystems. "Our worldwide thrust (is) to become the independent peripheral supplier for what portends to be IBM's largest computer market," says Kenneth R. Whitehouse, Decision Data vice president of marketing and business development. Whitehouse quotes combined market researcher projections of 121,000 System/34 and /38 installations through 1983, and more than 1.5 million CRT terminals for the System/38 over five years.

Decision Data *is pioneering in IBM System/34 and /38 plug-compatible peripherals with its 3751-11 CRT work station.*

The 3751-11, which is the company's first display station, is priced at $2800, compared to $3315 for the IBM 5251-11. The 3751-11 has a built-in single-board controller with a Z80 μp, 3K bytes of RAM and 7K bytes of program memory. It includes some features not available on the IBM terminal: a screen that tilts, a document holder, an automatic dimming feature, a keyboard palm rest, a field-convertible numeric keypad and an expanded error-message display. The terminal is said to be one-third less in volume and to require one-third less power than the IBM terminal. It can be used locally or remotely. A remote cluster controller will be introduced next year.

There are problems with being "the first kid on the block." "It is aggressive to enter one of these (new) markets before everyone else is in it," explains David Stein,

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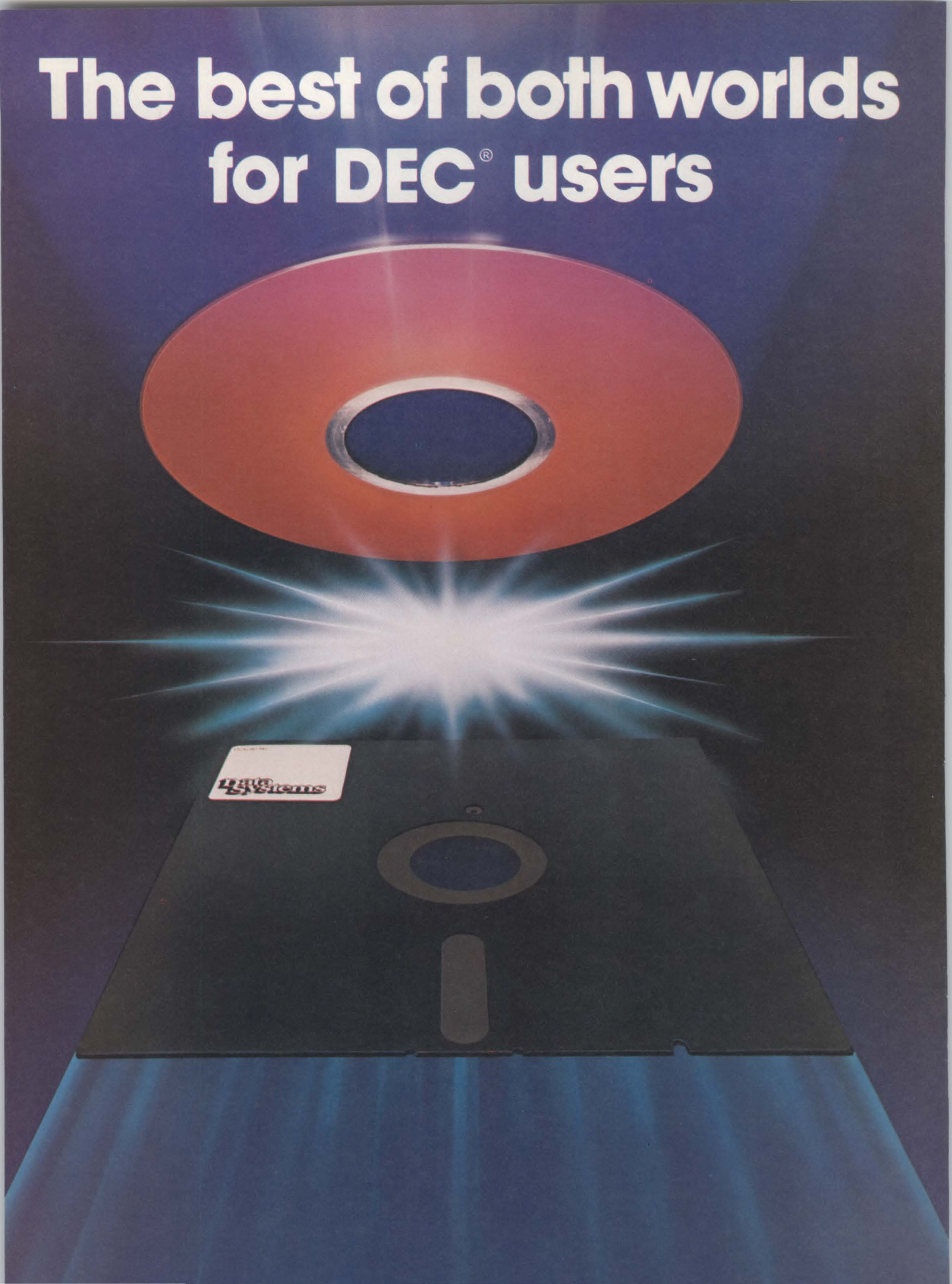

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CIRCLE NO. 14 ON INQUIRY CARD

executive vice president of the Gartner Group, Inc., a Greenwich, Conn., consulting firm. Stein says that plug compatibility requires more sophistication by users than is needed by those who continue using IBM peripherals.

"The System/38 is so new that no one is sure what IBM is delivering yet," says Stein (MMS, October, p. 26). Because the system has just been shipped, users may not know if they need additional capabilities. "It is very early to be going into that market. If you wait several years, market penetration is much less risky." Large customers do not want to complicate their risks by having to learn both the new System/38 and the new compatible peripherals. But, Stein contends, although the market will develop slowly, it will be large. The System/34 market is easier to approach, he says, because it is more mature.

But another source believes that the System/38 market is mature and says Decision Data's timing is good. "The add-on business develops six months to a year after initial installation, when the user gets enough terminals or peripherals to satisfy (initial needs)," says Dr. Mirek J. Stevenson, chairman of the board of Quantum Science Corp., New York, an information-services and consulting firm. He says users will later have additional applications that require more memory, disk storage and terminals.

Decision Data has a head start in the IBM-compatible peripheral market. Since its start 10 years ago, the company has been addressing the needs of IBM System/3 users with 96-column card equipment, and has an established customer base of 5000 to 6000 IBM General Systems Division users, Whitehouse says. The System/34 and /38 are upgrades for System/3 users.

Decision Data initially will pursue the add-on business. Whitehouse says there is a 10 to 20 percent add-on potential per year for installed systems. He sees the opportunity to sell multiple CRTs. "It's like bananas; you can sell these in bunches." Product marketing manager Rich Ginieczki says an average System/38 has 35 to 40 work stations, and a System/34 has six or seven. As the market grows, and IBM lead times continue to be seven to eight months, Decision Data can get some business because it has shorter lead times. First shipments of the 3751-11 will begin in January, with delivery times of 90 to 180 days.

But selling price and performance is just the tip of the iceberg in the IBM market. IBM emphasizes end-user support, and users are accustomed to it. "The IBM market is dependent on good on-site service," says Decision Data president Richard J. Schineller. "This restricts some (manufacturers), but it is an advantage for Decision Data," which has 250 field-service engineers in 70 locations in North America.

—Lori Valigra

STAYING OUT OF THE OEM BUSINESS

Company president Richard J. Schineller is justified in his reluctance to let Decision Data Corp. become an OEM business. The company stagnated under heavy debt after a Burroughs Corp. contract involving 45 percent of Decision Data's revenues was cancelled, and after its OEM sales declined. Last August, Decision Data reduced its debt from $12.5 million to $450,000 in an equity deal with Data Recording Instruments, Ltd., England, a recording-equipment company.

DRI holds 16 percent of Decision Data stock, or 8000 shares, valued at $2.5 million, which will increase to a 43-percent equity position. Decision Data also has the option to borrow more than $8 million from DRI. The company intends to balance revenues, including distributing 22 percent to OEM business, 31 percent to end-users and 28 percent to maintenance.

DRI's financial input is not the only new benefit to Decision Data. Many point to Schineller as having the potential to expand the company successfully with its clean financial slate. Schineller, who joined the company in March, came from Management Assistance, Inc., where he directed activities at its four subsidiaries, including Sorbus, Inc., a large, third-party computer-maintenance company, and Basic Four Corp.

Dr. Mirek J. Stevenson, chairman of the board of Quantum Science Corp., says Schineller is "capable and competent," and knows the IBM market, because MAI was originally in that market. David Stein, executive vice president of The Gartner Group, agrees. He explains that MAI endured upheavals similar to those of Decision Data, but succeeded with Basic Four small-business computers and Sorbus maintenance. Stein says that Schineller's affiliation with Sorbus will "probably reflect in the strategy to get Decision Data in the business."

Mostek unveils software development tool

Mostek Corp. has introduced the first packaged end-user system built around the company's SDT-Z80-BUS μc boards. The initial system, Matrix-80/SDT, is a software development tool composed of six STD-BUS boards that can be used to design systems based on these boards.

Officials at the Carrollton, Texas, firm—an alternate source for the Z80—say the desk-top Matrix-80/SDT software-development tool uses one Z80-based CPU card; two RAM boards—one with 16K bytes, the other with 32K bytes—a UART serial I/O board, a floppy-disk controller board and a parallel I/O card with 32 I/O lines. These are packaged in a six-slot card cage that includes an 8-in., single-sided, single-density floppy disk. The system will drive an ASCII terminal, and the parallel I/O card will support a PROM programmer or Centronics-type printer.

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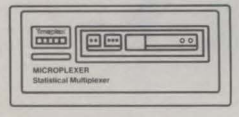

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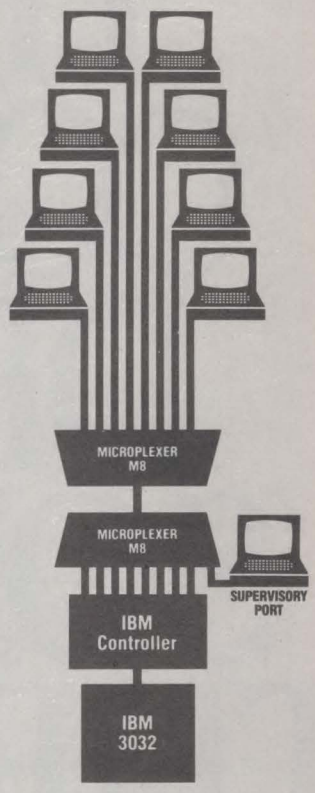

This West Coast data communications network, which is managed by Alco Data Services, is based on SERIES II MICROPLEXER statistical multiplexers located in Los Angeles, California and at the Corporate Data Center in Valley Forge, Pennsylvania.

*Patents pending

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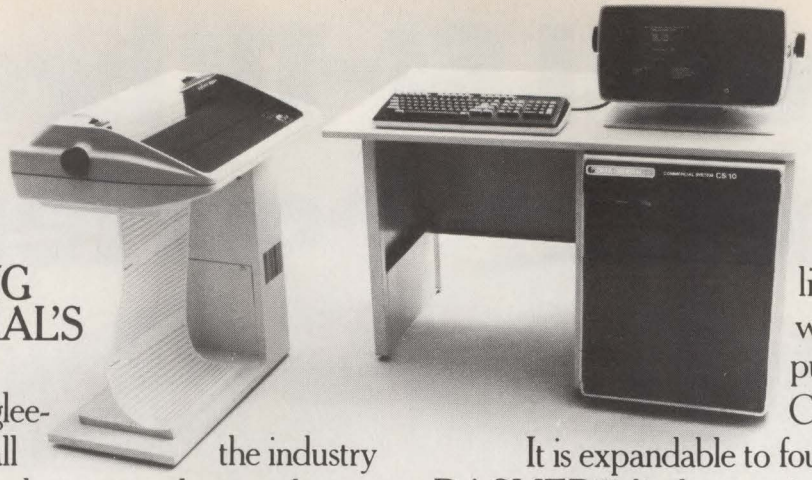

INTRODUCING DATA GENERAL'S NEW CS/10.

It has been gleefully estimated by all the industry pundits that during the next twelve months somewhere in the neighborhood of 500,000 small businessmen will purchase their very first computer.

Isn't it ironic that, until now, there was no computer perfectly suited to this emerging market? In fact, the choice narrowed down to computers that were either too much, or too little, or weren't capable of expanding to accommodate any but the most stagnant of businesses.

Which is precisely why we at Data General engineered the new CS/10. While the CS/10 is eminently affordable (actually it's the lowest priced—$10,950 list—serious multi-terminal computer in America and features one of the most aggressive discount policies for industry suppliers and volume purchasers), it is designed to provide a surprisingly wide range of sophisticated functions with enormous possibilities for expansion.

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And perhaps the most significant competitive aspect of the CS/10 is that it isn't just one lonely machine. It is part of an entire family (CS/10 through 70) of program and data-compatible systems, which of course means that one modest CS/10 installation can easily burgeon into a 17-terminal CS/70 system (with an impressive number of peripherals).

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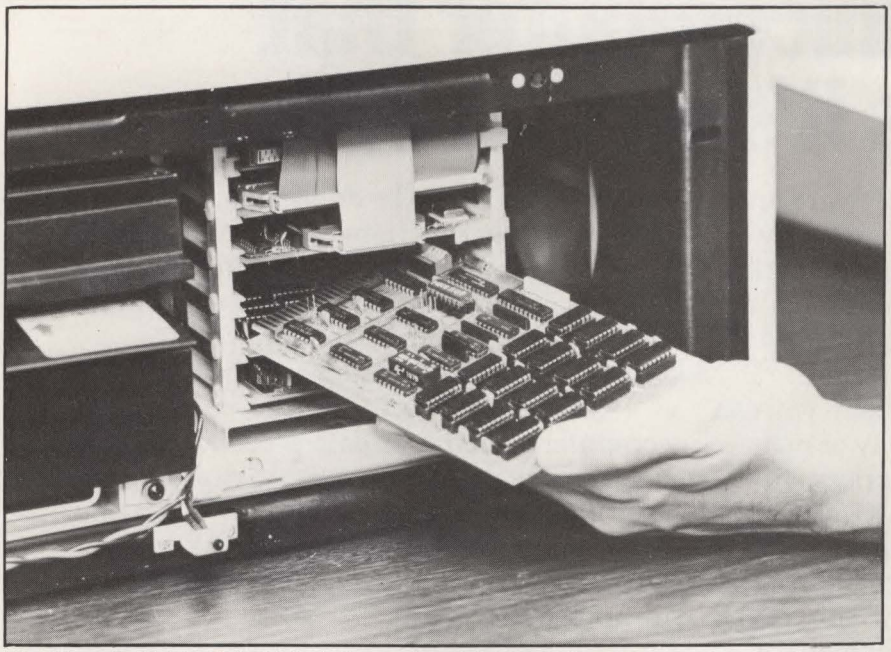

The Mostek Matrix-80/SDT *is built on the STD-Z80-BUS concept, using MDX boards mounted in a standard card cage. The boards are accessible through a front panel.*

The company has also added its FLP80DOS disk-operating system to the SDT. Resident software includes a text editor, a monitor, Z80 and 3870 (Mostek's single-chip μc) macro-assemblers, a linker and a debugger. FORTRAN and BASIC compilers are available as well.

Bill Smith, Mostek's microsystems manager, says, "Until the SDT, users have had to build STD-BUS from individual boards. Now, a user, even one who may not have the expertise to design a system from the ground up, can purchase a packaged system and with it determine his final system needs."

Smith says that the development system is being test marketed and that several systems have been in use since August. "We're trying to determine how many engineers would like to have a development system in their own offices." The SDT will be test marketed for about six months, he adds, before Mostek determines its exact production needs. However, Smith expects volume production to begin by mid-1981.

Besides the SDT software-development system, the six-slot chassis can be the basis for other Matrix-80 systems, including data-acquisition centers and energy-management systems. "An operator can tailor-make a system," says Smith, "depending on which MD cards are chosen." He says an average MD card sells for about $250.

Mostek is stocking its distributors—Wylie, Arrow and Bell—on the East and West Coasts only with SDTs, and $4495 buys a six-card system with card cage and floppy-disk drive. The chassis without the six SDT system cards and the disk is available to OEMs, Smith says. *—Larry Leitieri*

Morgan Data Systems wins backplane bus pact

The National Bureau of Standards (NBS) has awarded a contract to Morgan Data Systems, Inc., Fort Walton Beach, Fla., to design and implement the hardware and an operating system to conform to the IEEE Computer Society's proposed 32-bit, processor-independent μc backplane bus standard, P896 (MMS, October, p. 13).

The contract consists of two phases, says Morgan Data Systems president John Morgan. The first phase will be to design the hardware modules and the operating system, and to describe what the system will do. Morgan expects to complete this portion by the end of this month.

Phase two will be implementation of the system. Funding for the entire project is estimated to be about $60,000, Morgan says.

The system would be composed of three CPU boards using dissimilar μps. The CPUs are 16-bit devices—Motorola's 68000, Zilog's Z8001 and Intel's 8086. They will access 16K words of what Morgan calls resource memory, composed of RAM and PROM. The boards will be equipped with dual RS232C serial interfaces, an operator's control-panel interface for a keyboard and, possibly, an alphanumeric video display and a floppy-disk interface. The three boards will run on one backplane bus in a multiprocessing, multitasking environment, Morgan explains.

But the concept of a pool of processors in such an environment raises some questions. "It's assumed that all the CPUs are equally endowed," Morgan says, "and that all the processors can perform all the tasks equally well. This just isn't so." He says that processors in such a system will be designed to perform particular tasks, and that these tasks will affect the speed of the bus. "One of our jobs," he says, "is to optimize the performance of a task on the bus."

Despite these difficulties, Morgan is optimistic about the success of the project. The company is working from both the first and second drafts of the standard. A final draft isn't expected until next spring. Because of that, Morgan says the design has to remain flexible enough to change as the final standard emerges. Although he hasn't worked directly with the

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backplane subcommittee thus far, he expects the company "to deal with them directly or indirectly."

The NBS contract is a shot in the arm for the Computer Society and especially for the backplane subcommittee. Andrew Allison, chairman of the backplane subcommittee, says, "It's encouraging for us to have a government agency behind P896 with the power to make formal, federal information-processing standards."

The NBS has had bad experiences in its attempts to adopt de facto industry standards for government systems efforts. Allison thinks that those experiences spawned the agency's interest in the backplane standard. The contract for P896 states that it is a federal information-processing standard.

Allison's observations are confirmed by John Riganati, chief of the NBS's system components division, the group responsible for the agency's standards activity. "We're responsible for exploring interface standards in general," he says, "but specifically where those standards would benefit computer use within the federal government." He adds that the backplane bus standard seems to have "reasonable promise for both government and private industry."

The agency will work with the backplane subcommittee as the standard develops, Riganati points out. "We're using P896 as a starting point," he says. However, "We have no complete understanding of what the exact standard should be." He adds that his division will take comments from the entire technical community.

Regardless of the precise form the system will take, the agency appears to be reasonably confident that Morgan Data will produce a system that will work. A source close to the project says that this isn't the first time the two have worked together. —*Larry Lettieri*

A.B. Dick to revitalize its word-processing line

Although the Magna III word-processing system from A.B. Dick Co. won't be introduced officially until the second quarter of next year, potential customers got a preview of the product at the recent International Word Processing Show in Washington, D.C. The prototype that was privately shown was not demonstrated, but industry observers regard Magna III as a major step forward for the company for two reasons: it's a stand-alone CRT-based system, which A.B. Dick hasn't previously had, and it can be configured as a shared-resource system, with each terminal able to communicate with others in a communications loop.

"A.B. Dick needed a lower-cost, stand-alone system," says Patricia Seybold, editor of *The Seybold Report on Word Processing*. She says the Magna III may become a building-block product. Other word-processor manufacturers, such as CPT Corp. and NBI, Inc., had strong, stand-alone CRT-based products before they branched into shared-resource information systems.

A.B. Dick, which began as a wholesale lumber company in Chicago in 1884, graduated in 1978 from the magnetic card-based Magna I and II word processors to a CRT-based system developed by Hendrix Electronics. That system, the Magna SL, did not include an intelligent, stand-alone terminal on which to base a shared-resource system. The Magna SL shared-logic system incorporates from one to three dumb terminals that share a CPU and access a central system disk, according to the September, 1980 *Seybold Report on Word Processing*. The terminals in the system cannot function without the CPU and system disk. A system with a CPU, a terminal and a printer is priced at about $14,500.

Conversely, the Magna III is an intelligent stand-alone word processor based on an 8085 μp. The system consists of a 20-line CRT with a movable keyboard, a printer and two 5¼-in. dual-sided, double-density diskette drives that store as many as 273,000 characters. There is no hard-disk backup, says William P. Hayes III, A.B. Dick's marketing manager for word processing. The work stations, which will be priced at about $7500 each, use software or system disks to load software. When the software has been loaded, the disk is removed, and both disks can be used.

The Magna III can also serve as one of 255 linked devices in a loop shared-resource configuration, which the company describes as an interactive communications path that will also include telephones, printers and other peripherals. The system is said to be compatible with the company's other word-processing products. For example, the Magna SL is compatible with the Magna III via communications and can access the network through its CPU and a Magna III. But the Magna SL cannot hook directly onto the communications loop.

In a typical loop, the last CRT station is connected to the first through an IBM SDLC-like protocol, says Hayes. Transmission rate is 30,000 cps. Stations can be looped together through an 8- to 4000-ft. cable. Messages can be sent from terminal to terminal via the cable or

from loop to loop using a modem and telephone lines. A security system for information preparation and storage locks a particular station out of the loop, and assigns an access code to the document.

The Magna III's typing line is similar to that of a typewriter and a CPT 8000 word processor, which moves up line by line as text is entered. The system can also be used to create and manipulate scientific information, on multi-level lines. —*Lori Valigra*

Onyx co-founders start new microcomputer firm

Onyx Systems, Inc., co-founders Bob Marsh and Kip Meyers are back in the 16-bit μc business with plans for a yet-to-be-named, high-end Z8000-driven system, a new company called Cirrus Computers, Inc., and $1.5 million in venture funds (MMS, August, p. 6).

Sometime this month, Cirrus plans to move into new quarters in Santa Clara, Calif., where development work will begin on a UNIX-based system that Marsh says will support either 14-in. cartridge module drives or, as a tabletop device, 8-in. Winchesters tied to streaming tape drives for backup. Marsh says the new system will operate at the performance levels of a DEC PDP-11/45, and will support as many as 24 high-speed terminals equipped with direct memory access (DMA) capabilities. DMA will also be used to speed data transfers to and from the high-capacity disk drives planned for the new system.

First hardware, in the form of a CMD-based system, is scheduled for announcement in the second quarter of next year. The system will be in the $18,000 to $25,000 range.

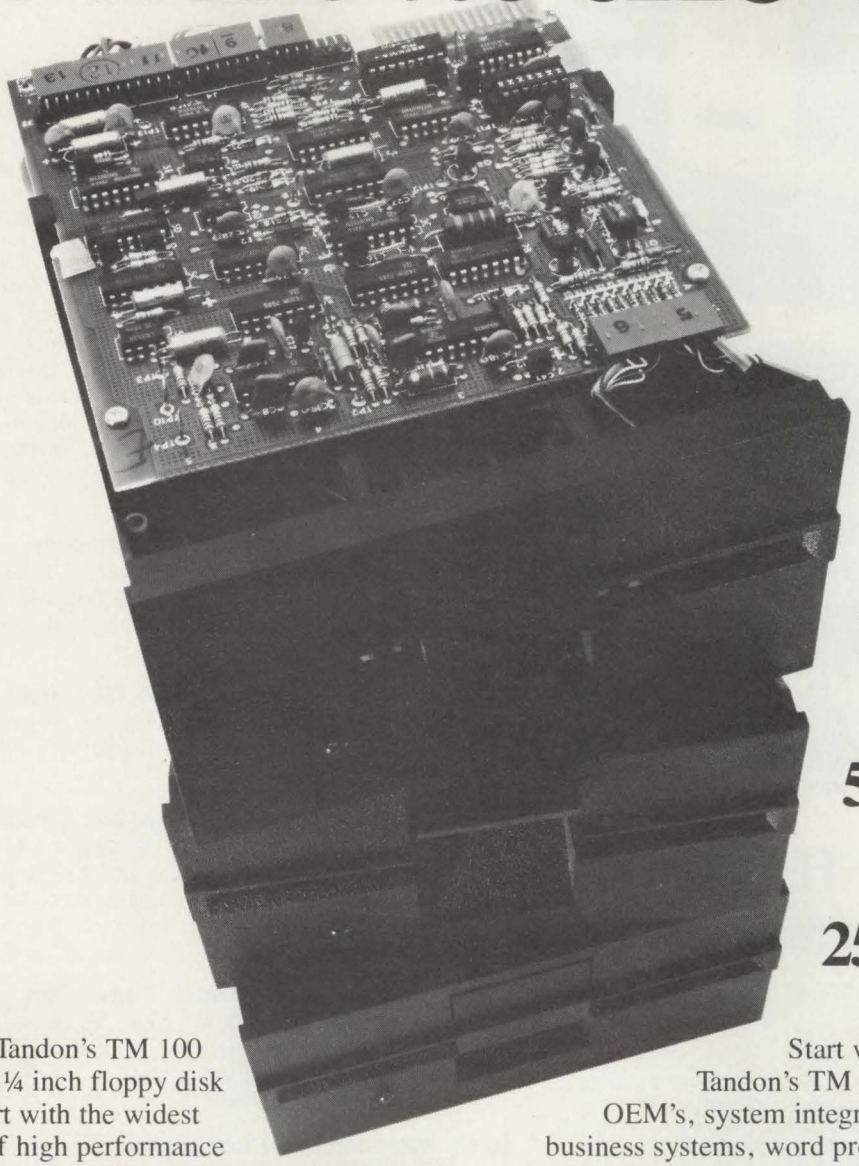
Marsh and Meyers resigned from Onyx last summer in a dispute with the company's backers over which markets should be pursued. According to Onyx sources, the two wanted to stress high-end Z8000-based systems and exclude Onyx's first hardware offering, a lower-capacity, highly successful Z80-driven desk-top μc. Marsh concedes that there were differences of opinion with the Onyx board of directors over which markets the company should pursue, but stresses that he did not intend to drop the 8-bit system. —*John Trifari*

BOX SCORE OF EARNINGS

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

Company	Period		Revenues	Earnings	EpS
Advanced Micro Devices	6 mos.	9/28/80	147,621,000	13,865,000	.88
	6 mos.	9/23/79	106,265,000	10,360,000	.70
Ampex	3 mos.	8/2/80	119,636,000	5,425,000	.47
	3 mos.	7/28/79	105,139,000	7,166,000	.63
Analog Devices	9 mos.	8/2/80	97,243,000	6,762,000	1.02
	9 mos.	8/4/79	72,400,000	5,120,000	.81
Centronics	Yr.	6/30/80	130,700,000	18,000,000	3.01
	Yr.	6/30/79	121,500,000	18,400,000	3.10
Cipher Data	Yr.	6/30/80	21,802,000	975,000	.85
	Yr.	6/30/79	15,082,000	745,000	.78
Control Data	9 mos.	9/30/80	2,764,000,000	114,400,000	6.59
	9 mos.	9/30/79	2,293,000,000	100,400,000	5.82
Decision Data	9 mos.	8/30/80	32,523,000	2,727,000	.63
	9 mos.	9/1/79	30,082,000	421,000	.10
Datum	9 mos.	9/30/80	11,830,000	290,000	.16
	9 mos.	9/30/79	11,430,000	195,000	.11
Hazeltine	9 mos.	9/30/80	97,907,000	3,698,000	1.81
	9 mos.	9/30/79	91,658,000	3,626,000	1.78
Honeywell	9 mos.	9/28/80	3,487,900,000	150,700,000	6.77
	9 mos.	9/30/79	2,976,800,000	175,400,000	8.05
Int'l Business Machines	9 mos.	9/30/80	18,407,683,000	2,329,176,000	3.99
	9 mos.	9/30/79	16,034,127,000	2,002,976,000	3.43
Lear Siegler	Yr.	6/30/80	1,423,397,000	65,722,000	4.23
	Yr.	6/30/79	1,327,271,000	63,276,000	4.50
Magnuson Computer Systems	9 mos.	9/30/80	20,654,000	2,442,000	.67
	9 mos.	9/30/79	5,531,000	(2,643,000)	(1.61)
Memorex	9 mos.	9/26/80	560,482,000	(26,204,,200)	(3.93)
	9 mos.	9/28/79	544,238,000	29,382,000	3.67
Monolithic Memories	Yr.	9/28/80	77,900,000	9,623,000	1.86
	Yr.	9/28/79	36,996,000	(898,000)	(.30)
NCR	9 mos.	9/30/80	2,238,064	136,701	5.11
	9 mos.	9/30/79	2,014,776	136,252	5.09
Penril	Yr.	7/31/80	33,333,828	1,782,405	1.35
	Yr.	7/31/79	22,691,797	1,453,169	1.10
Plantronics	13 wks.	8/30/80	25,093,000	1,852,000	.29
	13 wks.	9/1/79	23,245,000	2,105,000	.33
Prime Computer	9 mos.	9/18/80	182,271,000	21,205,000	1.10
	9 mos.	9/28/79	104,790,000	11,831,000	.67
RCA	9 mos.	9/30/80	5,919,800,000	236,200,000	2.53
	9 mos.	9/30/79	5,471,400,000	213,700,000	2.80
Storage Technology	9 mos.	9/26/80	418,523,000	31,391,000	1.23
	9 mos.	9/28/79	345,287,000	28,192,000	1.12
Sykes Datatronics	6 mos.	8/31/80	8,797,627	877,482	.50
	6 mos.	8/31/79	5,195,872	477,401	.31
Tandem Computers	9 mos.	6/30/80	74,897,000	7,348,000	.74
	9 mos.	6/30/79	37,861,000	3,369,000	.41
Tektronix	Yr.	5/31/80	971,306,000	85,072,000	4.66
	Yr.	5/26/79	786,936,000	77,151,000	4.28
Wang Laboratories	Yr.	6/30/80	543,272,000	52,113,000	2.00
	Yr.	6/30/79	321,565,000	28,585,000	1.17

Start at the top



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Calendar

SHOWS & CONFERENCES

JANUARY

7-9 Second Annual Western Conference & Exposition, Anaheim, Calif., sponsored by Armed Forces Communications and Electronics Association. Contact: Judith H. Shreve, Armed Forces Communications and Electronics Association, One Skyline Place, 5205 Leesburg Pike, Suite 300, Falls Church, Va. 22041, (703) 820-5028.

8-9 Fourteenth Hawaii International Conference on System Sciences, Honolulu, Hawaii, sponsored by the Department of Decision Sciences, the Department of Information and Computer Science and the Department of Electrical Engineering at the University of Hawaii. Contact: Prof. Dennis J. Streveler, University of Hawaii of Manoa, Advanced Management Program, 2404 Maile Way, Honolulu, Hawaii 96822, (808) 948-8135.

13 Invitational Computer Conference, Costa Mesa, Calif. Contact: B.J. Johnson & Associates, 2503 Eastbluff Drive, Suite 203, Newport Beach, Calif. 92660, (714) 644-6037. Other dates and locations available.

13-15 Communication Networks 1981, Houston. Contact: Terri Hamilton, Communication Networks, c/o The Conference Company, 60 Austin St., Newton, Mass. 02160, (617) 964-4550.

13-15 Southcon Electronic Show and Convention, Atlanta, Ga., sponsored by the Georgia and Florida units of the Institute of Electrical and Electronic Engineers and the Electronic Representatives Association (ERA). Contact: Robert Myers, 999 N. Sepulveda Blvd., El Segundo, Calif. 90245, (213) 475-4571.

14-19 National Audio-Visual Convention and Exhibit, Dallas, sponsored by the National Audio-Visual Association, Inc. (NAVA). Contact: Nora McGillen, Exhibit Manager, NAVA, 3150 Spring St., Fairfax, Va. 22031, (703) 273-7200.

16-17 Microcomputer Conference, Tempe, Ariz. Contact: Dr. Gary G. Bitter, Conference Director, Arizona State University, Payne 203, Tempe, Ariz. 85281.

17-18 Educational Software Symposium, Bridgeport, Conn. Contact: Monica Kantrowitz, President, Queue, 5 Chapel Hill Drive, Fairfield, Conn. 06432.

17-23 Alpha Micro User's Society Convention, Miami Beach, Fla., sponsored by AMUS. Contact: William L. Miller & Associates, 8380 S.W. 151 St., Miami, Fla. 33158, (305) 233-1216.

19-22 Bank Administration Institute P.A.T.H. (Productivity through Automation, Technology and Human Resources) Conference, Dallas. Contact: Alice M. Moore, Director, Public Affairs, P.O. Box 500, 303 S. Northwest Highway, Park Ridge, Ill. 60068, (312) 693-7300.

27-29 Advanced Semiconductor Equipment Exposition, San Jose, Calif., sponsored by the Electronic Representatives Association - N. California Chapter. Contact: Cartlidge & Associates, Inc., 491 Macara Ave., Suite 1014, Sunnyvale, Calif. 94086, (408) 245-6870.

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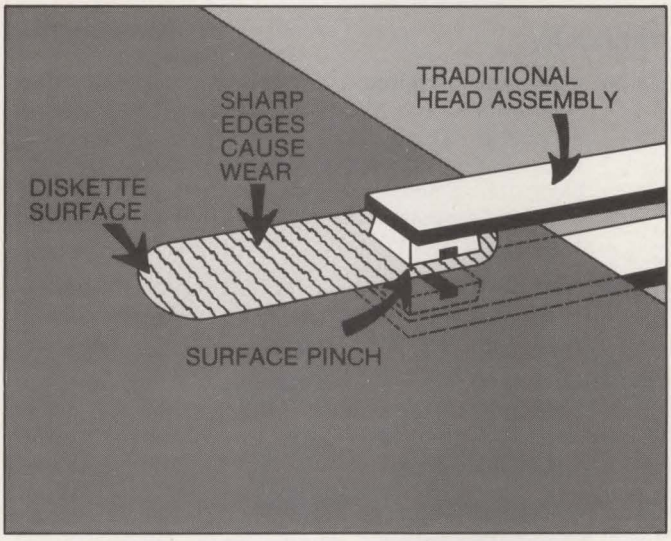

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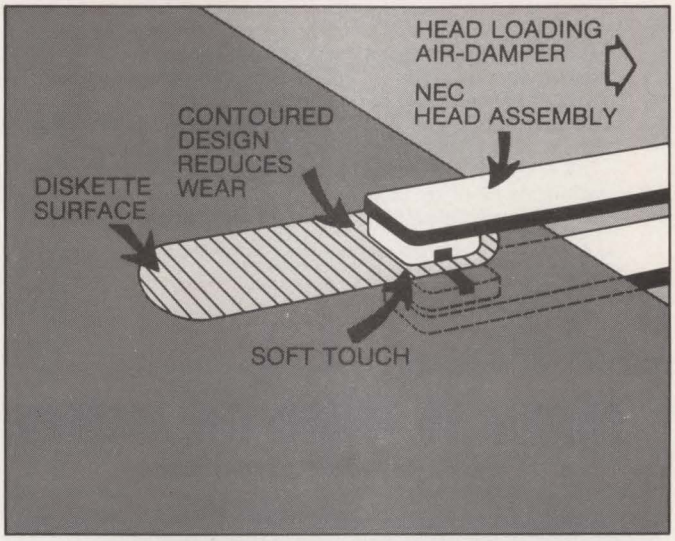
NEC diskette drive



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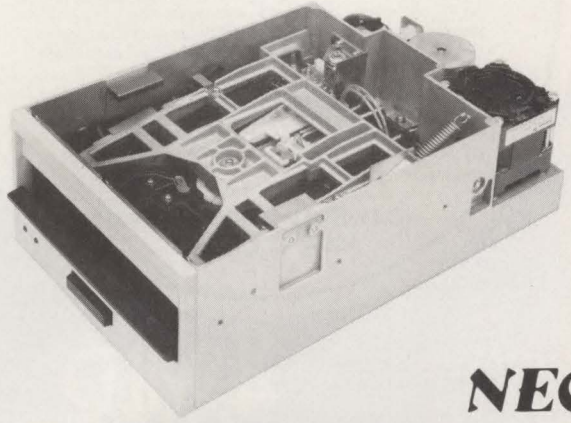

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Calendar

28-31 Internepcon Japan/Semiconductor International '81, Tokyo, Japan, sponsored by Industrial & Scientific Conference Management, Inc. Contact: Industrial & Scientific Conference Management, Inc., 222 W. Adams St., Chicago, Ill. 60606, (312) 263-4866.

28-31 International Microcomputers, Minicomputers, Microprocessors/Data Communications Exhibition (IMMM/DATACOMM), Tokyo, Japan, sponsored by Industrial & Scientific Conference Management, Inc. Contact: Industrial & Scientific Conference Management, Inc., 222 W. Adams St., Chicago, Ill. 60606, (312) 263-4866.

FEBRUARY

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

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

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

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

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Mini-Micro Systems is planning a special report on data communications and network products for March, 1981. The report will include several survey articles, and we want to be sure that as many vendors are represented as possible. Vendors of products in either of the two fields below are invited to contact our contributing editor on data communications, Walter A. Levy, President, Edgewood Computer Associates, Inc., 51 Strawberry Hill Road, Hillsdale, N.J. 07642, immediately to assure that you receive the appropriate vendor questionnaire.

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Tektronix graphics copier lowers cost, raises quality

An electrostatic graphics hard-copy unit introduced by Tektronix, Inc., this month uses a novel moving print head and dry toner system to lower unit cost while also improving image quality. The innovative design gives the new copier a significant price and performance edge over electrostatic copiers from other manufacturers, according to Gerard H. Langeler, marketing manager for Tektronix's copiers, plotters and imaging systems business unit.

The Tektronix copier comes in two versions: the model 4611 for use with storage-tube display terminals and the model 4612 for use with raster-scan displays. Intended to copy small screen displays, the units produce 7½ × 5¾-in. images on 8½- × 11-in. sheets of dielectric paper.

Both devices sell for $4400, with OEM prices and discounts available. This compares to $6400 on the V-81 electrostatic copier from Versatec. Houston Instruments, Inc., offers a hard-copy unit, the model 8610, at about the same price as the Tektronix unit, but Langeler claims that the Tektronix unit provides better image quality.

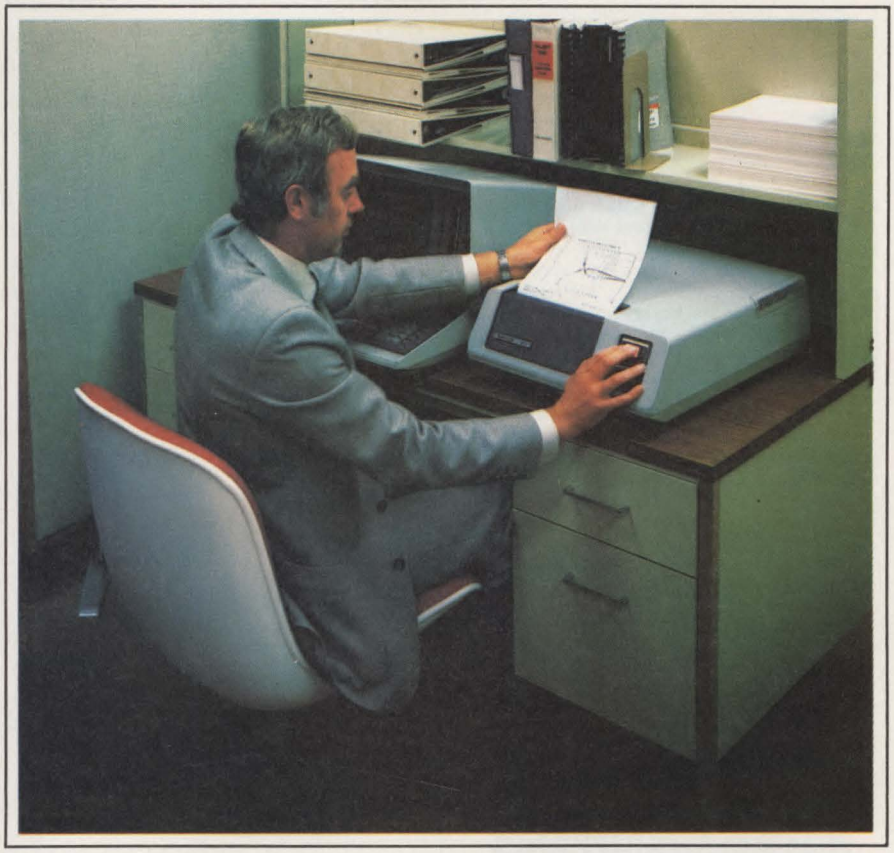
The 4610 series units are aimed at black-and-white hard-copy applications where cost is an important consideration. For example, they can be used where economical working copies are necessary to preview gray-scale or color copies. The low cost per copy associated with electrostatic technology, plus the low unit price of the new Tektronix copiers, also make them appropriate for use with the increasing numbers of low-cost graphics terminals and desk-top computers now available, Langeler says.

The two units expand the Tektronix line of hard-copy devices, which include the 4631 (storage tube) and 4632 (raster-scan) units for applications requiring photographic quality or continuous gray shades. These units, which use electrophotographic technology to produce high-quality copies for dense and complex graphics displays, are priced about the same as the electrostatic printers, but they use a more expensive photosensitive paper. The company's line also includes the model 4634 imaging hard-copy unit for applications requiring high-resolution copy with multiple gray shades.

The Tektronix electrostatic copiers use a dielectric paper that has the look and feel of bond paper, permitting pen or pencil notations on the copy. The paper comes in rolls, with each roll providing about 540 copies. The cost per sheet averages about 2¢, making total copy cost, including toner, about 3¢ per copy. This compares to a 10¢ to 20¢ per-copy cost for Tektronix's electrophotographic copiers.

The new copiers are the first products from Tektronix to use electrostatic technology, and they are seen as signaling the firm's recognition of the expanding role of electrostatic technology in computer graphics systems. "Electrostatic technology has emerged as a major hard-copy choice," says Langeler. "We expect it to become even more important in the next few years."

Electrostatic copiers create an image by placing an electrical charge on specially treated paper.



The low cost per copy *associated with electrostatic technology, plus the low unit price of the new Tektronix copiers, make the copiers appropriate for use with low-cost graphics terminals and desk-top computers.*

Mini-Micro World

The charge attracts a toner, which is then permanently fused to the paper. Electrostatic copiers are attractive to graphics users, Langeler says, because of low copy cost and the good qualities of electrostatic paper. "However, we saw three disadvantages to electrostatic copiers: high unit cost, poor image quality and the inconvenience of liquid toner systems."

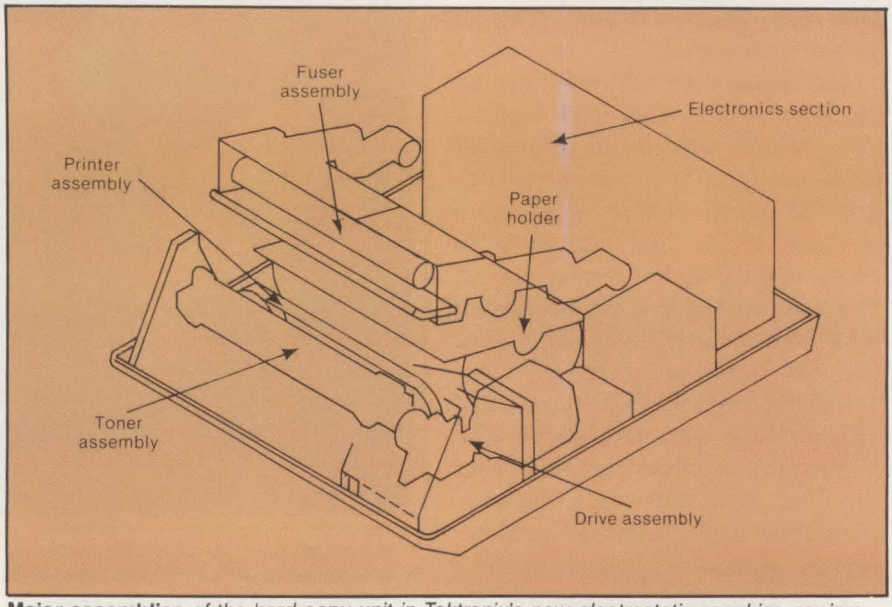
The primary reason for the high product price, Langeler explains, is the traditional implementation of the charge transfer operation. The charge transfer usually is achieved by using a matrix of fixed wire nibs containing as many as 200 nibs per in. The cost of manufacturing the wire matrix and providing the electronics necessary to drive the nibs is high, Langeler says.

The new Tektronix units, in contrast, use a moving steel band containing six writing styli and dual backing electrodes to transfer charge to the paper. The moving belt is easier to produce and is less costly than the fixed writing heads, Langeler says. Hence, the Tektronix unit costs less.

Moreover, the moving belt design improves image quality, Langeler says, by overlapping the dots that create the copy image. Several overlapping dots create a smoother, blacker line than distinguishable dots, Langeler points out. The Tektronix unit places as many as 256 dots per in. horizontally and 171 dots per in. vertically. Each dot copier overlaps the next by more than two-thirds horizontally and by nearly a half vertically.

The Tektronix copier's print-head design, however, would appear to entail a speed disadvantage because it involves moving the head's writing styli. Indeed, the Tektronix unit is slower—at 24 sec. per copy—than fixed-head copiers, Langeler concedes. But he maintains the speed difference is slight. For example, he estimates that the Versatec V-81 copier turns out copies in 20 sec.—a 4-sec. difference. Tektronix engineers were able to minimize the 4611/12's speed disadvantage, Langeler says, by using dual backing electrodes on the unit's writing styli—a design trick that effectively doubled its speed.

The toner system used by the Tektronix copiers also contributes to image quality, Langeler says. Toner systems used on other electrostatic copiers use liquids, which, besides being messy, inconvenient and often including



Major assemblies *of the hard-copy unit in Tektronix's new electrostatic graphics copiers.*

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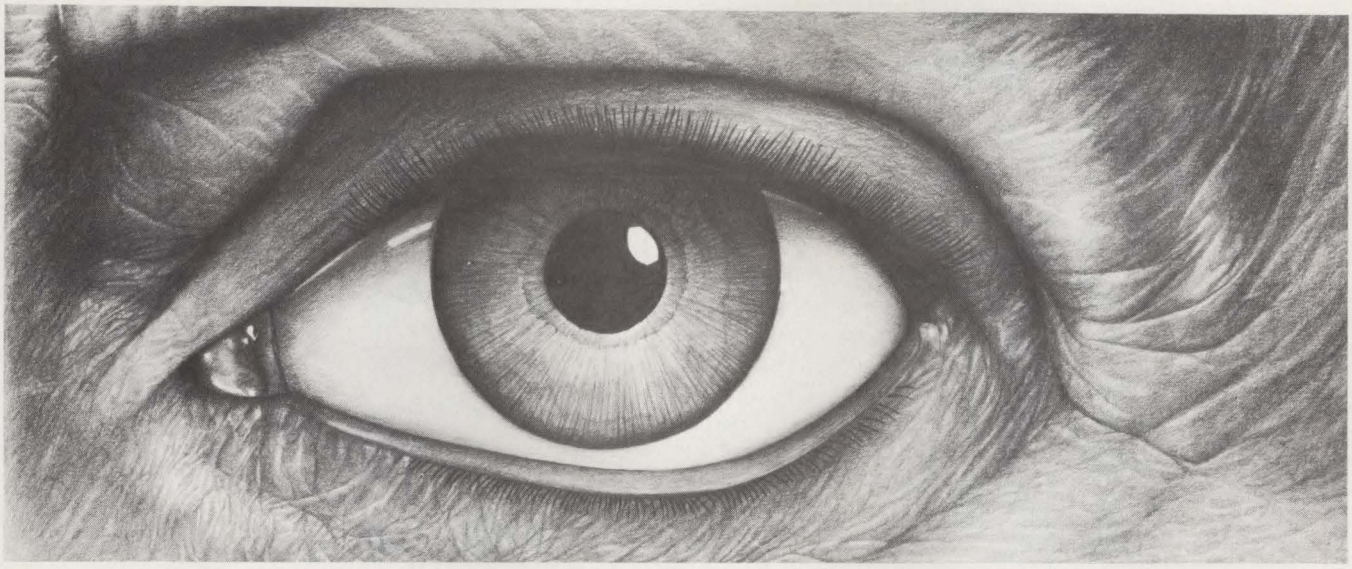

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toxic substances, produce copies of inconsistent quality with copies getting lighter as the supply of toner is exhausted. Also, the toner seeps into the paper between copies, leaving a characteristic "gray bar."

The Tektronix unit uses a dry toner that produces images of consistent blackness, Langeler says. The toner consists primarily of magnetized particles of carbon and wax. The charge on the paper attracts the toner. As the paper passes through the copier, a hot metal band melts the wax in the toner, making a permanent image on the paper. Dry toner is also easier and safer to use, Langeler says, because it uses nontoxic ingredients and is magnetic, so spilled powder is easy to retrieve.

—Paul Kinnucan

Pertec printer undercuts daisy wheel prices 50%

The most expensive part of a computer or word-processing system traditionally has been the printer, which carries a big price tag initially, and also can eat up as much as 50 percent of service costs. That cost of ownership has deterred price-sensitive, small-business and other low-end system users who want high-quality printers.

Pertec Computer Corp.'s Peripherals division, Chatsworth, Calif., is addressing this low-end, daisy-wheel-printer market with a price/performance breakthrough in printing: its high-quality Stylist 360 printer is priced at $820 in OEM quantities of more than 100. That price is about 50 percent lower than that of similar printers now on the market.

Pertec is able to achieve the low price by taking advantage of high-volume production by parent company Triumph-Adler, West Germany. The Stylist 360 daisy-wheel printer is based on the Triumph-Adler typewriter mechanism, already in high-volume production.

More than 200,000 Stylist 360s will be manufactured in the first year, says Lee Benedict, division product marketing manager.

The Stylist 360, initially aimed at large OEMs that can supply interface electronics and packaging, operates under μp control at 17 cps. An 8-bit Intel 8041-A μp supports bidirectional logic-seeking printing and diagnostics. This feature enables the next bit of printable data to be searched and the print head to move directly to it. The 360 prints 100 upper- and lower-case ASCII characters, has a 1024-bit buffer and a noise level of about 60 dB.

The printer's speed is about one-third that of other daisy-wheel printers, which average 45 to 55 cps. But it will still represent some competition to high-end printer manufacturers. "Diablo Systems, Inc., and Qume Corp. should be concerned," says Melody Johnson, a consultant at Quantum Science Corp., New York. She explains that Pertec has a good reputation as a supplier, Triumph-Adler has reliable products, and the printer represents a price breakthrough.

NEC SQUARES OFF AGAINST DIABLO

By incorporating multiple μps and denser parts packaging, NEC Information Systems, Inc., Lexington, Mass., is taking a stab at the lower-end word-processing market with its 3500Q typewriter-quality printer.

The printer, not including an optional control panel, is priced at $1430 in 100-unit OEM quantities. Use of the printer reduces the number of mechanical parts needed 50 percent and the number of electronic parts needed 60 percent over earlier NEC models, the company says. Industry sources say the 3500Q will compete with Diablo Systems, Inc.'s, low-cost entry, the model 630, which prints from 32 to 36 cps and carries a price of $850 in 500-unit OEM quantities, and $1705 for 500-unit quantities of fully configured versions (MMS, May, p. 71).

The 3500Q prints at 30 to 35 cps, is the size of an office typewriter and uses NEC's thimble print element rather than a daisy wheel. A Qume interface is built in.

The Intel 8085 μp drives the printer instead of the less powerful 8080 used in earlier models. All printer electronics, including three μps, are mounted on one circuit card rather than the three used previously. The μps control interfacing, carriage control, printing and paper feeding. Two μp-driven stepper motors coupled in a linear ball-bearing system direct the thimble up and down and as it rotates. This print-element-positioning method is said to reduce the number and cost of high-tolerance electromechanical parts. A technique called swagging is used in manufacturing the printer. With this technique, one automatic machine shapes and fits the printer's frame. The company claims that this provides greater strength and precision, and reduces the number of metal screws required for manufacture 75 percent.

The company also claims that the printer's design eliminates the need for factory and field adjustments, periodic preventive maintenance and lubrication of moving parts. OEMs will need to stock only three parts per printer—a print assembly, a universal power supply and a printed circuit board—says Bruce Thatcher, the company's peripherals product manager.

Qume Corp. is also expected to offer a printer in this price and performance range. Shipments of the 3500Q are scheduled to begin in January.

NEC Information Systems' 3500Q *typewriter-quality printer is aimed at low end of the word-processing market.*

Mini-Micro World

She says that other systems sell for about $1500 in OEM quantities, and end-user prices are $4000 to $6000. End-user price for the 360 is $1295.

The 360's competitive price is "not an attempt by Pertec to buy market share," says Ralph Gabai, Pertec's senior vice president and division general manager. "We want to establish prices that will expand the market in the next few years." Gabai says the $500 million daisy-wheel OEM market will grow about 35 percent annually over the next few years.

The market potential for the printer in word processing alone is more than 175,000 units in 1984, says Johnson. "The cost of printers has always been out of line with the cost of the rest of the system. This is what is needed for systems." Johnson views the 360's use primarily as a backup printer. As such, it will not compete closely with 55-cps printers.

Despite the low speed, which Pertec hopes to increase to 40 cps in a follow-on version, the company touts the 360's superior print quality and design features. A V-shaped fork cut into the print hammer and an inverted wedge on the back of each symbol ensure accurate character placement. The print wheels are strengthened with a compound, and rubber reinforcements are placed on the back of the characters. The company claims that print-wheel life is more than 50 million strokes, compared with the market standard of 4 million to 10 million strokes. Benedict also points out that the printer has enhancements that cut noise 10 to 15 dB over other daisy-wheel printers.

The printer is now wholly manufactured by Triumph-Adler in Germany, but the company is exploring the idea of assembly in the U.S. Licenses for manufacture of the printer may be available in the future. *—Lori Valigra*

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Lexiscope 4000 is priced at $2,500.00 for quantity one with substantial quantity discounts available. Delivery is two weeks ARO. For more information call Ron Noonan at (617) 891-6790 or write to Lexicon.

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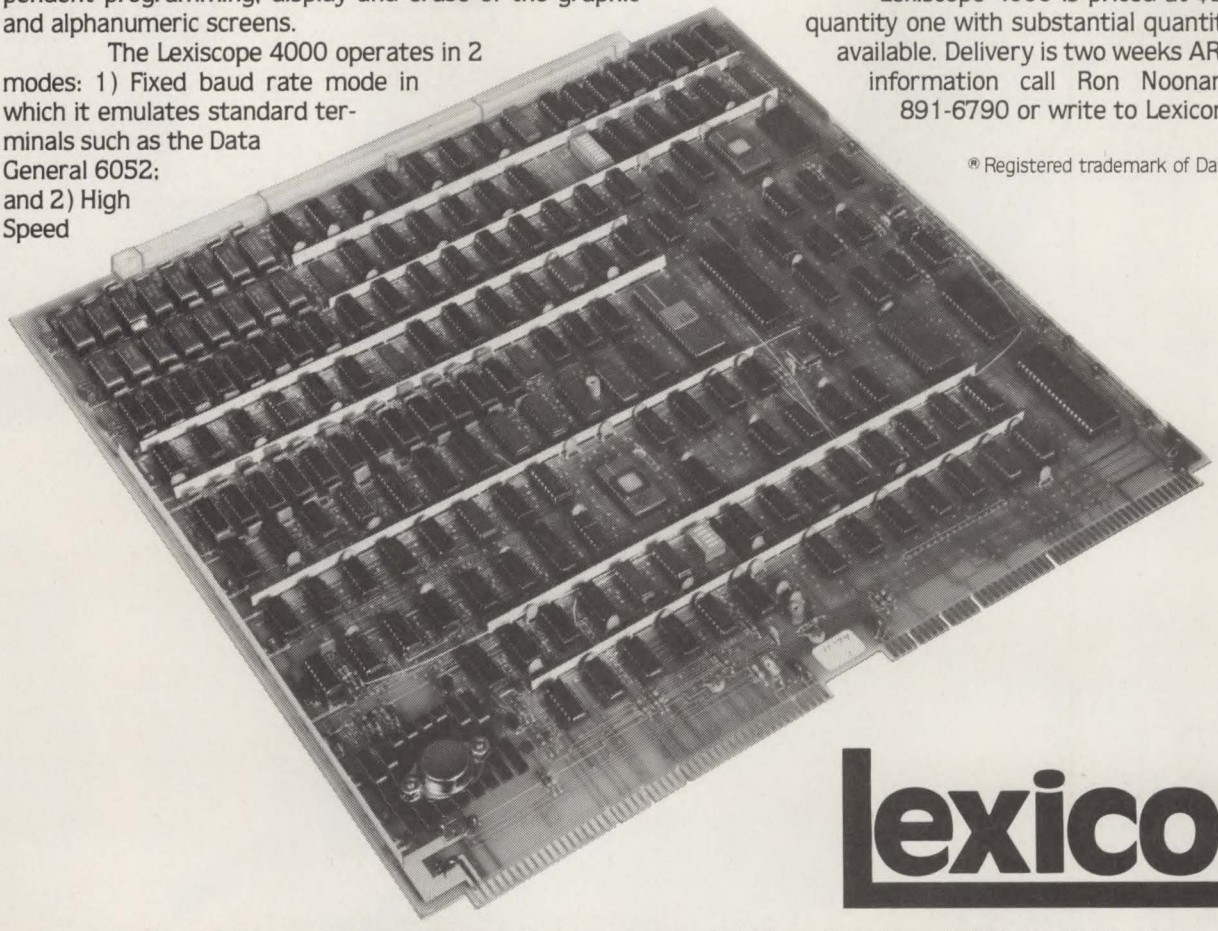

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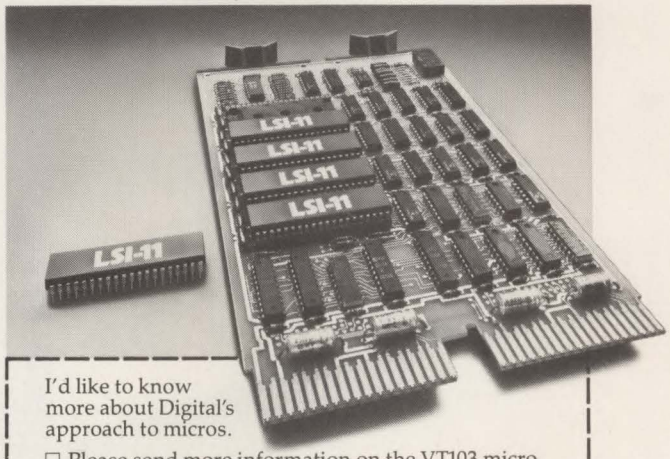

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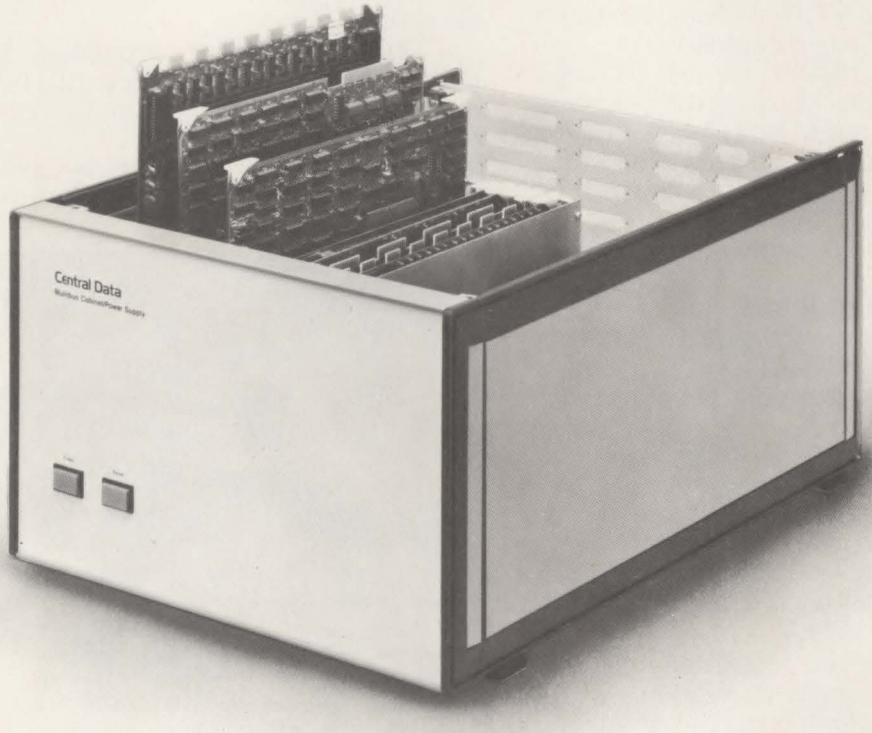

The Roloff System

Until now, the limitations of 8-bit microprocessors made the development of multi-user systems for micro-computers impractical and unattractive. The Roloff System has conquered those limitations by exploiting the performance potential of the 16-bit microprocessor. Roloff system's 16 bit zilog Z8000 processor has five to ten times the throughput of its 8-bit counterpart, giving it the extra power to handle the burden of communicating with several terminals at once. And Roloff systems put that power to work with an advanced operating system never before used in microcomputers.

The Roloff system supports from one to 32 users simultaneously, each running a different program. The system can range from 1-32 terminals or printers and 96K to 16M bytes of internal RAM. For disk storage, it can accommodate from 2M to over 250M bytes using floppy, winchester or cartridge disk interfaces.

A time-saving indexed file system efficiently stores and retrieves data using multiple keyed fields. Searching from an index instead of reading a long file saves many disk operations and allows more than one user to access the same information at once.

Users can "talk" to each other through the terminals with Roloff Systems advanced communications system. Notes files, both personal and general, can be accumulated and displayed using simple commands. A special paging function enables users to conduct typed "conversations" with each other. A tone from the terminal pages the user and the two-way message is displayed on the screen.

A reliable but simple security system protects files from unauthorized access. Every file on the system can have read access or read/write access for certain individuals. Most users will not have to type any passwords once they have signed onto the system, yet all data bases are still protected from unauthorized entry.

Fast response is the benefit of Roloff Systems file cataloging. When all users leave a program, the system can catalog it for quick access later. If a user selects a program that is already being used, in most cases both users can share the program in memory.

System components are "state of the art" and go through extensive quality control tests and burn-in procedures to insure reliability. Floppy disk, Cartridge disk, winchester disk, and cartridge tape drives are available.

Options include selection of internal memory size, disk memory type, arithmetic processing units, and I/O interface boards. The versatile Intel Multibus allows the user to expand the system by purchasing boards from many different manufacturers. You can start with a small system and easily enlarge it, without making any changes in original programming.

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An example system might include 128K bytes of internal RAM, a 10 megabyte cartridge disk, and an interface for up to four terminals or printers. Such a system would cost $11,345.

The Roloff System

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The computer as library

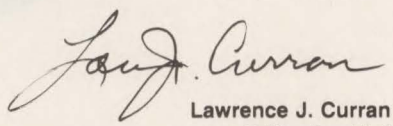
My hometown is a city near Pittsburgh that had a very good library. Steel baron Andrew Carnegie endowed many communities in that area with splendid libraries that included far more than books. Ours had a year-round swimming pool, gymnasium and pool tables, all of which acted as a magnet that unavoidably exposed us to books at an early age. Books have provided me with avenues to learning, leisure and fantasy ever since, and libraries still provide a quiet refuge.

Libraries don't seem to have the same attraction for my sons, who are children of the television age. But the screen of that tube they watch so much is a powerful educator, which offers adventure and fantasy as well. It is to their generation what books are for mine. It was with mixed feelings, then, that I read of a fascinating development at Clarkson College, Potsdam, N.Y., in a *New York Times* News Service article by Dena Kleiman. The college has built a new $4 million library that takes advantage of the computer's power both as an archival and communications medium that has more immediacy than do books.

Clarkson's curriculum emphasizes science, technology and management, so it's not surprising that the administration there recognizes the need to have its library loaded with computers, videotape decks and slide projectors that can contain and convey the very latest in reference data. Dr. Robert A. Plane, Clarkson's president, contends that books can be too slow, especially books about technical topics. Information they contain is often outdated by the time the book is distributed. He points out that with computer processing and communication, educational information can be written, edited and immediately disseminated via terminals.

The Clarkson administration is to be commended for its enlightenment in recognizing the potential of computers in education.

I hope my sons can attend schools that offer similar opportunities. But indulge me as I wring my hands at the prospect of libraries, as I know them, disappearing. The one I knew in my youth fell victim to the wrecker's ball, and wasn't replaced. Ms. Kleiman's article about the Clarkson "educational resources center" reports that it replaces something that was called a library. I hope that Clarkson has made provision to keep books, especially works of fiction, in a section of the center that smells like a library. I'm all for progress in technology and education, but I want to be sure that my sons will have some places of refuge where they can lose themselves in a good book.



Lawrence J. Curran
Editor-in-chief

Intel used to make the hottest In-Circuit Emulator in town. But not any more.

Introducing Advanced Micro Devices' RTE16/8050.

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Frank W. Zurcher, President, Advanced Micro Computers. A subsidiary of AMD

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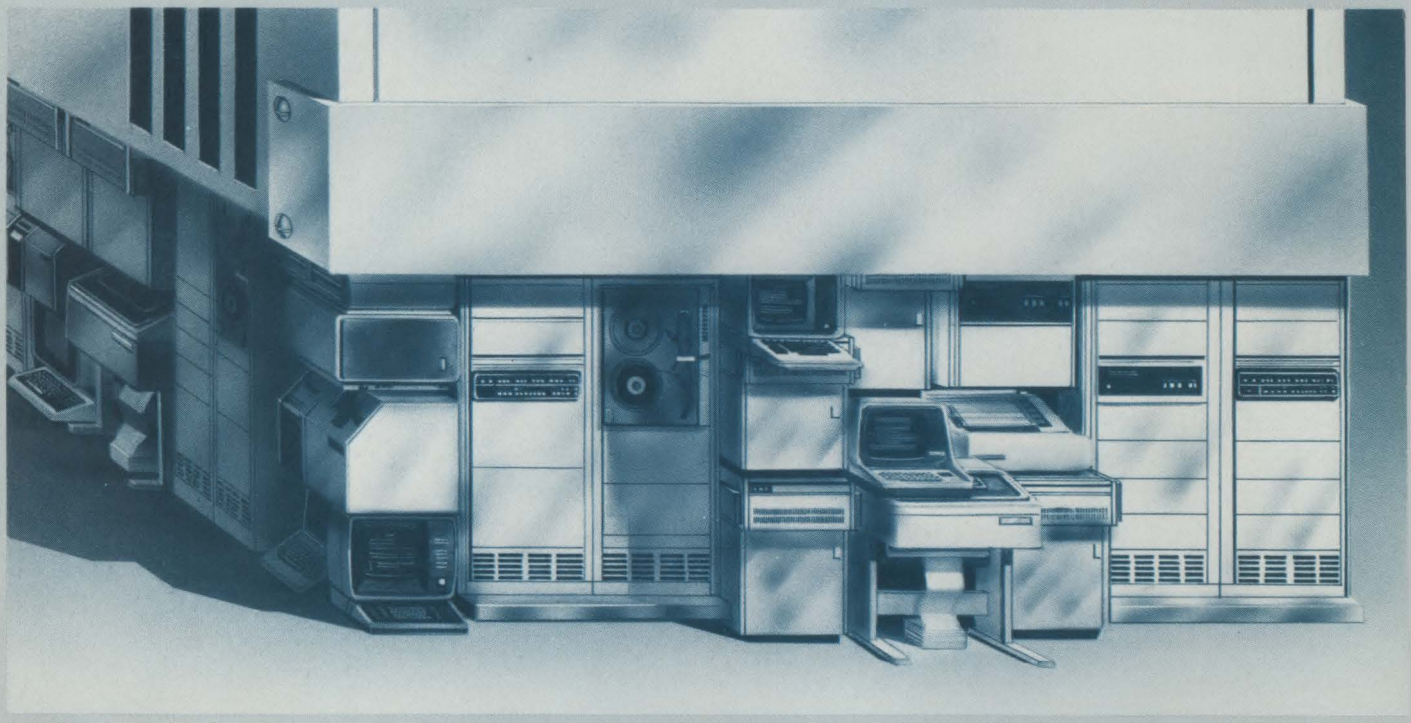

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Letters

EVALUATION QUESTIONED

To the editor:

I read with great interest the article on the ORACLE data base management system by Harvey M. Weiss (MMS, August, p. 111). I was involved in the design of INGRES, a relational DBMS running on PDP-11 and VAX machines, and I retain a strong interest in similar systems.

Mr. Weiss does not make it clear in the article whether his evaluation was based on first-hand operating experience. I too have had no first-hand experience with ORACLE, but users at two recent ORACLE installations (UNIX and RSX) tell me that many of the important features on which ORACLE scores high in the Weiss survey either did not exist or did not work in their copies of the system.

I think it is important that an article purporting to "survey the features" of a DBMS and "evaluate its performance" be based on hard evidence gained from actual use. If, instead, it is at least in part based on a vendor's product announcements, that fact should be clearly stated. The hard realities that users face are often quite different from the vendor's hopes and dreams.

An independent feature analysis of ORACLE has been prepared by the ANSI task force on relational systems. A similar analysis also exists on INGRES. Interested readers should contact Professor Michael Brodie of the University of Maryland, College Park, for further information.

Eugene Wong, Professor
University of California, Berkeley

(The author replies: In the review of any software, whether for an article or potential purchase for a client, two sources for evaluating data exist. The first is from the vendor; the second is from a client reference list. Both have been used in this effort. If a discrepancy develops between the data received from the vendor and its client, we explore it. If not, these discrepancies can be found only through a third source. The facility for proving the vendor's products from a "hands-on" situation often cannot be done.)

Harvey M. Weiss
Weiss & Associates
Aurora, Colo.

VERBAL COMMUNICATIONS

To the editor:

I look forward to reading *Mini-Micro Systems*, because it is one of the few truly professional publications for small computer-development people. The other publications lean mostly toward personal computer users and hobbyists. Every month, as I peruse the contents, an entry describing a particularly interesting piece catches my attention. Inevitably, when I turn to the indicated page, Carol Anne Ogdin's byline appears.

Although I sometimes am familiar with the topic of Ms. Ogdin's piece, I find myself reading it avidly anyway. Her means of expression is so articulate that she helps me organize my ideas in any given area, expanding my grasp of the subject. In those areas with which I am unfamiliar, I become quite familiar by the time I have read her column. As a woman who also publishes technical explanations, I know the difficulty of using English prose to convey computer concepts. One often struggles a long time for precise vocabulary free of jargon. Sometimes I read the results of a creative burst and wonder if anyone but myself will understand what I thought I expressed so succinctly.

Ms. Ogdin and *Mini-Micro Systems* are to be commended for their success in the difficult art of verbal communication.

Abby Gelles, Author
"Robotics Curriculum," Trillium Press
New York, N.Y.

CORRECTION

An article that appeared in the October, 1980, issue of *Mini-Micro Systems* should have included a list of references. A portion of the article, "Multiprocessing networks vs. mainframes," which began on p. 121, drew heavily on one written by Burt H. Liebowitz of International Computer Co., Bethesda, Md., in the October, 1978, issue of *Computer Design*, and should have credited both Mr. Liebowitz and that publication.

CORRECTION

In the October issue, the prices were inadvertently reversed for Spectra Logic Corp's Spectra 20 and 21 ("Single-board controller ties disk and tape drives," p. 17). The correct prices are $5100 for the Spectra 20 ($4100 in quantities of 25) and $6000 for the Spectra 21 ($4700 in quantity).

Hewlett-Packard announces another small breakthrough.

The two-board, 1/2 megabyte microcomputer.

Our HP 1000 L-Series now offers state-of-the-art 64K RAMs. They're the reason we've been able to put 512 kilobytes of memory on just one 6¾" x 11" board.

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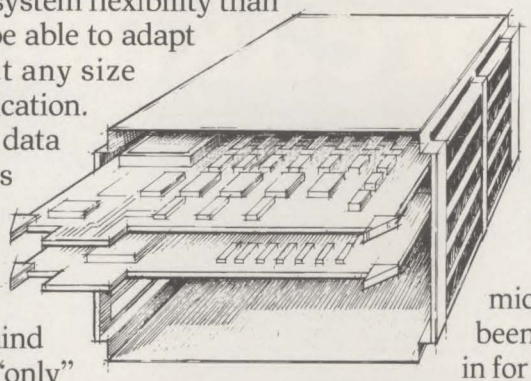

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You may have to remind yourself that the L-Series is "only" a microcomputer. With powerful software features like our multi-programming, multi-user RTE operating system and language support that includes Assembler, FORTRAN 4X, BASIC and PASCAL, there's almost no limit to the high performance products you can build. Especially if you take advantage of our proven data base management system and networking software—also upwardly compatible throughout the entire HP 1000 line.

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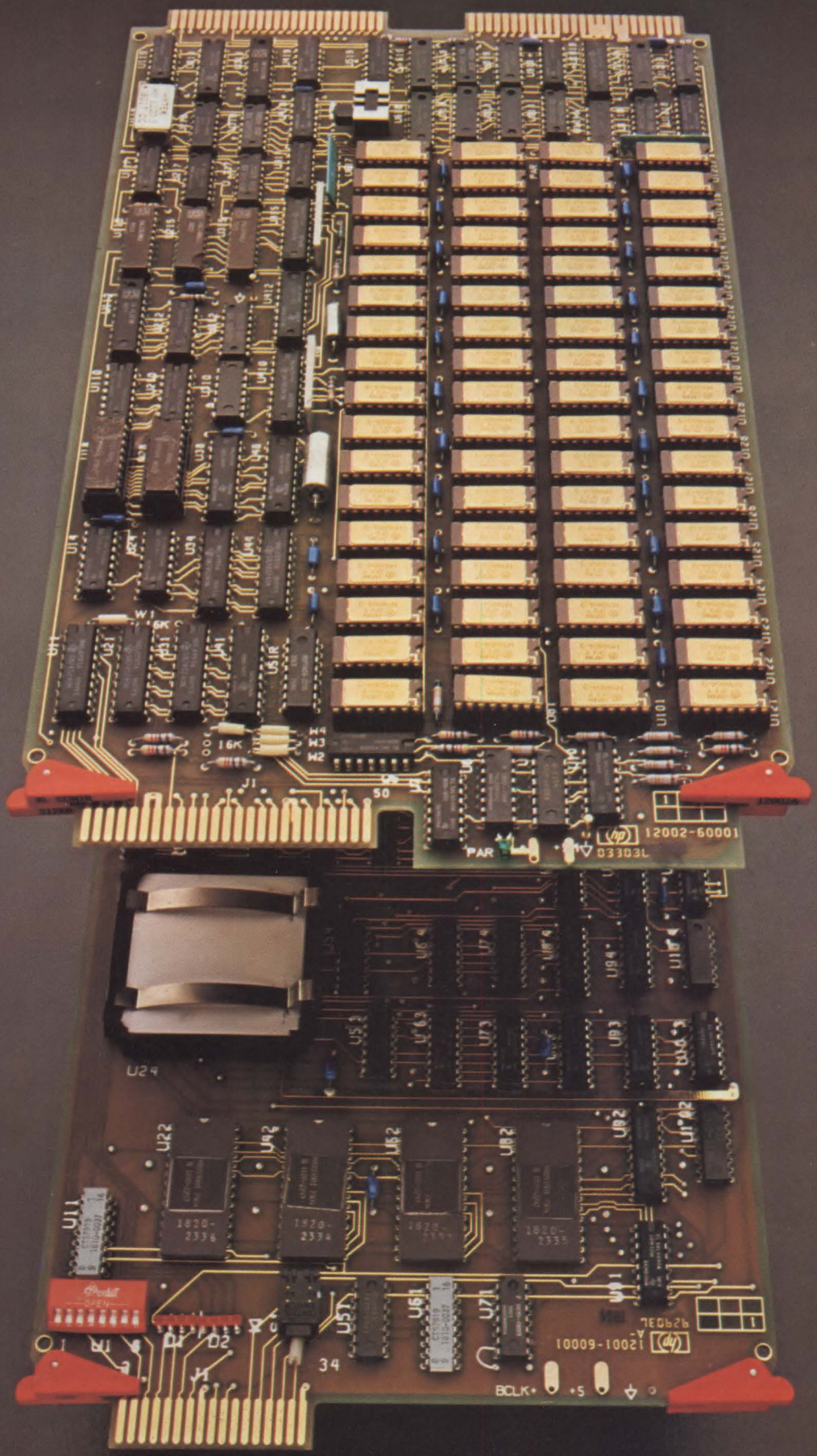

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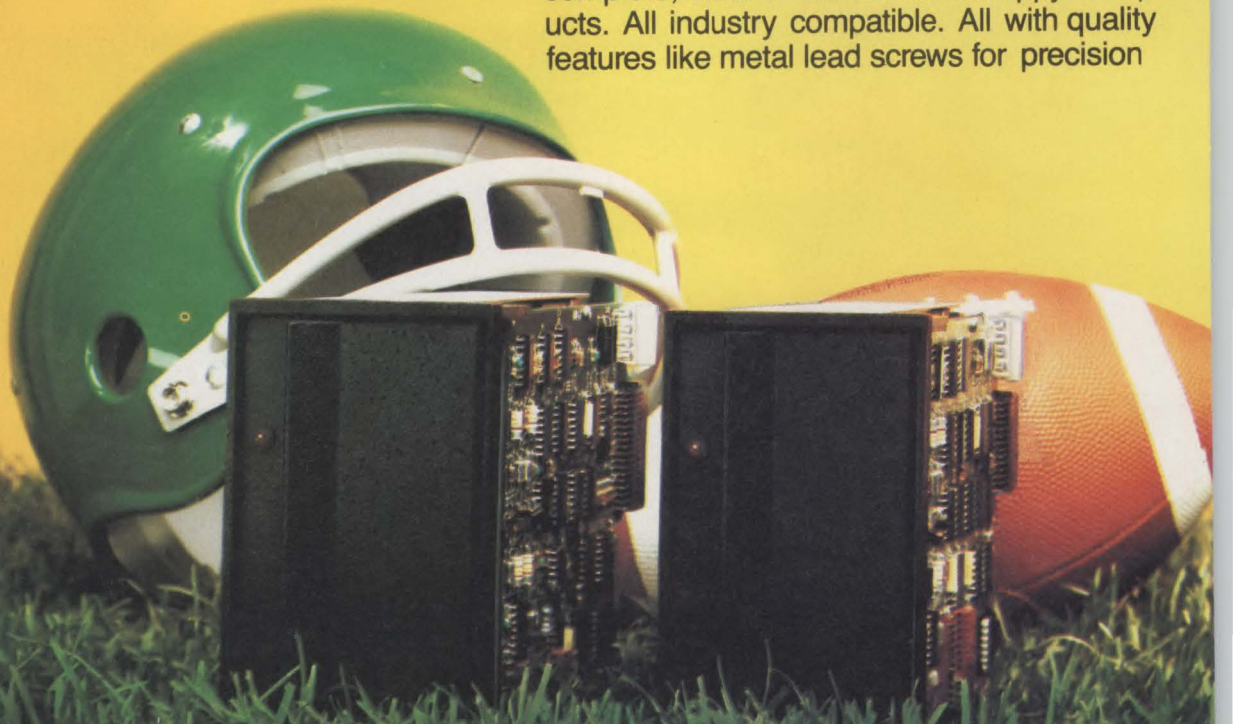

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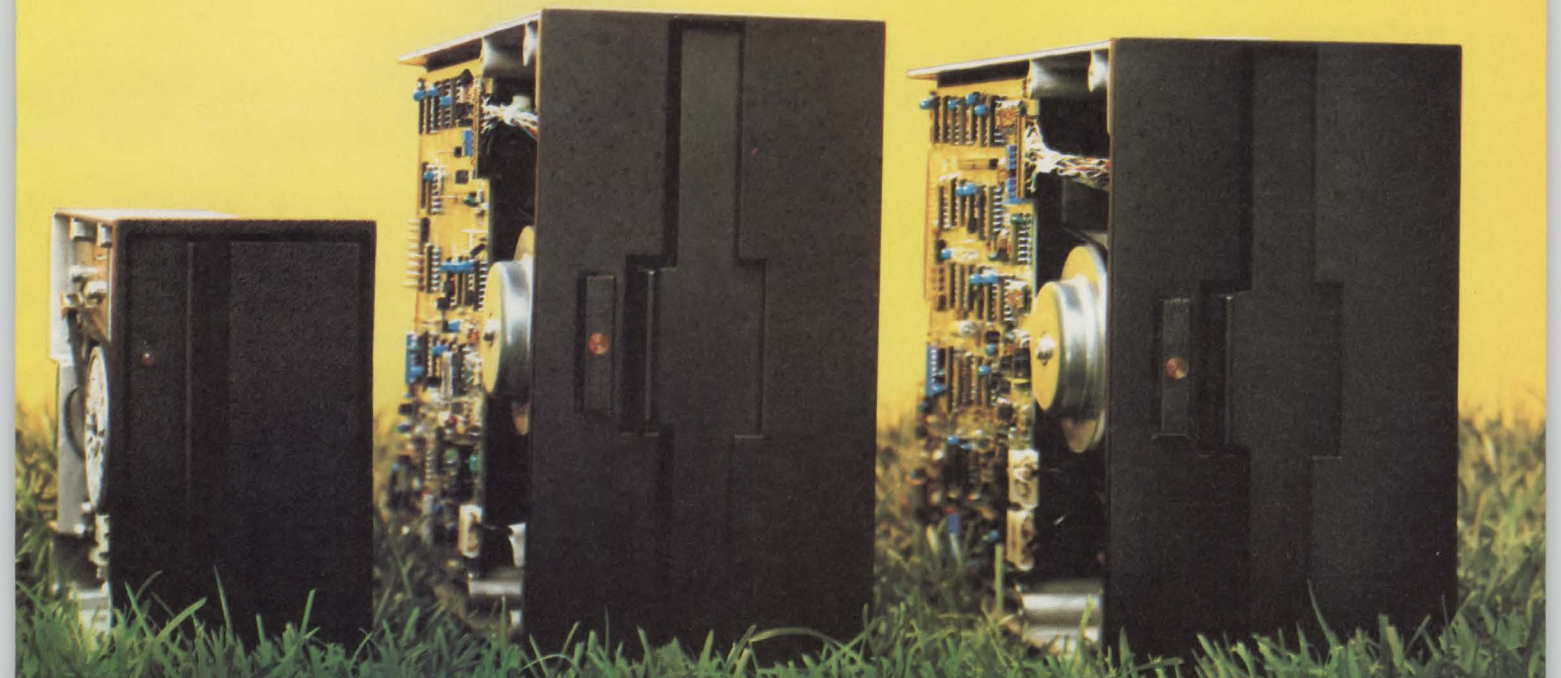

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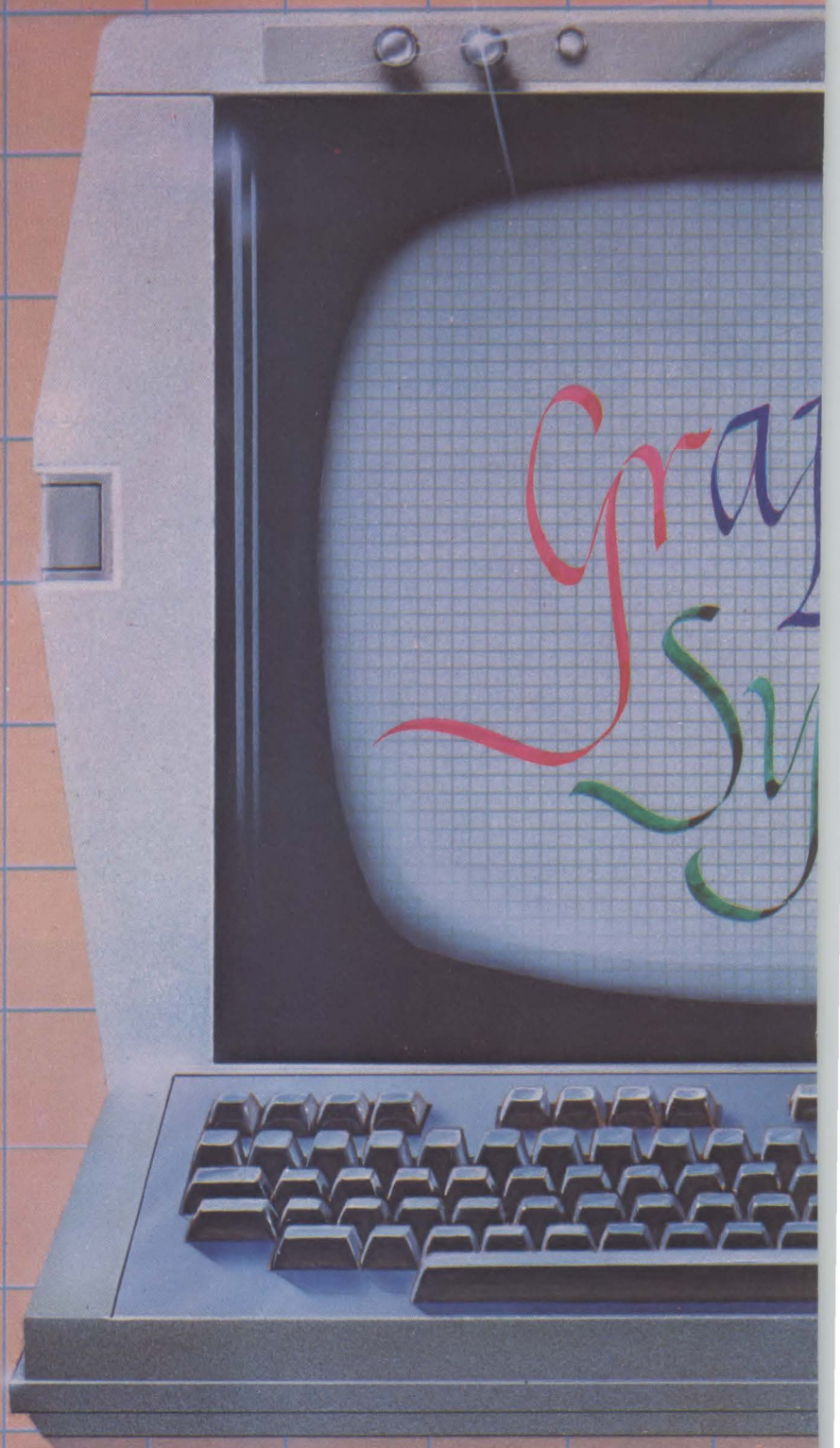
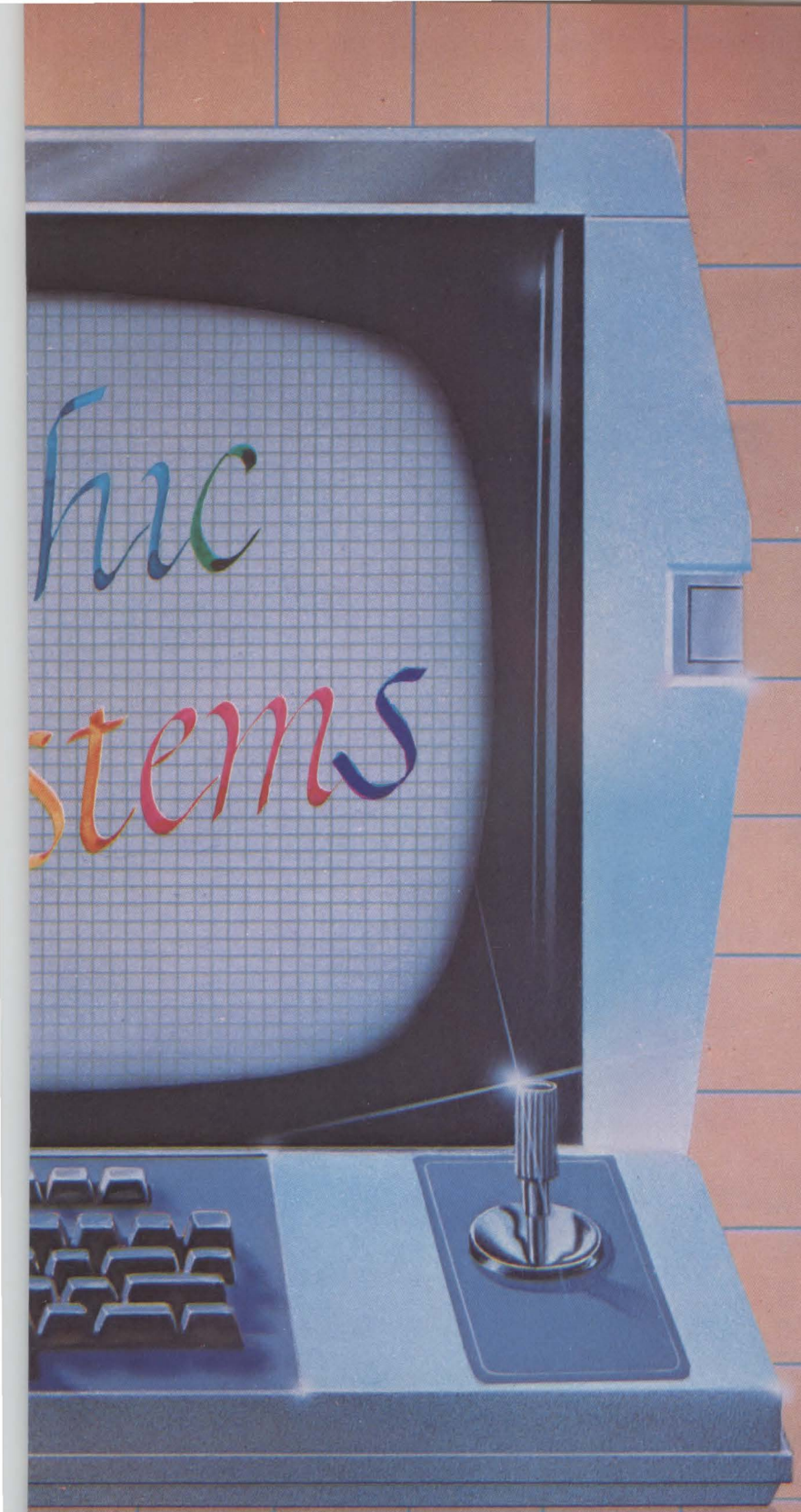


Computer graphics represents the computer state of the art more than any other single machine discipline. That's a strong blanket statement, but supportable on several levels.

Technologically, graphics draws on—and forces—development in every complex hardware and software area. Software advances in data base design, structured programming techniques and finite mathematical algorithms for computer projections (e.g., the calculation of hidden line coordinates) are absorbed almost immediately by product designers. Similarly, hardware advances in the form of specialized processors (such as array and arithmetic processors), faster memories and better displays, also find their way into products with a minimum of technological lag.

From a broader standpoint, however, the forcing function is not technological, but human. To say that today's graphic systems are better because graphics technology is better not only is putting the cart before the horse, but is losing it in the forest. Graphics technology is better today because users *need* better graphics. Computer users have always needed graphics. It just hasn't always been realistically available. Thus, rather than making a market, the increased performance and lower price of available graphics products have finally reached one. An existing market pulls technology; technology does not push the market.

The commercial sector, particularly, is falling all over itself for low-cost graphics because, unlike other sophisticated computer technologies, business users do not have to be told about graphics, only shown. The situation is analogous to the salesman who sells himself to a company. The company *sees* what it never doubted it needed. Once business decision makers see that they can get pie charts instead of share-of-market figures, graphs instead of time series data, and histograms instead of relative per-



centages, the question becomes only a matter of which graphics system to choose. Raw need is rarely the issue.

This should surprise no one. Humans receive hundreds of times more information from their eyes than from all their other senses. Moreover, humans *think* graphically.

Technology, then, has its work cut out for it. Graphics hardware and software designers have a long way to go before their products can approach the capabilities of that incredible graphics processor—the human brain—but there can be no argument about the need for moving in that direction. The operative words for current and prospective graphics end users are not "why" or "if," but "which" and "how."

In the articles that follow, we concentrate on those words. The lead survey article on interactive graphics systems by contributing editor Mal Stiefel discusses that universe of "which." Similarly, information on selecting between alternative graphics hard-copy devices is presented in an article by Tektronix's Gerry Langeler. A third "which" article, by Gary Sawyer of Genisco Computers, outlines the advantages/disadvantages of raster scan versus storage tube displays. While Genisco manufactures raster-scan systems exclusively, we found Sawyer's treatment objective and valuable for prospective users of either type of display. Users still undecided, however, will be interested in the description by Megatek's Peter Shaw of a system that implements both these display technologies.

"How" issues are addressed in an article on a new computer language for visualizing structural designs, and one from IBM on that company's approach to commercial graphics applications.

Taken together, these articles provide a valuable perspective on what is available, which systems are best for you, and how best they can be used.

Alan R. Kaplan
Executive Editor

Illustration by David Biedrzycki/Calligraphy by Joan Joos

The AED 512... graphics, imaging, Superoam™ and integer zoom in one desktop terminal!

At the Siggraph '79 Show, it was acclaimed as 'The Incredible Graphics Machine!' Since then, the AED512 full-color graphics and imaging terminal has more than lived up to its reputation among sophisticated users. Its ability to display 256 simultaneous colors (from a total palette of 16.8 million) on a 512 x 483 pixel screen; zoom at integer increments to x16; pan continuously via joystick; perform full-screen DMA transfer in 0.5 second; emulate Tektronix 4014 software; allow overlaying TV images with computerized graphics; permit animation by using read/write masks and colorblink make its under $20,000 price tag seem small. Add to this its unique ability to Superoam an expanded image of 1024 x 1024 pixels and you'll see why the '512 is way ahead of the competition. For information call Advanced Electronics Design, 440 Potrero Ave., Sunnyvale, CA 94086. Tel: 408-733-3555. Boston: 617-275-6400. LA: 213-705-0379.

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Graphic Systems

Surveying interactive graphics systems

MALCOLM L. STIEFEL, Contributing Editor

As hardware prices come down, interactive graphics systems are finding more buyers and fresh applications

The opening hours of the 1980 National Computer Conference were quiet. The hordes had not yet fully descended, leaving the cavernous Anaheim Convention Center, for the most part, sparsely populated. But only for the most part. At the Megatek booth, curious onlookers were packed in so tightly that seeing the exhibit was difficult, and moving closer was almost impossible. They shoved and craned to get a better view of the animated airplanes and printed-circuit layouts shimmering in living color across the CRT displays. For a computer is just a computer, and a picture is just a picture, but together they are spellbinding—fun for young and old, and increasingly profitable.

The profit potential alone is enough to excite anyone, user or vendor. Recent figures from Merrill Lynch show the computer-aided design and manufacturing (CAD/CAM) segment of the interactive graphics (IG) market growing at 60 percent a year. The animation market is as explosive as Mount St. Helens, and

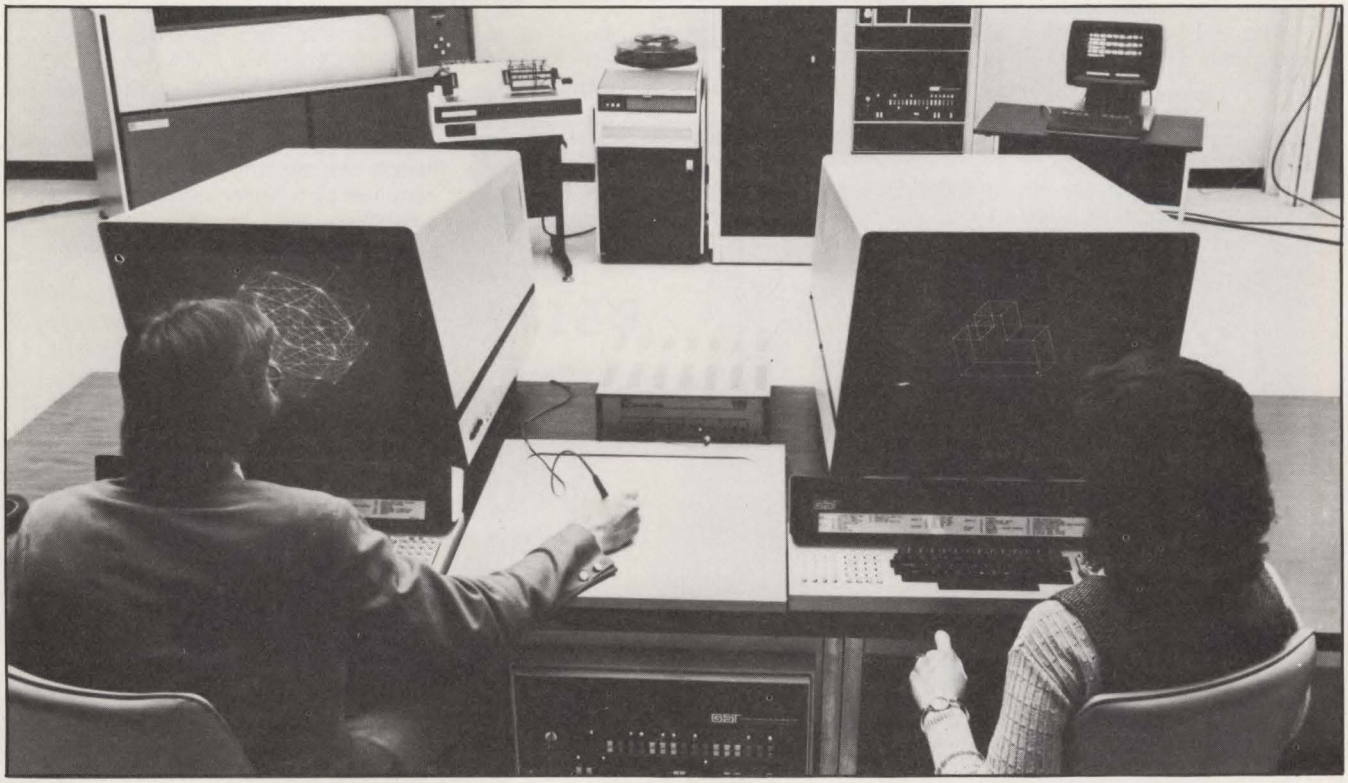


Fig. 1. A typical interactive graphics system *from Gerber Systems Technology, Inc.*

Many products—notably VLSI chips—would not exist at all were it not for the IG systems used to design them.

mapping is on the move. As hardware prices spiral downward, more and more users with more and more applications appear, checkbooks in hand. For them, graphics systems are more than toys: they're cost-effective tools for product design, process control, research and a host of other tasks, old and new.

Applications

Interactive graphics systems may never have the pervasive effect on society that general-purpose data-processing systems have already had—printing bills, clearing checks, printing mailing labels, computing biorhythms—but they are key elements in dramatic, almost magical applications that bubble to the surface in a steady stream. Many products—notably VLSI chips—would not exist at all were it not for the IG systems used to design them.

Printed-circuit board design and artwork generation, a major IG application, belong to the growing class of activities called CAD/CAM. The cost-effectiveness of such systems is well established; users expect productivity gains of 300 to 500 percent in design work. For example, General Electric Co.'s Aircraft Engine Group uses interactive graphics to link jet-engine design with manufacturing, cutting production lead time substantially.

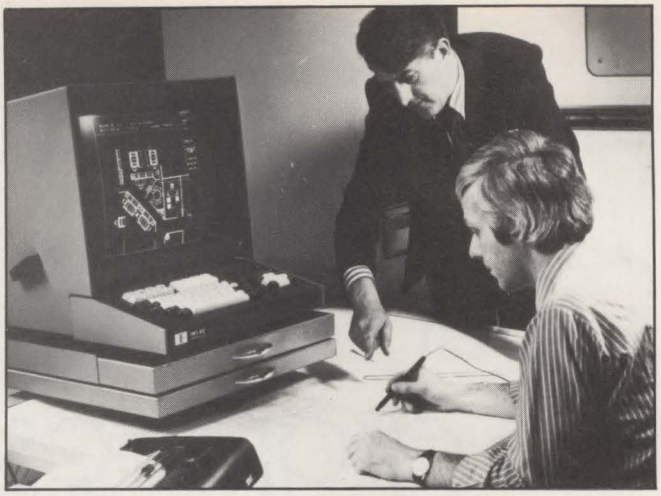


Fig. 2. Imlac Dynagraphic *display system.*

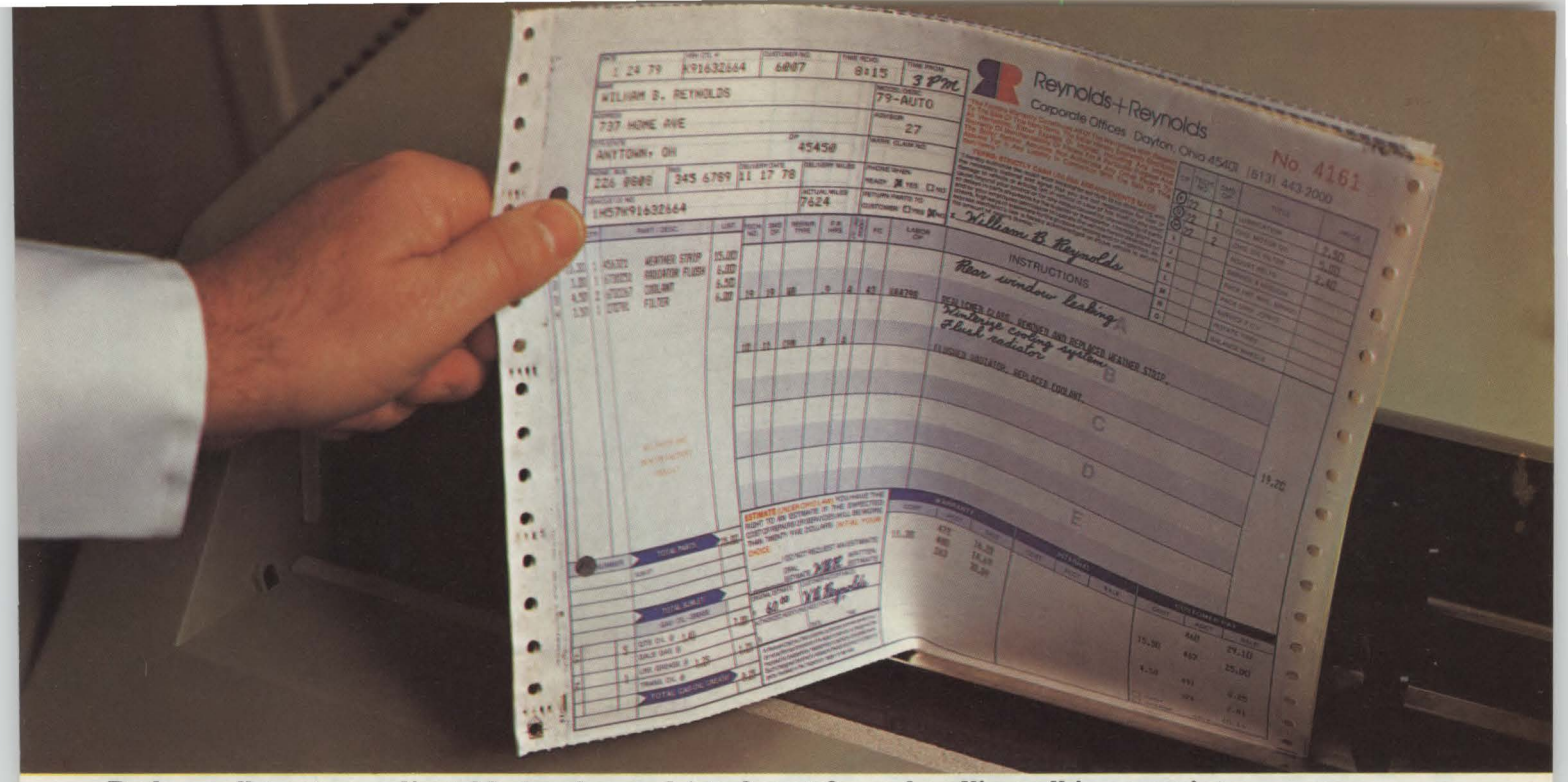
A far-reaching program is under way at International Harvester's Solar Turbines Group, which is pouring $5 million into CAD/CAM hardware and software over the next five years, to automate everything from the engineering conceptual process to production on the shop floor. General Motors already has more than 1000 IG stations on its premises to assist in automotive design and engineering, and recent Ford Motor Co. television commercials have shown glimpses of IG stations in action.

Many state and local government planning agencies are using IG systems to create, edit and retrieve from map data bases. Specific applications range from land-use analysis to redistricting, water-quality management and study of criminal activity patterns. For

VIDEO INPUT ENHANCES GRAPHICS

The ability to combine a live video input with previously stored alphanumeric and graphic data—and to display the combination—distinguishes a system from Octek, Inc., Burlington, Mass. Built around a Data General Corp. Nova 4 computer, the Octek 2000 has a video input port that permits live scenes or pictures to be acquired, digitized, stored on disk and displayed in real time. The live scene can be anything that can be acquired by a closed-circuit television camera.

Real pictures and computer-generated graphics can then be combined in a mixed display from the same graphics memory. For example, the linear and alphanumeric data in the accompanying graph were entered into the computer conventionally, then the portion of the dollar bill on which they are displayed was captured, and the combination displayed to provide a more compelling graphic effect than the graph's data provides alone. Applications for the Octek 2000 include cartography, advertising layout and composition, character-font creation and cartoon animation.



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Now CalComp brings you two more alternatives to help you meet your operational needs: The Graphic 7 stroke-refresh display system and Talos digitizers.

The Graphic 7 combines the latest technological features, including dual microprocessors, complete graphics support software and stroke-writing capabilities to give you all the benefits of interactivity, high quality image and operational ease.

Talos highlights its long line of fine digitizing devices with two new products, the Wedge and the 800 Series, each with advanced electromagnetic technology. The Wedge, with a five-degree sloped surface gives you greater operating ease. And the 800 Series, available in a variety of tablet sizes, allows for dual tablets, cursors and multiple interfaces for your varied applications.

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Whether for engineering, scientific, or business applications, you can be sure there's a CalComp product for you. Our family line of drum plotters includes a full range of sizes from desk tops, to our biggest drum plotter yet, the Model 1065 with an impressively large 72″ drum.

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CalComp 11″ and 22″ electrostatic plotter/printers offer an affordable solution to many applications requiring high speed production, and can also function as a high-speed line printer, while clear mylar media furnishes finished drawing quality.

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Users expect CAD/CAM systems to yield productivity gains ranging from 300 to 500 percent.

example, the U.S. Fish and Wildlife Service uses its system as an aid to fish and wildlife management and protection. And the U.S. Department of Energy uses an IG system for oil-shale resource mapping.

Military command-and-control applications have been around for more than 20 years, dating back to the SAGE air-defense system built in the late fifties, which displayed aircraft tracks and calculated vectoring instructions to send fighters to targets. Real-time track mapping has also been applied to en route and terminal air-traffic control problems.

In a lighter vein, IG systems have taken the movie business by storm, as exemplified by the fabulous success of *Star Wars* and its computer-generated special effects. And businessmen are showing interest in interactive graphics as a management tool, although progress in this market has been slow, because it is difficult, if not impossible, in most situations to calculate a finite payoff period for a business graphics system. IBM's recent announcement of a color graphics terminal and printer/plotter has caused a stir, but whether substantial sales will follow remains to be seen.

Progress is being made in graphic arts, where IG systems are interfaced to phototypesetters to create publication-quality drawings.

Chemical and petroleum companies are using IG systems to design new molecules, tailored to user requirements. Straight out of science fiction, this application illustrates better than any other the power, versatility and promise of interactive graphics systems.

Configurations

A typical IG system (Fig. 1) includes several standard components: a processor; one or more user terminals, with graphic displays and graphics entry devices; mass storage units, such as disk or tape drives; and output devices, such as plotters. The system also includes software to manipulate data and make the system's elements play in harmony. Some configurations also provide means for communication with other systems.

The distinctions among systems are seen most clearly in their relative size, power and flexibility, but it is difficult to draw a sharp boundary between IG systems and other types of graphics systems. A minimum IG system (Fig. 2) includes one terminal connected to a processor, which may or may not be embedded in the terminal. The largest IG systems (Fig. 3) include a dozen or more terminals tied to a mainframe or supermini, manipulating a disk-resident data base of several hundred megabytes. Between these extremes, a user can configure a system of, say, four clustered terminals (Fig. 4), tied to a minicomputer that also controls a variety of plotters or printer/plotters.

Some systems also incorporate alphanumeric terminals to facilitate handling of tabular information accompanying the graphics. For example, CalComp's IGS-500 system uses an alphanumeric terminal to display the bill-of-materials information that is produced with drawings of power and process-plant pipeline networks. Every user work station includes a graphics display and an alphanumeric display, side by side.

Graphics systems do not always come with full-blown application software. Many units, such as Genisco Computers' GCT-3000, are furnished only with general-purpose software development tools, with which the user is expected to implement his own applications. However, IG system development is fairly complex; typical graphics software development facilities are hard to use, and typical application programs are difficult to debug. Turnkey systems are advisable for all but the most technologically advanced end users. Fortunately, IG-system vendors have long recognized this situation, and turnkey systems are readily available for many applications. Moreover, the vendors are usually prepared to develop custom routines or to modify their standard software to satisfy specific user needs.

A user with installed hardware can buy or lease application packages from a software house. For example, Arrigoni Computer Graphics, Inc., of San

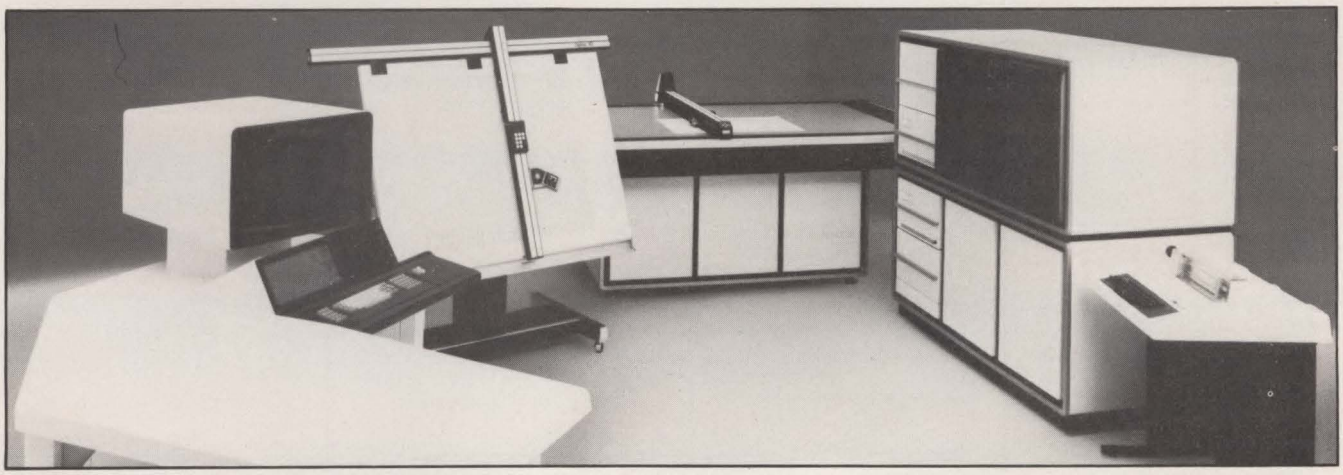

Fig. 3. Auto-Trol Technology Corp.'s AD/380 *is an example of a large IG system.*

TABLE OF INTERACTIVE GRAPHICS SYSTEMS SUPPLIERS

The following table is provided as a guide to evaluating vendors of interactive graphics systems. *Mini-Micro Systems'* staff prepared the table from its own sources and from information supplied by GML Corp., Lexington, Mass.

Manufacturer and Model No.	Terminal Characteristics	Graphics Functions	Output Media
Adage, Inc. GS/300 and model 4100	four terminals per system, stroke writer, 21-in. monochromatic CRT, trackball, light pen, joystick, digitizing tablet, 26,000 vectors, 256 characters	zooming, 2D, 3D, circle and arc generator, rotation, translation, windowing	electrophotographic hard copy, printer/plotter
Advanced Electronics Design, Inc. AED512	raster, 512 x 483 pixels, 14-in. CRT, 256 colors from palette of 16.8 million, 256 shades of gray, 256 symbols, joystick, emulates Tektronix 4010 terminal	horizontal and vertical scroll, pan, 16:1 zoom, image overlays, vector and circle generation, polygon fill, blink	RS170 video output to user device
Applicon, Inc. AGS Series	raster-scan and storage tube, four terminals per system, 19- or 21-in. monochromatic CRT, 34- x 44-in. digitizing tablet	integrated-circuit design; electrical and mechanical drawing; zoom; 2D and 3D windowing, rotation, translation and perspective projection	photoplotter, color plotter, video hard-copy unit
Auto-Trol Technology Corp. AD/380	12 terminals per system, 19- or 25-in. monochromatic storage tube, 15,000 vectors, thumbwheel, joystick, gantry digitizer, line follower	dimensioning and annotation, crosshatching, scaling, rotation, layering, symbol creation, and 3D projection; mechanical, electrical and architectural applications	flatbed plotter; electrostatic and thermal printer/plotters
Aydin Controls System 16/10	12 monochrome or four color terminals, 2000 colors from 4000-color palette, 19-in. raster CRT, 1K x 1K resolution, 256 characters, joystick, trackball, graphic tablet	core-standard compatible, curve-fitting, 2D, 3D, edge detection and enhancement, contrast enhancement, image focusing, zoom, windowing, psuedo color, FFT	color camera, video copier, plotter
California Computer Products, Inc. IGS-300, IGS-400, IGS-500	raster-scan CRT; 300 x 416 or 1024 x 768 resolution, monochromatic 15- or 20-in. CRT, joystick, digitizing tablet	mapping, piping, engineering drawing	drum, flatbed, beltbed, microfilm plotters; printer/plotter
Cambridge Development Laboratory Dynamic Blackboard	640 x 512, color or monochromatic	scroll, rotation	optional graphics printers
Chromatics, Inc. CGC 7900	19-in. color raster-scan CRT, 1024 x 768 resolution, 256 out of 16 million colors, joystick, light pen	roll, pan, zoom, windowing, overlays	via host computer
Control Data Corp. 777 Series	stroke-writer, two terminals per system, monochromatic 20-in. CRT, light pen, drawing rate as high as 670,000 ips	zoom, 2D, 3D, windowing, translation, rotation, perspective projection	plotter, video hard copy
Cromemco, Inc. Z2H/GS	13-in. color raster-scan CRT, 754 x 482 pixels	dual-page windowing, automatic area fill, can display different parts of a picture in either bit- or nybble-mapped mode	printer
Data Technology, Inc. CDA	vector, monochromatic, digitizer	drafting applications; scaling, rotation, mirror imaging, interpolate curves, cross-hatch	40- x 60-in. plotter
De Anza Systems, Inc. Visacom/23	four-color raster-scan CRT, four terminals per system, 512 x 480 resolution, joystick, trackball	zoom, overlay, windowing, pan, conics	via host computer
Decision Graphics, Inc. PEAC model 100, PEAC model 200	monochromatic 21-in. CRT, digitizer	2D, 3D, overlays; computer-aided design applications, drafting	36-in. - wide plotter
Digital Equipment Corp. VT-11	stroke-writer, monochromatic 17-in. CRT, as much as 1400 in. of vectors at 30 frames per sec., light pen	vector manipulation	via host computer
Evans & Sutherland Computer Corp. Picture System 2, Multi Picture	stroke-writer, monochromatic CRT, six terminals per system, as many as 21,500 vectors per frame, light pen, joystick, digitizing tablet	zoom, 2D, 3D, windowing, translation, rotation, orthogonal projection, viewpoint mapping, scaling	plotter
Ferranti Ltd. GT-7	eight terminals per system, four-color stroke-writer CRT, trackball, light pen, joystick, digitizer	circle/arc, scaling, rotation, mirror image, zoom, 3D	plotter
Genisco Computers G-1000	19-in. monochromatic raster-scan CRT, 1024 x 792 resolution, digitizer, joystick	Tektronix 4014-1 replacement	printer/plotter
Gerber Systems Technology, Inc. IDS-80	four terminals per system, 19- or 25-in. monochromatic storage tube, touch-sensitive entry device, digitizer	computer-aided design and manufacturing applications; scaling, zoom, pan, clip, translation, 2D, 3D	video hard copy; drum, flatbed and photoplotters
Hewlett-Packard Co. 2647A, 2648A	monochromatic raster-scan CRT, 720 x 360 resolution	zoom, pan, rubber banding	printer/plotter, plotter
Hitachi H-7000	raster-scan CRT, seven colors	overlay, special symbols	plotter

CPU Characteristics	Mass Storage	Interfaces	Typical Price
30-bit minicomputer, 8K to 32K words; separate microprogrammable display processor with 64K x 64K points addressable	81M-byte disk drive, 7- or 9-track magnetic-tape drive	RS232 synch, as high as 9600 baud	$42,920 to $133,000
6502A μp, 16K to 256K bytes memory	80M-byte disk drive, diskette drive, cartridge-tape drive	direct memory access to DEC LSI-11 and PDP-11, Data General Nova and microNova and Sperry/Varian minicomputers; RS232 asynch, speeds as high as 19,200 baud	$8875
DEC PDP-11/34, 48K to 256K 16-bit words of memory	800M-byte disk drive, four tape drives	emulates IBM 2780, HASP work station, CDC UT200 or Univac 1004 terminal	$192,500 to $280,500
Sperry/Univac V77 minicomputer with Vortex operating system and 256K to 2M bytes of memory; also DEC VAX-11/780 computer	80M-byte disk drive; magnetic-tape drive	asynchronous, synchronous, binary synchronous; data rates as high as 60K bytes per sec.; can interact with IBM, Sperry-Univac, Burroughs, Honeywell, CDC and Amdahl mainframes	
8086 μp (as many as 16 per system), as much as 768K bytes of main memory	disk-cartridge drive	serial asynch. and synch., binary synchronous, HDLC, DDCMP, SDLC, RS232, RS422/423, parallel	
CC 16/40 minicomputer with 96K to 256K 16-bit words of main memory	800M- byte disk drive, two tape drives	synchronous at rates as high as 9600 baud, emulates IBM 2780	$71,700 to $89,000
S-100 μc with 64K bytes of RAM	floppy-disk drive, hard-disk drive optional	serial	$9950 to $14,500
MC68000 μp, real-time clock	10M-byte disk drive, diskette drive	RS232, RS449	$19,995
Cyber 18-17B with 24K to 64K 18-bit words of memory	magnetic-tape drive	as high as 50K baud to CDC Cyber 70, Cyber 170 or 6000 Series computers.	$110,000 to $115,000
4-MHz Z80A with 64K bytes of RAM	11M-byte hard-disk drive, dual floppy-disk drives	RS232	$14,500
DEC PDP-11 with 28K bytes of memory	5M-byte disk drive	RS232	
DEC LSI-11 with as much as 512K bytes of memory	diskette drive	RS232, parallel, Q-Bus	$39,000
DEC PDP-11/34 or PDP-11/44 with 256K bytes of memory	magnetic - tape drive, 20M-byte disk drive	via telephone lines to remote host	$190,760 to $217,940
DEC PDP-11/04 or PDP-11/34 with 16K to 124K 16-bit words of memory	disk drive	RS232 at rates as high as 9600 baud, Unibus	$44,040 to $46,600
DEC PDP-11 with 16K to 64K 16-bit words of memory	disk drive, magnetic-tape drive	asynch. RS232 at rates as high as 9600 baud	$69,000
DEC PDP-11 or Argus 700 computer with 16K to 32K bytes of memory	disk drive, magnetic-tape drive, tape-cassette drive	Teletype-compatible, parallel, IBM 2250 emulation	$28,000
Z8001 μp with 16K to 32K 16-bit words of memory		asych. RS232 at rates as high as 19,200 baud	$10,000
H-P 1000F 16-bit computer, with 384K to 2M bytes of memory	magnetic-tape drive, 880M-byte disk drive	to other IDS-80 systems or host computers	$240,000
8-bit word, 8K to 32K bytes of memory	220K-byte mini-cartridge drive	Teletype, RS232C at rates as high as 19,200 baud, parallel	$6000 to $9000
64K bytes of memory	diskette drive	RS232, Teletype	$11,000

Manufacturer and Model No.	Terminal Characteristics	Graphics Functions	Output Media
Hughes Aircraft Co. C-9	17-in. monochromatic stroke-writer CRT, 16-level gray scale, joystick, digitizer	zoom, circle/arc generator, windowing, rotation, 2D	via host computer
IBM Corp. 2250	monochromatic stroke-writer CRT, light pen		plotter
Imlac Corp. Dynagraphic Series II	19-in. monochromatic stroke-writer CRT, as many as 16,667 vectors, light pen, joystick, digitizer		plotters
Industrial Data Terminals Corp. IDT-2000	monochromatic raster-scan CRT, 512 x 512 resolution	polygon fill	printer/plotter
Information Displays, Inc. IDIIOM/II	21-in. monochromatic stroke-writer CRT, light pen, joystick, digitizer	computer-aided design applications; windowing, rotation, 2D, 3D	plotter, printer/plotter
Interstate Electronics Corp. Analyst's Console System	two to eight terminals per system, 19-in. CRT, eight colors, 512 x 483 resolution, trackball	military and industrial command and control applications	
Lundy Electronics & Systems, Inc. Hypergraf 2600	21-in. monochromatic stroke-writer CRT, 16 terminals per system, light pen, digitizer, joystick, trackball	rotation, scaling, windowing, scissoring, zoom, circle/ellipse generation	plotter, printer/plotter
Magnavox Display Systems Orion-60 Series	monochromatic plasma display, 512 x 512 resolution, touch-sensitive entry device	background overlays from slide projector	printer/plotter
Megatek Corp. Whizzard 7250	raster-scan CRT, 16 colors, 512 x 512 resolution, joystick	3D, pan, zoom, clip, rotate, scale, translate	printer/plotter
M & S Computing, Inc. IGDS	two 19- or 25-in. monochromatic storage-tube display screens per station, 16 digitizer stations per system	2D, 3D, scale, rotate, mirror, interactive measurements, polygon overlay and intersection	plotters
National Computer Systems, Inc. CompuTool	six terminals per system, light pen	zoom, rotate, mirroring; computer-aided design applications, toolmaking	numeric control tapes
Planning Systems SPACEMAN	19-in. storage tube, digitizing tablet	3D, others	plotter
Ramtek Corp. 6200A	eight-color raster-scan CRT, 512 x 256 resolution, joystick	fill, windowing, pan, conics	
Raytheon Raycomp 100	raster-scan CRT, four terminals per system, 1024 x 1024 resolution, trackball, digitizer	zoom, scrolling	printer/plotter, plotter, phototypesetter
Redac Interactive Graphics, Inc. Mini PCB Designer	17-in. monochromatic stroke-writer CRT, light pen, digitizer	printed-circuit board applications	plotter
Sanders Associates, Inc. Graphics 8	256-color raster-scan CRT, eight terminals per system, 1024 x 1024 resolution, joystick, trackball, digitizer	3D coordinate conversion, polygon fill	printer/plotter
Spatial Data Systems, Inc. Eyecom II	three-color CRT, 640 x 480 resolution, joystick, digitizer	overlay, windowing, zoom, pan	
Stanford Technology Corp. model 70, System 500, System 101	19-in. color or monochrome raster-scan CRT, 512 x 512 resolution, trackball, tablet, joystick	arithmetic between images, radiometric point processing, zoom, pan, split screen, N x M convolution, histograms, cluster, rotation, scattergram, array transposition, interpolative zoom, video frame digitizing, scroll, overlay	video hard copy, printer, camera
Summagraphics Corp. Datagrid II	11-in. monochromatic storage tube or 19-in. color raster CRT, digitizer	printed-circuit board, drafting, mapping applications	flatbed and drum plotters
Synercom Technology, Inc. Informap	19-in. monochromatic storage tube, 16 terminals per system, digitizer	mapping applications	plotters
Tektronix, Inc. 4054	monochromatic storage tube, joystick, digitizer	window, scale, rotate	plotter, printer/plotter, CRT hard copy
Telecrafters MCD 4001B	eight-color raster-scan CRT, 512 x 256 resolution, three terminals per system, light pen, joystick, trackball	overlay, underlay, circles	printer/plotter
Terak Corp. 8510/A	monochromatic raster-scan CRT, 320 x 240 resolution		printer/plotter
Vector Automation Graphics 80	stroke-writer CRT, light pen, digitizer, 66,000 vectors	2D, 3D, translation, rotation, zoom, pan, windowing, nesting	plotter, CRT hard copy
Vector General, Inc. Vectorgraphics 11	21-in. monochromatic stroke-writer CRT, four terminals per system, light pen, joystick, trackball, digitizer	2D, windowing, translation, rotation, orthogonal projection	plotter
Vectron Graphic Systems, Inc. 2019 Users Station	19-in. monochromatic storage tube, digitizer	pan, zoom, scale	plotter

CPU Characteristics	Mass Storage	Interfaces	Typical Price
		asych. RS232 at rates as high as 9600 baud; parallel with Data General, DEC, H-P and Varian computers	$9950 to $17,000
		to IBM host computer	$64,000
8086 μp, 32K to 64K bytes of memory		asych. RS232 at rates as high as 9600 baud	
8K to 64K bytes of memory		serial at rates as high as 9600 baud	$7000
Varian 620 computer with 4K to 256K 16-bit words of memory		parallel	$70,000
DEC PDP-11/70			
16-bit μc with 24K to 128K words of memory		to host DEC PDP-11 or CDC Cyber-17	$56,000
8-bit μp, 8K to 32K bytes of memory	diskette drive	RS232 at rates as high as 9600 baud	$8400 to $17,250
32-bit word, 64K to 192K bytes of memory	diskette drive, tape drive	RS232 at rates as high as 9600 baud, parallel	$20,000
DEC PDP-11/44 or PDP-11/70 with 512K to 2M bytes of memory	magnetic-tape drive, 1200M-byte disk drive	SDLC, rates as high as 56K baud per line up to 500K baud per system	
DEC PDP-11			
Tektronix 4054	floppy-disk drives		$50,000 to $75,000
Z80 μp, 4K to 16K bytes of memory	diskette drive	RS232 at rates as high as 9600 baud	$9950
64K bytes of memory	disk drive, tape drive	current loop	$38,000
DEC PDP-11/34 with 32K 16-bit words of memory	disk drive, magnetic-tape drive		
minicomputer with 32K to 256K bytes of memory		RS232, parallel; 10 others optional	$23,000
DEC PDP-11	magnetic-tape drive	to DEC and Data General host computers	$14,500
DEC PDP-11 or VAX, Data General Eclipse, or HP 1000, 21MX or 3000 host, model 70 image processor	disk or tape drives		$25,000 and up
minicomputer with 64K to 96K bytes of memory	25M-byte disk drive, magnetic-tape drive, diskette drive	asynch. RS232	
DEC PDP-11 or VAX with 256K bytes of memory	1200M-byte disk drive, magnetic-tape drive		
	300K-byte cartridge	RS232 at rates as high as 9600 baud, GPIB	$16,500
8-bit word, 4K to 64K bytes of memory	diskette drive	RS232 at rates as high as 9600 baud, parallel	$12,000
DEC LSI-11 with 56K bytes of memory	diskette drive	RS232	
16-bit word, 32K to 256K bytes of memory		RS232, parallel	$24,500
DEC PDP-11	disk drive, magnetic-tape drive	RS232 at rates as high as 9600 baud, parallel	$40,000 to $150,000
32-bit minicomputer with 512K bytes of memory	300M-byte disk drive, magnetic-tape drive		$55,000

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CIRCLE NO. 45 ON INQUIRY CARD

A minimum interactive graphics system includes one terminal connected to a processor, which may or may not be embedded in the terminal.

Jose, Calif., supplies design and drafting software for the Tektronix 4050 Series desk-top computer, equipped with a plotter, disk drive and digitizer. Computer Aided Design Centre of London, England, provides Ginozone, a set of FORTRAN routines for creating and displaying maps. And Brigham Young University offers Movie.BYU, a set of general-purpose graphics manipulation routines. Hundreds of such packages are available, although users may have trouble finding some of them. Comprehensive directories of graphics applications software are not sold on every newsstand. Users should contact the National Technical Information Service of the U.S. Department of Commerce in Springfield, Va. NTIS publishes software abstracts regularly.

Similarly, a user can shop around for components and build an IG system from scratch. Terminals are available from many sources, and popular minicomputers, such as Digital Equipment Corp.'s PDP-11 and VAX, are suitable for most graphics applications. PDP-11 and Prime computers are particularly appropriate, in that DEC and Prime Computers, Inc., supply the processors for a wide variety of turnkey systems. Alternatively, one can seek out a company such as Lexidata Corp., Burlington, Mass., or Ikonas Graphics Systems, Inc., Raleigh, N.C. These vendors sell processors designed specifically for graphics applications, which can be interfaced to terminals, plotters and other peripherals, directly or through a separate host computer. The Ikonas unit can also accept an analog television signal, sample it at rates as high as 16 MHz and store the digitized image for further processing.

The same freedom extends to the selection of plotters, digitizers and other I/O units. A user with the necessary skills can easily configure a system to meet his requirements.

Terminals

As a user's window into a system, the graphics terminal deserves special attention. A typical terminal consists of a CRT, an alphanumeric keyboard for command entry and display annotation and an auxiliary graphics-entry device to enable a user to designate specific points or elements in a display for further processing (Fig. 5).

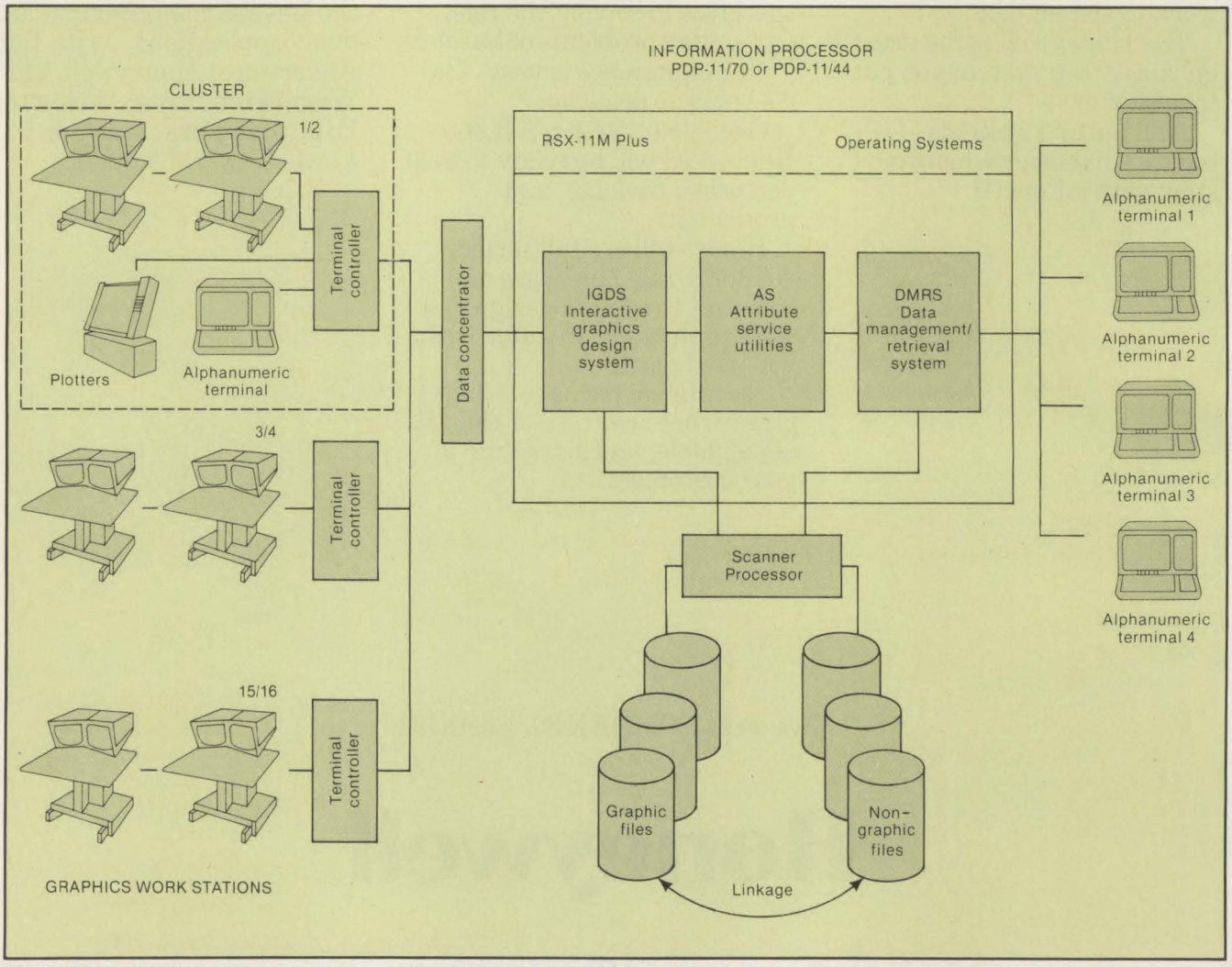
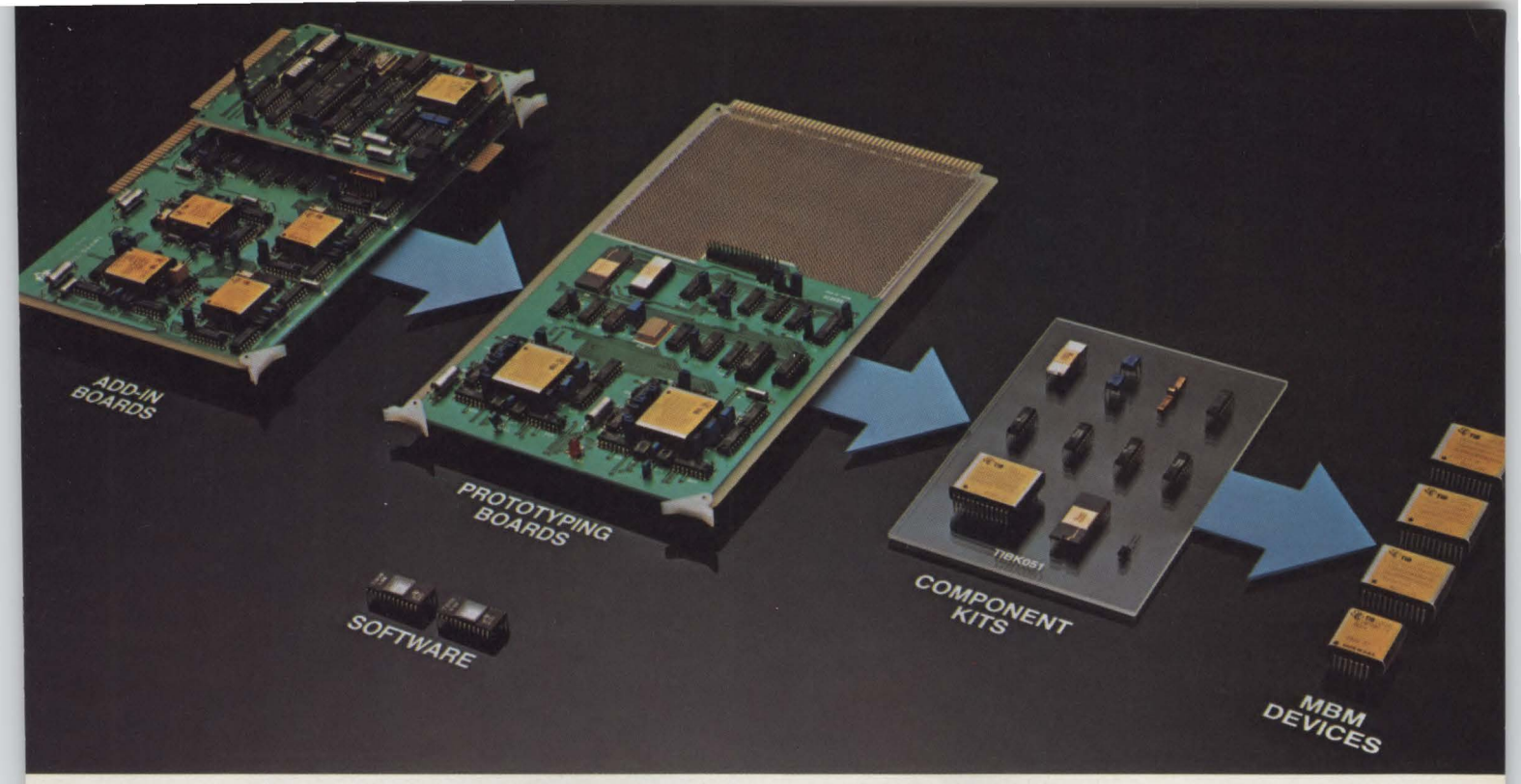


Fig. 4. Two pairs of graphics terminals *can be clustered in the IGDS system from M&S Computing, Inc.*



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TM990 TM990 STD OEM (9900,8080, Z80) OEM (9900, 8080, Z80) LSI-11† MULTIBUS‡ S-100	TM990/210 TM990/211 TBB7090/91 TBB5005 TBB5010 MBC11* MBB80* MBB100*	23 to 69 128 to 1024 11 to 104 64 128 46 to 736 92 46 to 736	
SOFTWARE			
TM990/431 TM990/453	Interactive monitor to test and demo TM990/210 Power Basic with file management for TM990/210		

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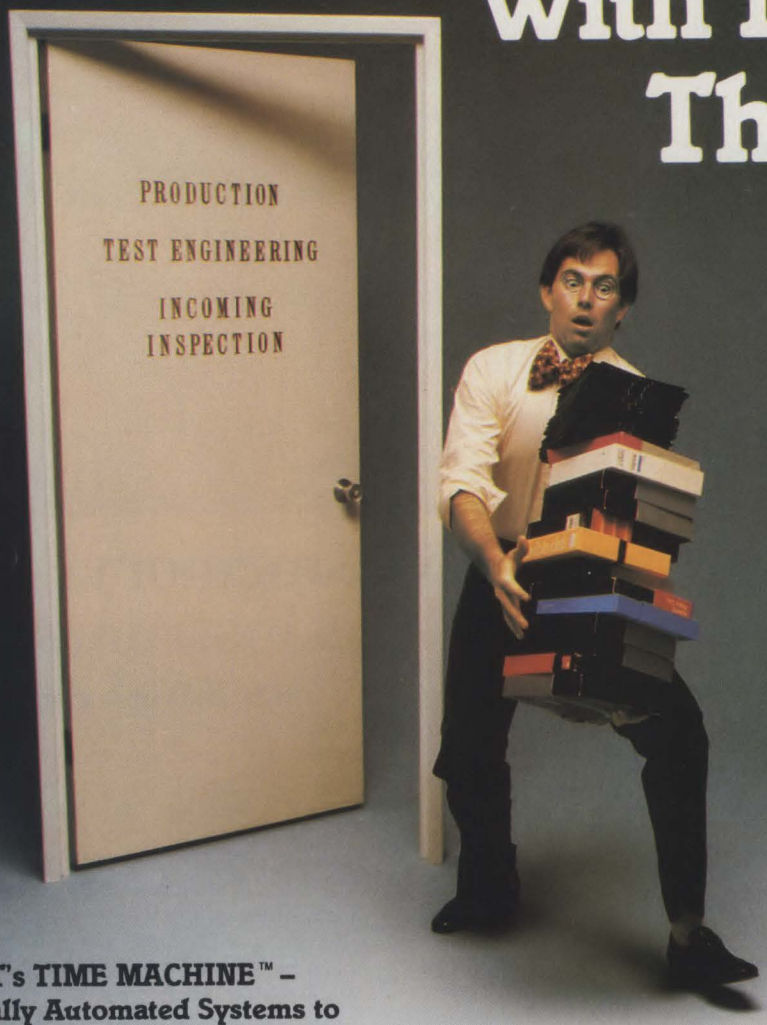

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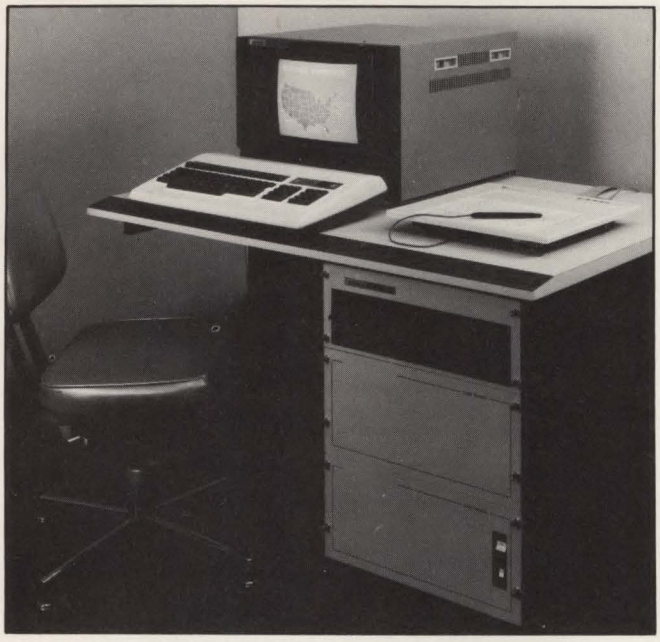

Fig. 5. An interactive graphics *terminal from Ramtek Corp.*

The three main display techniques are raster scan, stroke (or vector) and storage tube. Raster scan has the lowest price tag, but also the lowest information capacity. A typical unit has 512 × 512 picture-element (pixel) resolution (i.e., points are displayed only at the intersections of a 512 × 512 matrix on the screen). Resolutions as fine as 1024 × 1024 pixels are available in a few systems, at much higher prices. With such modest resolution, diagonal lines written across a screen appear to be jagged. For most people—and in many applications—the "jaggies" do not reduce a system's utility. But for slide-making, architectural design or publication, the quality of drawings copied from the screen must be consistently high, and jagged lines are unacceptable.

In these situations a user may turn to a stroke-writer terminal, such as the Imlac Dynagraphic II, which draws vectors from point to point on a CRT. The starting and ending positions can be resolved on a 2K × 2K point matrix, without jagged lines. This improvement costs a little more, but is easily justifiable in many circumstances.

Both the raster and stroke-written displays must be refreshed 30 times per sec. or more to maintain a flicker-free picture. Storage tubes, however, require no

REFERENCE LITERATURE

For more information on the interactive graphics systems surveyed in this article, use the reader circle numbers below.

Company	Circle No.
Adage, Inc., Billerica, Mass.	416
Advanced Electronics Design, Inc., Sunnyvale, Calif.	417
Applicon, Inc., Burlington, Mass.	418
Auto-Trol Technology Corp., Denver, Colo.	419
Aydin Controls, Fort Washington, Pa.	420
California Computer Products, Inc., Anaheim, Calif.	421
Cambridge Development Laboratory, Watertown, Mass.	422
Chromatics, Inc., Tucker, Ga.	423
Control Data Corp., Minneapolis, Minn.	424
Cromemco, Inc., Mountain View, Calif.	425
Data Technology, Inc., Woburn, Mass.	426
De Anza Systems, Inc., San Jose, Calif.	427
Decision Graphics, Inc., Southboro, Mass.	428
Evans & Sutherland Computer Corp., Salt Lake City, Utah	429
Ferranti Ltd., Millbank, Lancashire, England	430
Genisco Computers, Irvine, Calif.	431
Gerber Systems Technology, Inc., South Windsor, Conn.	432
Hewlett-Packard Co., Palo Alto, Calif.	433
Hitachi, Ltd., Tokyo, Japan	434
Hughes Aircraft Co., Newport Beach, Calif.	435
IBM Corp., White Plains, N.Y.	436
Imlac Corp., Needham, Mass.	437
Industrial Data Terminals Corp., Columbus, Ohio	438
Information Displays, Inc., White Plains, N.Y.	439
Interstate Electronics Corp., Anaheim, Calif.	440
Lundy Electronics & Systems, Inc., Glen Head, N.Y.	441
M & S Computing, Inc., Huntsville, Ala.	442
Magnavox Display Systems, Fort Wayne, Ind.	443
Megatek Corp., San Diego, Calif.	444
National Computer Systems, Inc., Minneapolis, Minn.	446
Planning Systems, Lafayette, Calif.	446
Ramtek Corp., Santa Clara, Calif.	447
Raytheon, Lexington, Mass.	448
Redac Interactive Graphics, Inc., Littleton, Mass.	449
Sanders Associates, Inc., Nashua, N.H.	450
Spatial Data Systems, Inc., Goleta, Calif.	451
Stanford Technology Corp., Sunnyvale, Calif.	452
Summagraphics Corp., Fairfield, Conn.	453
Synercom Technology, Inc., Sugar Land, Texas	454
Tektronix, Inc., Beaverton, Ore.	455
Telecrafters Corp., Harrisburg, Pa.	456
Terak Corp., Scottsdale, Ariz.	457
Vector Automation, Baltimore, Md.	458
Vector General, Inc., Woodland Hills, Calif.	459
Vectron Graphic Systems, Inc., Santa Clara, Calif.	460

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As in all data-processing systems, the key to success interactive graphics is good software.

refresh: images remain in place, unwavering, as long as power is applied to the CRT. The drawback is that when a picture is altered in any way, no matter how small, the entire screen must be erased and the image rewritten. This quirk makes it fairly useless for animation, for example. And storage tubes are all monochromatic, whereas raster and stroke-writer tubes are also available in color versions. Even so, this technique is fine for many applications, and it is solidly supported, because Tektronix uses storage tubes exclusively.

Another technique, called plasma display, has been vying for user attention for several years, with little success, because it is relatively expensive. Interstate Electronics is the strongest advocate of plasma displays but until prices come down, it will remain an uphill battle. That is a shame, because plasma displays are bright, low-power, compact and require no refresh. Their day may come, but not soon.

Graphics-entry devices include light pens, joysticks (similar in appearance to the controls found in light aircraft) and trackballs, all used with the image on the CRT screen. Trackballs and joysticks control the horizontal and vertical movement of a cursor on the screen. The user presses an enter button to transmit the cursor position to the graphics processor. A light pen is held in a user's hand like a pen and pointed at the area of interest on the screen. When the refresh system illuminates that point, a photocell in the pen is activated, and its position is automatically passed to the processor. These techniques have been around for many years and are of comparable effectiveness.

In some systems, a separate digitizing tablet may be used as an entry device for creating a graphics data base. The CRT is then used for editing the data base. A digitizer is certainly called for when the data source is a picture or map that cannot be pasted on a CRT screen.

Software

As in all data-processing systems, the key to success in interactive graphics is good software: operating systems, software to handle graphics input and output devices (plotters, digitizers, CRTs), application software, development software (compilers, debuggers) and communications software (to transfer data among system components). Software requirements are eased in systems whose graphics terminals have some intelligence of their own, to perform such fundamental operations as translation and rotation of coordinates, scaling of coordinates, zooming (magnifying part of a picture), panning (moving the field of view right or left, up or down, without changing magnification), windowing (displaying a portion of a picture, leaving the rest blank) and overlaying (displaying multiple images, like multiple exposures of a single film frame).

In many cases, the vendor supplies the bulk of the software in all the major categories, leaving the user little to do except turn the key and go. The software-development process doesn't disappear; it just moves from the user's shop to the vendor's. And the user may still be stuck for software maintenance, unless he makes a maintenance arrangement with the system vendor or a third party.

Fortunately, the state of IG-system development tools has improved in recent years. In 1979, the Association for Computing Machinery's Special Interest Group on Graphics (ACM/Siggraph) published an update to an earlier Core Standard for graphics-software development tools. It details the object-manipulation functions a programmer must have and the naming conventions he must use in developing graphics applications. For example, Aydin Controls' model 5216 display computer has an instruction set that is said to be compatible with the Core Standard. By and large, system vendors have embraced the standard warmly, trying to work with it and discover its deficiencies in the process.

The experience of 25 years in data processing has taught everyone how valuable standards can be. Intended to provide program portability among computers from different vendors, the popular languages have had two far more important effects: a large body of programmers has been trained and become experienced in these languages, and the economy of expression in high-level languages has increased programmer productivity. These same benefits will accrue to graphics system designers as the Core Standard proliferates and stabilizes.

The future

It may be an exaggeration to say that interactive graphics faces a glorious future, but a fair measure of optimism is warranted. As hardware costs continue to decline, and as more and more control functions are embedded in firmware to cut execution time, IG systems will find their way into applications such as remote sensing, which now are handled as batch rather than interactive problems. At the same time, applications such as weather prediction, which today cannot be handled adequately in batch mode on even the largest computers, will become commonplace on IG systems. The romance between users and computer graphics is just starting, and they will live happily ever after. ■

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

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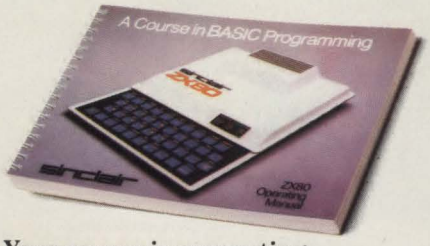

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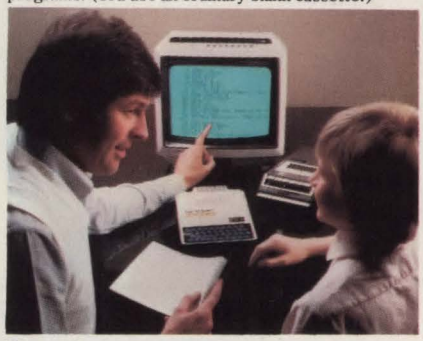

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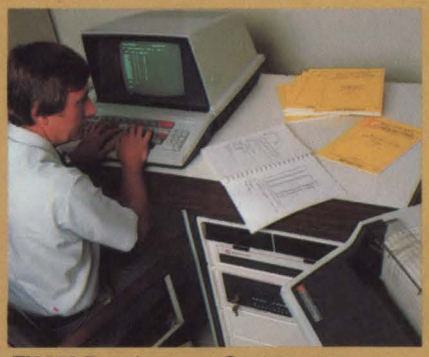

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Raster vs. storage tube

GARY L. SAWYER, Genisco Computers Corp.

An exponent of raster-scan technology argues that the DVST has a challenge in both cost and performance

The low-cost, high-resolution monochrome graphics terminal market has been dominated by the direct view storage tube (DVST) since the early 1970s. No other graphics technology could match DVST performance at a comparable price, but with such big market stakes (Fig. 1), it was inevitable that DVST dominance should be challenged.

The challenger is bit-mapped raster scan. This graphics technique, which has established itself as the rapid-growth technology in high-end color systems, is moving down into low-cost, high-resolution monochrome applications. While the DVST is still alive and well, many observers believe the future belongs to raster (see "Comparing technologies," p. 96).

The standard for this market was established about 10 years ago by the Tektronix series of DVST terminals, of which the most familiar, the model 4014-1, offers a resolution of 1024 × 1024 addressable points and a 19-in. screen and sells for slightly less than $15,000. A bit-mapped raster-scan terminal of the same addressable resolution requires a 1M-bit (128K-byte) memory to contain the monochrome image. In addition, the logic to implement the raster version is more complex than that required by the DVST because in raster, an address has to be calculated for each picture element (pixel). These penalties have been severe enough to preclude any significant penetration of this market by raster-scan devices until now.

Recent economic and performance gains in semiconductor technology have made raster-scan techniques competitive in the low-cost, high-resolution monochrome market. This year saw Genisco Computers Corp.'s bit-mapped G-1000, which offers 1024 × 1024 addressable points and a 19-in. screen, offered for slightly less than $10,000.

To compare the DVST and bit-mapped raster scan technologies, let's consider the Tektronix 4014-1 and the Genisco G-1000. Each unit is typical of its breed, and the G-1000 is plug-compatible with the 4014-1. At the serial interface, the same software will drive both units (including the popular Tektronix PLOT-10).

Cost, the factor that kept raster technology out of the market for several years, has become one of its strengths. The raster terminal is priced at less than $10,000, while the Tektronix 4014-1 sells for about $14,000. But that comparison is not equivalent, because the Genisco terminal incorporates as standard most of the capabilities of the optional Tektronix-enhanced graphics module—including point plot, incremental point plot and vectors in dotted, short-dashed, long-dashed and dot-dashed formats. This option costs the Tektronix user an additional $1000. But even if

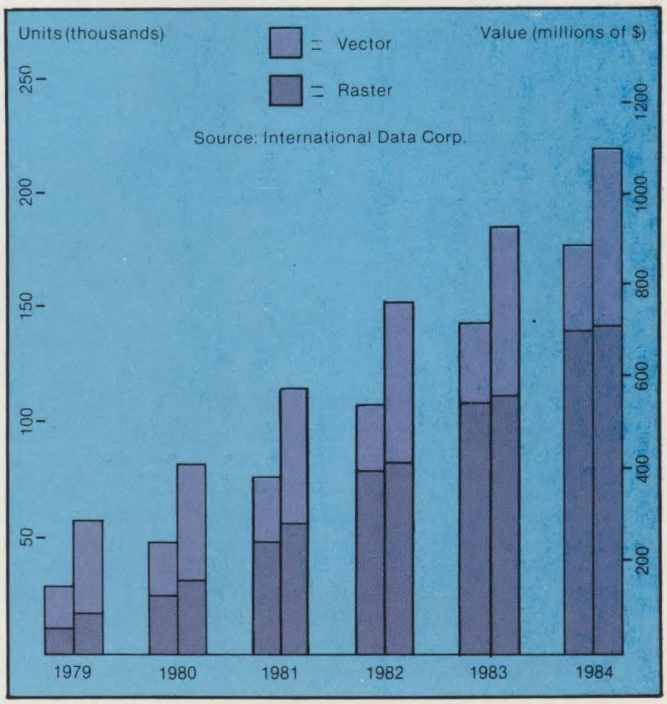


Fig. 1. Graphic display market forecast—*worldwide shipments by U.S. manufacturers.*

Cost—the factor that kept raster technology out of the market for several years—has now become one of its strengths.

future raster terminals do not maintain their hefty price advantage up front, the devices are, as a function of their technology, always likely to excel in cost of ownership. The primary consideration is in tube-replacement cost. A DVST is a relatively short-lived device. It must be replaced under normal use every three to four years at a cost of more than $2000. The raster tube, on the other hand, requires virtually no replacement because of use. Because most companies will replace their graphic terminal with a new model before a raster tube would require replacement, in 10 years a user may be comparing a $10,000 cost of ownership bill for DVSTs versus virtually nothing for raster tubes.

Resolving resolution

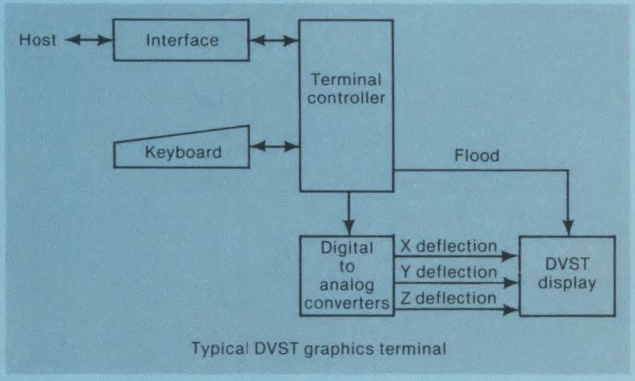
Before a user rushes to the economical raster, however, he should compare performance. Resolution, which to the user translates as the fineness and evenness of lines drawn on the tube, is an area of clear DVST superiority. While the Tektronix and Genisco units have comparable addressable resolution within the viewed area, (1024 × 780 for Tektronix versus 1024 × 792 for Genisco), what the viewer sees is different. The storage tube literally draws vectors while the raster device simulates those vectors by lighting a series of dots called pixels, much like the difference between fully formed- and dot-matrix-printer characters. When lines drawn on the raster are horizontal, vertical or at a 45° angle, the eye perceives them as being virtually as even as a storage tube vector. At other angles, however, the raster vectors have a noticeable "stairstep" (Fig. 2). Raster manufacturers argue that this minimal stairstepping makes no difference in the product's usefulness and it's a small price to pay to get raster's other benefits.

Storage tube goes one more step in high resolution, however. When the Tektronix 4014-1 terminal is equipped with the optional enhanced graphics module, the address base of the terminal is changed from 1024 × 1024 to 4096 × 4096 addressable points. The result is an even finer, more precise vector, limited only by the inherent resolution and spot size on the face of the tube. Raster, of course, cannot upgrade its number of addressable points as easily. Because each addressable point requires a corresponding bit of memory, comparable resolution in raster would require far more memory than a low-cost system could presently support. However, the G-1000 is compatible with Tektronix software with or without the enhanced graphics module. Data sent to the terminal in a 4096 address base is converted into a 1024 address base automatically. The G-1000 still looks like a Tektronix 4014-1 to the host.

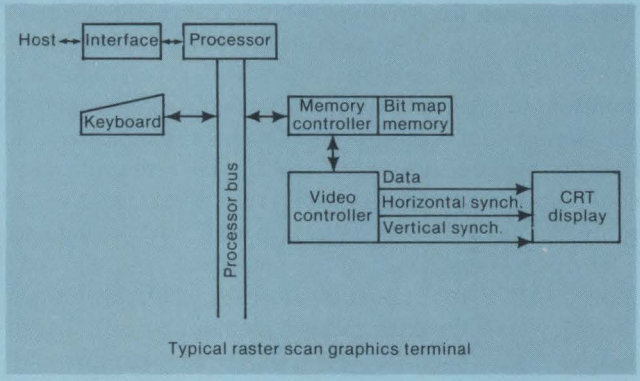
Raster shines in contrast

What raster lacks in resolution it strives to make up in contrast and brightness (Fig. 3). The refreshed raster image—in black and white versus the DVST's green on green—is sufficiently bright to be viewed easily in normal room light. The storage tube requires

COMPARING TECHNOLOGIES



Typical DVST graphics terminal



Typical raster scan graphics terminal

The direct view storage tube (DVST) is a type of CRT using a special bi-stable phosphor. The phosphor is uniformly "flooded" with accelerated electrons to excite the entire CRT face. The level of excitation is carefully controlled to produce only slight emission of light over the entire screen; this level provides the background unwritten state. To write, a selected point is further excited by a focused beam of accelerated electrons. While the beam is on, the phosphor being excited glows brightly. When the beam is removed, the special bi-stable phosphor continues to glow, although not as brightly. In this manner, an image can be written and stored on the CRT face. DVSTs are used not only in graphic terminals, but also in laboratory storage oscilloscopes.

A bit-mapped raster-scan system is closely related to a standard television and is often referred to as a "digital television" system. The beam of a simple CRT is constantly scanned over the face of the tube, usually in horizontal lines. The data constituting the image modulates the intensity of the beam (z-axis) to excite points selectively in the phosphor and form a viewable image. The image data is stored in a large memory (the bit map). Each displayable point requires at least 1 corresponding bit in the memory.

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CIRCLE NO. 51 ON INQUIRY CARD

WHEN IT COMES TO PUTTING IT ALL ON DISPLAY, THE ORION-60 STANDS ALONE.

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That means you can project a slide onto the screen coordinates and plot your own course over it. You can program your own character sets. You can generate vectors of any length to absolute screen coordinates. In short, you'll have a flexible terminal that will keep up with your needs today—and grow with your operations tomorrow.

Of course, since Magnavox was a leader in the development of plasma terminals, you can be sure your Orion-60 will have a bright, high-contrast display free from jitter and distortion.

There's a lot more you should know about the ways this remarkable terminal can help you get more out of graphic displays. For a demonstration, call or write Tyler Hunt at Magnavox Display Systems, 2131 S. Coliseum Blvd., Ft. Wayne, IN 46803, (219) 482-4411.

Magnavox
DISPLAY SYSTEMS

CIRCLE NO. 52 ON INQUIRY CARD

What raster lacks in resolution it strives to make up in contrast and brightness.

hooding and reduced light for long-term use.

The difference is a function of the technologies. Raster images are limited in brightness only by the efficiency of the phosphor and the amount of excitation at the tube face, which may be varied over wide limits. DVST image intensity is essentially fixed by the characteristics of the phosphor, and phosphors in current use yield lower levels of contrast and brightness.

This difference in the two methods of image creation also influences the number of hard copies available from the raster versus storage tube. The storage tube creates a hard copy on a printer device by interrogating the phosphor on the screen with a low-intensity beam. This interrogation degrades the image, therefore limiting the number of copies that can be made before "smearing" results. Raster, however, can produce unlimited hard copies because the process is simply one of reading the contents of a semiconductor memory bit map.

The erasable tube

A particularly significant requirement of most graphic terminal buyers is selective erasing that allows the user to remove part of the image without having to redraw the screen's entire contents. Raster can perform selective erase with ease because each pixel is manipulated individually. Because a storage tube vector is stored in the phosphor, erasing one vector on a DVST requires erasing the entire screen. To overcome this, the 4014-1 has a special mode called "write through" in which the vectors are continuously written on the phosphor with insufficient energy to be stored. Using this mode, the designer can experiment with a particular set of vectors before committing to them.

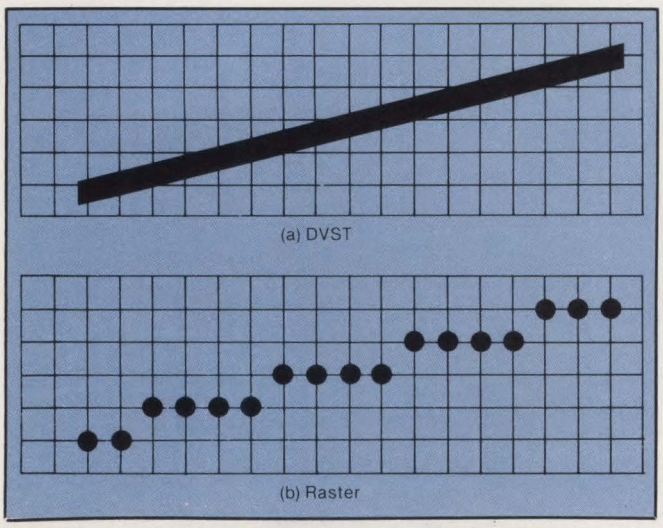

Fig. 2. Both (a) and (b) represent vectors *drawn between the same addresses on displays with equal addressable resolution. The DVST unit draws a straight line between end points, while the raster unit displays a set of dots (pixels) to approximate the vector. The discontinuous nature of the raster vector is known as "stair-stepping."*

A limitation of the write-through mode in the 4014-1 is flicker. In write-through mode, the storage tube is acting as a stroke writer, rewriting the same vector again and again. As the number of vectors increases, the time between refreshing each vector becomes longer and the image begins to flicker. In the extreme case, the vector becomes just a moving dot.

Raster scan requires no write through because it has selective erase. But in order to remain fully compatible with the Tektronix 4014-1 terminal, the Genisco G-1000 is equipped with a software construct that simulates write through. In this mode, the system will automatically erase the portion of the image written in write through after a given period.

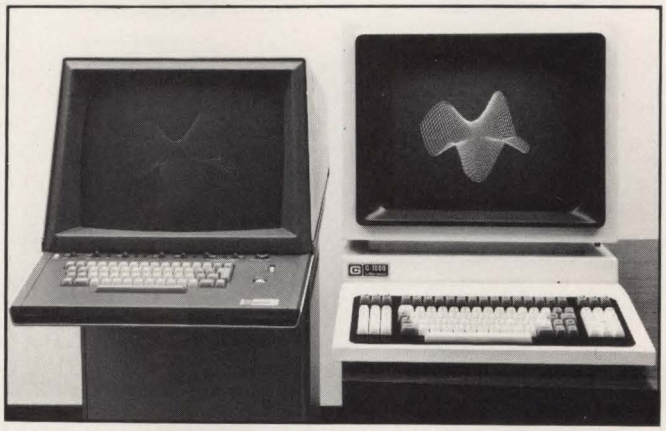

Fig. 3. Unretouched photograph *shows representative DVST unit (left) and raster-scan unit (right) under the same ambient light conditions. Note the differences in contrast and brightness.*

Making up for speed

If the optimum writing speeds of the raster and DVST devices are compared on a per-addressable-point basis, the 4014-1 comes up a 10 to one winner, with a speed of approximately 2½ μsec. per pixel versus about 25 μsec. per pixel for the G-1000. The limitation on raster speed is a function of interface rate versus vector length. Most applications use RS232 interfaces that limit the rate of received data to within raster terminal speeds. But where the graphic data received by the raster terminal consists of a large number of very long vectors, data could be lost during the process of converting the vectors to pixels. To prevent this, Genisco has equipped the G-1000 with an input buffer of as much as 14K bytes.

Z8001 and beyond

A low-cost graphics terminal is generally required simply to display data and accommodate human interaction via a keyboard. However, greater intelligence would be desirable in some applications. The terminal could then accomplish key tasks locally, freeing the host system for other work. Such local functions might include curve and symbol generation and variable-sized alphanumerics. The 4014-1 supplies local intelligence by adding an optional processor at extra cost. The option allows images to be saved locally and displayed on command. Saved images can be edited

The DVST is a mature product. It has dominated the market for a decade.

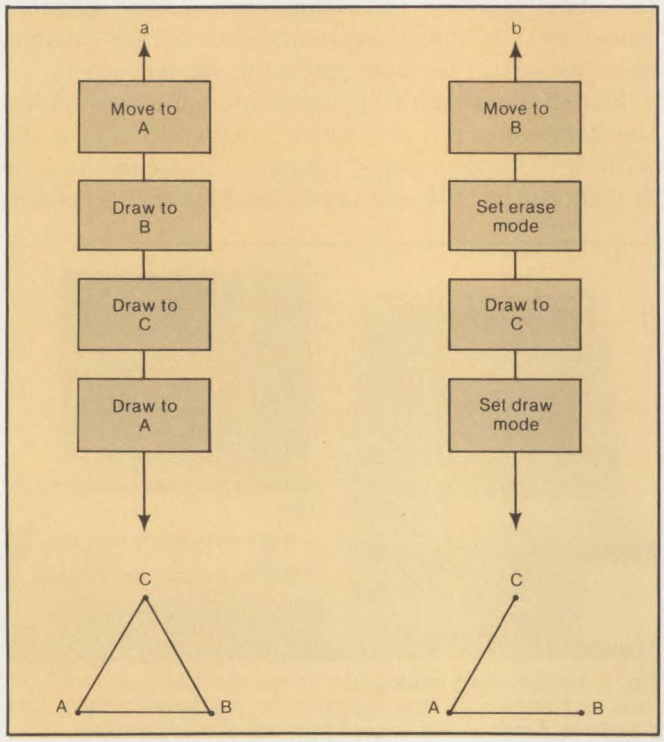

Fig. 4. Flowchart (a) *shows sequence of steps to draw triangle ABC. Flowchart (b) shows sequence of steps to erase line BC.*

to approximate a selective-erase feature. The image must still be erased and redrawn, but the drawing speed will not be limited by the terminal interface. The G-1000 is inherently intelligent, based on a Z8001 16-bit μp. This processor makes it possible for the G-1000 to be competitive with the 4014-1 in price and in speed. In the critical vector drawing operation, Genisco benchmarks showed the Z8001 to be 20 percent faster than the nearest 16-bit competitors, and six times faster than an 8-bit chip. In actual function, however, the power of the Z8001 is barely scratched in the Tektronix-compatible mode. In its standard configuration, the G-1000 includes 16K words of RAM and as much as 16K words of PROM. The standard firmware requires about 8K words; as much as 8K words of special features may be defined by the user.

The DVST is a mature product. It has dominated the market for a decade and has undergone no major changes in years. Significant developments in this technology seem unlikely in the future. ■

Gary L. Sawyer is project manager for Genisco Computers Corp., Costa Mesa, Calif.

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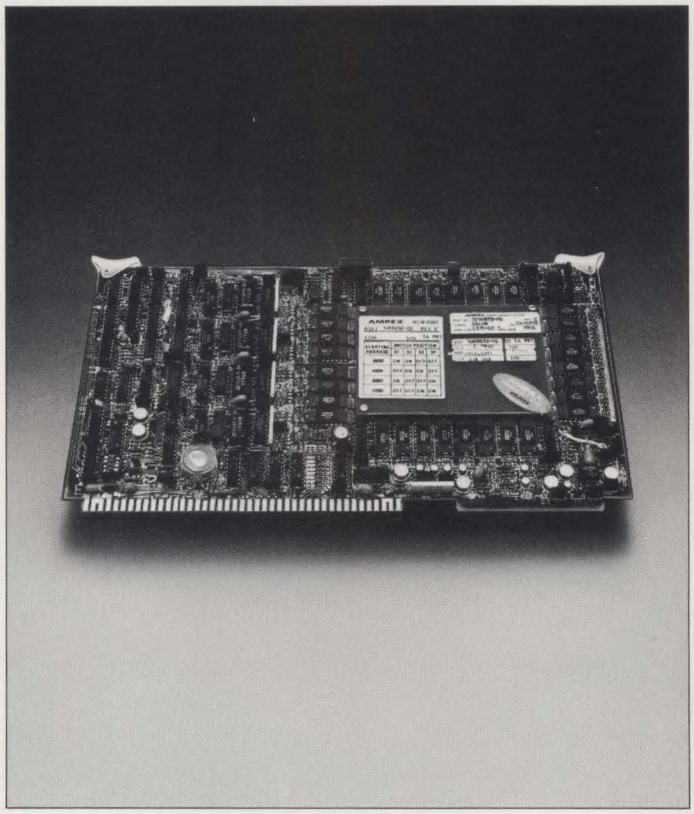

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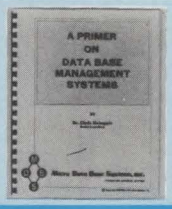

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CIRCLE NO. 55 ON INQUIRY CARD

Architecture for combined vector/raster graphics

PETER J. SHAW, Megatek Corp.

An alternative to selecting between vector refresh or color raster capabilities is to select a combination

Because different graphics applications call for different graphics technologies, each with its own special advantages, engineering users with a mix of requirements have had to compromise on features or purchase more than one system. Megatek has addressed this problem with a "best-of-both-worlds" system—the Whizzard 7290—that combines vector and raster technologies.

Megatek believes that the areas of computer-aided design (CAD) and computer-aided manufacturing (CAM) best illustrate the dilemma resolved by the Whizzard system. Detailed designs require the high-resolution lines associated with vector systems; manufacturing analyses call for the dynamic color displays of raster systems. Most engineering users need both.

In the design of a car, for example, engineers prefer high resolution so they can design the structural elements right down to the door locks or suspension parts. In the computer analysis of these finished designs, however, color attributes assist in an engineer's evaluation of heat, stress and other parameters. The Whizzard 7290 dual-output graphics system operates with both vector refresh and color raster work stations. The benefits are numerous:

- Engineers can use one multiple work-station system for both design and analysis applications.
- The cost for each work station is reduced because each shares a common set of hardware with the others. The dual-work-station system sells for $35,000, vs. $50,000 for separate vector and raster systems.

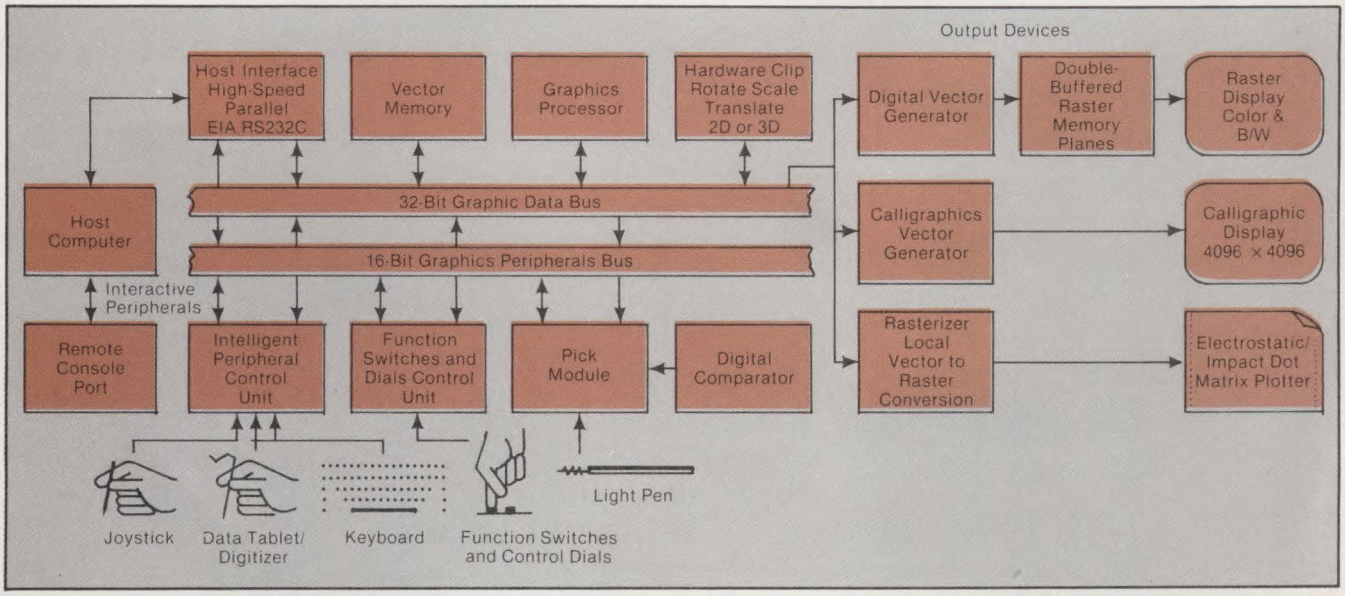

Fig. 1. The "Graphics Engine" *consists of a graphics processor, a host computer interface, vector memory and optional plug-in modules.*

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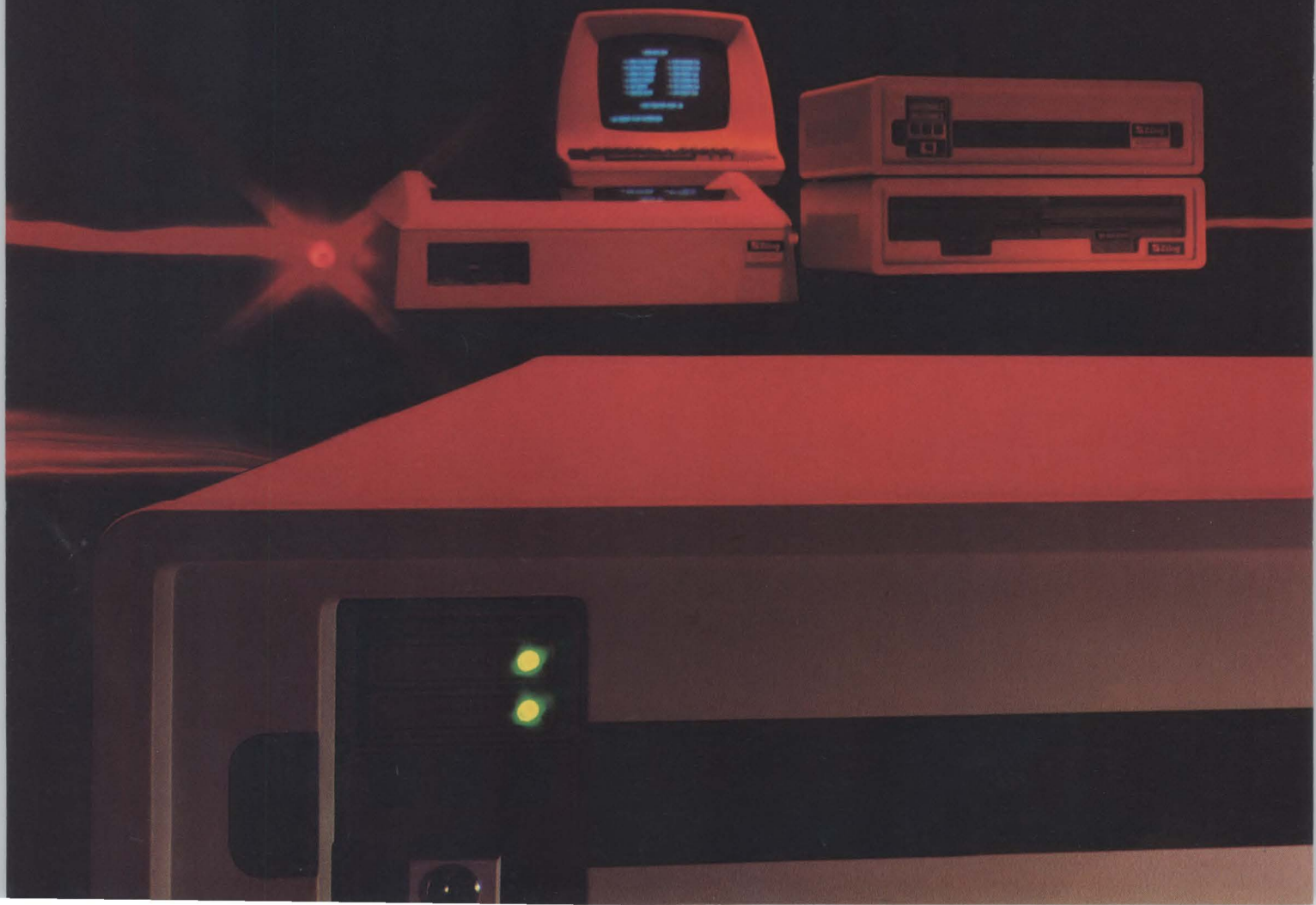

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Engineers can use one multiple work station system for both design and analysis applications.

- The FORTRAN programs developed on either type of work station can be used interchangeably, thus simplifying writing applications software.
- Development costs are reduced because programmers need not learn new protocols or programming techniques when moving from one system to another.

A single engine for a dual vehicle

The key to Megatek's dual-output graphics system is its proprietary Graphics Engine, which comprises the common hardware elements for both types of work station. It includes the host computer interface, vector memory, the graphics processor itself and optional two- and three-dimensional hardware transformation modules (Fig. 1).

The host computer interface permits parallel or serial connection either locally or remotely to a wide variety of minicomputers and medium-scale processors. Display commands are transferred between the graphics system and the host either in programmed I/O or in DMA modes. The memory requirements and loading of the host computer are minimized because the system contains its own RAM vector memory and microcontroller.

Dual multidirectional buses are integral to the graphic system's architecture. Vector calculation and refresh data are handled by a 32-bit-wide, tri-state graphics bus. A 16-bit-wide bus performs peripheral I/O transfers and routine interrupt servicing.

The memory modules use 16K RAMs for display refresh. Each module contains 16K words of 32-bit RAM and can accept 2K 32-bit words of PROM. Memory may be expanded to 48K 32-bit words (192K bytes) for both vector and raster output. Vector form requires that only the end points of a line be stored, while raster data require storing all the points on a line.

The graphics processor

The graphics processor is built around a proprietary bipolar bit-slice architecture. This 32-bit-wide μp controls access to the graphics display list stored in the memory modules. It interprets the display data, controls the microcode-implemented graphics functions and prepares X-Y coordinate pairs for input to a FIFO memory located in either the analog or digital vector generator.

The graphics processor instruction set includes two- and three-dimensional vector formats, selective erase, textured and blinking lines, 16 levels of intensity and beam-penetration color control for the vector refresh displays, 16 colors, a color-lookup table control for raster displays and hardware character-generation facilities with optional user-definable symbol sets.

Two types of vector generator

The output from the Graphics Engine makes up display lists that are used by two types of vector generators: an analog vector generator (AVG) for use with the vector refresh displays and a digital vector generator (DVG) for use with the raster monitors.

The analog vector generator incorporates a FIFO buffer to permit the digital portion of the system to keep up with fast analog circuitry. High-speed normalization circuits ensure constant vector intensity regardless of the length of the vector and reduces the setup time required for short vectors.

Each analog vector generator can control two monitors, with either identical or different images. The system can support a variety of monitors with several

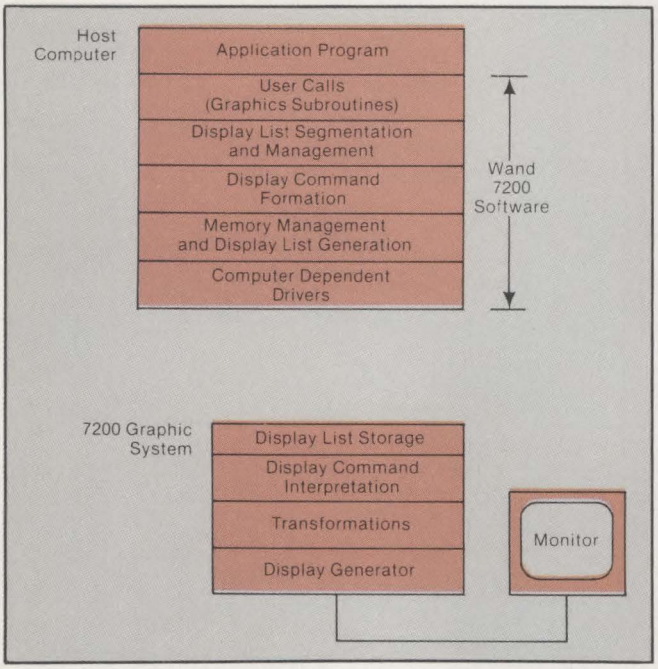


Fig. 2. Functional division of software *between host and Megatek hardware (parallel interface).*

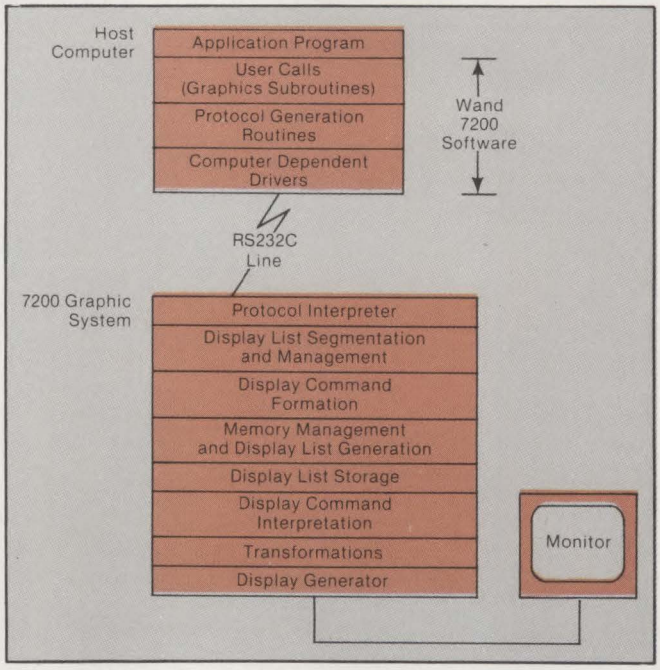
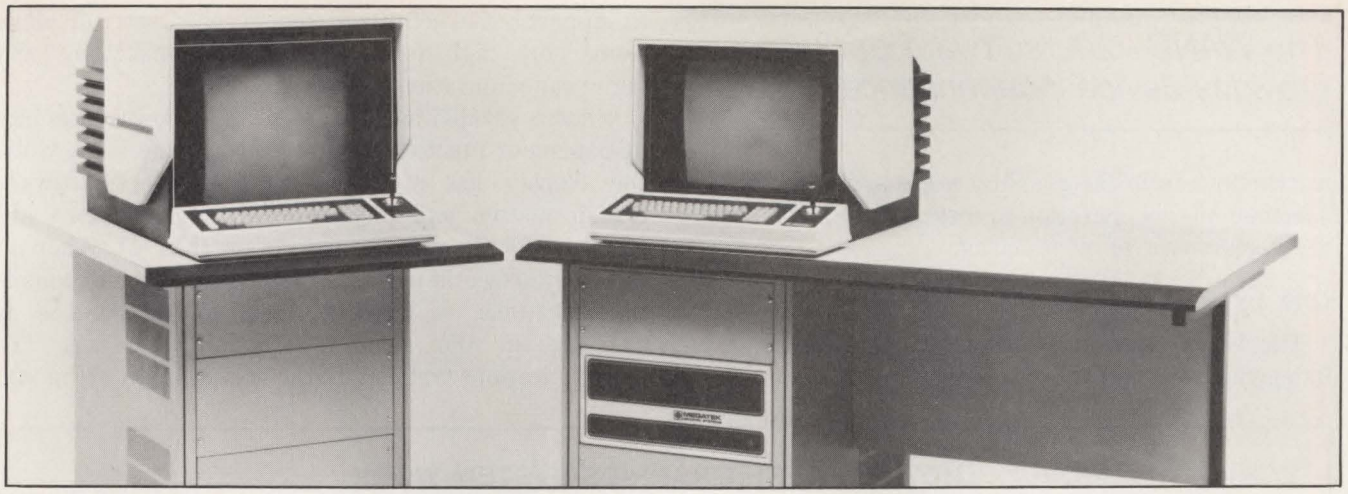


Fig. 3. Functional division of software *between host and Megatek hardware (serial interface).*



The Whizzard 7290 *dual-output graphics system operates with both vector refresh and color raster work stations.*

phosphor speeds and colors as a beam-penetration color monitor. The most common monitor used has a 21-in. diagonal and P40 (white) phosphor.

To use the digital vector generator, the system adds one or more double-buffered bit-planes of raster memory along with timing, control and video output circuitry. The digital vector generator rasterizes the vector information received from the Graphics Engine and writes the results into raster memory for the video output circuitry.

This combination of raster memory architecture and the processing speed of the digital vector generator provides real-time dynamics for the raster work stations. Because each raster memory bit-plane is double-buffered and contains two full 512 × 512 memory arrays, the video output circuitry can be reading from one buffer while the generator is writing into the other. The result is that the screen need not be blanked for updates. The writing speed of the digital vector generator averages 160 nsec. per picture element (pixel), enabling complex pictures to be updated more than 30 times per sec.

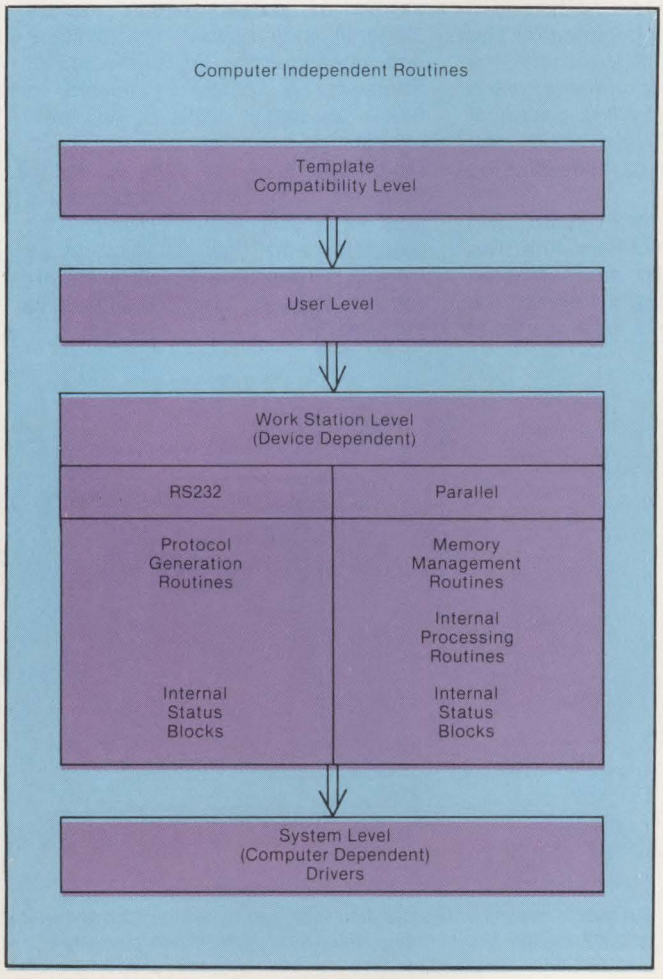
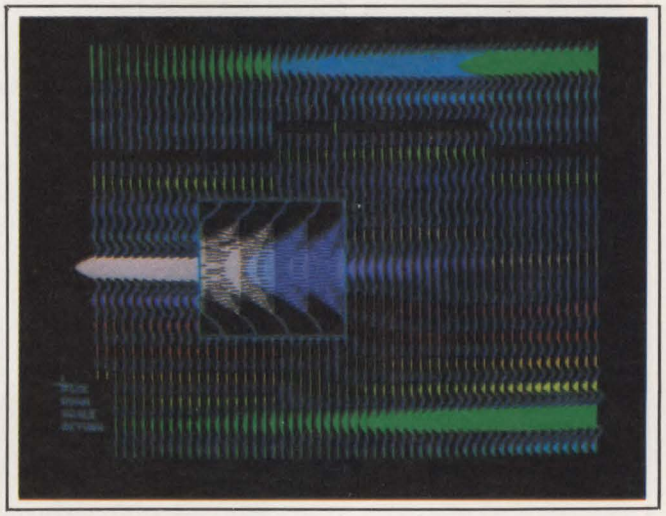


Fig. 4. WAND 7200 *multilevel software structure.*



Raster color display *of sonic traces, indicating various reflectivities of geological formations in a prospective petroleum deposit.*

The user also may make use of virtual vector space. He can display the entire 4096 × 4096 area on the screen or zoom in on a smaller viewport, such as 2048 × 2048, 1024 × 1024 or 512 × 512.

An optional two- or three-dimensional hardware clip, rotate, scale and translate (HCRST) module can be added for use with either the raster or vector refresh monitors. The system software enables engineers to specify transform parameters with a single FORTRAN call, thus eliminating the need to write complex matrix formulas. Host loading is also reduced for these scaling, clipping and rotating operations.

As the HCRST module receives processed vector

The WAND 7200 software package provides device independence.

instructions from the graphics processor, it applies the specified matrix operation to scale, rotate and translate the vector with 16-bit precision.

One software system

The WAND 7200 software package provides device independence, enabling one set of FORTRAN programs to support both vector refresh and color raster displays using both high-speed parallel communications and serial communications to 9600 baud.

When a parallel host interface is used, the graphics management functions are retained in the host, while the display list storage, interpretation, hardware transformation and display-generation functions are reserved for the graphics processor (Fig. 2). When an RS232 interface is used for remote graphics-terminals configurations, a greater level of intelligence is provided in the remote terminal to reduce the communications traffic with the host computer (Fig. 3).

HOW REFRESH GRAPHICS SYSTEM WORK

Refresh graphics systems usually employ one of two basic technologies for information display: vector refresh or raster scan. Each offers dynamic line-drawing capabilities, but differences in implementation and attributes make each more useful for certain applications.

A vector refresh system, also referred to as a stroke or calligraphic system, produces higher resolution drawings because it draws the pictures directly from point to point on the screen. The electromagnetic deflection beam is driven by X and Y signals that control its position for drawing. A vector list is processed continually and converted to analog X and Y signals, providing the points to be connected. As the beam moves from one point to another, it excites the CRT tube phosphor and causes it to glow. Since the phosphor fades, the picture is continually refreshed to maintain the image.

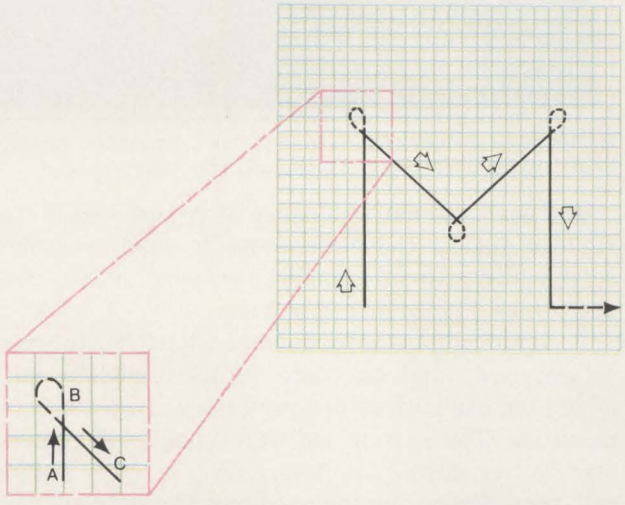
Changes in the vector list appear immeidately in the picture on the screen because the display is refreshed regularly. This provides dynamic displays. But complex pictures take longer to refresh: redrawing of the picture may slow, and the picture may fade before it is redrawn. However, the rate at which the picture is refreshed need not be synchronized to the AC line. Sophisticated graphics systems can provide a refresh rate that is sufficient to prevent fade and flicker except in unusual circumstances.

In raster displays, an electron beam sweeps horizontally across the screen from left to right, drawing the picture as a series of scan lines. At the end of each line, the beam is turned off and repositioned down and to the left—the horizontal retrace—for the start of the next line. After the last line, the beam is repositioned at the upper left corner—the vertical retrace—and the scan is repeated.

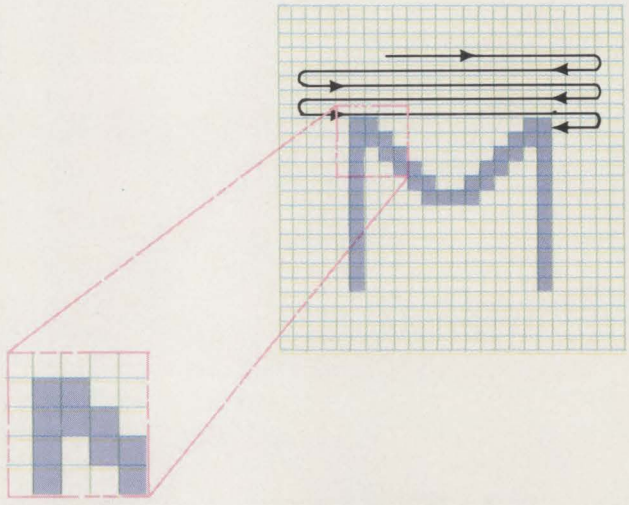
Interlaced displays require two such scans to complete a picture. The first scan draws the odd-numbered lines, and the second draws the even-numbered lines. Non-interlaced displays draw the entire picture at every scan. The display scan rate of a raster display always matches the AC line frequency, resulting in a 60-Hz refresh rate for non-interlaced displays and a 30-Hz rate for interlaced displays.

The information on the raster screen is typically refreshed from a bit map in which each bit in the map, which may be several bits deep to provide color or gray scale, corresponds to a picture element (pixel) on one of the scan lines on the screen.

Raster displays draw lines as a series of pixels, which makes diagonal lines appear as stairsteps and consequently limits resolution. There is no complexity related to flicker on raster displays, however, except that horizontal vectors, which fall on one scale line, may appear to flicker at 30 Hz. Raster monitors are less expensive than vector refresh monitors, and they easily provide full-color capabilities. On vector refresh displays, color is difficult to implement.



In calligraphic systems, *vectors are drawn with "strokes" of the beam on the display surface. At the end of one stroke (A-B), the beam is turned off until it is in position to begin stroke (B-C).*



On raster systems, *vectors are displayed by turning "pixels" on and off as the beam moves back and forth down the display surface; thus, diagonal vectors are "stair-stepped" pixels.*

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A μp-based hardware vector-to-raster converter may be added for hard-copy output with no software sorting.

WAND 7200 is written entirely in ANSI FORTRAN and follows CORE guidelines established by ACM SIGGRAPH. It provides work-station-level routines as well as more convenient user routines. It also may be interfaced with compute and device-independent software packages such as Template (Fig. 4). Thus operators may move from small to large systems, from stroke to raster systems, and from high-speed parallel to remote terminal configurations without having to modify existing application programs or change programming techniques for new applications.

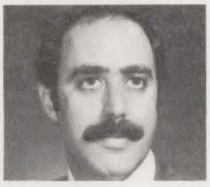
At the system level, device drivers tailor the software for use with various manufacturers' computer systems. The work-station level supports all output functions, including segment- and memory-management control, display-processor control, display- and segment-attribute control, hardware-transformation function control and error-generation control.

Intelligent peripherals

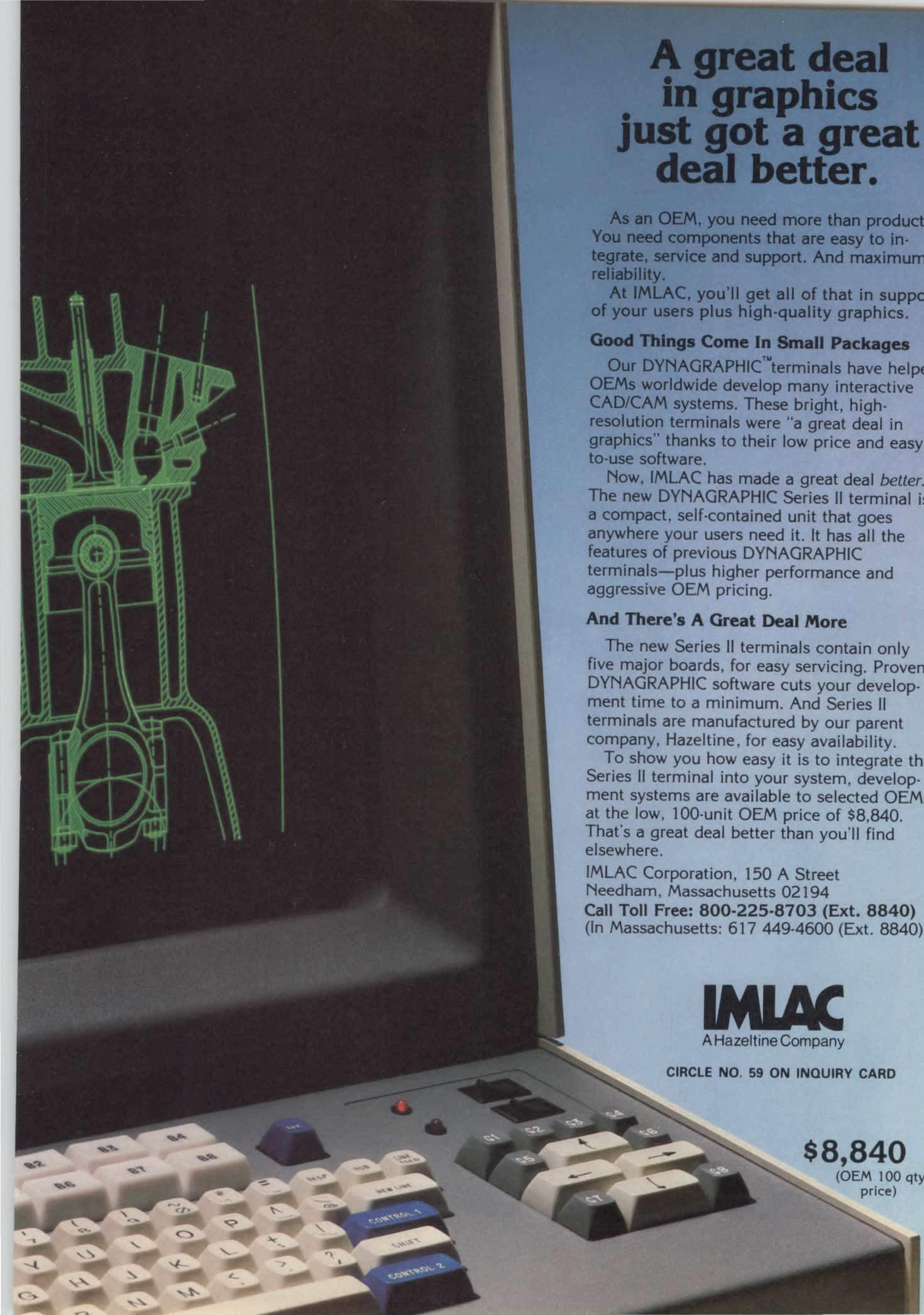
An intelligent peripheral-control unit (IPCU) within the chassis interfaces keyboards, joysticks, data tablets/digitizers and asynchronous consoles, reducing loading. A "pick module" processor interfaces a light pen or a digital comparator to the system, allowing users to pick items on the display either under direct host supervision or in an intelligent, host-independent mode. This module maintains a set of display list labels so that when an item is selected, the user is provided with the names of segments, sub-segments and subroutines involved. This permits interactive programming in applications that require frequent display list modification.

Continuously rotatable dials or valuators and switches with lights can also be added for communications with the graphics processor through the IPCU.

Finally, a μp-based hardware vector-to-raster converter may be added for hard-copy output with no software sorting or host conversions. Vectors are processed randomly, and unordered vector lists are converted into raster-bit data for most printer/plotters. The speed of the hard-copy output is limited only by the speed of the printer. ■



Peter J. Shaw is vice president of Megatek Corp., San Diego, Calif.



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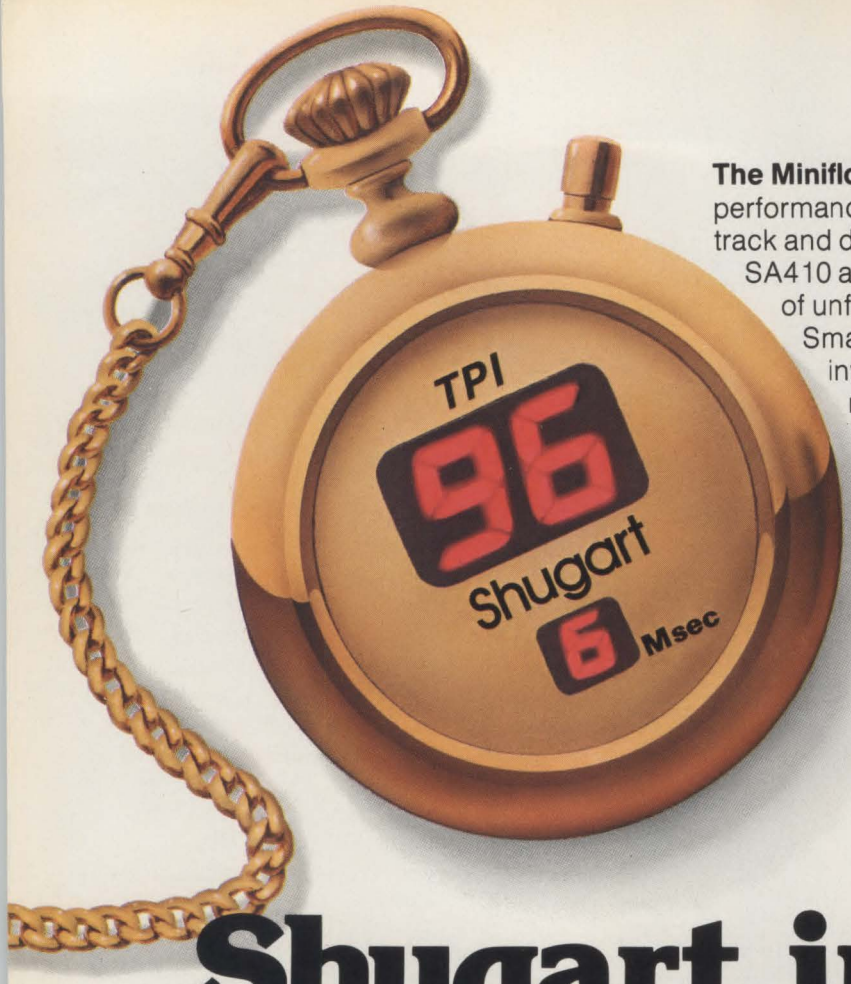

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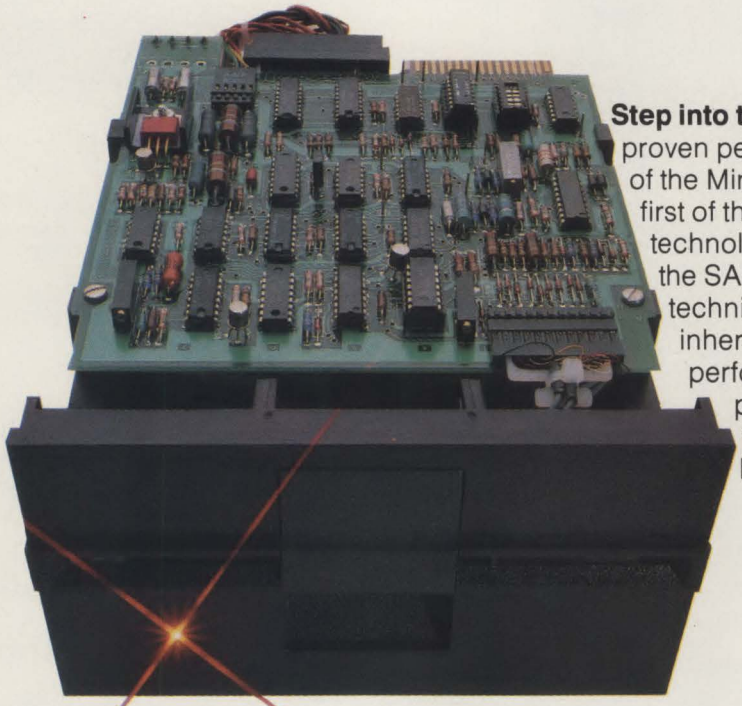

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The IBM 3279 *display in an office environment.*

A close look at IBM's color graphic offerings

FRANK ROSSITER, IBM Corp.

The 3279 color display station and 3287 printer are educating users to the colorful world of EDP

Compared to monochrome displays, color displays significantly improve the presentation of complex data. Data is easier to recognize, exceptions and errors are easier to detect, and operator productivity and satisfaction increase. But to realize these advantages in a general-purpose alphanumeric display, an extremely high level of picture quality is required. A picture that is acceptable when viewed from a distance of 10 ft. is unacceptable when viewed from the normal display distance of 18 in. At the shorter distance the picture appears grainy and may seem to flicker and lack sufficient color convergence.

IBM Corp. announced the 3279 color display station in November, 1979 (MMS, December, 1979, p. 45), together with the 3287 printer and enhancements to the 3274 control units. In the course of developing these new products, significant improvements were made in color-display technology. As well as providing high-quality alphanumerics and graphics in as many as seven colors, the new color display station enables users to meet varying business needs by creating charts and graphs interactively at a terminal.

The 3279 display and the original idea for the 3287 printer, as well as the graphics software that supports the new terminals, were developed at IBM's Hursley, England, laboratory. The development work on the 3287 was done at Raleigh, N.C., and Endicott, N.Y. The enhancements to the 3274 control units were developed in Kingston, N.Y.

The complete package consists of new hardware

devices and programming features as well as enhancements to existing products. These developments add three new visual aspects to data display:

- Color
- Extended highlighting
- Symbols and pictures

Color is available in two forms: "base color," giving red, green, blue and white; and "extended color," which adds yellow, turquoise and pink. The extended highlighting now available adds underlining, blinking and reverse video (color interchange between the highlighted area and the background).

The ability to create special symbols and pictures is provided by the graphics software package developed at Hursley. A user can design special symbols at the keyboard, such as special language characters, mathematical symbols and shading patterns. Pictures such as graphs, charts and diagrams can be created either by the new software package or by a user application program. Symbols and pictures can be displayed in as many as seven colors, and a permanent copy in four colors can be obtained from the enhanced printer.

Design innovations

The main requirements for a high-quality color display, suitable for both alphanumeric and graphics applications, include high resolution, small spot size, properly chosen colors, absence of flicker and easy and accurate convergence adjustment.

The high-quality color display provided by the IBM 3279 satisfies these requirements through design innovations in color-picture-tube technology. The use of more shadow mask holes and phosphor dots than found in color television allows superior character resolution, and greater color convergence is achieved by more accurate control of the magnetic convergence fields.

The color cathode ray tube

The IBM 3279 uses a shadow mask CRT with a delta electron gun (Fig. 1). The group of red, green and blue phosphor dots activated from one shadow mask hole is called a triad. To draw good character strokes on the screen, it is necessary to straddle at least seven triads with the electron beam. The minimum spot size that can be achieved is, therefore, directly related to the triad pitch.

The IBM 3279 uses a high-resolution CRT with a triad pitch of 0.012 in. compared with the conventional TV CRT triad pitch of 0.023 in. (Fig. 2). The smaller spot and sharper character strokes produced on the high-resolution CRT greatly increase alphanumeric legibility and graphics clarity.

Choice of phosphors

The criteria dictating the choice of phosphor colors for data processing displays are different from those for TV. The objective in alphanumeric displays is to have seven easily distinguishable colors that are pleasing to an operator. For TV, the goal is to reproduce colors as faithfully as possible. In addition, the more stringent

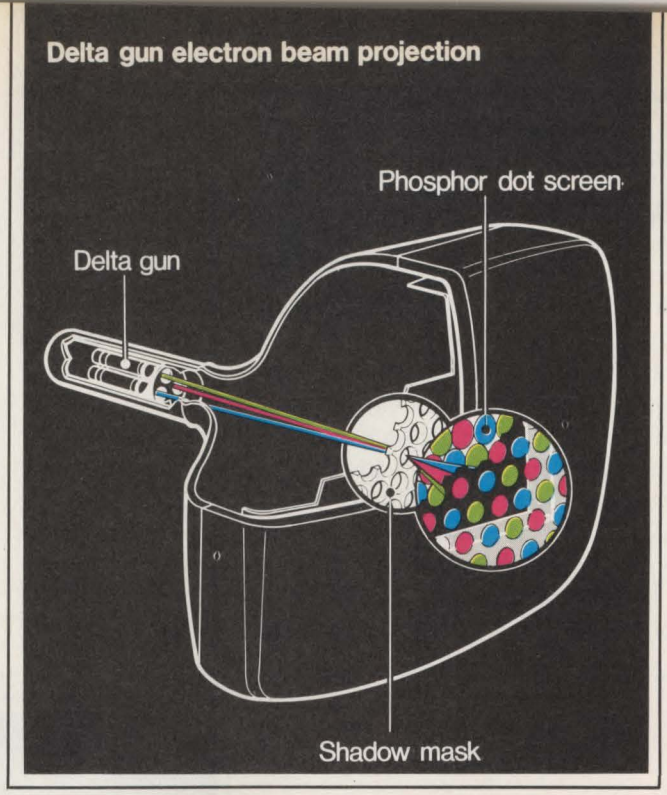


Fig. 1. The color *cathode ray tube used in the IBM 3279.*

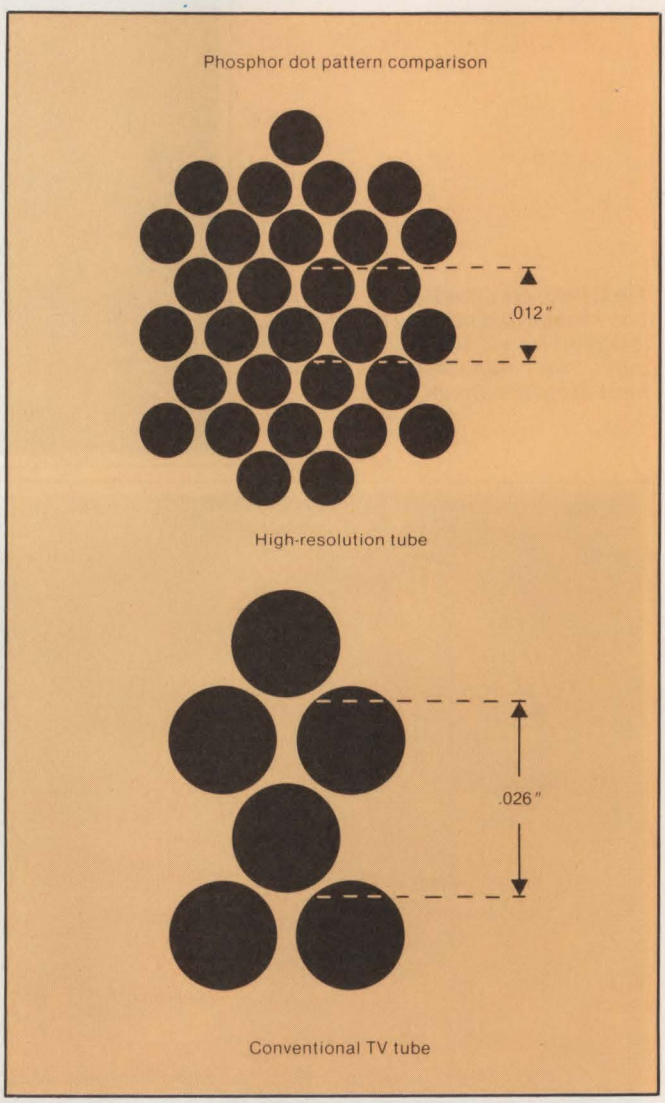


Fig. 2. Comparison *of the phosphor dot pattern in a high-resolution tube and in a conventional TV tube.*

The advanced-function microcode for the 3279 is provided on a diskette as one of several support packages.

requirement of flicker-free pictures at a short viewing distance in data-processing displays requires a nice balance in the phosphor persistence to match the refresh rate with the required range of brightness.

IBM human-factors engineers put a great deal of effort into the right specification for the phosphors for the 3279. This involved work on the problems of using color as a formatting aid and as a visual code, choosing the categories of data fields to be color and choosing the colors in which to display those categories.

Color CRTs use three "primary" colors, mixtures of which produce "secondary" colors. The primaries are red, green and blue; if all three are superimposed, the resulting color is white. When two primary colors are superimposed to produce a secondary color (for example, red and green to produce yellow), it is

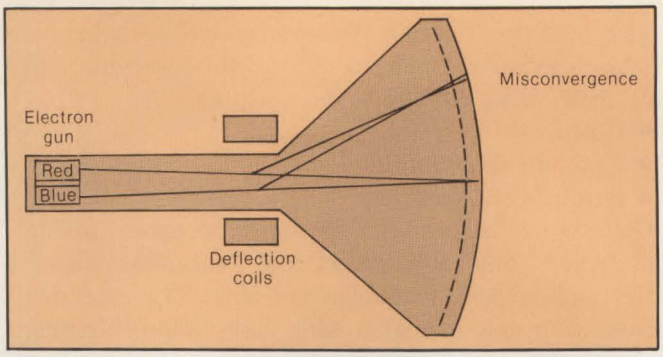
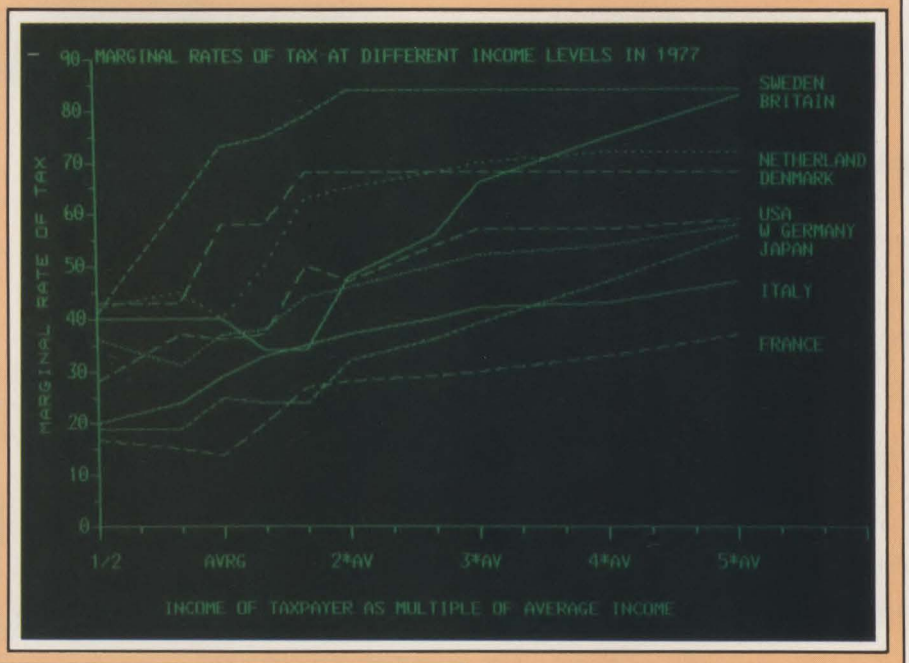
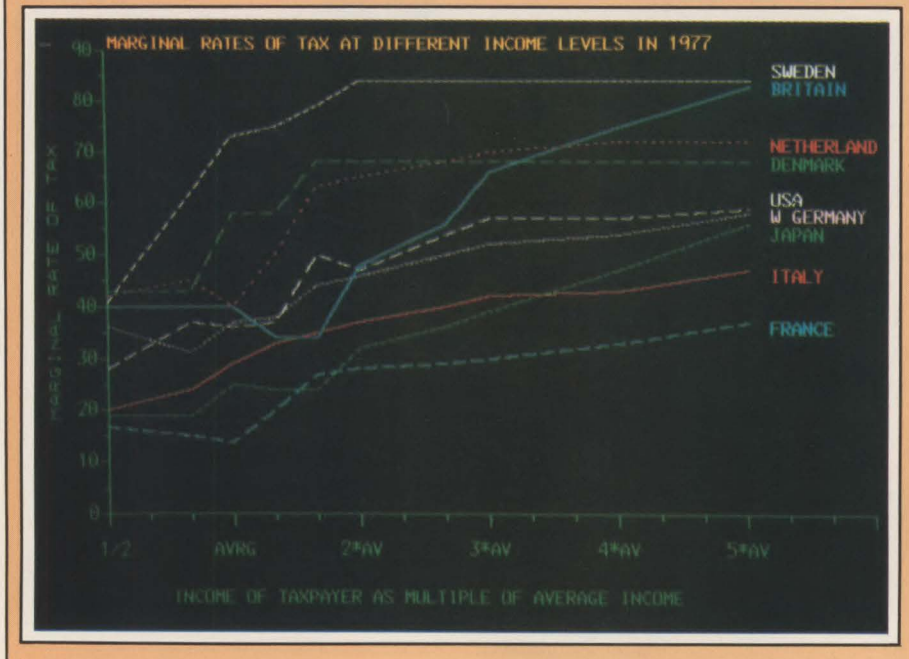


Fig. 3. Geometry *of cathode ray tube deflection system showing misconvergence at the edges of the screen.*

Fig 4. Displays differing *only in the addition of color illustrate the benefits color images (below) have over monochrome (right). With monochrome, overlapping lines become difficult to trace . . .*





. . . while the plotting on this color display is easy to follow. In the IBM 3279 display at the left, red and green are used to discriminate between headings and data, red to highlight special cases, and white to indicate the current transaction.

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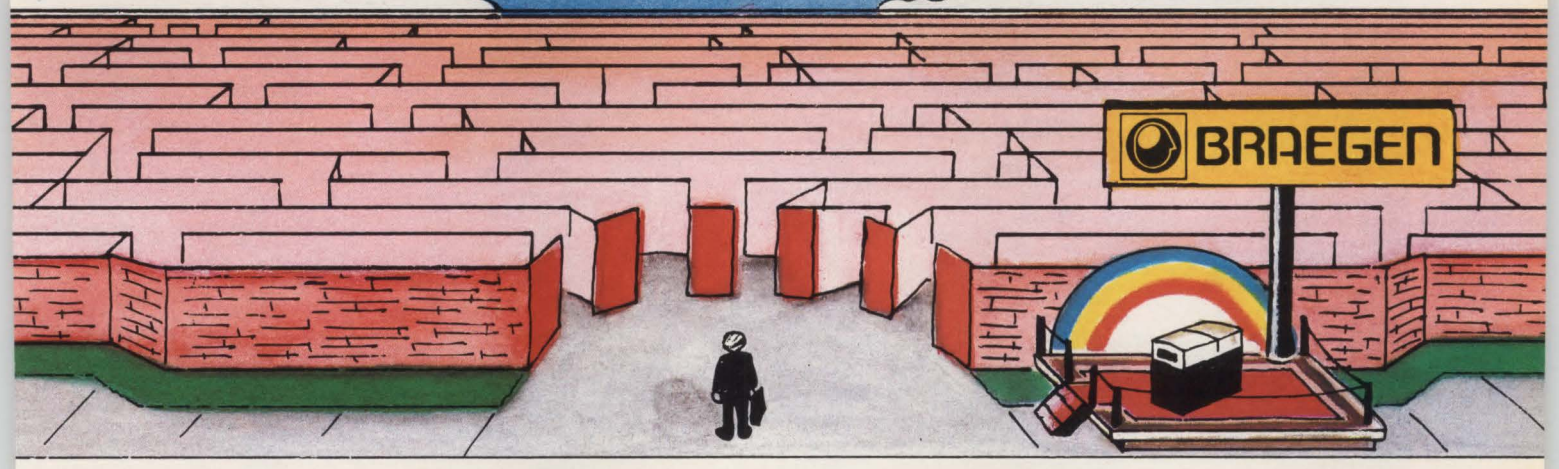

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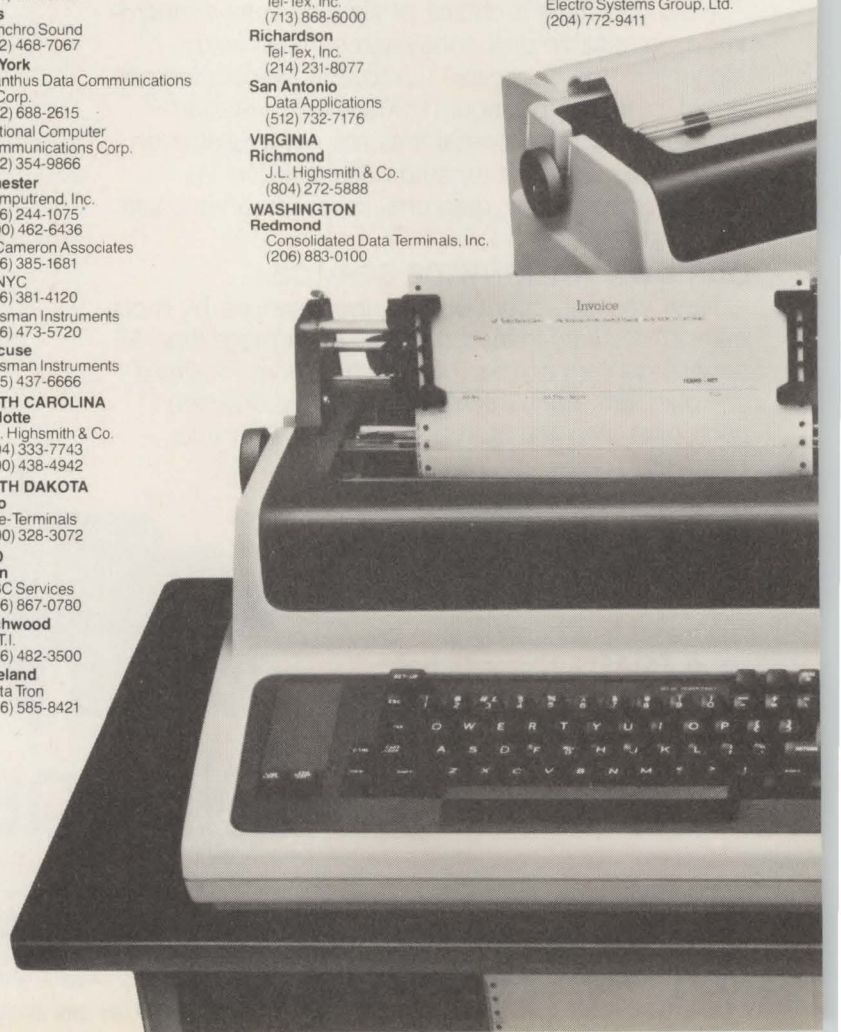

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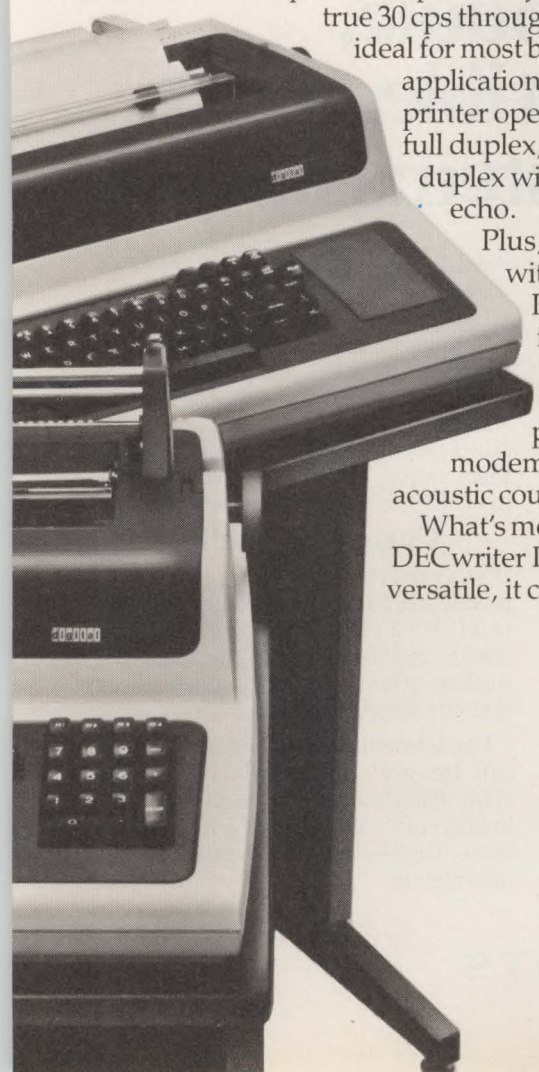

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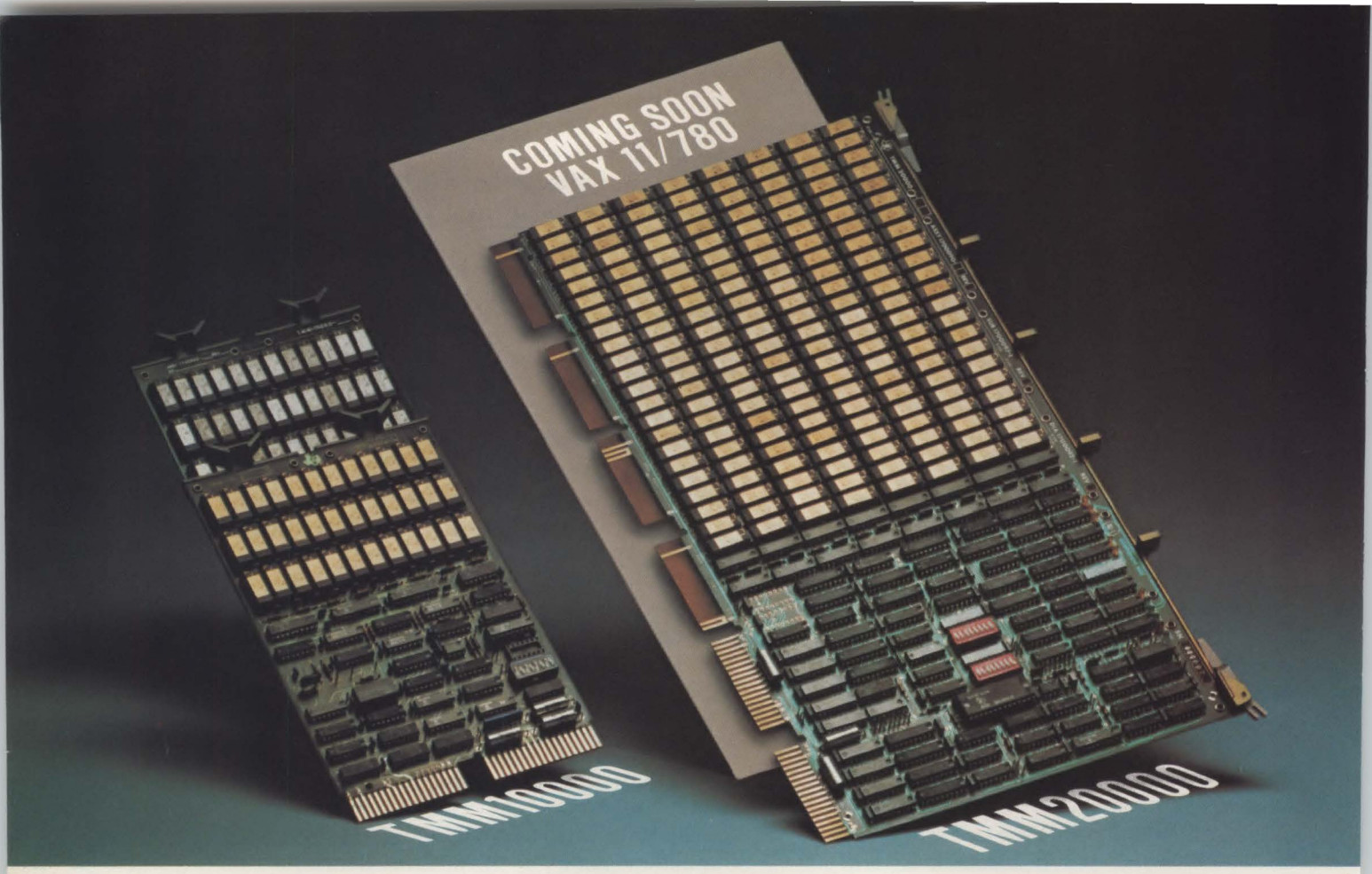

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The base color models of the 3279 are supported by existing 3270 software; extended color models are supported by releases of several IBM systems.

important to ensure that the two primary colors exactly overlap, otherwise an "edge effect" occurs. In our example, if the primaries did not overlap (or are "misconverged"), the yellow image would have a red edge on one side and a green edge on the opposite side.

In a TV picture, the edge effects caused by a misconverged CRT are somewhat annoying, but the same degree of misconvergence on an alphanumeric display of a table of numeric data would make the picture completely illegible.

From the geometry of the CRT deflection system (Fig. 3), it is apparent that a CRT converged at the center of the screen will need convergence adjustment at the edges. The adjustment is applied by correction voltages to the deflection system and, in conventional CRTs, is controlled by a number—perhaps 40 or so—of potentiometers. An added complication is that convergence adjustment may need to be repeated at intervals during the life of the CRT.

The adjustment process, in which potentiometers are involved, is a time-consuming task that requires a skilled technician and can add a significant servicing cost. To overcome these problems, IBM developed a unique digital convergence system that allows an unskilled operator to adjust convergence in a few minutes from the keyboard. When adjustment is required, an operator is presented with a series of test patterns in 13 zones of the screen and, using the cursor move keys, the operator can light the red, green and blue images. The operator generates the convergence-correction during this process; microcode expands this

HOW THE 3287 PRINTS

The print operation for all models of 3287 printers consists of printing dots from a moving print head. The print head contains eight vertically arranged print wires, each of which is controlled by a print actuator. When the print actuator forces the print wire against the print ribbon, a dot of ink is deposited on printer forms (Fig. 5).

The 3287 forms characters by printing a pattern of dots that correspond to a stored character cell (matrix) in the printer. Fig. 6 shows how a character is formed within an 8-dot-high by 7-dot-wide character cell as the print head moves across the form. The character A is formed by actuating a series of print wires within a character cell. The sequence of wire/dot patterns within the character cell is shown from left to right across the illustration. Note that:

- No single wire is used in successive horizontal positions.
- No more than 25 wires can be used in a character cell.
- Each wire can strike the ribbon no more than four times per character (e.g., print wire 5 when printing the character A). This restriction allows for mechanical settling of the print wire and its driving mechanism.
- The space between characters is equal to three adjacent dot positions.

To print in color, the 3287 uses a multicolor ribbon cartridge (Fig. 7) on which color tracks are selected mechanically under program control.

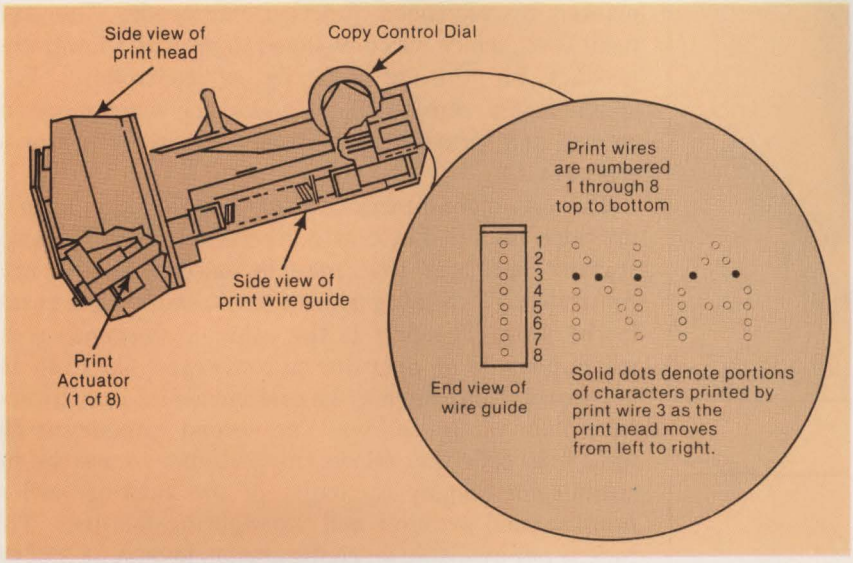


Fig. 5. The IBM 3287 *print head mechanism.*

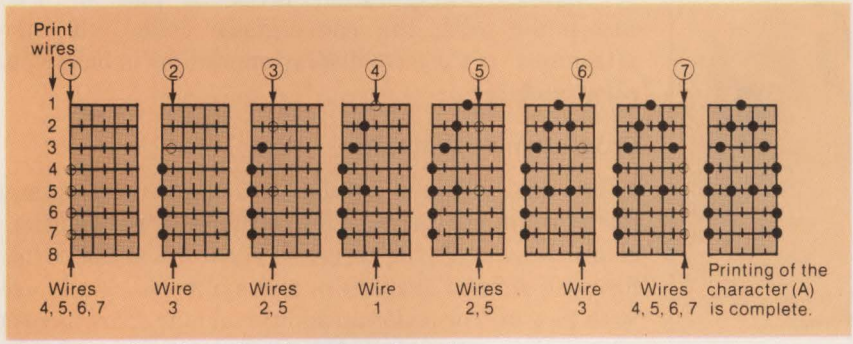


Fig. 6. Forming characters *in a character cell.*

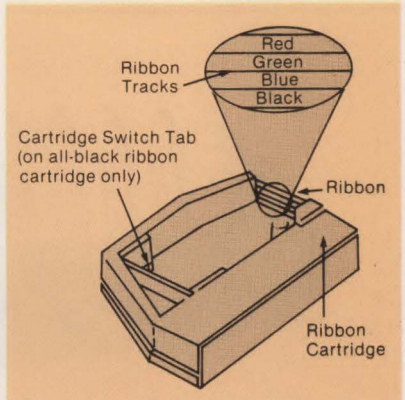


Fig. 7. The IBM 3287 *ribbon cartridge: If an all-black ribbon cartridge is installed, track selection is uniformly distributed (by microcode) to increase ribbon life.*

The interactive vector symbol editor is useful for creating headings or logos or for complex characters used in languages such as Japanese.

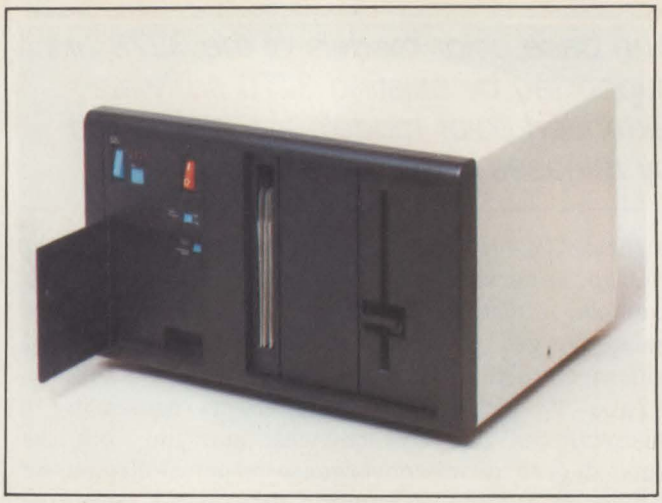
set of values to 480 screen zones and provides smoothing between the zones.

The hardware

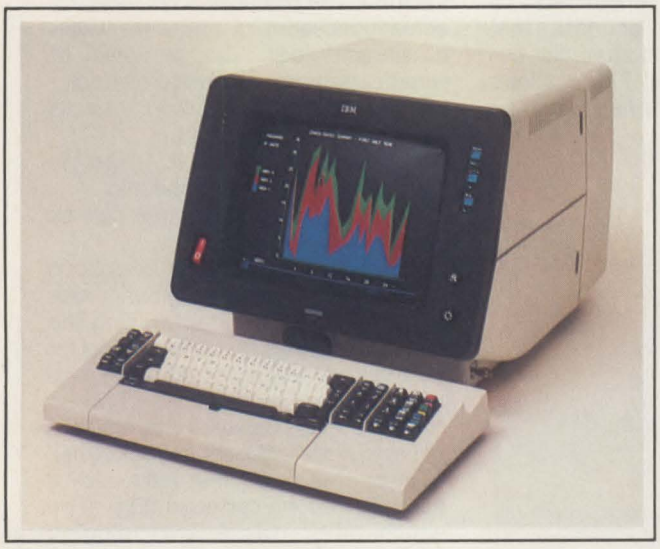
Display. The 3279 antiglobe screen measures 14 in. diagonally. The unit is designed with many human factors improvements, and is half the weight of a 3278, with which it is still functionally compatible.

Printer. The 3287 four-color printer can operate either as a color printer or as a standard "black" 3287. Bidirectional printing allows as many as 132 print positions at the normal rated speeds of 80 and 120 cps. It uses a four-track, easy-loading ribbon cartridge, and when operating as a color printer, it makes as many passes for each line as there are colors on that line.

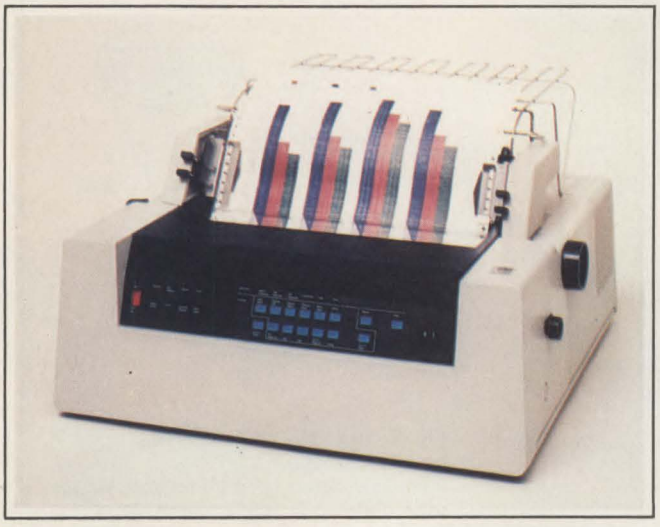
With the programmed symbol feature, users can create and print additional character sets. The 10 × 8 matrix cell has all locations available, which allows printing continuous horizontal and vertical lines. Because customers have the ability to control color on a dot basis as well as by character, they can design unique multicolor symbols and graphics.



The 3274 model *51C desk-top control unit.*



The IBM 3279 *color display station.*



The IBM 3287 *printer showing a typical page of graphics output.*

Controller. The 3274 control units, models 1A, 1C and 1D, each of which can attach 32 terminals, and the smaller desk-top control unit, the 3274 model 51C, which can attach a maximum of 12 terminals, handle the extended features of the 3279 display and the 3287 printer by advanced function microcode. The 3274 model 51C, which was developed to provide a lower-cost product for the 3274 family of controllers, is a small-cluster remote mono and color display station control unit, providing essentially the same function as the 3274-1C.

The advanced-function microcode for the 3279 is provided on a diskette as one of several configuration support packages that may be used with the 3274 controllers. Two categories of 3279-related code reside in the 3274. The first is the color convergence code, which permits an operator to converge color from the keyboard. This code may be customized into any level of 3274 code configurations. The second category is the functional code that allows the customer to use the full seven-color display capability of the 3279 as well as programmed symbols and highlighting features. This code is not available on configuration level A or B of the 3274 code; it is provided only on configuration levels C or higher. Configuration levels A and B, when customized with the convergence code, will allow attachment of the 3279 display operations in base (four) color mode.

Programmed symbols

Two programmed symbol (PS) modes are optional features of the 3279. PS-2 provides two additional character sets of 190 characters each, which can be used for user-defined characters and symbols. PS-4 is used with PS-2 and provides an additional four character sets of 190 characters each. Three of these four character sets can store multicolored characters or symbols, an

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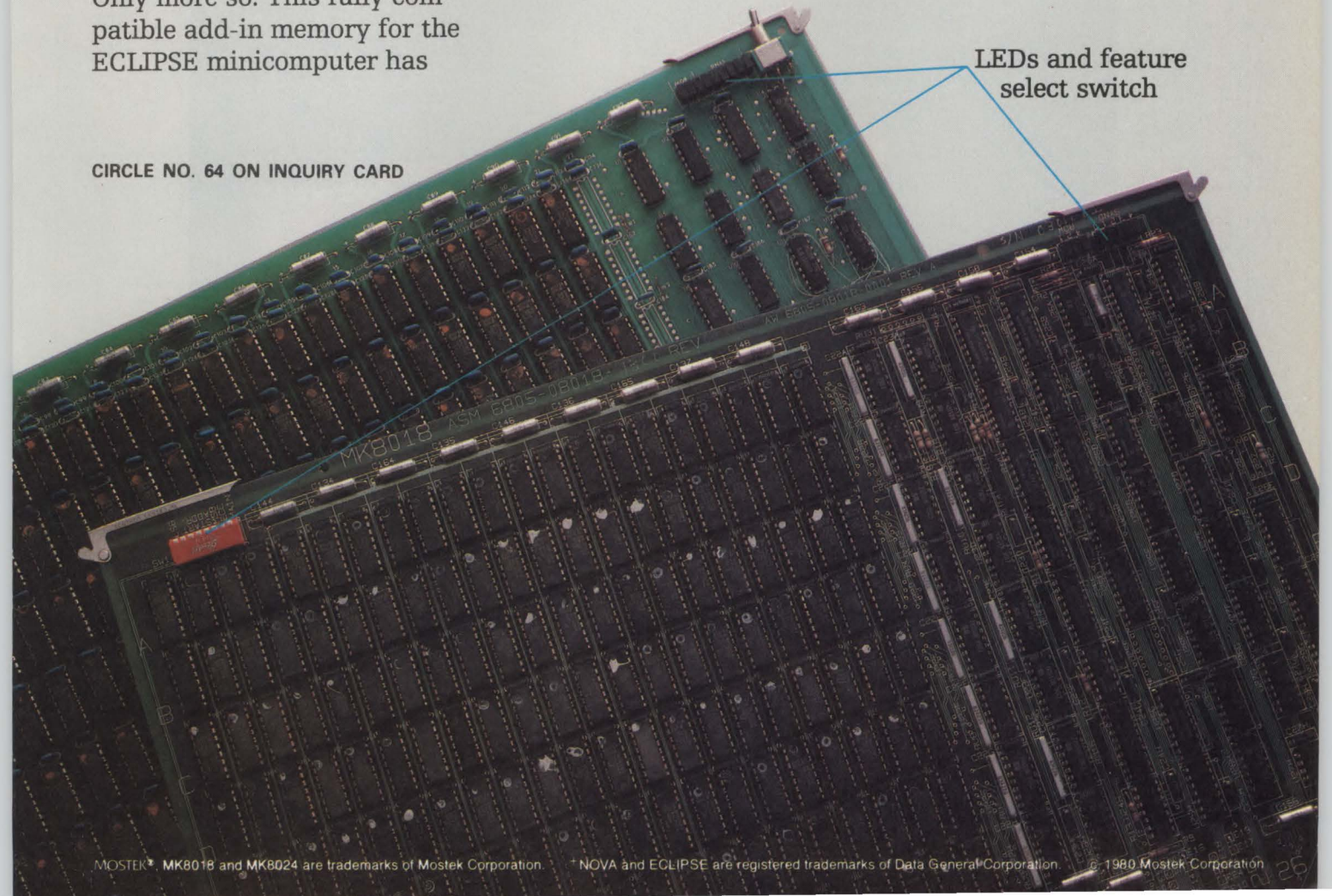

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For a widely dispersed audience, color TV monitors attached to the 3279 can be used to relay the display to nearby locations. With a booster, several monitors can be run at once.

important consideration in graphics applications.

Existing 3270 software supports the base color models of the 3279, and the new releases of several IBM interactive and transaction-processing systems support the extended color models. The support includes the control of color, highlighting and programmed symbols as well as existing alphanumeric functions of the 3270 display.

A new mainframe program product, the graphical data display manager (GDDM), also developed by IBM, provides graphics and alphanumeric programming support. GDDM uses the programmed symbols hardware feature: from numeric data it constructs and loads into PS the special characters needed to display a picture such as a graph or block diagram. The application programmer is provided with a subroutine call language to control the graphics appearing on the screen.

Also in GDDM is the interactive symbol editor utility, which allows a terminal operator to create and edit new characters or symbols. User-defined symbols include language symbols, such as Greek and Cyrillic; mathematical symbols, such as integral signs, exponents, etc.; and chemical symbols. The user can create "sets" of as many as 190 such symbols, and the sets can be stored and retrieved for future use.

An optional feature of GDDM, presentation graphics feature (PGF), allows common types of graphs and charts to be created with very little programming effort. PGF can be used either with the application program or interactively. In the latter case, the operator can generate the graphics by keying in data.

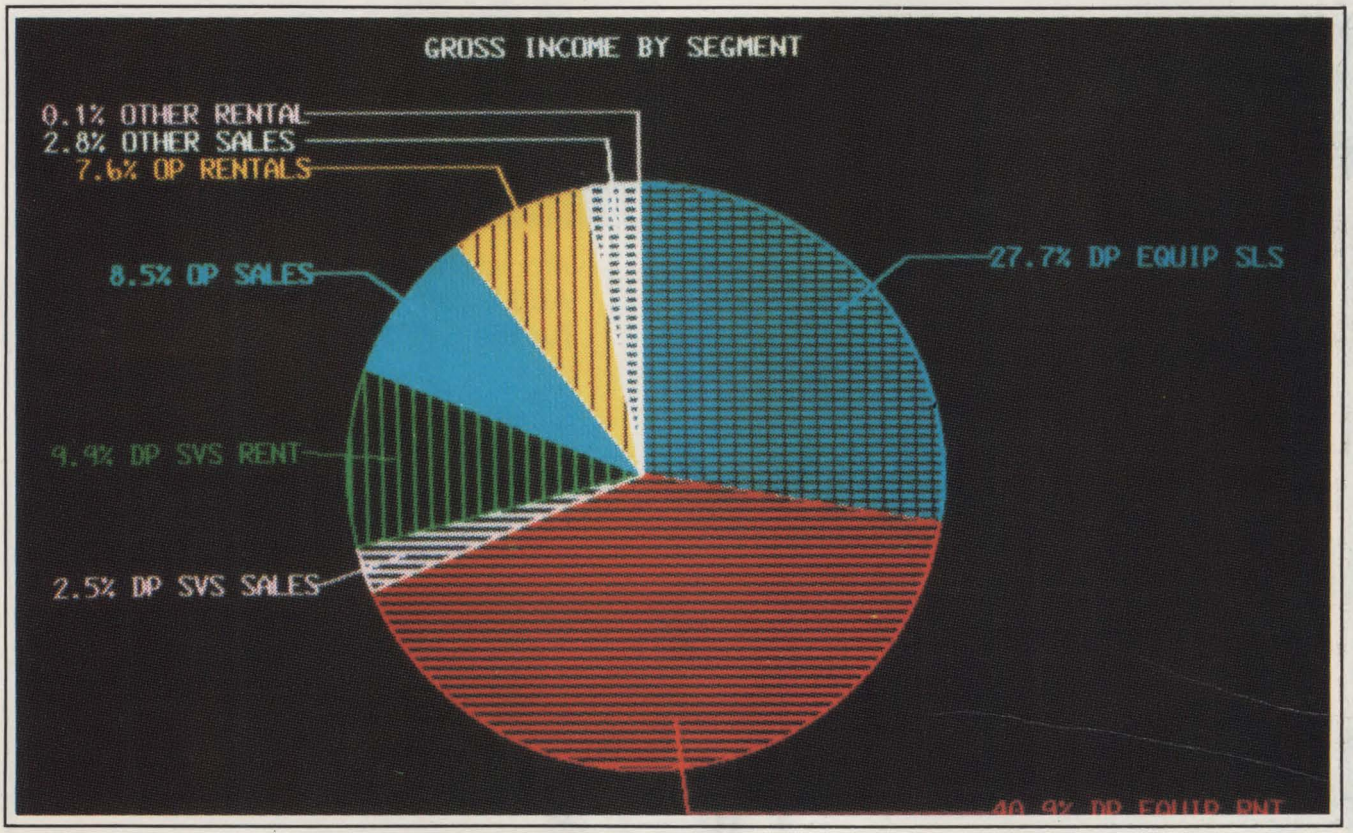
Graphics available in PGF include line graphics, bar charts, histograms, pie charts and Venn diagrams. A "menu-selection" style of entry from the lists displayed on the screen lets a user define the format of the chart together with line type, color, shading and so on. A chart created in this way can be stored and retrieved.

The interactive vector symbol editor is included within PGF and enables the user to create large symbols or characters. This can be useful for creating headings and logos, or complex characters used in such languages as Japanese.

Applications of color

Investigation, both by human-factors engineers and in user involvement tests, has shown that all alphanumeric applications using monochrome displays benefit when color is introduced. The photographs in Fig. 4 show the use of the 3279 in a graphics application.

Although now exhaustive, the tests made by the engineers at Hursley have shown some of the ways in which color can be used. In the report describing this research, the use of color is recommended as a coding agent (to indicate to an operator the category into which the data being displayed falls) and as a



A pie chart created *by way of the presentation graphics feature.*

IBM has developed a unique digital convergence system that enables an unskilled operator to adjust convergence from the keyboard.

formatting aid (whereby color aids the operator in understanding the logical structure of the data on the screen). The report also points out uses of color that do not aid the operator but simply confuse him. If the application programmer or screen layout designer chooses to use too much color or the wrong color, benefits are lost.

In addition to choice of colors and quantity of colors, the designer can use the highlighting features of the 3279, including brightness, blinking or reverse video. For example, it has been found that blue, with its relative dullness against the background color of the screen, tends to de-emphasize data fields, whereas white, with the opposite effect against the dullness of the screen, can be used for emphasis.

With the acceptance of color displays came the demand for ways of presenting the data displayed to larger audiences. In July, IBM announced a new feature called video output that allows the data displayed at the screen of the IBM 3279 to be presented as output in a variety of ways by compatible devices supplied by manufacturers other than IBM.

- **Projection.** Using a suitable large-screen projection device (one able to show a color image), the display shown on the screen of the 3279 can be projected for viewing by large audiences.
- **TV monitors.** For a more widely dispersed audience, color TV monitors can be used to relay the display to nearby locations. The number of monitors that can be attached to a 3279 is limited by the ability of the devices themselves. With booster units, several can be operated at once. For example, color TV monitors in airport lounges can display passenger or flight information from a central 3279.
- **Hard copy.** With a suitable permanent-copy image device attached, full-color photographs (typically as large as 8 × 10 in.) can be made of any given display within minutes. This provides a "hard copy" record for those who require it. Alternatively, foils and 35-mm. slides could be produced. All would be used as high-grade material for later presentation.

Reference

P.F. Robertson, "A Guide to Using Color On Alphanumeric Displays." Technical Report TR.12.183. IBM United Kingdom Laboratories Ltd., Hursley, England. December, 1979.

Frank Rossiter is a researcher with IBM Corp.'s United Kingdom Laboratories, Ltd., Hursley, England.

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Graphic Systems

Selecting hard-copy devices

GERARD H. LANGELER, Tektronix, Inc.

Terminals and desk-top computers are important, but there's also a wide range of other products and technologies to consider

There is a good argument that suggests that the selection of hard-copy devices for computer graphics systems is as important, or more important, than the selection of a graphics terminal or desk-top computer. The argument begins with the assumption that the hard copy, not the display on the screen, is the "action" document.

Of course, terminals and desk-top computers are excellent for manipulating and displaying data. But, in a sense, they are only preview devices for the desired hard-copy output. After all, engineers design parts, managers make decisions, cartographers make projections after they've examined hard copy in a report or set of reference documents.

To help eliminate the confusion over hard copy, this article surveys hard-copy technologies and products, discusses the major performance variables and trade-offs, and then describes the ideal product types for given sets of needs. The article closes with a brief assessment of what the future holds for hard-copy technology.

All photos courtesy of Tektronix, Inc.

Diverse image-making capabilities

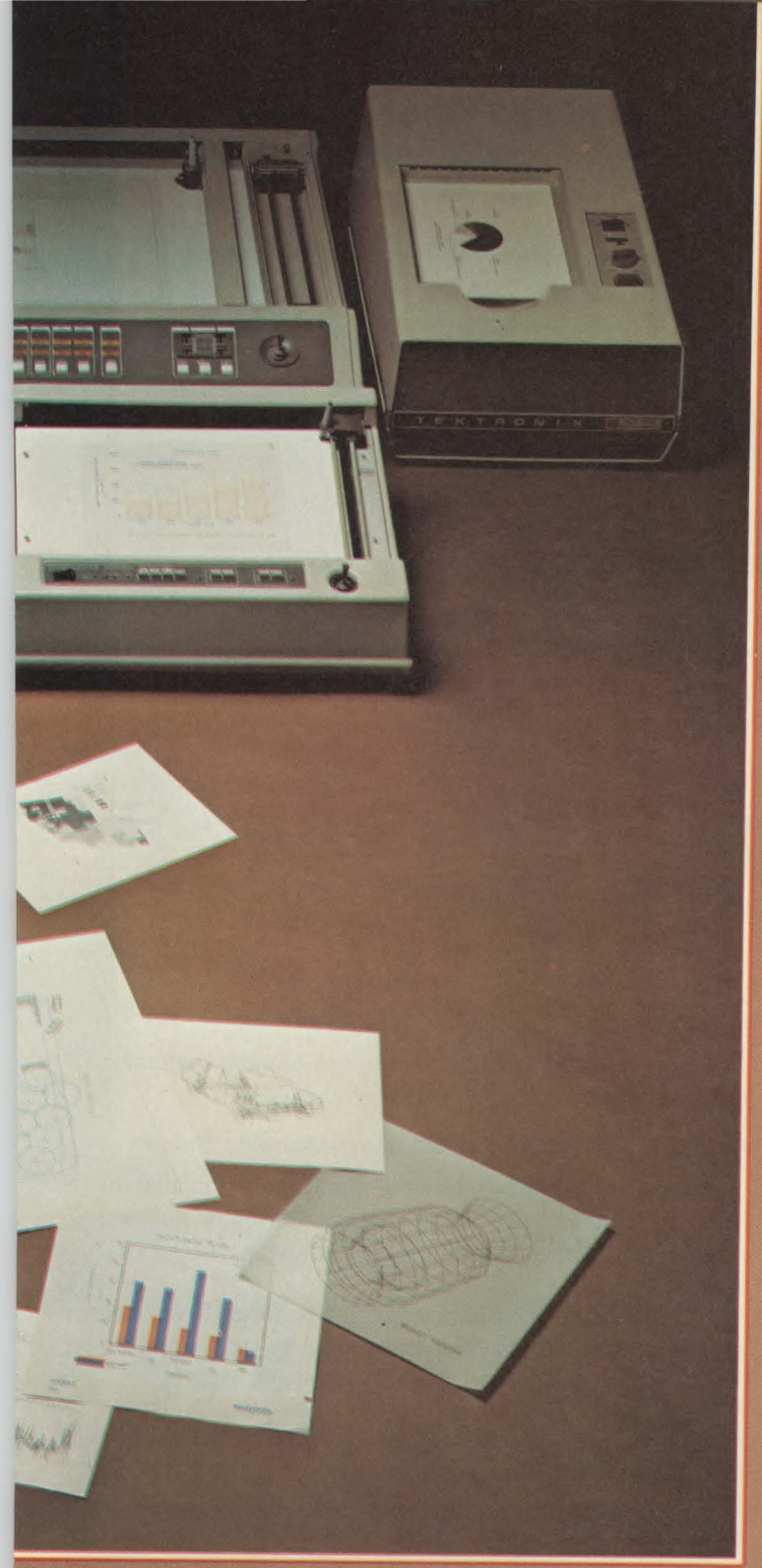
Hard-copy technology began with the electromechanical-vector-impact approach, more commonly known as putting pen to paper. Changing pens allows color or line width to be varied, but the image is limited to solid colors only, with no gray scale.

In the electrophotographic technique, a beam of light is used to expose a light-sensitive medium, which is then developed. Most designs using this technique are based on a CRT with a fiber-optic faceplate. The intensity of the light can be varied to produce fine gray-scale as well as pure black-and-white images.

Electrostatic technology does what electrophotographics do, but instead of light, it uses wires and electrodes to put down a charge on dielectric paper, which is then passed through a toner. The toner is attracted to the charged areas, and when the paper and toner are fused, the hard copy is ready.

Thermal technology closely resembles electrostatic technology, except that the wires heat a thermally sensitive paper. The heat breaks open microcapsules in the paper, releasing a liquid that creates the graphic information.

The dot-matrix-impact technique strongly resembles the electrostatic and thermal approaches. But the wires



are replaced by tiny hammers. A ribbon is placed between the hammer and the paper, and output is obtained much as it would be with a typewriter. If the ribbon color is changed, the color of the output can be changed as well.

Ink jets put dots onto paper, but unlike the previous three approaches, place the dots onto the paper without the aid of wires or hammers.

Finally, the electro-optical, or pure photographic, approach involves simply putting a camera in front of some image (normally a CRT) and snapping the shutter.

There are five major classes of computer-graphics hard-copy devices on the market: electromechanical or pen plotters, CRT copiers, printer/plotters, impact-graphics printers and camera systems.

Plotters. Pen plotters draw vectors and characters directly from computer output or from a magnetic-storage device, often with a graphics display as a preview. Plotters vary greatly in size, and sometimes are difficult to use because the pens clog or dry out, but they are only moderately expensive to own and fairly inexpensive to operate. They produce high-quality output on paper or transparent film but are very slow. Yet they do offer the distinct advantages of low-cost color and different levels of line quality because they can use liquid-ink, fiber-tip or ballpoint pens. Plotters are normally used to prepare output for reports or presentations, for camera-ready drawings and for archival copy.

The three leading suppliers of pen plotters are the Sanders/Calcomp/Gould combine, Tektronix and Hewlett-Packard. Other products are available from Benson-Varian, Nicolet-Zeta and Houston Instruments.

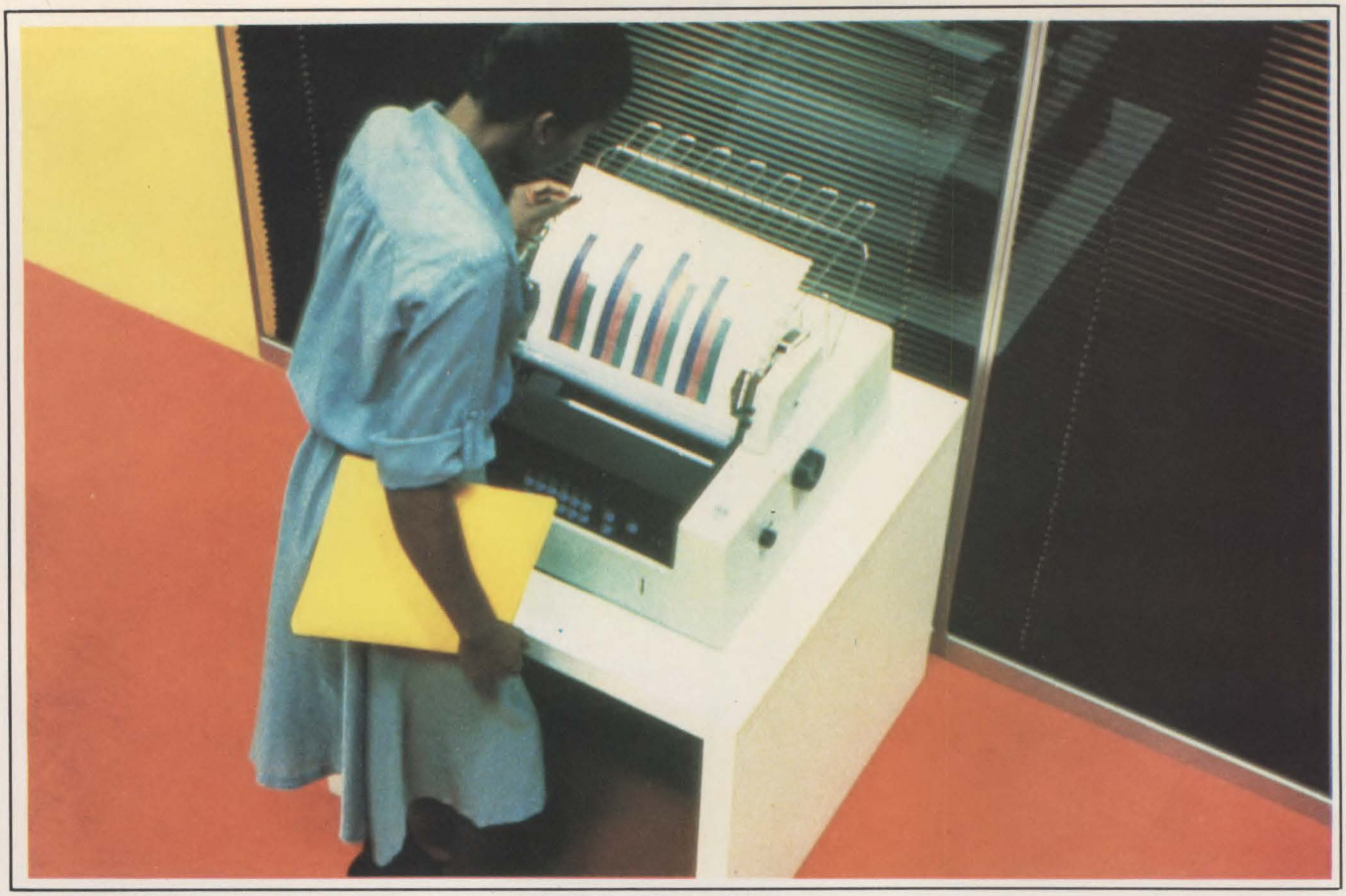
CRT copiers. CRT copiers reproduce the image from a graphic terminal, display, or desk-top computer system either directly from the screen or out of memory. They employ either electrophotographic, electrostatic or thermal technology. CRT copiers are compact, easy-to-use and relatively inexpensive to own and operate. They produce high-quality black-and-white and gray-scale paper copies at fairly high speeds. Primary uses are providing working reference copy and output for reports or presentations.

Using fiber-optic CRT, and now, dry-toner electrostatic, technology, Tektronix provides CRT copiers for raster-scan/video and storage-tube displays. Other offerings come from Hewlett-Packard (using the thermal approach) and Versatec (using electrostatics).

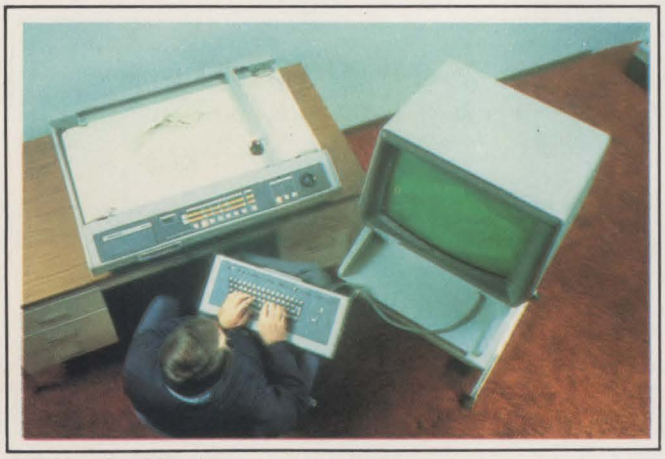
Printer/plotters. Printer/plotters produce images electrostatically on dielectrically coated paper from computer output or from a graphics display. Printer/plotters are relatively large, expensive and occasionally troublesome to use because of difficulties with the liquid toner. But they offer the advantage of producing high-quality black-and-white copies on paper or vellum at high speed and at a moderate cost per copy. Major printer/plotter uses are previewing large plots and obtaining direct computer output.

Versatec holds the lion's share of the printer/plotter business, followed by Benson-Varian and Sanders/Calcomp/Gould.

Impact printers. Impact-graphics printers produce alphanumerics and graphics using the dot-matrix-impact approach. Graphics printers usually are moderate in price and relatively easy to use, although interfacing problems have limited their use somewhat. Low cost per copy is a major advantage, but poor image



The IBM 3287 *impact-graphics printer prints both graphics and alphanumerics.*



A Tektronix 4663 plotter, *tied to a 4016 terminal, plots a topographical map.*

resolution is a critical restriction. Impact printers are used primarily for computer output, where high-volume line printing makes low cost per copy a paramount consideration.

IBM, Printronix, Trilog, Ramtek and Okidata all compete in this category. (IBM, Trilog and Ramtek do so with color.)

Camera systems. The advent of color in graphics displays has resurrected camera/film techniques for generating hard copy. While camera systems are often cumbersome and costly, they offer superior resolution and color if the high cost per copy and the long wait are not important considerations.

Matrix and Dunn Instruments are the two primary entrants here.

Define the terms and avoid specsmanship games

A user who is confused by the many choices available in technology and products can examine major performance variables and trade-offs to eliminate most of the confusion.

A user evaluating a hard-copy device for a particular application should consider these four major variables: resolution, speed, device cost and cost per copy.

Resolution. The terms "dots per inch" and "addressable points per inch" are indicators of potential resolution, but neither term tells the whole story. Discernible line pairs per inch is a more revealing and accurate measure of resolution.

The problem with using dots per in. or addressable points per in. as a measure of resolution is that they ignore major problems with many of the electrostatic products—dot blowup and artifacts. For example, in many applications it doesn't do much good to have a 200-dpi device if each dot is greater than 1/200 in. wide.

Dot overlap is one thing; dot blowup is another. Dot overlap decreases resolution as it is defined here, but increases the visual appeal of the image. Dot blowup decreases both resolution and visual appeal. Artifacts, or stray marks on the paper, also detract from the visual appeal.

The important question here is, what is the real resolution in discernible line pairs per in.? If the

In industrial environments, *Tektronix color-graphics systems are used for such applications as printed circuit designs.*

Examples of Tektronix's color-graphics products: *4027 terminal (top left), 4054 desk-top computer (top right), and 4632 (front left) and 4631 hard-copy units.*

product uses electrostatic technology, push for good answers on dot blowup and artifacts. Ask for a sample copy of the desired configuration of equipment. If terminal copy is needed, it is important to match the copier's resolution to that of the terminal. For instance, a 1029-line, 15-in. tube system has only about 100 lines per in. If a 200-line-per-in. copier is chosen for it, the user is buying more performance than is needed. In fact, the imperfections of the screen will be copied.

Speed. Here again, several terms can be misleading: "inches per second," "Gs" and "lines per minute." The truly important question is, from the time the button is pushed, how long does it take before the output is ready?

Inches per second is used by vendors of electromechanical plotters to indicate the speed of the pen, while Gs refer to pen acceleration. Both are elements of output speed, but neither tells the whole story. The same problem appears in printer/plotters and graphics printers, where ips generally refers to the line-printing mode.

Another measure of speed to be considered is rasterization, which printer/plotters require. Many buyers have purchased printer/plotters because they wanted fairly high-speed output only to find that while indeed the printing/plotting is rapid, they must wait an inordinately long time while their mainframe or minicomputer rasterizes all the vectors—and computer time is very expensive. If the product is a printer/plotter, the user should check on the time and cost of rasterization, which must be done either locally or on the host.

For example, a typical eight-layer circuit-board layout may require only a few seconds to be produced on a printer/plotter, yet a minicomputer may have to run for 20 min. rasterizing the vectors. At $100 per min., computer time can be a significant expense for a design group during a normal work year.

To alleviate this problem, many manufacturers now offer black boxes to perform local rasterization, a welcome move. Nevertheless, the black boxes do add thousands of dollars to the purchase price of the system.

Dot overlap decreases resolution but increases the visual appeal of the image. Dot blowup decreases both resolution and visual appeal.

For making comparisons, pages per minute is the most effective measure of output speed. Consider a page to be a fairly typical graphic output of approximately 200 vectors on an 8½ × 11-in. (or A4-size) sheet of paper.

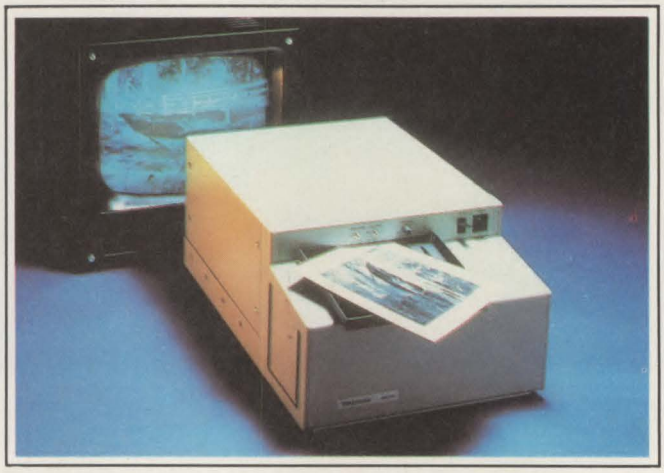
Device cost. This variable is often more straightforward than resolution or speed, if all the necessary interfaces, rasterizers and software needed to make the device operational are included. The trade-off charts discussed below feature a fairly standard configuration of a Tektronix graphics terminal and a minicomputer, with rasterization (for those devices needing it) done locally by a vector-to-raster converter. The question here is, what is the total cost of making this product work in the intended environment?

Cost per copy. This variable is easy to calculate also, as long as all attendant costs (paper, pens, toner, film or whatever) are included. Consider any regular wastage (such as that caused by liquid toner seeping into the paper between copies) and then use an average order quantity to determine costs (for example, four rolls of paper to a box; the average user orders four boxes at a time). What is the total cost per copy including wastage?

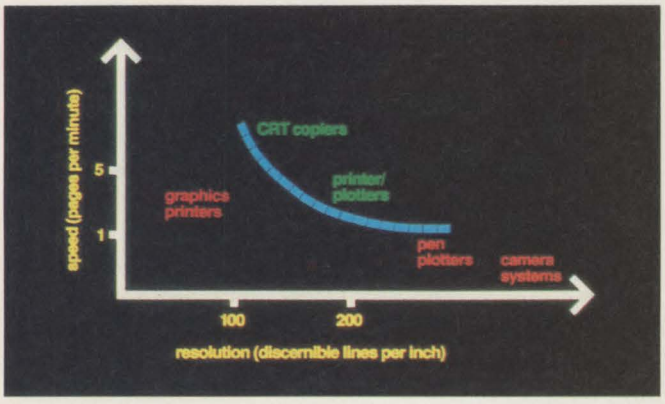
With the four major variables defined, four major trade-offs among those variables should be examined. They are: resolution vs. speed, device cost vs. resolution, cost per copy vs. speed and device cost vs. cost per copy.

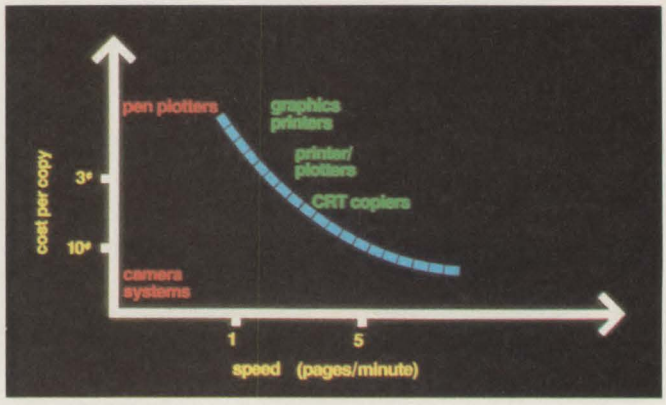
For purposes of this analysis, the most popular sizes and configurations of each class of device are compared because most potential users seem to buy from among those sets of products. Generally, that means A- or B-size devices by U.S. standards and A4- or A3-size devices by international standards.

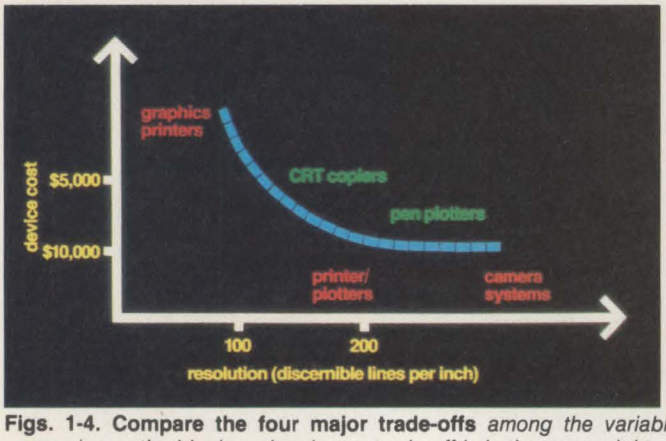
Several generalizations have been made here regarding resolution, speed, device cost and cost per copy. Although certainly quite arbitrary, these generalizations reflect the prevailing attitudes in the market today.

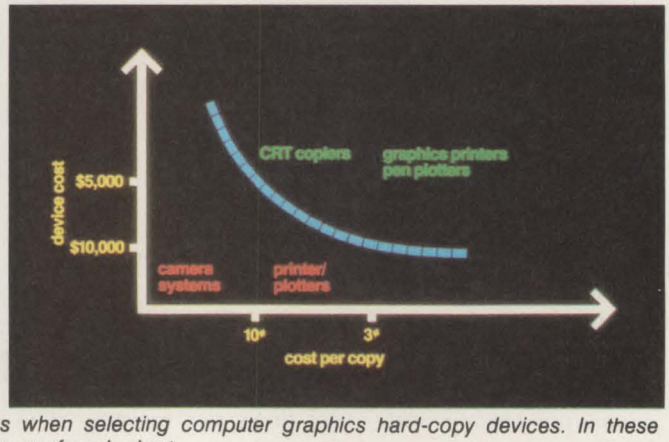


This Tektronix 4634 hard-copy unit *takes its image off a video screen.*

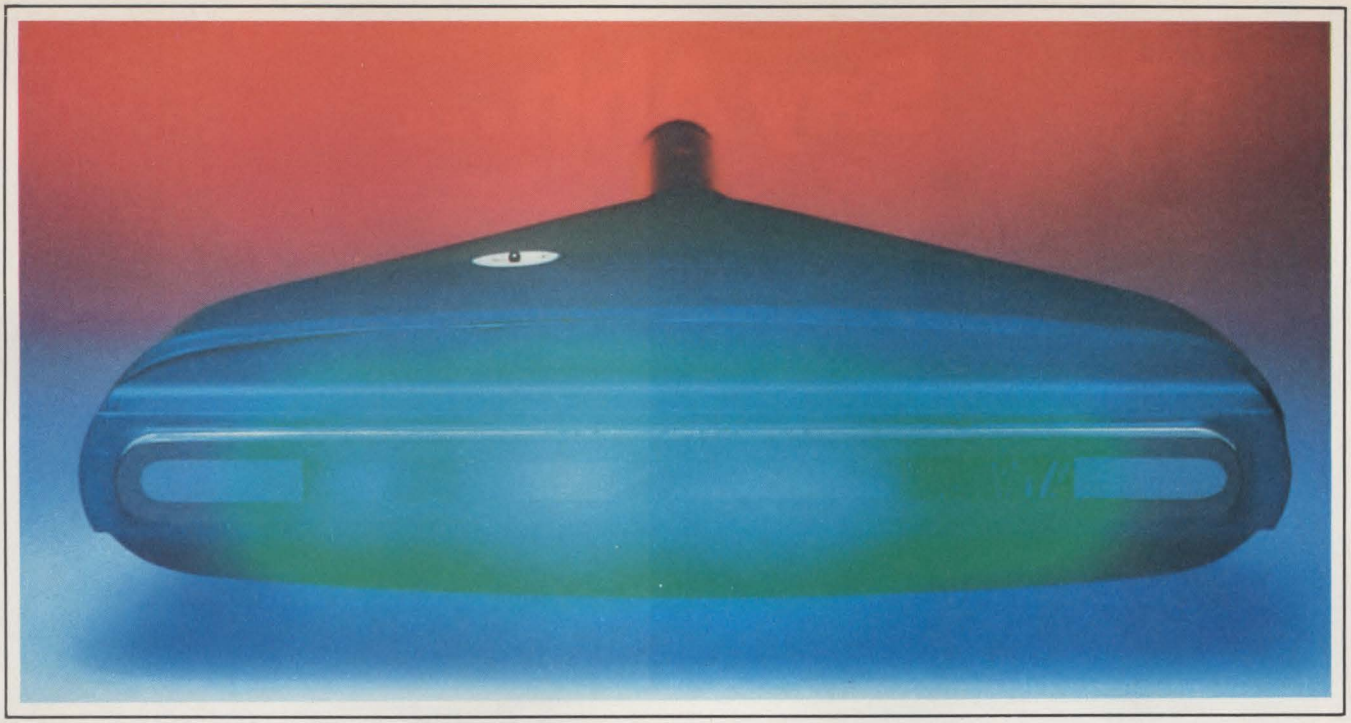








Figs. 1-4. Compare the four major trade-offs *among the variables when selecting computer graphics hard-copy devices. In these comparisons, the ideal product in any trade-off is in the upper right corner of each chart.*



A fiber-optic CRT, *the driving engine for all 4630 series hard-copy units.*

The charts shown in Figs. 1-4 have been organized so that the farther the result is from the origin, the better it is for the user (i.e., higher resolution, higher speed, lower device cost, lower cost per copy). Therefore, in these comparisons, the ideal product in any trade-off will be located in the upper right portion of each chart.

What is the ideal product?

With these trade-offs in mind, let's look at the ideal product for a given set of user needs. What is usually a complex decision may be simplified here; nevertheless, these observations should serve as a fairly good guide.

If quick, high-resolution black-and-white or gray-scale copies are needed for working reference, filing or presentations from a low-cost device at moderate cost per copy, a CRT copier is the cost-effective solution.

If very-high-resolution line-graphics copies are desired for presentations, reports or final reference, particularly in color, with no concern over a few minutes of waiting time, choose a pen plotter.

If high-resolution plot previews and line-printing computer output are needed and equipment cost is not much of a concern, consider a printer/plotter.

If low-resolution copies at relatively high speed are called for in an environment where low copy cost is paramount, consider an impact-graphics printer.

And, if what's wanted are superior resolution and color, particularly 35-mm. slides, without regard to speed or cost, a camera system can't be beat.

Hard-copy futures will perform well

The future of the hard-copy business looks bright . . . but confusing. More good technologies are available than can be used. The competition among them should make ink-jet, laser/electrophotographic and electrostatic technologies more important. The cost of most devices will stay relatively constant, but the performance of those devices will improve dramatically. A possible exception to this cost trend is camera systems, where some significant price decreases may occur.

The number of devices offering color will expand, but it will still be a few years before the availability of a truly good solution to the problem of obtaining high-quality color output at high speed from a reasonably priced device at a reasonable cost per copy.

So while the future holds improvements in both price and performance, the user should also expect promises of a more challenging product-selction task. ■

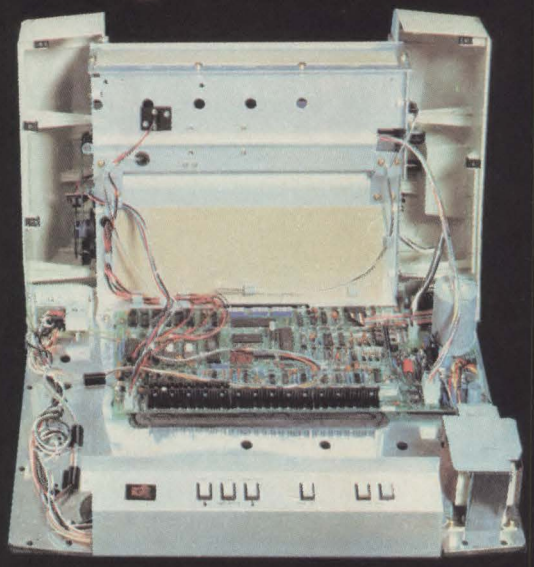
Gerard H. Langeler is marketing manager for Tektronix, Inc., Beaverton, Ore.

NEXT MONTH IN MMS

January will bring the fifth annual printer issue of Mini-Micro Systems, including supplier directories intended to be clipped and saved. Included in the feature article package will be:

- Line printers: a review of the latest hardware and trends in line printers designed for use with minicomputers.
- Line printer selection guide: directions about what to look for when faced with the need to select from competitive products to fit your prices, performance and application needs.
- Serial printers: a comprehensive survey of trends and hardware for matrix printer users.

Say Ahh...



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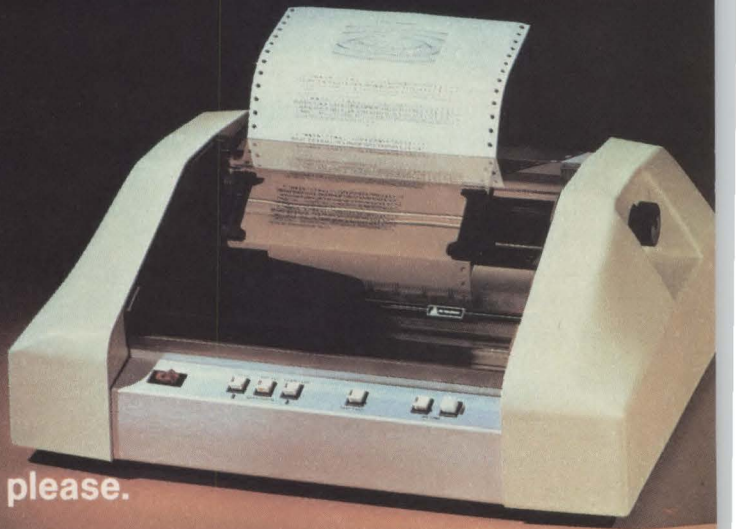

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Graphic Systems

Language aids in computer designing

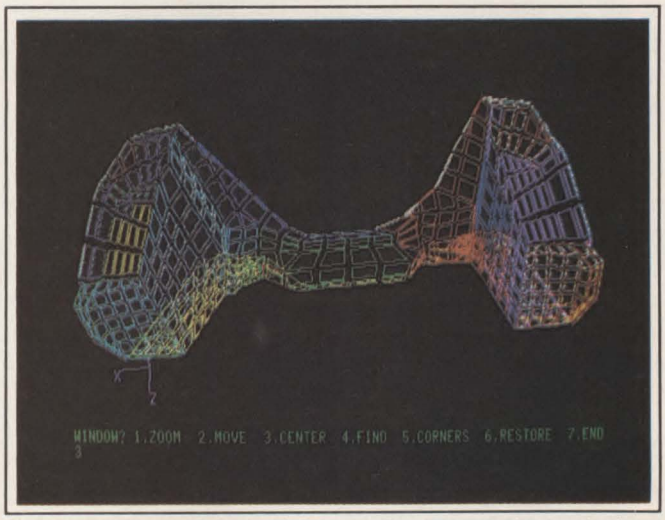
Engineering firm combines PDA/PATRAN language, 3D color graphics and VAX-11/780 to slash structural design time

A new computer language, along with three-dimensional color-terminal data entry, has dramtically reduced the engineering effort required to prepare computer-aided models of a variety of complex structures and post-CAD processing. Developed by Prototype Development Associates, Inc., Santa Ana, Calif., the language not only improves engineering productivity but also lowers computational time and structural design time. Projects that once required months are accomplished in weeks; jobs that took weeks are done in hours.

Prototype Development Associates is a 60-employee engineering firm that specializes in design and analysis of complex structures, especially those using advanced composite materials. The firm has conducted studies of rocket engines, ablative materials in missile nose cones, aircraft structures, automobile frames and other structures. The company also manufactures tow targets and the Thermoshield system for protecting down-hole instruments in oil wells.

"In 1973, we started developing the new language, called PDA/PATRAN, to aid us in designing complex three-dimensional shapes," says Lou Crain, PDA director of software products. "Using a time-shared CDC Cyber 173 and a Univac 1108, we designed several batch programs to define structural geometries, analyze material properties and to post-process CAD results.

"By mid-1977, our service-bureau charges were between $12,000 and $40,000 monthly. We had been looking at minicomputers for some time, but the 16-bit address space was insufficient for our applications. When the VAX-11/780 was introduced, with its 32-bit architecture, we could see its value in the engineering disciplines. Our VAX-11/780 was installed in July, 1978, and we converted PDA/PATRAN from batch to interactive and incorporated color graphics."



Finite-element model *of ship's propeller hub required only three days to develop, as opposed to an estimated several man-months with conventional methods.*

The Digital Equipment Corp. VAX-11/780 used by PDA has 1.5M bytes of main memory and three RP06 disk drives providing 528M bytes of storage. A DEC VS-11 Colorgraphic terminal, a Ramtek 6200A, two Megatek 7000 terminals, a Tektronix 4014 and 19 other terminals enable a number of engineers to solve problems simultaneously on-line. Hard-copy graphics output is printed on a Trilog 100 × 100 dot-per-in. matrix plotter.

Analyzing complex structures

Structural analysis using computer-aided design usually involves many steps. Initially, a draftsman

A color display offering 15 shades further enhances visualization. The designer may assign any color to any element or use system-defined colors.

prepares two-dimensional line drawings from which the computer model geometry is defined by measuring X-Y-Z coordinates manually, or with a digitizer.

Next, the engineer must create a finite-element model, which consists of a series of small discrete sections representing the complete structure in aggregate. During this step, the materials must be incorporated into the computer model, along with the external environment, such as pressure, temperature, loads and constraints. Next, the model is processed using a general-purpose analysis program such as NASTRAN, ANSYS, SAP6, MARC or SAAS. Results must then be interpreted, and then the process is repeated to check new test results against design changes.

"The time required to accomplish these functions varies greatly, depending on the structure's complexity," Crain says. "A 1½-month-long project would typically require three man-weeks to define the model and create the finite elements. Another man-week would be devoted to applying the loads and environment, two days for CAD program operation and another week for interpreting the results. Each iteration would require the same amount of time at each step.

"With PDA/PATRAN-G and the VAX-11/780, the engineering effort is greatly reduced. Defining the model and finite-element creation requires about two man-days. Application of materials and CAD computation each requires about a half-day, and interpretation will require an additional day." Much of the increased productivity can be attributed to the 3D, color graphics capability of the VAX-11/780-PATRAN combination, Crain says.

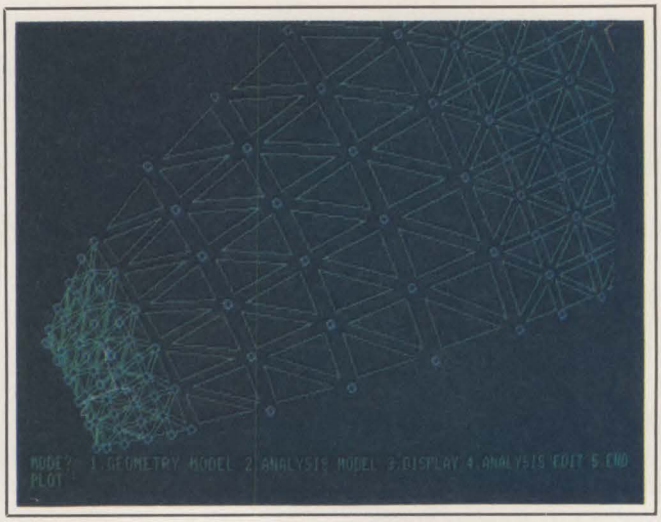
3D color, too

Instead of poring over code sheets and listings, designers construct, on-line, a continuous representation of the structure, as well as the finite-element model, including material properties and loads. Then the computer draws mathematically defined figures on the color video-terminal screen in much the same manner that it can be done on paper, except faster. The program employs the classical principles of parametric, cubic and descriptive geometry, but the designer needs no special skills in either mathematics or computer programming. The command language consists of nonmathematical directives in a free-flowing and order-independent format. The computer handles the tedious mathematics, automates the drafting procedures and guides the user through the process with an extensive menu that allows the designer to query the computer when he has questions.

The designer typically will enter specific coordinates and dimensions, then supply translational and rotational directives that create the shape, in three dimensions, on the screen. Additional sections may then be developed and added to the original shape.

As finite model segments are constructed, the computer sequentially displays each segment on the video screen and stores the mathematical description in memory. Using the VAX-11/780, several engineers can work on one product, and each engineer can create a different portion of the structure. When the shapes are joined, the program checks adjacent surfaces and automatically assigns consistent coordinates for intersecting boundaries.

"We modeled a hydraulic-turbine impeller for conversion to a numerically controlled machine tape," says Crain. "The impeller hub required only six directives and was completely defined in less than 3 min. The blades were complex shapes, but the designer had only to plot significant points along the surfaces, and the program calculated the coordinates between the blades and hub surfaces. The total project required a man-day;



Color aids visualization *of complex structural geometries in automobile cross member. Normally, cyan represents grid points, green for surfaces, dark blue for solids. But designer may stipulate colors indicating types of elements or materials.*

with manual practices, the same design would have required three months."

Irregular shapes are developed in a number of ways. The designer may plot discrete points defining the surface, then call upon an option to construct continuous lines between them; or he can call up a regular shape from memory and warp it, on-line, to the desired configurations. There are no limitations to what can be modeled using PATRAN-G.

As model construction continues, hidden lines are omitted to clarify the illustrations. The depiction may be rotated at any time so that the designer can view the model from any angle.

A color display offering as many as 15 shades further enhances visualization. The designer may assign any color to any element or use system-defined colors. For example, cyan represents grid points, green defines surfaces, dark blue signifies solids, and yellow shows construction lines. Other colors indicate different types of material within the structure or special program

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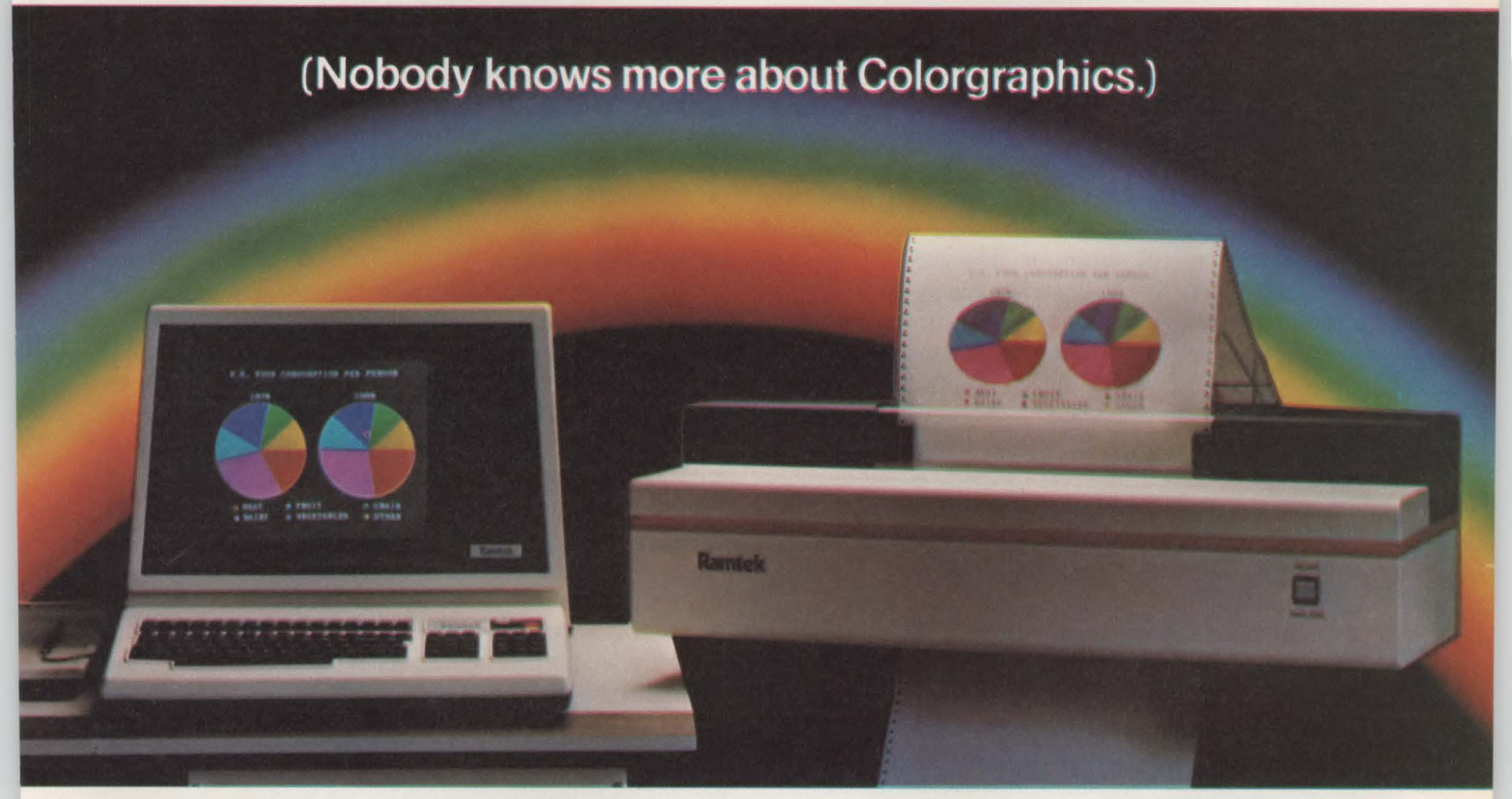
(Nobody knows more about Colorgraphics.)



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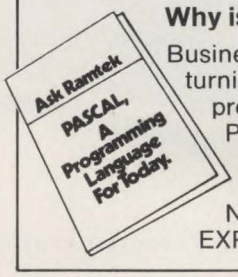

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'Stress analysis usually requires the most minute modeling, while dynamic and thermal models are normally less detailed.'

items, such as previously written directives (yellow) or menu selections (green).

"The VAX-11/780-based program allows as many as 16 different views to be displayed on the screen simultaneously," says Crain. "The designer normally uses a large working area with a three-dimensional view, and smaller areas for reference display, such as two-dimensional plans, elevation or side views. Construction changes made by the designer can be limited to the working-area display or automatically incorporated into the reference displays. Hard-copy images can be generated for reference, documentation or archival purposes at any time.

Once the model structure has been defined, the system establishes parameters for finite-element analysis, which consists of dividing complex geometries into simpler objects. By entering clear language directives, the designer receives 3D color displays that depict the finite elements.

The system can zoom to magnify or reduce any section of the model. Using a cursor control, the designer positions an aperture over an area, enters the desired size and initiates the action. The VAX-11/780 automatically displays the area surrounded by the aperture, with the proper magnification, permitting more detailed study within the designated portion.

"This aspect is important," Crain says, "because analysis accuracy, as well as cost, is related to the density of the finite-element mesh. Stress analysis usually requires the most minute modeling, while dynamic and thermal models are normally less detailed. With PATRAN, mesh densities can easily be modified to match mesh size to the type of analysis.

"The VAX-11/780 has given us a two-year return on investment in terms of avoided service-bureau charges alone," says Crain, "with vastly increased engineering productivity, as well.

"For example, one of our clients wanted an analysis of an automobile-chassis cross member that supported a transverse-mounted engine. This was an extremely complex stamping that had virtually no regular shapes. In an earlier attempt, the manufacturer had retained a consulting firm that devoted 10 months to the project, without success. With the VAX/PATRAN combination, we were able to complete the structural geometry and finite-element model in five days."

PDA has a cooperative marketing agreement with DEC under which both companies are selling PDA/PATRAN-G for use on VAX-11/780s. The system is being used by major aerospace, heavy-industrial, nuclear, electronics and food-processing equipment companies and high-technology government laboratories. ■

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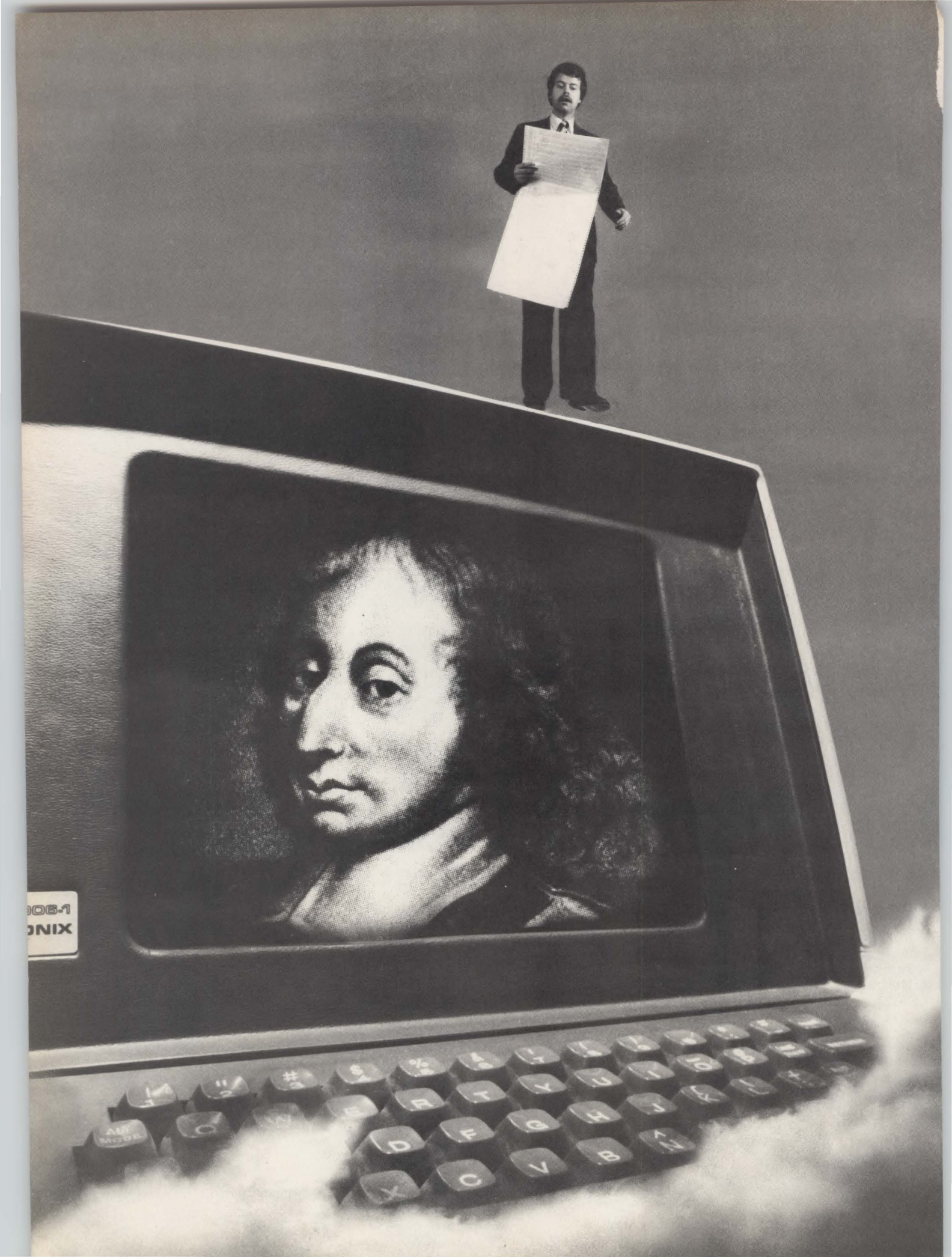

Software

Avoiding Pascal's pitfalls

Jim Isaak, Data General Corp.

Pascal's rise to stardom in the seventies was fueled by its ability to reduce software development and maintenance costs—by as much as 80 percent in some cases. It is easier to use than almost any other commonly used high-level language besides BASIC, and it was designed with structured programming in mind. Pascal is also widely implemented and, to a degree, standardized.

A formal standard now under review by ISO and ANSI would resolve many of the present discrepancies between various versions of Pascal. But it will not deal with all of them. In particular, some of the "holes" in Pascal—legacies of its origin as a teaching, rather than applications-programming, language—will not be filled in. As a result, there will still be significant variations in how different implementations handle these issues, and program portability will remain less than universal. Anyone contemplating use of Pascal for applications programming should be aware of these pitfalls, and of the common ways around them, so that he can choose the implementation with the best features and extensions for his applications.

All Pascal I/O is via sequential files, which must be read in order, record by record, beginning with the first. Once a record has been read, it cannot be written back out to the same file. Files are limited to read only or write only. *Continued on p. 144*

Photo Illustration by Ralph Mercer

Pascal's worst shortcoming is its lack of separate compilation modules.

User interaction is also difficult. Many "standard" implementations require pre-read on devices, making interactive I/O difficult, at best. Once data is in, a user must avoid automatic conversion from text to numeric data, because no exception processing is available, and a conversion error on data entry, such as an operator key-in error, will abort a program. Text must be read in a character at a time and stored in an array. A user can then call a procedure that converts the data while checking for errors.

In a production environment, certain tools and facilities are essential to the efficient development and management of software projects. In some ways, Pascal is itself such a tool, but it is an imperfect one. Its worst flaw is its lack of separate compilation modules. In a project involving development of a series of programs to perform related tasks, sharing common procedures, data types and data bases is necessary for efficiency, reliability and project control. But with standard Pascal, common code must be duplicated in every program that uses it, and each program must be individually updated when a change is made. This results in frequent errors in updating large, monolithic programs, especially when more than one programmer is involved.

Different implementations overcome this deficiency in different ways. Some extensions provide not only separate compilation and INCLUDE, but more. By overriding the strict declaration order, it is possible to group into a single INCLUDE file a mix of constants, types and procedures. By this means, Pascal can be made to handle, among other things, decimal arithmetic, complex numbers or matrix operations.

Another limitation of Pascal is that it does not allow dynamic arrays. This has its merits, but at its worst, a procedure cannot be written that accepts more than one size array as a parameter.

In real-time applications, performance is the key. FORTRAN or assembly language may be better for some time-critical operations, but for many applications, Pascal is adequate. The question then becomes whether to use an interpreted, compiled, P-machine or threaded-run-time implementation (see "Interpreters vs. Compilers," p.144). This can be determined by benchmarking or by checking with other users whose requirements are similar to your own.

In many real-time applications, it is useful or necessary to overlap multiple I/O operations (e.g., start a read on disk, then start I/O on a channel, then wait for one or the other to complete). Pascal does not have any standard overlapped I/O procedures, but some versions support either unpended I/O or multitasking. Unpended I/O refers to system I/O procedures that enable program execution to continue without waiting for I/O to complete. A second procedure then tests the I/O operations to determine whether it is complete.

Multitasking, on the other hand, has no clear definition. For some vendors, it is synonymous with multiprogramming, in which multiple programs run concurrently. Multiprogramming enables separate programs to control each I/O operation or asynchronous real-time event, but has high overhead in the context switch (and even worse overhead if program swapping occurs).

Another approach to multitasking is to have one program perform multiple tasks, which can easily exchange information because they can share a set of common variables. Systems procedures are needed to create tasks or kill them, as well as to coordinate priorities and enable one task to wait for a message from another, and so forth. This form of multitasking is ideal where coordination between asynchronous events is required. Many real-time applications involve direct

INTERPRETERS VS. COMPILERS

Program performance, ease of debugging and code compactness are the main issues in selecting a language implementation. For Pascal, the basic categories of choice are interpreters, P-machines, compilers and threaded code. An ideal interpreter maintains both a copy of the source code at run time and the "compilation" facilities necessary for program modification at that time. This approach yields compact, easy-to-debug code, but with the space overhead of the "compiler" and the performance overhead of the FETCH/DISPATCH cycle involved in interpreting each statement.

Many Pascal implementations rely on a P-machine (i.e., pseudo-machine). In this arrangement, a compiler generates intermediary P-code for the hypothetical P-machine. A P-machine emulator in the host processor interprets the P-code at run time. This method provides compact code, but requires space and performance overhead for the interpreter.

Compilers translate source code directly to machine code. The computer executes some of the in-line statements directly and uses run-time libraries to provide the rest of the language facilities, thereby reducing the amount of memory required for program execution. If many functions are put in run-time libraries, the in-line code can be boiled down just to means for building parameter lists and calling subroutines. There is a trade-off, however. The performance overhead for a subroutine call may be greater than that for the dispatch code in an interpreter, and the compiler code starts to pay for its space advantage by losing its performance advantage.

Threaded code combines the code compactness of a P-machine with the benefits of selectively loaded run-time libraries, but without the overhead of either dispatch or subroutine code. Here, a compiler generates code similar to P-code, but containing the addresses of run-time routines instead of pseudo instructions. Each routine is loaded only if needed, then "threads" to the next routine by branching to its address.

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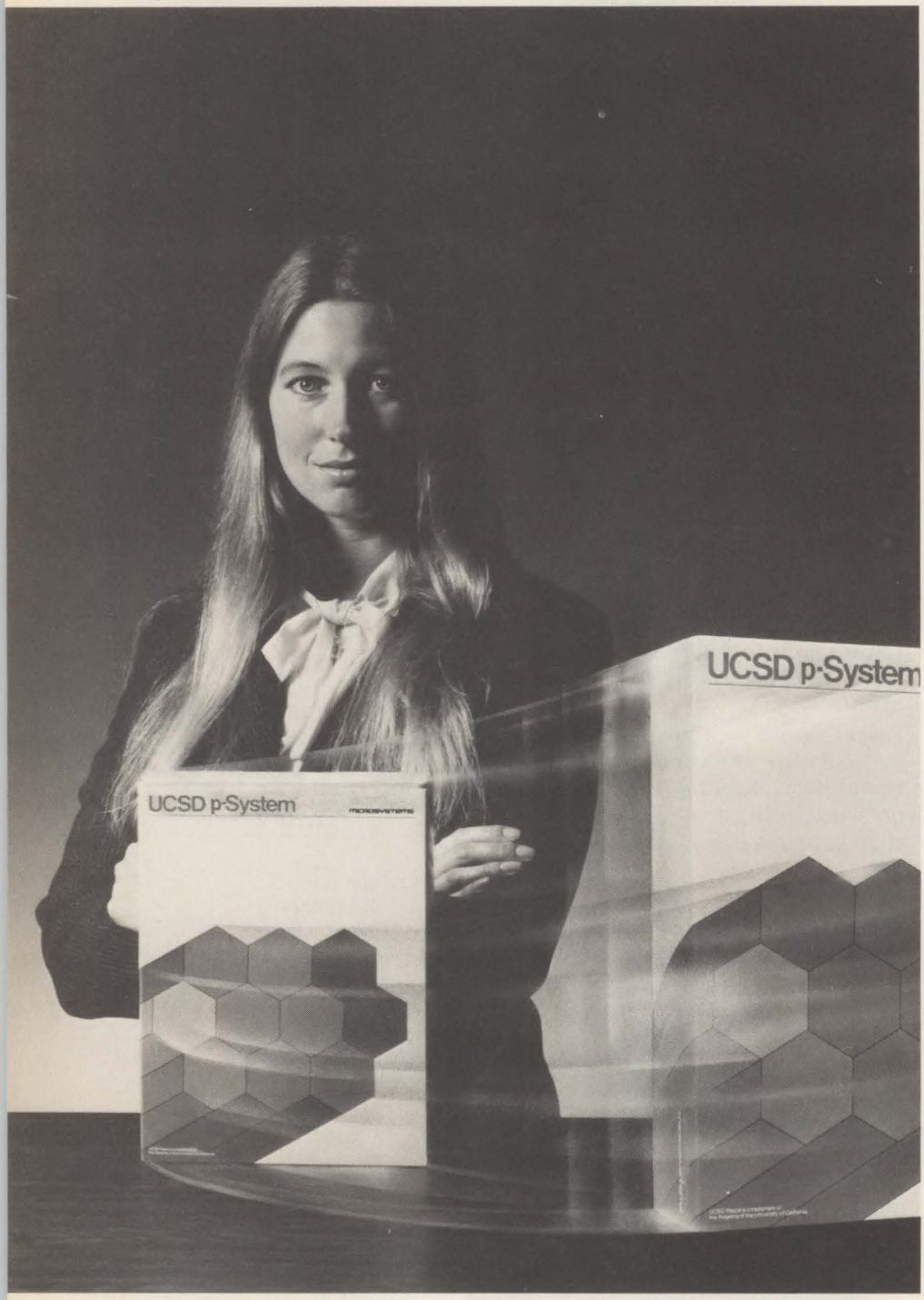

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CIRCLE NO. 72 ON INQUIRY CARD

There are a number of places where the proposed Pascal standard does not specify how the implementation should be done.

control of devices, which may entail explicit access to real memory if I/O operations are controlled via memory locations. Or it may require access from Pascal to system or assembly-language driver routines. All such operations require extensions to the proposed standard Pascal.

Commercial applications

Pascal has several shortcomings that severely limit its usefulness in commercial applications. First, it lacks random or indexed-sequential file-access methods. In a version of Pascal with system procedures that support random access and update of files and separate compilation of modules, ISAM procedures can be implemented as modules, which can then be used by all programs. However, some versions of Pascal do not allow modification of global data from routines: data cannot be modified unless explicitly passed to a procedure. If this limitation includes issuing I/O commands, it is not possible to implement an ISAM procedure in this way, and modular, portable coding becomes much more difficult.

Other difficulties arise when there is a need for arithmetic operations with precision better than that provided by most versions of Pascal. Pascal's lack of exception-handling facilities makes it necessary to test for range conditions before making assignments to sub-range variables, because an out-of-range condition will terminate program execution.

String data-type extensions can be useful for text fields, especially if they have a fixed maximum length (so that record lengths stay constant and location of fields in records on the disk is simplified) and also have a "current" length used by the processing routines. Also, routines processing strings should allow variable-length strings to be passed in as parameters. Related to this is the ability to set specific binary values into strings for forms and screen control. Unfortunately, Pascal's I/O standard does not provide for data-sensitive input (such as fields terminated with Newline or Enter), so it is necessary to read data in one character at a time. Again, improvement would require extensions beyond standard I/O facilities.

A PASCAL-SELECTION CHECKLIST

This checklist has three sections: a list of functional characteristics covered in the proposed standard, a list of features that may vary even within "standard" implementations and a list of extensions that may be necessary or useful for certain applications. Prospective users should weight these items according to their individual applications and management styles, for few will need (or find) a version that is "best" in all respects.

I. STANDARDS COMPLIANCE (Circle areas that differ, cross out areas not implemented)

TYPES: Integer, Boolean, Real, Character, Pointer, Array, Label, Record (tagged and untagged variant records), Packed, File, Text

I/O: Read, Write, Reset, Rewrite, Read Line, Write Line, Page End of File, End of Line, Get, Put, (file-buffer pointer). Is I/O allowed from within a procedure (to global files)?

STATEMENTS: Assignment (strong type checking by name?), If-Then-Else, Case (Otherwise), For-Do, Repeat-Until, While, With, Goto

PROCEDURES: Nesting allowed, Forward, Assignment to 'value' parameters, Procedure names as parameters, Side effects allowed.

PRE-DEFINED FUNCTIONS: New (with variants), Dispose, Pack, Unpack, ABS, SQR, SIN, COS, ACRTAN, EXP, LN, SQRT, ODD, TRUNC, ROUND, ORD, CHAR, PRED, SUCC

II. IMPLEMENTATION PARAMETERS

Value Ranges: Integer: – _____ to + _____; Character: _____ to _____

Real: _____ (= _____ digits); Pointers: _____ (address limit)

Number of significant characters in identifier _____ Maximum length: _____

Maximum program size: _____ Maximum number of identifiers: _____

Type of implementation (P-machine, threaded, in-line code): _____

Range of hardware supported: _____

III. VENDOR EXTENSIONS

I/O: Interactive files? Data-sensitive I/O control? RAM files? ISAM? Ability to read and write the same file? Data conversion with exception processing? Facility to access a file whose name is provided during execution?

PROGRAM MANAGEMENT: Separate compilation facilities? Assembler interface? Include facility? (Can you mix constant, type and procedure declarations?) How can you access system functions? Can you override strong type check?

REAL-TIME EXTENSIONS: Multitasking? Unpended I/O? Are octal, hex or binary constants allowed? Can programs be put in PROM? Run without disk or diskette?

BUSINESS APPLICATIONS: Facilities for extended-precision arithmetic? String data type? (Can procedures accept variable-length strings?)

Unlike the ANSI COBOL standard, which is divided into modules and implementation levels, the proposed Pascal standard gives vendors no simple way to compare their implementations to it.

All the features discussed so far require extensions to the proposed Pascal standard for implementation. Because few applications can exist without at least some of these, extensions are inevitable, and portability is limited. There are a number of places where the proposed standard does not specify how the implementation should be done. For example, the standard does not specify values such as the size of sets (different implementations allow from 16 to 4000 elements) or the number of characters in a variable name that are significant. This means a program carefully written in one exact implementation of the standard may not be portable to another exact implementation.

Limits on the number of files also vary; for example, many P-machine implementations support no more than four pre-defined text files. And in some versions, the maximum size of a program module can be a severe constraint. In addition to these gaps in the proposed standard, there are certain areas in which many existing implementations deviate from the standard.

For example, for dynamic memory allocation, the procedures New and Dispose are standard. New is often implemented with a single parameter, rather than a full list of record variants, and Dispose is often replaced by Mark and Release, providing a different technique for management of the available memory space.

Another anomaly is that some versions of Pascal have no GOTO, or limit it to local control transfer (within a block or procedure). Much has been said about "GOTO-less" programming—and for easy portability, this is probably wise. However, escape from a program or procedure may be a facility to look for, even if it is not done with a GOTO.

Standard Pascal I/O involves a set of fairly common routines: Read, Write, ReadLN, WriteLN, Reset and Rewrite and the Boolean functions EOF and EOLN, which enable easy detection of end-of-file and end-of-line. The standard also calls for a file buffer that is used in a specific pre-read/buffered-write I/O technique ideally suited to sequential processing in batch programs. Other forms of I/O tend to conflict with these uses, and, therefore, standard facilities, with the result that GET, PUT and the pointer to the file buffer are sometimes not implemented. And many implementations limit files to text data, which can impair file-management efficiency.

In standard Pascal procedure calls, the name of other procedures can be passed as a parameter. This is difficult to manage in a compiler and is often omitted. In fact, ANSI has opposed this feature of the ISO proposal.

Pascal also calls for strong type checking, to assure that data is being used in a consistent fashion. For example, a program might define two types of data:

```
Time = Record
Hours, Mins, Sec: Integer
End;
Date = Record
Year, Month, Day: Integer
End;
```

Many implementations would allow dates to be assigned to Time, because they have the same shape (i.e., a triple integer), but the standard calls for this to be detected as an error, because the types Time and Date differ in name.

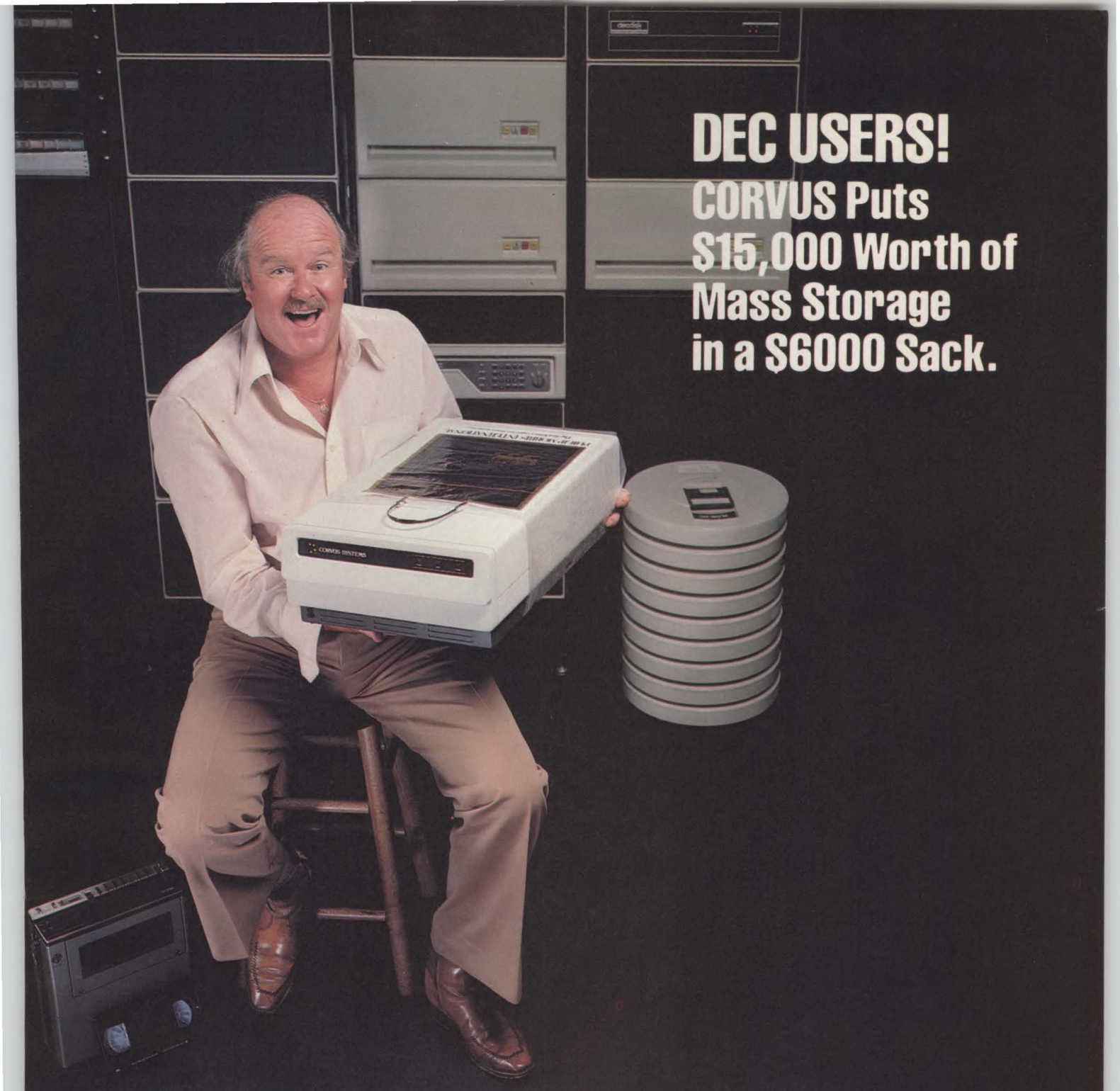
Finally, there is the question of what can be modified within a procedure, which raises two issues. The first involves the modification of parameters passed by value (i.e., variables that are not specifically marked as such cannot be modified for return of results from a routine). Some implementations do not allow these to be modified temporarily within a routine, although the standard does permit this. (Again, this can lead to difficulty in reading a program later, so it is probably not a very good programming practice.) Second is the modification of variables not explicitly passed to the procedure, which is known as a side effect. This practice can compromise program readability (as well as attempts to verify program correctness). But it is standard. The most serious consequences of limiting side effects are that I/O devices are treated as global variables, and procedures are not allowed to do I/O. This hurts modular coding technique and any attempt to improve portability by isolating I/O-related code to procedures.

Choosing a Pascal

At present, there is no easy technique for comparing Pascal implementations to the proposed standard. Unlike the COBOL standard, which is divided into modules and levels of implementation, the Pascal standard gives vendors no simple way to compare their implementations to it. A user must depend on his own ability to evaluate the vendor's documentation in light of the user's needs (see "A Pascal-selection checklist," p.147).

A user should look at extensions (and also standard adherence) with an eye to future portability. The ability to isolate problems into separately compiled modules might be the most useful extension toward this end, because it will simplify later migration. In some functions, such as multitasking, an application might limit a user to a specific implementation. If this is necessary, the user should make sure he has a range of equipment—μcs, minicomputers, mainframe computers, etc.—that can satisfy his immediate and foreseeable needs. ■

Jim Isaak, manager of real-time systems marketing at Data General Corp., Westboro, Mass., plans and guides the development of new software products.



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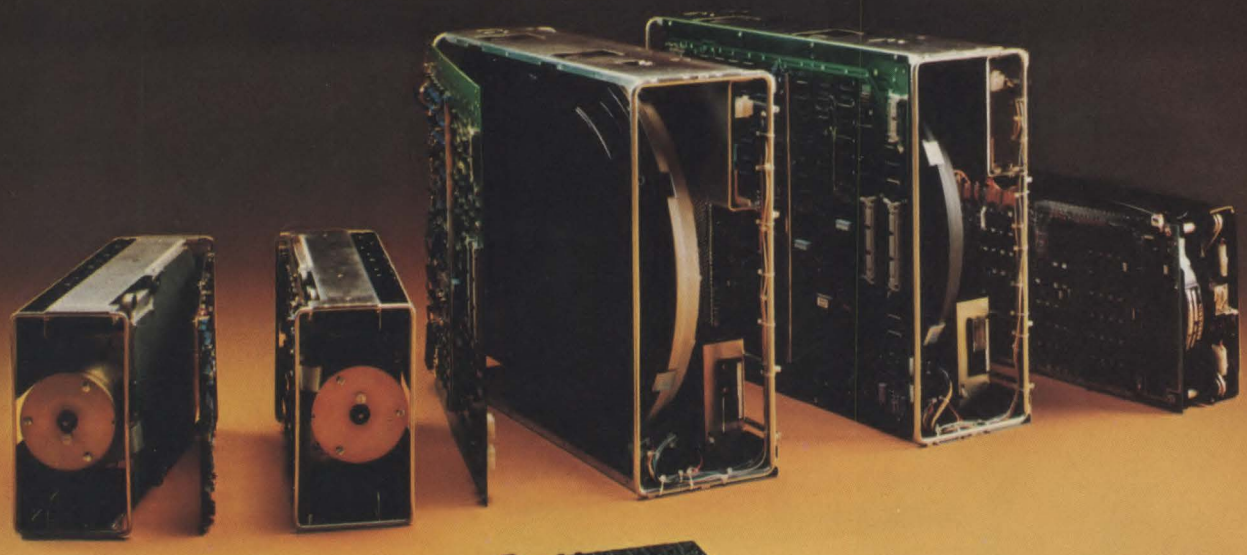
CIRCLE NO. 73 ON INQUIRY CARD

THE SMART SET



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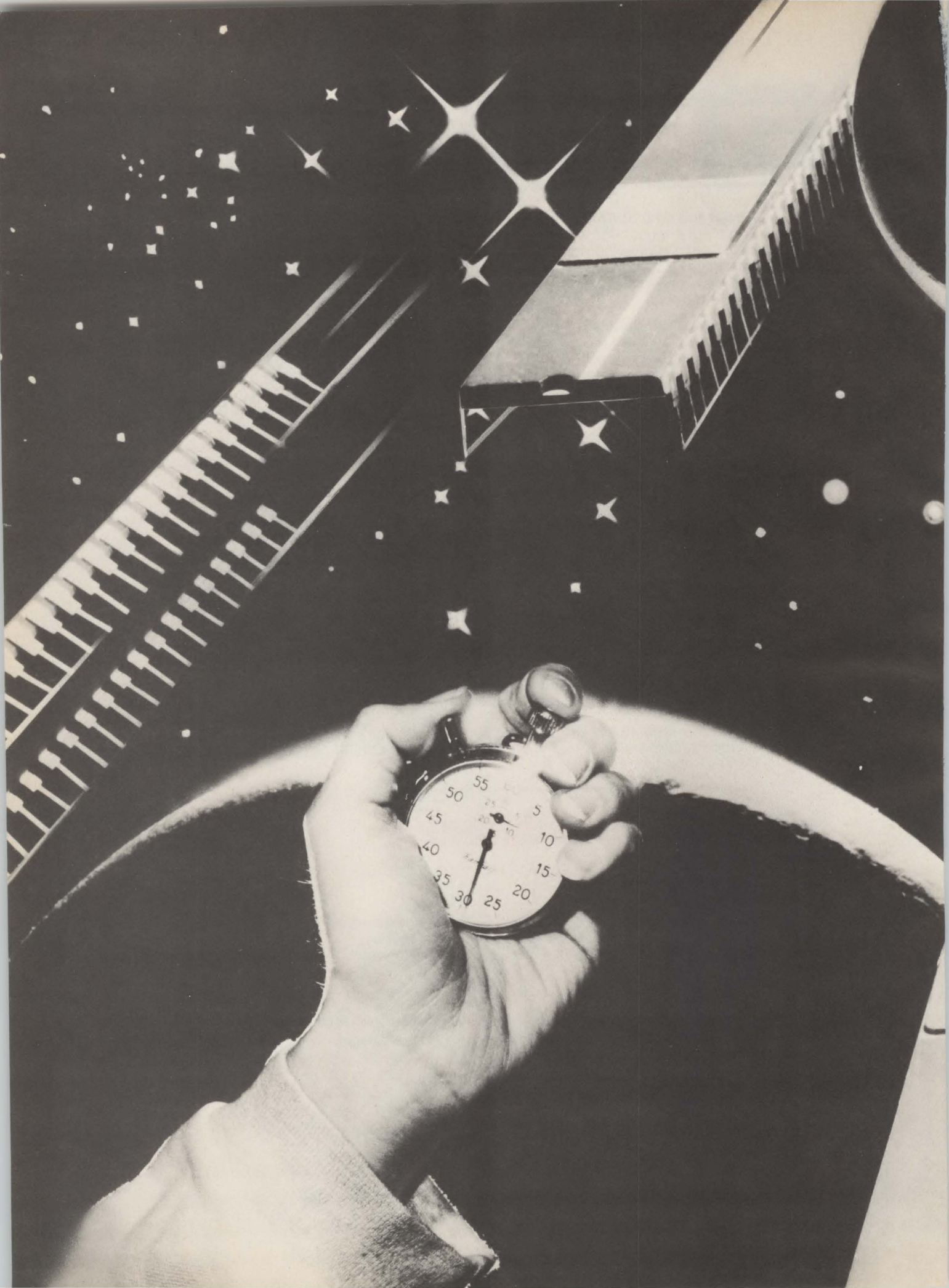
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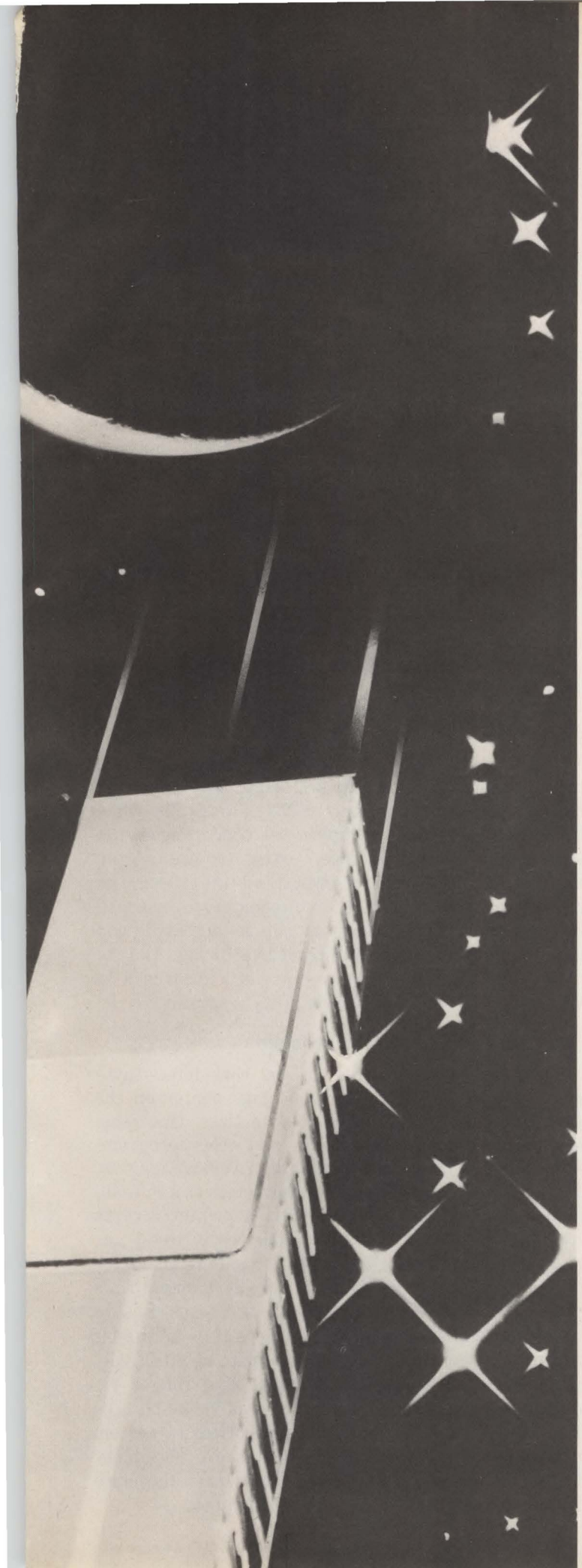

MICROPROCESSORS

EVALUATING THE 16-BIT CHIPS

ROBERT GRAPPEL
and JACK HEMENWAY,
Hemenway Associates, Inc.

System designers who are considering graduating from 8- to 16-bit μps as the basic system building block need to compare the leading 16-bit candidates for their application. We've acquired considerable hands-on experience with the three leading processors—the Intel 8086, the Motorola 68000 and the Zilog Z8000—and have come to know their strengths and shortcomings in relation to five key criteria. Those criteria are the processors' provision for system calls, byte manipulations, number crunching, architectural features and extended memory addressing.

For example, the Z8000 requires some software to vector system calls, while the other two have automatic vectoring. But the Z8000's kinship to the Z80, the most powerful byte-manipulation 8-bit processor, enhances the Z8000's byte-manipulation ability. And while the 8086 offers extensive byte features, it has no facilities for 32- bit or larger data. The 8086 is quite impressive in its provision for as many as 256 system calls, where the 68000 is limited to 16. But if number crunching is the most important criterion for an application, the 68000 may be the best choice because it efficiently handles long-word data. The 68000 also shines in its provision for extended memory addressing. It's the only 16-bit μp available that provides uniform addressing of its entire addressing space. Users can reach the entire 16M-byte space from any location without employing segment numbers or special registers.

Hemenway Associates is a Boston-based system software house specializing in operating systems and languages for μps. This article, which compares the 8086, Z8000 and 68000 in relation to five key characteristics, is an edited version of one that appeared in the Sept. 5, 1980, issue of EDN magazine

Photo Illustration by Ralph Mercer

The 68000 is the only 16-bit μp available that provides uniform addressing of its addressing space.

Our comparisons all focus on fine points that are open to debate, and the performance improvement gained from switching from an 8-bit μp to any of these three 16-bit units ia almost unbelievable at first. Programs that previously required seconds to execute can be done in milliseconds. In system applications, the I/O devices—not the processors—quickly become the limiting factors. The sheer power of the μp tends to encourage better programming because users no longer need to resort to trickery to get a job done. The system designer/integrator's task, then, is to make the most effective use of the near-embarrassment of riches that the processor manufacturers have provided.

System-call instructions extend machines

The operating systems that control the 16-bit μps are more sophisticated than those of earlier machines. Providing new facilities such as memory management, multi-user and multitasking abilities, they require special support from a processor. The system call is one instruction that provides this support. Some 8-bit μps also have this type of instruction—the 8080's RST (restart) or the 6800's SWI (software interrupt), for example—but the 16-bit units have extended the system-call mechanism significantly. In them, the system call forms the basis of the "user-system" separation so vital to complex systems. It provides straightforward ways of coding system-user program interfacing.

	8086	Z8000	68000
Automatic vectoring	•		•
Number of vectors	251	256	16
System/user modes		•	•
Separate system stack		•	•
Privileged instructions		•	•

Fig. 1. Comparison of system-call mechanisms *in the 8086, Z8000 and 68000, each of which implements such mechanisms differently.*

The 8086, Z8000 and 68000 each provides a system-call instruction, but the implementations are not equivalent (Fig. 1). In the 8086, the INT (interrupt) instruction functions as a system call. Its second byte causes an indirect call through a table of 256 vectors—a procedure similar to that used in the 8080 family's RST instructions. Intel reserves the first five of these vectors for special-purpose use. The Z8000, on the other hand, provides the SC instruction to implement a system trap—a 16-bit command that gets pushed onto the stack as part of the trap's execution. Because the instruction's low-order 8 bits are not defined, they can contain a number. The trap-processing routine must access this number on the stack and perform its own vectoring. The SC instruction can also switch the Z8000 into the system state, permitting execution of "privileged" instructions (all I/O commands, HALT, etc.). This segregation of certain instructions into the system state prevents user programs from producing undesirable side effects on concurrent programs.

	8086	Z8000	68000
Block move	•	•	
Block I/O	•	•	
Translate	•	•	
String comparison	•	•	
Byte push/pop			•

Fig. 2. A comparison of the character-string capabilities *of the three processors, indicating the 8086's and Z8000's emphasis on byte-handling abilities.*

The 68000's TRAP instruction implements that μp's system call. The instruction's low-order 4 bits form a vector to one of 16 indirect addresses; TRAP automatically switches the processor into the supervisor (system) state. A separate stack pointer for this state isolates the system from user programs. Certain privileged instructions (STOP, RESET, etc.) can only be executed from the supervisor state, providing a further degree of protection for the system programs.

Comparing the three μps' system-call facilities yields some clear differences. The Z8000 requires some software to vector the SC calls, while the other two processors have automatic vectoring. The 8086 and Z8000 can implement as many as 256 system calls, while the 68000 is limited to 16 unless the user foregoes the automatic vectoring. Hence, extensive use of the system-call mechanism is easiest on the 8086. The Z8000's software overhead for this feature is balanced by the large number of system calls it can handle and the flexibility of software-controlled vectoring. And the 68000's limited number of vectors is a drawback to widespread use of system calls in its programs.

The data size must fit the problem

The next two features to be considered—byte manipulations and number crunching—center on the μp's ability to handle different data sizes. Operating systems, assemblers, compilers and other programming tools all must deal with data of various lengths. For example, an operator types characters at a console, a disk outputs a stream of bytes, a printer accepts bytes—indeed, many peripheral devices in 16-bit μcs must deal with bytes. The ease of handling character (byte) data is thus one test of a μp instruction set's power. At the other end of the scale, 16-bit μps are sure to find application as number crunchers of 16- and 32-bit and even longer data words, which must be effectively manipulated. Their extended addressing ranges require more arithmetic power, just as the 8-bit μps require extension by means of subroutines or system calls to handle 16-bit arithmetic operations. The ability to perform arithmetic with large data items is therefore another test of a 16-bit μp's instruction set.

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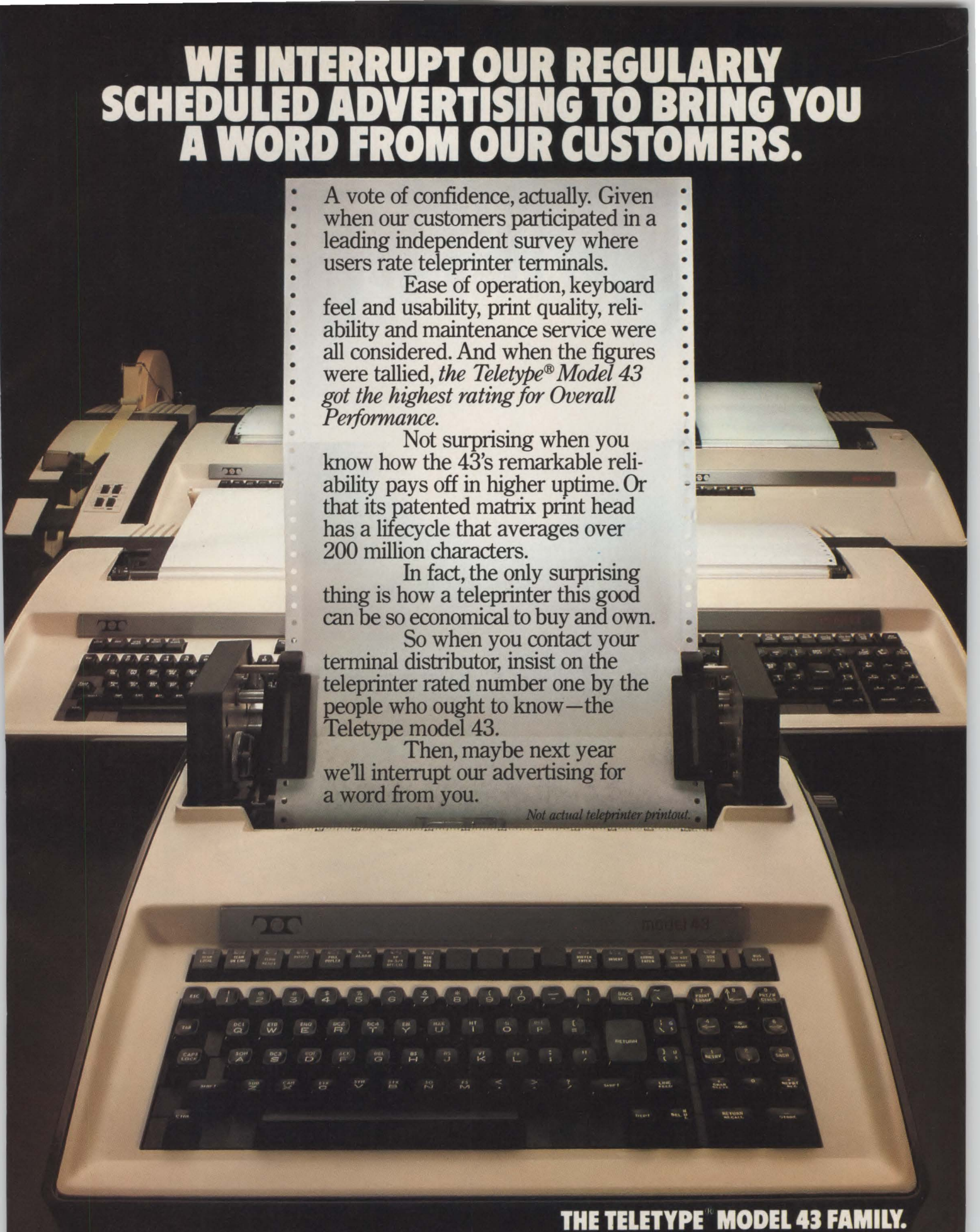

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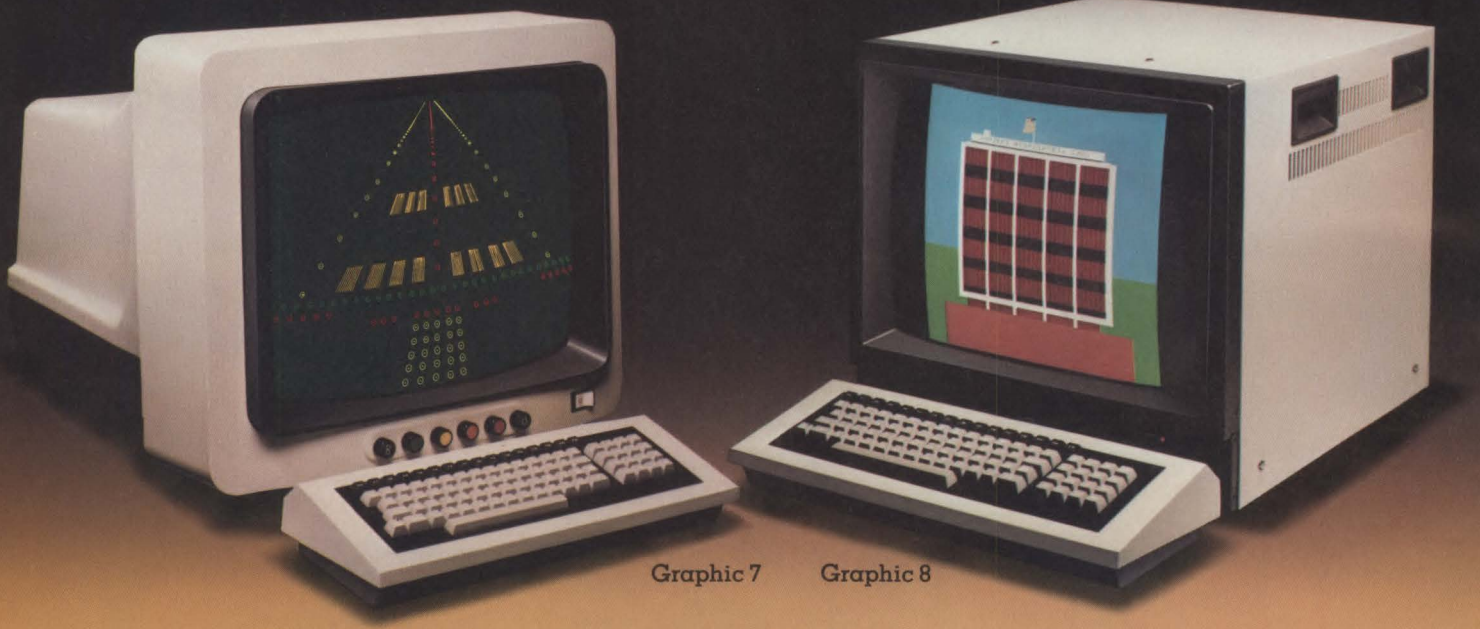

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CIRCLE NO. 76 ON INQUIRY CARD

In 16-bit units, the system call forms the basis of the "user-system" separation that is vital to complex systems, providing straight coding.

The 8086, Z8000 and 68000 differ widely in their ability to work with byte-wide data. The differences arise because of a trade-off between maintaining compatibility with older 8-bit μps and obtaining orthogonal instruction sets. An 8-bit μp has no trouble handling byte data; that's what it's designed to handle. The problem arises with the extension to 16 bits: Can the user maintain the 8-bit machine's special abilities without compromising 16-bit features extensively?

Consider, for example, one problem the 8-bit μps never have to deal with: word alignment. An 8-bit μp addresses instructions at byte boundaries, but most 16-bit μps expect their instructions to occur on word boundaries. And there's no guarantee that the programmer might not spoil the alignment of words in memory. If the alignment is off, can a 16-bit data value be loaded from an odd boundary, as it can in an 8-bit μp? Not in many of the 16-bit devices.

Fig. 2 compares the character-string abilities of the 8086, Z8000 and 68000, while Fig. 3 compares their arithmetic abilities for 8-bit data. System designers seeking to expand or translate a system from 8- to 16-bit will have to explore these trade-offs.

For example, because Intel deliberately tried with the 8086 to maintain a reasonable compatibility with the 8080, it has maintained the 8080's byte-register set and instruction power in the 8086. And to compete with the 8-bit Z80, Intel added block I/O, block move, string compare and other byte-oriented primitives. The 8086 has only two pointer registers, which autoincrement or decrement, and the accumulator must be used to execute the byte- or word-primitive instructions. But the special registers used for this purpose make the instructions highly nonorthogonal with the rest of the instruction set. The byte registers map into the 16-bit registers, allowing byte manipulation of word data and the building of words from separate bytes.

The 8086's instruction set includes single-byte instructions—a feature that allows the user to program many functions in fewer bytes of code in the 8086 than in its competitors. Frequently used instructions, such as return from subroutine, require only 1 byte in the 8086, compared with an entire word in the Z8000 or 68000. Additionally, users can express addressing modes more compactly in the 8086.

A result of these features is elimination of boundary-alignment problems. The 8086 is the only processor of the three that allows word data to lie in odd-addressed locations. It provides the most extensive set of byte-data arithmetic features, is the only 16-bit μp that furnishes multiply and divide instructions for 8-bit data, and it also furnishes adjust instructions for use with BCD and unpacked ASCII data.

The Z8000 maintains family similarity with the Z80, which may be the most powerful byte-manipulation 8-bit processor. It has all of the Z80's features (block I/O, string compare, etc.) and a set of 16-byte-wide registers that map into its first 8-word-wide registers. The Z8000 also provides a reasonably orthogonal set of byte instructions, without special registers or bits.

All the Z8000's instructions require entire words, which means that it must have boundary alignment for word-mode data and all instructions. Unfortunately, it does not provide a trap or other mechanism to catch boundary-alignment errors, making it difficult to predict what the Z8000 will do in an odd-address situation, which complicates debugging.

	8086	Z8000	68000
(8-bit data)			
Add, subtract	•	•	•
Multiply, divide	•		
BCD adjust for add/sub	•	•	•
BCD adjust for mult/div	•		
Unpacked ASCII adjusts	•		

Fig. 3. A comparison of the three processors' *arithmetic abilities.*

	8086	Z8000	68000
(16-bit data)			
Add, subtract	•	•	•
Multiply, divide (unsigned)	•		•
Multiply, divide (signed)	•	•	•
Add, subtract with carry	•	•	•
Remainder of division	•	•	•

Fig. 4. A comparison *of the μps' arithmetic abilities for 16-bit data.*

The 68000 has the most orthogonal instruction set of the three. To achieve it, Motorola has sacrificed the special byte-manipulation features provided by its competitors; the 68000 provides no special byte registers or byte primitives. A byte-oriented I/O instruction is the only added feature for manipulation of character data.

The 68000 requires full words for every instruction and also calls for proper boundary alignment of data words. But unlike the Z8000, it provides an automatic trap for boundary-alignment errors. The μp's autoincrement and autodecrement address modes, combined with a two-address MOVE instruction and other primitives, provide much the same capabilities as the other 16-bit μp's string instructions.

It's clear then that the requirement of downward compatibility with an 8-bit μp forces nonorthogonality of a 16-bit unit's instruction set. It also tends to make the 16-bit device more powerful in applications stressing byte manipulations. Text editors, for example, which are heavily byte-oriented, can make use of all the 8086's and Z8000's special byte features. True, these μp's nonorthogonal instruction sets make optimal coding more difficult, but the results are faster and

The ease of handling character data is one test of a μp instruction set's power.

cleaner. And it's easy to convert 8-bit programs for use with these 16-bit μps because of the presence of byte registers: users can map the 8-bit registers from the 8-bit instructions to the byte registers in the 16-bit processor.

Number-crunching comparisons

The use of 16-bit μps as number crunchers requires properties different from those required by byte-oriented tasks. The extended address spaces of these chips call for extended math (more than 16 bits) to effectively address the range. The need is for larger registers (32 bits or wider).

Heavily mathematical applications that aren't practical with 8-bit devices become quite reasonable for these 16-bit units. Their extensive integer-arithmetic facilities make writing efficient floating-point software virtually painless, and the floating-point software allows the units to compete in speed with larger minicomputers.

	8086	Z8000	68000
(32-bit data)			
Add, subtract		•	•
Multiply, divide (signed)		•	
Compare		•	•
Shift		•	

Fig. 5. A comparison *of processors' ability to manipulate 32-bit data.*

The 8086, Z8000 and 68000 each provides features for extended-length arithmetic. As with byte-manipulation, there are trade-offs of compatibility versus orthogonality. Fig. 4 compares the μps' arithmetic capabilities for 16-bit data, while Fig. 5 compares their ability to manipulate 32-bit data.

Intel has compromised the 8086's ability to handle large data in favor of byte capabilities, leaving the 8086 no arithmetic capability for data larger than 16 bits.

The 8086, however, does provide both signed and unsigned multiplication and division for 16-bit data.

Unlike the 8086, the Z8000 furnishes extensive support for 32-bit data. Load, store, arithmetic, comparison and other instructions all have 32-bit forms. A set of 32-bit register pairs maps into the 16-bit set, permitting effective combinations of byte, word and long-word manipulations.

The processor achieves its 48M-byte addressing range by means of segmentation, using a byte-wide segment number. It lacks unsigned multiplication and division, but it's the only μp that provides 32-bit multiplication and division—a big plus in number-crunching applications.

What about the 68000? Motorola designed it to address large memories easily and effectively. Because that task calls for at least 24 addressing bits, the 68000's registers are all 32 bits wide. And all instructions can manipulate 32-bit data as efficiently as 16-bit data. Furthermore, the processor's highly orthogonal instruction set simplifies extension to large data sizes. Unfortunately, though, the 68000's instruction set does not provide 32-bit multiplication or division.

How then, do the three processors compare in number crunching? The trade-offs required to obtain byte-manipulation features interfere with the features needed to handle large data items. Thus, the 8086, with its extensive byte features, has no facilities for 32-bit or larger data. The Z8000 provides 32-bit ability in many instructions. And the 68000, because it is designed to handle a 32-bit data width, deals with large data items in a straightforward manner. The bottom line? Some applications are not efficient with the 8086 if they require extensive math. The Z8000 has enough power to function as a number cruncher, although not all of its instructions can manipulate long-word data. The 68000 is the most efficient handler of such data. Its lack of 32-bit multiplication and division is its only math drawback.

Hardware design affects software

The bus architecture and other hardware features of the three processors have an important impact on the software written for them. Each machine is clearly an outgrowth of its manufacturer's design philosophy; all three build on system builder's experience with 8-bit μps.

Many support chips are available for 8-bit applications. The ease with which these products can serve the 16-bit μps is an important consideration for the system designer contemplating using one of the 16-bitters. The peripheral chips, however, approach the μps themselves, in terms of complexity, requiring extensive software support and careful system integration. Those 16-bit μps that can directly support 8-bit peripheral chips therefore have an advantage.

The 16-bit μps also provide hardware features not present in the 8-bit devices. Such features supply support for multiprocessing, vectored interrupts, memory management and other advanced capabilities; evaluating them calls for an extensive knowledge of the application.

Showing its 8080 heritage, the 8086 employs a distinct I/O space manipulated by special I/O instructions. The 16-bit design extends the space's size from 256 to 64K locations. Taking a lead from the Z80, the 8086 has I/O instructions that can use a register as the address pointer in I/O space.

Providing both byte and word I/O, the 8086 is fully compatible with the 8080 family of peripheral chips. Its LOCK-prefix instruction, together with its hardware features, allows multiprocessor systems built around it to work together effectively. And its ESC (escape) instruction provides an efficient way for external processors or other hardware to interact with it and to accept data from the processor memory.

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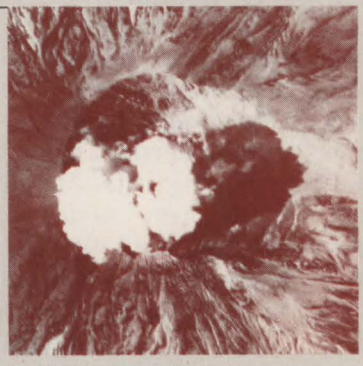

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The requirement of downward compatibility with an 8-bit μp forces nonorthogonality of a 16-bit unit's instruction set.

Just as the 8086 reflects the 8080, the Z8000 mirrors its Z80 roots. Its I/O structure is similar to that of the 8086; it uses a distinct I/O space with 64K locations. A family of I/O instructions (all privileged) provides byte- and word-I/O capabilities. And a parallel "special I/O" instruction set works with the memory-management unit planned for the Z8000 family.

The Z8000 can employ both Z80 and 8080 peripheral chips. One problem appears, though, if users attempt to build an interrupt-driven system using 8080 or Z80 parts: The Z8000 does not have a Z80- or 8080-compatible RETI (return-from-interrupt) instruction. However, an extra I/O port and some software can simulate this instruction to make the interrupt-return mechanism work with Z80 devices.

The Z8000 provides several special instructions and hardware features to support multiprocessing. For example, its multi micro pins form a daisy chain that can tie together several Z8000 processors. And the multi micro instructions provide a mechanism for software control of a Z8000-based multiprocessor system. If the application doesn't call for multiprocessing, the processor's MREQ (multi micro request) instruction can function as a timer.

The 68000 also reflects its 8-bit Motorola predecessors. But its design employs two different bus types adding to its basic 8-bit abilities.

Recognizing that many users have incorporated 6800-type peripherals in their designs, Motorola has provided the 68000 with a completely compatible 6800-style I/O configuration: Memory-mapped synchronous-transfer I/O devices connect directly to 68000 hardware lines dedicated to this function. Additionally, the 68000 provides hardware support for much more complex systems. It contains a seven-level vectored-interrupt structure, a hardware instruction trace and an extensive set of traps and interrupts to facilitate a variety of advanced functions. Two unusued-opcode families provide emulation traps that can also activate parallel processing units. And the processor supports a totally independent asynchronous bus for faster transfers of data using DMA and other techniques.

How do the three processors compare in terms of architectural features? Evaluating such hardware features depends on the evaluator's interests and experience; users of 8080/Z80 systems find the 8086 and Z8000 familiar, while users of the 6800 favor the 68000. Unquestionably, converting programs written for 8080-type peripherals for use in a 16-bit system is complicated by a switch to 6800/68000 peripherals. Conversely, a 6800 program is more difficult to translate to the 8086 or Z8000 than to the 68000, where I/O programming stays constant.

The 68000 does provide support for on-chip vectored interrupts; the 8086 must use an 8259 interrupt controller, while the Z8000 is complicated by the need to simulate an RETI instruction. The 68000's asynchronous bus more closely resembles what a minicomputer or mainframe computer provides, although many applications might not require its complexities.

Big problems need big memories

One of the most important features of a 16-bit μp is its ability to address large memory spaces. Each of the three performs this task differently, producing important trade-offs for designers of systems requiring large memories. Fig. 6 compares some of their addressing features.

The 8086 has the smallest addressing range of the three, although it's difficult to think of 1M byte as small. Four segment registers implement addressing beyond the 64K range provided in the instructions themselves. These registers furnish base addressing for the code, data, stack and extra (user-definable) segments. Users must ensure that the segment registers contain the desired contents and that the instructions use the appropriate segment registers to achieve the desired extended address.

	8086	Z8000	68000
Addressing range	1M byte	8M to 48M bytes	16M bytes
Direct addressing range	64K bytes	64K bytes	16M bytes
Autoincrement/decrement addressing	(Special)	(Special)	•
Multiple stacks		•	•
Memory segments	4	128	Unlimited
Byte addressing in registers	•	•	
Two-address move			•

Fig. 6. A comparison of *addressing features of the three processors.*

The 8086 incorporates a stack-segment register and a special stack-pointer register; it can maintain only one stack at a time. Users can employ only autoincrement or autodecrement addressing on certain registers in certain instructions. (A user can choose between increment and decrement results by setting a bit in the status register by means of a special instruction.)

The 8086's segment-addressing scheme yields some advantages over the addressing used in the other two processors. For example, the code-segment register makes writing relocatable program modules easy. And separating the data segment from the code segment facilitates writing ROMable programs, with the ROM address in the code-segment register and the RAM address in the data-segment register. Furthermore, users can address shared memory regions using the extra segment from several different program modules. Finally, the stack-segment register can be used in programming with stack-oriented high-level languages.

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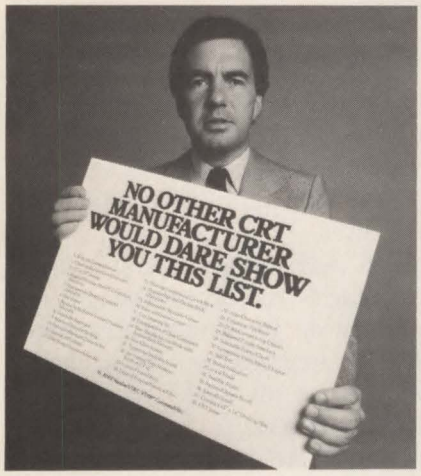

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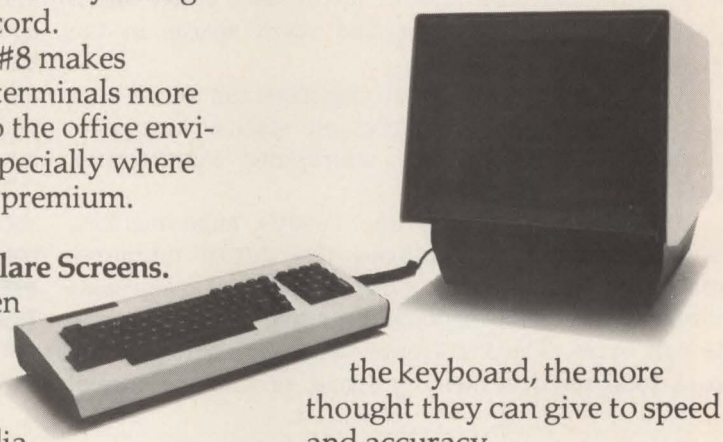

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One of the most important features of a 16-bit μp is its ability to address large memory spaces.

The Z8001 (segmented) version of the Z8000 can address as many as 48M bytes of memory. Addressing results from combining a 16-bit address from the instruction with a 7-bit segment number. Each segment consists of 64K bytes, and users must exercise care at segment boundaries.

This composite 23-bit address can handle as many as 8M bytes, with further address expansion resulting from decoding the chip's status outputs, achieving as many as six 8M-byte address spaces. Users can maintain code, data and stack spaces in the user state, and a parallel set of code, data and stack spaces in the supervisor (system) state.

Any of the Z8000's 16-bit registers can serve as a stack pointer, permitting multiple stacks. Autoincrement and autodecrement addressing characterizes certain instructions.

To effectively manage the Z8001's huge memory space, Zilog has produced the Z8010 memory-management unit (MMU), which supports as many as 64 randomly accessible segments ranging in size from 256 to 64K bytes. The MMU maps these segments into the μp's total physical memory space, providing a logical memory structure largely independent of the data's physical location.

The MMU also furnishes several levels of memory protection: An executing program may not invade the data space, and user programs may not access the system spaces. The MMU and the Z8000's special I/O instructions (which manipulate the MMU) thus form a versatile and effective mechanism to manage large and complex memory spaces.

Memory-addressing capabilities

The 68000 is the only 16-bit μp to date that provides uniform addressing of its entire 16M-byte space from any location without employing segment numbers or special registers. The μp's number of "segments" is therefore effectively unlimited.

Furthermore, the 68000 permits use of any of the address registers as a stack pointer, enabling the maintenance of multiple stacks. Its MOVE instruction uses two general-address expressions to achieve versatility, but the 68000 lacks the 8086's and Z8000 byte addressability within registers.

Motorola plans to provide an MMU to handle features such as memory protection and dynamic address translation. ■

Robert Grappel is vice president, and Jack Hemenway is president of Hemenway Associates, Inc.

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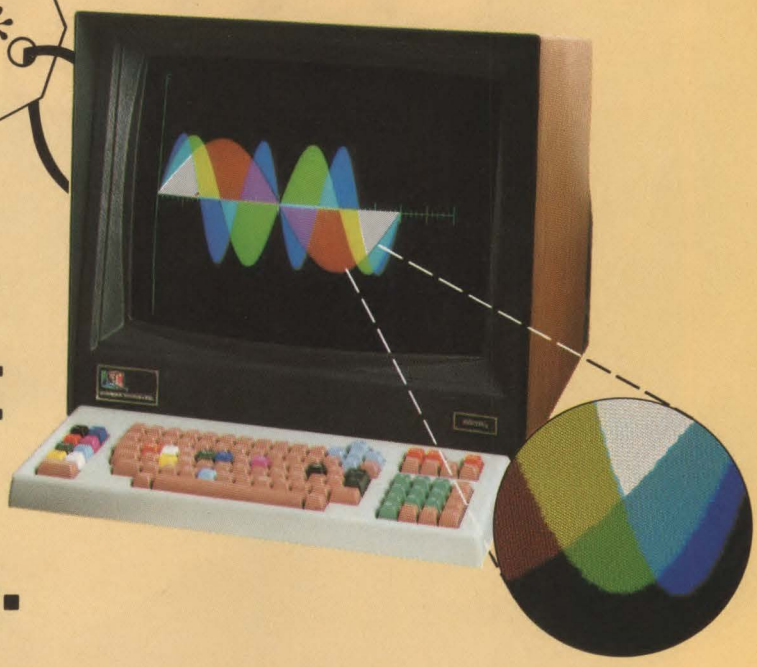

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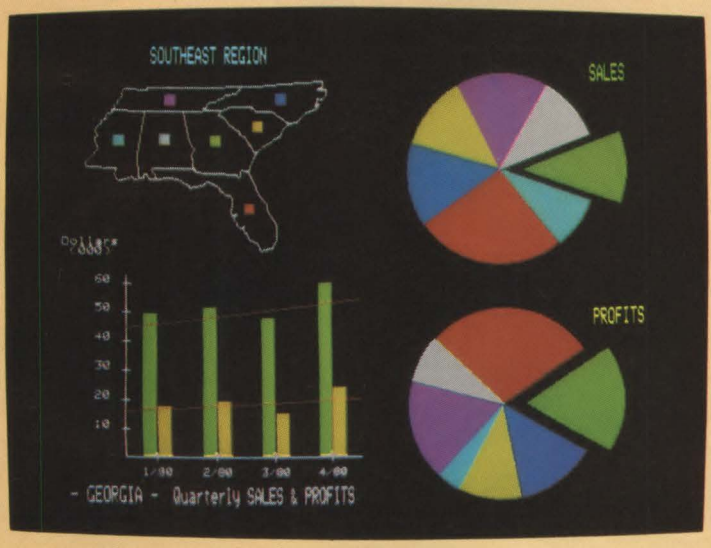

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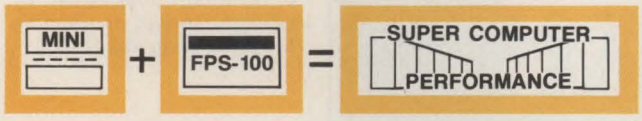

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Chromatics solidifies position in color graphics with 7900

A new offering from an increasingly aggressive contender in the exploding market for color graphics promises to make waves with CAD/CAM and imaging users.

The Chromatics CGC 7900 is a high-resolution (1024 × 768 screen with 1024 × 1024 graphics memory) stand-alone color graphics computer. It has a 19-in. display with two integral floppy-disk drives, and is driven by the 16-bit Motorola MC68000 CPU.

Features include high-speed image generation, simultaneous display of as many as 256 colors and an optional 10M-byte Winchester-disk drive.

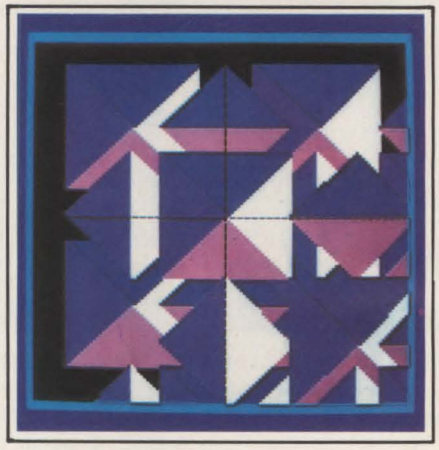
An eight-color overlay mode permits alphanumeric characters or graphics to be overlayed on a bit map unaffected by rolling, panning or zooming the underlying image. The overlay mode also permits dividing the screen into as many as eight graphic windows, with eight additional overlay windows.

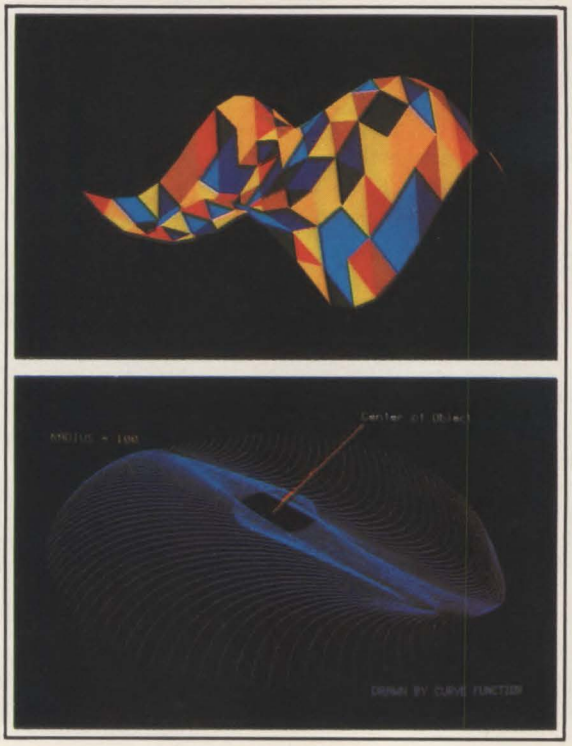
For even more graphic information content, an optional dual-screen buffer allows a second full-screen display to be held in memory for alternate display.

The 7900 keyboard contains 151 keys, of which 34 are dedicated to graphics functions, 21 are lighted for visual feedback, and 24 are program function keys. There are two repeat speeds for rapid cursor movement, and the cursor can also be addressed by an optional joystick that additionally controls zooming and panning. Other options include a light pen and real-time clock with battery-backed RAM. A three-tone sound generator is standard.

The 7900 is base-priced at $19,995, and deliveries will begin next February. **Chromatics, Inc.,** Tucker, Ga. **Circle No 261**

Chromatics' CGC 7900 *is driven by the 16-bit Motorola MC68000 CPU.*





Features on the Chromatics *CGC 7900 include high-speed image generation and simultaneous display of as many as 256 colors. An eight-color overlay mode permits alphanumeric characters or graphics to be overlayed on a bit map unaffected by rolling, panning or zooming the underlying image.*

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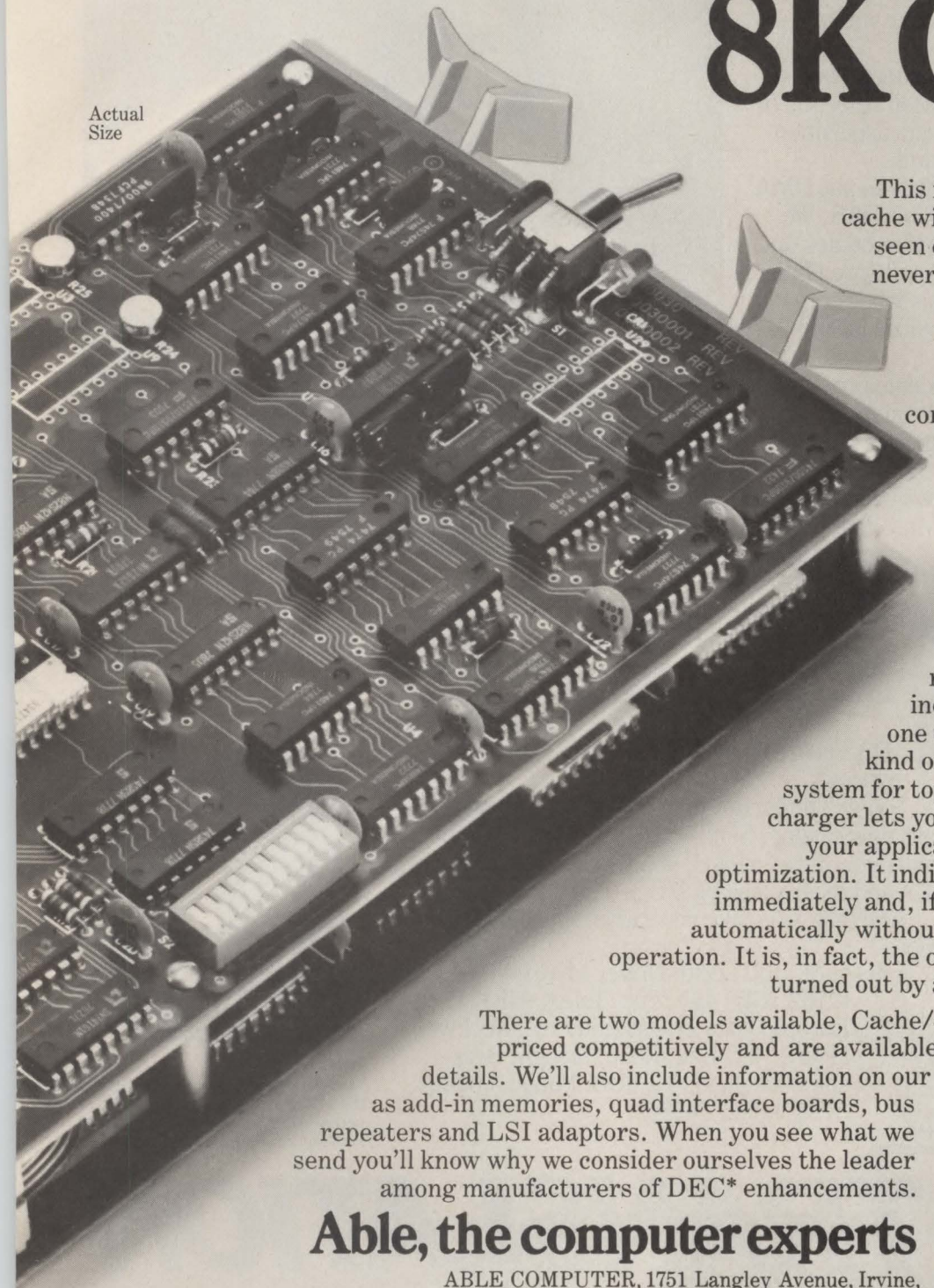

This is the ultimate version, the 8K cache with everything. You have never seen one like it before, and you may never see another. Designed for the 11/34, 11/35 and 11/40, it has byte and address parity, upper/lower limit switches, on-line/off-line manual switch control, activity indicator lights, 8K bytes of memory (4K words) providing a capacity four times that of competitive units and an interconnect board design which consumes no extra space in the computer.

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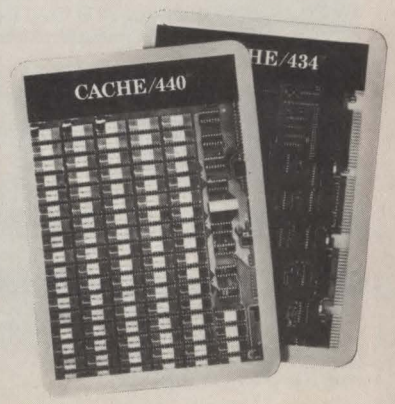
There are two models available, Cache/434™ and Cache/440™. Both are priced competitively and are available within thirty days. Write for details. We'll also include information on our other buffer memories as well as add-in memories, quad interface boards, bus repeaters and LSI adaptors. When you see what we send you'll know why we consider ourselves the leader among manufacturers of DEC* enhancements.



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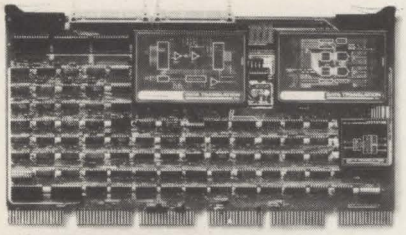

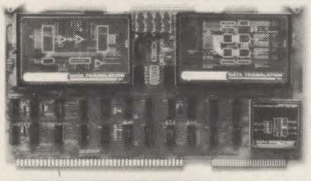

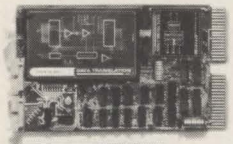

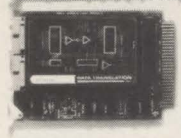

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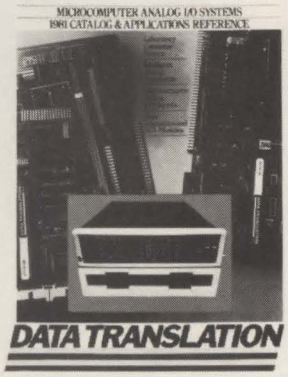

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New Systems

ENTRY-LEVEL BUSINESS SYSTEM. The Synergist M1000 entry-level packaged business system is designed for applications such as order entry, warehouse management, business accounting and financial management. The models 10, 15 and 30 support as many as four Dasher display terminals, as much as 52.4M bytes of on-line data storage and several printer and communications options. Based on a 64K-byte MicroNova processor, all three models run interactive BASIC under the Extended Operating System (EOS), which uses English-like operator instructions and prompts. A copy utility performs disk-to-disk data and software backup. Price ranges from $10,950 to $25,000. **Data General Corp.,** Westboro, Mass. **Circle No 262**

DESK-TOP BUSINESS COMPUTERS. These desk-top business computers—the System 1000 and 2000—support financial applications, including accounts payable, accounts receivable, payroll, general ledger and inventory control, order entry, word processing and data entry. The mid-range System 2000 has dual μps for high-speed concurrent processing and disk access, 32K to 64K bytes of user memory and 650K to 1.3M bytes of diskette storage. It can communicate with one or more host computers in a distributed-processing network and can perform remote computing. The entry-level System 1000 uses one μp with a minimum of 32K bytes of user memory and 325K bytes of diskette storage. It has the same applications software as the System 2000 and can perform the same operations, but with lower throughput potential and data flow. Prices are $3995 to $14,995, **Digilog Systems, Inc.,** Horsham, Pa. **Circle No 263**

UNIX-COMPATIBLE μC. The Decision I, a multitasking S-100 μc, includes a UNIX-compatible operating system that runs CP/M as a sub-task. The operating system supports UNIX system calls in a source-compatible manner. UNIX programs compile directly, and UNIX documentation is almost totally applicable. The System's CPU comprises a 4- to 6- MHZ Z80 microprocessor, a floating-point processor, memory management hardware, including a memory map that supports as many as 16 tasks without swapping. Software includes the C language, business applications and word-processing packages. Disk support includes dual 800K-byte 5¼-in. floppy-disk drives mounted in the mainframe, dual 1.2M-byte, 8-in. floppy-disk drives and a 26M-byte Winchester hard-disk drive. Price is less than $5000. **Morrow Designs,** Richmond, Calif. **Circle No 264**

MANUFACTURING-MANAGEMENT SYSTEM. The QMRP manufacturing-management system enables different levels of control to be phased into different-profit-centers, thus avoiding long start-up times and bottlenecks. QMRP can also be plugged into one of the vendor's small-business computers, enabling it to interact with other aspects of a company's business. Other features include master scheduling to coordinate marketing and manufacturing, customer order processing, bill-of-materials processing and product costing. QMRP also performs material-requirements planning to automate order planning and recommends scheduling on a net-change basis. **Qantel Corp.,** Hayward, Calif. **Circle No 265**

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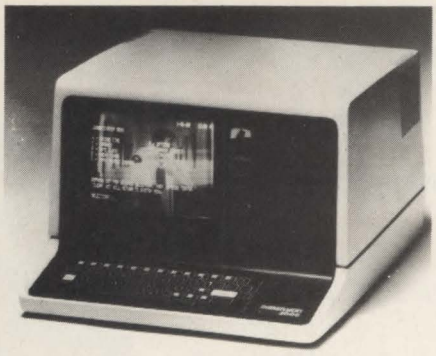

SECURITY-MANAGEMENT SYSTEM. The Dimension 2000 desk-top security system performs all major security functions for an office or plant: television surveillance, alarm monitoring, access control and control of security-related building operations. One person can visually monitor and control all security activities. The system includes a 9-in. CRT/CCTV screen for 64-character data display and television surveillance; computerized alarm monitoring for fire, smoke and intrusion; access control for as many as 4100 card holders at as many as 32 card-reader locations; and automatic message display. As many as 64 primary access levels—which determine the doors a card holder can use—can be combined in eight primary time zones. **Cardkey Systems,** Chatsworth, Calif. **Circle No 266**

INFORMATION-PROCESSING SYSTEM. The Spectrum 80, a μp-based information system designed for both word and data processing, is geared to first-time computer users or users who want to distribute applications processing via host communications to one or more Spectrum 80s. It includes a central file-management computer and an expandable modular InfoCenter work station, which comprises a CPU and one of four configurations of peripheral equipment. The file-management computer, which manages and schedules all the system's resources, includes a CPU, 64K bytes of main memory, a 2M-byte fixed-disk drive and a 1.2M-byte diskette drive and sells for $6790. The DP InfoCenter sells for $9200, the WP InfoCenter for $10,690, and the Information Processing InfoCenter for $11,150. **Management Assistance, Inc., Basic Four Information Systems Division,** Santa Ana, Calif. **Circle No 267**

CAD SYSTEM. The Cadet, a dedicated computer-aided-design system for printed circuit board designers, is said to be the first system oriented toward the increasing board densities expected in this decade. The system includes a raster-scan CRT, a 16-bit microprocessor, a keyboard, a graphics tablet and a cassette-tape unit. Cadet can produce a data base for check plots, artwork, silk screen, solder resist, pads only, drilling drawings and N/C drill tapes. Price is less than $50,000. **Redac Interactive Graphics, Inc.,** Littleton, Mass. **Circle No 268**

μC SYSTEM. The model 6100 Z80A-based μc system includes 64K bytes of main memory and two 8-in. double-density floppy-disk drives, each with six status indicators to verify major functions. Disk capacity is 1M byte. Each drive has a write-protect switch, and two extra disk drives can be added. The system is compatible with the CP/M operating system, the IEEE S-100 bus and peripherals using RS232C interfaces. Four slots in the backplane accept modems, graphics hardware, additional I/O and memory. Price is $4950. **Innotronics Corp.,** Lincoln, Mass. **Circle No 269**

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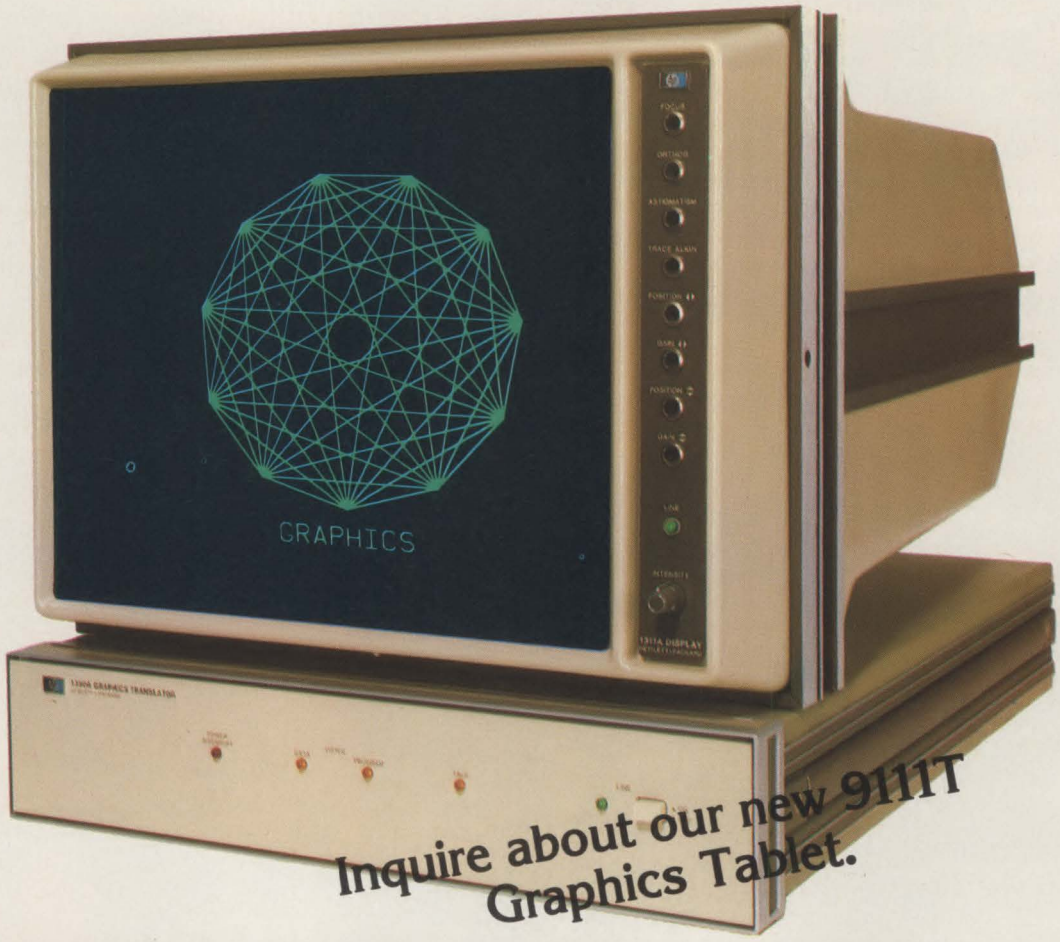

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accessories and supplies

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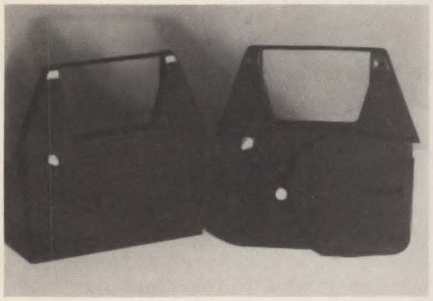


CARTRIDGE RIBBONS. These cartridge-type printer ribbons are direct replacements for Diablo's HyType I and II and similar cartridges. The ribbons are available in black multistrike film, which provides as many as 2.5 million impressions, and nylon, which provides as many as 2 million. The ribbons are wound on automatic machines to assure proper tension. **Compu-Rite Corp.,** Tarzana, Calif. **Circle No 271**

REVERSIBLE MINIFLOPPY DISKS. This dual-sided reversible 5¼-in. minifloppy disk, which is compatible with TRS-80, Apple, Commodore and other computers, enables users to record on both sides. The disk has two recording surfaces and two sets of write-enable and index holes. The disks are certified error-free and are rated for more than 12 million passes without disk-related errors or significant wear. Suggested end-user list price is $5.95 each. **Dennison KYBE Corp.,** Waltham, Mass. **Circle No 272**

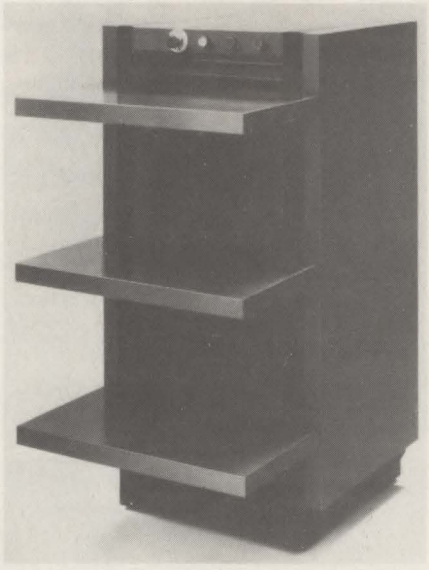
CONDUCTIVE LAMINATE. The CPF 201 Micastat conductive tabletop laminate, intended for use in laboratories and clean rooms, dissipates static charges. The heat-, chemical- and solvent-resistant material comes in a variety of colors and can be laminated to wood with contact adhesives. The amino resin laminate dissipates a 5000V static charge in less than 0.05 sec. Surface resistivity is 109 ohms per sq. in., and volume resistivity is 108 ohms per cm. Prices for the CPF 201 Micastat start at $7 per sq. ft., depending on dimensions. **Charleswater Products, Inc.,** Needham, Mass. **Circle No 273**

FLOPPY-DISK STORAGE. This rotary file holds floppy disks in 48 panels, arranged in carousel fashion. Each panel holds four disks, for a total of 192 disks. An index system lists the contents of each disk and keeps track of removed disks. The rotary file also accepts panels that can hold as many as four mini-disks or as many as 10 magnetic cards. **Wilson Jones Co.,** Chicago, Ill. **Circle No 274**

New Products

accessories and supplies

FIRE EXTINGUISHER. The Data Rescue fire extinguisher fights computer-room fires without damaging hardware or data. The extinguisher uses Halon 1211, a chemical agent that is two to three times more effective than CO_2 in fighting fires. Halon 1211 is not cold like CO_2-type extinguishing agents, whose −110°F discharge can shock or destroy PROMs and other sensitive chips. The chemical does not leave a residue; weighs five times as much as air, enabling it to minimize harmful flashback; and does not generate static or corrode electronic components. Data Rescue is effective over a range of 9 to 15 ft. It comes in 2½-, 5- and 17-lb. capacities, priced at $62, $87 and $230, respectively, with discounts available on quantities of four or more. **Inmac,** Santa Clara, Calif. **Circle No 275**



DOCUMENT SHREDDER. The EBA Agent 004 document shredder processes as much as 2600 lbs. per hr. of continuous computer forms or other waste paper, with a 1200-ft.-per-min. draw-in speed. The unit can shred 33 to 40 sheets in a single pass, with 4-mm. shred width. The unit compresses waste in a plastic bag, or a baling press can be used. The EBA Agent 004, which is unaffected by paper clips or staples, stops if overloaded and can be reversed to clear jams. It operates on 110 VAC, measures 27 × 22 × 50 in. and incorporates adjustable loading tables for feeding multiple stacks of continuous computer forms. The unit sells for $3900. **Standard Duplicating Machine Corp.,** Andover, Mass. **Circle No 276**

PAD & TRACK REPAIR. The CIR-KIT selector pack, intended for field repair and replacement of lifted, damaged or missing pads and tracks on printed circuit boards, eliminates the need for discarding boards and reduces downtimes caused when boards must be removed for repair. CIR-KIT includes pre-tinned and scored eyelets; several Trak-Pads, which are pre-tinned sheets of various-sized replacement pads and tracks; an abrasive stick for cleaning the work area and the Trak-Pads; and the necessary tools and accessories for cold-setting the eyelets. The user must provide a soldering iron and solder. The CIR-KIT selector pack sells for $79. **Pace, Inc.,** Laurel, Md. **Circle No 277**

data entry

GENERAL-PURPOSE OCR SYSTEM. The LASER OCR-TWO is a general-purpose OCR data-entry system consisting of a microprocessor-controlled OCR reader with an automatic document transport, a high-resolution laser scanner, a microprocessor-based data editor and formatter and a control console and keyboard with numeric pad and function keys. The system can scan single-line turnaround documents at a rate of 4400 per hr. and 8½- × 11-in., 30-line pages at a rate of 550 per hr. Character-recognition rate is 400 cps for machine print and 195 cps for hand print. A complete system, including printer, floppy-disk input and nine-track 800- or 1600-bpi tape-drive output sells for $94,900. **Optical Business Machines, Inc.,** Melbourne, Fla. **Circle No 278**

SELF-CONTAINED OMR SYSTEM. The Sentry 80, an integrated optical mark reading scanner, minicomputer and document-processing system designed for interactive control and processing of input data, comprises a Sentry scanner integrated with a Texas Instruments 990/10 or 990/12 minicomputer. The scanner operates either off-line or on-line to the TI processor, and scanner output can be directed either to magnetic tape or directly to disk storage. Software includes scanner software, an operating system, a selection of high-level languages and utilities and document-processing systems. Two models of the Sentry 80 are available: the Sentry 8008, which scans 3000 8½- × 11-in. sheets per hr., and the Sentry 8018, which scans 6000 sheets per hr. Purchase price ranges from $90,000 to $200,000. **National Computer Systems,** Minneapolis, Minn. **Circle No 279**

Preview our new double feature.

Now that our 9" and 12" CRT monitors have become big box office hits, we're ready to show you two new performers: a 15" model for fans of the big screen, plus a 5" model in the compact category.

As with all C. Itoh CRT monitors, you'll be impressed by the superior bandwidths and resolutions of our models. For example, our 5" features 15 MHz and a 600 line resolution while our 15" offers 30 MHz and 1200 lines on a large 239 mm x 171 mm display area.

Our popular medium-sized 9" and 12" screens offer a horizontal rate of 15.72 KHz. All screens feature separate horizontal drive, vertical drive and video inputs which eliminate composite sync and video signal processing. The simple output circuitry and integrated PC board construction contribute to the high reliability of our monitors.

Our screens are available in kit or chassis version, equipped with standard P4 phosphor or optional P31 and P39 phosphors. The heavy duty zinc chromate plated chassis can be furnished with a power supply.

Make your reservations for a private screening today and get ready to judge our performance for best picture of the 80's. Contact your nearest C. Itoh representative or C. Itoh Electronics, Inc., 5301 Beethoven Street, Los Angeles, CA 90066; Tel. (213) 390-7778; or 666 Third Avenue, New York, NY 10017; Tel. (212) 682-0420.

C. Itoh Electronics, Inc.

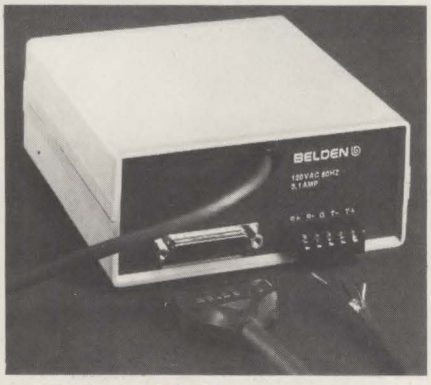
CIRCLE NO. 93 ON INQUIRY CARD

New Products

datacomm

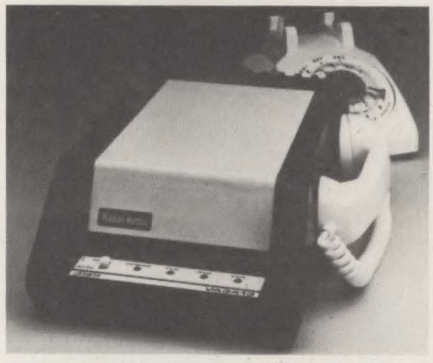
MODEM EXPANDER. The ME4 expander is said to reduce data communications hardware costs by allowing one modem to be shared among four polled remote terminals. Network management features include automatic or manual disabling of a streaming terminal, tri-state status monitors for modem and terminal interfaces and terminal priority allocation. The ME4 supports synchronous or asynchronous data rates as high as 19.2K bps. The unit costs $876. **Kapusi Laboratories,** San Mateo, Calif.
Circle No 280

X.25 PROCESSOR. The model M3216 packet processor switches packet transmissions between X.25-compatible computers, terminals and other digital devices. An auxiliary packet assembly/disassembly unit enables both asynchronous devices and IBM-compatible bisynch devices to be served. Specifications include aggregate data rates as high as 300K bps, as many as 36,000 call connections per hr., 800 packet-per-sec. packet rates, 1500 virtual circuits (on 64 channels), 9600-bps asynchronous terminal rates and 64K-bps synchronous terminal rates. Three M3216s can attach to a Tran M3201 network processor. The resulting hybrid multiprocessor supports time division switched and packet switched data simultaneously at aggregate data rates as high as 1.25M bps. Prices begin at $50,000. **Tran Telecommunications Corp.,** Marina del Rey, Calif.
Circle No 281



SHORT-HAUL MODEM. The model 9338 modem transmits asynchronous simplex and duplex data at speeds as high as 56K bps over metallic-conductor links as long as 15,000 ft. The model 9338 includes a 25-pin type D RS232C connector and a terminal block for attaching a balanced two-pair shielded cable. A three-unit LED array on the front panel indicates system status and aids diagnosis. Price is $195. **Belden Corp.,** Geneva, Ill.
Circle No 282

FIBER-OPTIC LINK. This fiber-optic evaluation kit enables a system designer to install a simplex link 1000m. in length. The LINK II kit contains a transmitter module, a receiver module and a 10m. length of fiber-optics cable, pre-terminated with matching AMP connectors. This kit also includes component specifications and applications literature explaining LINK II's theory of operation and the basic concepts of fiber-optics communications. Price is $125. **Motorola Semiconductor Products Inc.,** Phoenix, Ariz.
Circle No 283

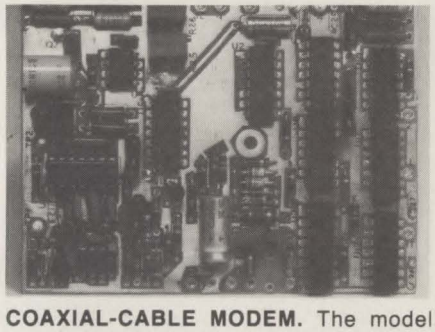


DUAL ACOUSTIC COUPLER. This dual acoustic coupler operates at both 1200 bps and 0 to 300 bps in full-duplex asynchronous mode. Compatible with VA3400- and 103/113-type modems, the model VA3413 coupler employs an automatic detection scheme to select the VA3400 or 103 mode. The unit automatically recognizes 9- or 10-bit character lengths in the VA3400 mode to allow operation with 9-bit (primarily IBM) or 10-bit systems. Single-unit price is $895, with OEM discounts available. **Racal-Vadic,** Sunnyvale, Calif.
Circle No 284

COMMUNICATIONS PROCESSOR. The ICOT 257 communications processor series employs a μp-per-line architecture and special busing (ICOBUS) to enable users to overcome incompatibilities in network codes, speeds and protocols. The 257 performs routine network management functions including polling, message editing and processing, queueing, priority scheduling, diagnostics and error recovery, statistics gathering and security. The 257 also adds line-concentration and message-switching functions to a network. The 257 series hardware includes a 48K-byte system memory, timing boards and as many as 13 communications processor boards. Each processor board contains 6K to 12K bytes of PROM/ROM, 2K bytes of RAM, an interrupt processor and a serial line interface. Prices range from $13,000 to $30,000. **Microform Data Systems, Inc.,** Mountain View, Calif.
Circle No 285

MULTIPLEXER SUBSYSTEM FOR HP 1000. This eight-channel asynchronous multiplexer subsystem enables as many as eight terminals or electrically compatible μp-based devices to be connected to a Hewlett-Packard HP-1000 series computer. An optional multiplexer panel may be located as much as 300 ft. away from the main HP 1000 computer, breaking the typical 50-ft. barrier for standard RS232C specifications. The HP 12792A multiplexer subsystem buffers each full-duplex channel separately and uses direct-memory access control to reduce I/O processing time. The HP 12792A multiplexer subsystem, including software, costs $2000; the HP 12828A multiplexer panel, $600. **Hewlett-Packard Co.,** Palo Alto, Calif.
Circle No 286

14,400-BPS MODEM. This μp-based modem operates at 14,400 bits per sec., which is 50 percent faster than other data modems available for use on telephone lines, according to its maker. The μp-14400 modem, which uses separate microprocessors to handle transmit and receive functions, is said to provide significantly lower communications costs over slower modems. For example, the company claims that a pair of 14,400-bps modems operating on a single, transcontinental line costs about 35 percent less than two lines operating at 9600 bps and 4800 bps. A μp-14400 modem with a two-channel multiplexer option costs $14,400. **Paradyne Corp.,** Largo, Fla.
Circle No 287



COAXIAL-CABLE MODEM. The model 30-0080 modem transmits and receives synchronous data on coaxial cable at rates ranging from DC to 1.544M baud. The modem, which can transmit over 27,000-ft. distances without amplifiers or repeaters, employs multilevel FSK modulation at high carrier frequencies to reject EMI and RFI noise frequently encountered in industrial and commercial environments. Bit-error rates are typically lower than 10^{-12} for a signal-to-noise ratio of 20 dB. Packaged on a 3- × 4-in. PC card, the model 30-0080 sells for $250 in 100-unit quantities. **Computrol Corp., Ridgefield, Conn.**
Circle No 288

Middle Managers.

TI's DS990 Models 4, 6 and 8 Commercial Computer Systems. Our shirt-sleeve executives.

By themselves or as part of a distributed processing system, these hard-working mid-range business managers have the power, speed and versatility you need to get the job done.

DS990 Models 4, 6 and 8 computers are fluent in the languages of commerce. COBOL, FORTRAN, BASIC, RPG II and Pascal all run under our powerful DX10 Operating System. To speed your program development, there's TIFORM, our unique forms generation package. Further, the Models 6 and 8 are also equipped with our highly efficient Data Base Management System and easy-to-use Query language.

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Since they're from Texas Instruments, you know you're getting a lot of performance for the price. Multi-user, disk-based systems in this series start at under $30,000*.

Built into every DS990 computer system is 50 years of experience in the electronics industry, and the technical expertise and support of our worldwide organization of factory-trained sales and service representatives.

Versatility, reliability and growth potential—everything you'd want in an outstanding middle manager. With TI's DS 990 Models 4, 6 and 8, you get it.

Fifty Years of Innovation

*Quantity one, U.S. domestic prices.

TEXAS INSTRUMENTS

We put computing within everyone's reach.

CIRCLE NO. 97 ON INQUIRY CARD

XENIX OS.

It would have made Edison proud.

"Genius," said Thomas Edison, "is 1% inspiration and 99% perspiration." How right he was. Microsoft is taking the authentic UNIX™ Version 7 OS— an inspiration to us all—and is working to make it even better.

How? By applying every bit of our system software expertise towards the creation of a standard operating system to unite all 16-bit microprocessor software development. Now, and through the 80's.

We call it the XENIX™ OS. You'll call it genius.

First, the XENIX-11 OS for PDP-11's.

The first adaptation of our XENIX operating system is the XENIX-11 system for DEC PDP-11™ computers.

If you're a PDP-11 user, you're no doubt familiar with the remarkable UNIX system from Bell Laboratories. It is a highly sophisticated, interactive, multi-user, multi-tasking OS featuring a vast array of utilities. Features include device-independent I/O, tree structured file directory and task hierarchies, a user-space command language, pipes and signals, and security protection.

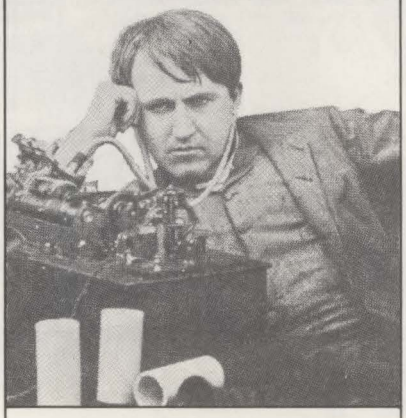
Do you get all this with the XENIX-11 system? Of course. Plus a lot more, all at a very reasonable price.

Positively inspiring.

UNIX is a trademark of Bell Laboratories.

PDP-11 is a trademark of Digital Equipment Corporation.

XENIX is a trademark of Microsoft.



Genuine UNIX OS. Not a look-alike.

Understand first of all that Microsoft's XENIX-11 system is the very same UNIX OS you know and love. Under license from Bell Laboratories, we offer the same proven code that's been subjected to intense field testing throughout the world for over five years. In fact, thousands of successful installations attest to the quality of the UNIX OS.

Finally, a standard you can depend on.

In addition to the XENIX-11 OS, Microsoft is also transporting the XENIX system to run on all new 16-bit micros. That means the XENIX system will define the standard operating system environment in the 1980's.

Which will in turn make it as popular as the lightbulb. Because now, you and your software can stay with the XENIX OS, even after moving to new 16-bit hardware.

Very ingenious.

Solid support from the experts.

Best of all, the XENIX OS is brought to you by Microsoft, the leading innovator in quality system software. We believe in full support for our customers, no matter how much perspiration we expend in the process.

That explains our long-term commitment to keep the XENIX OS state-of-the-art. And our obligation to pass each advancement on to our customers through periodic improvements and updates.

Because as Thomas Edison might have said, "No one stays on the forefront of technology by taking a back seat to progress."

An object license for the XENIX-11 OS is available to single-copy buyers or OEMs for a very reasonable price. For more information, contact Microsoft or your local Microsoft dealer.

Microsoft
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206-455-8080
Telex 328945

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We set the standard.

MICROSOFT

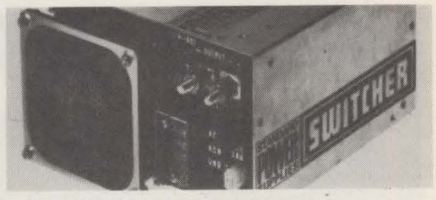
power supplies

OPEN-FRAME SUPPLY. The SOLV45 power supply provides voltage and current outputs ranging from 5V at 9.0A to 48V at 1.5A, with optional overvoltage protection. Line and load regulation are 0.1 percent over a temperature range of 0° to 55°C. The unit measures 4.88 × 7 × 2.88 in. and sells for $52 in quantities of 250. **Elpac Power Systems,** Santa Ana, Calif. **Circle No 289**

PLUG-IN AC POWER CONDITIONER. The model 300 AC power conditioner, designed for electronic devices that use μp and other semiconductor circuitry, incorporates a wall-socket-type fixture, so that equipment can simply be plugged in. The device enables any 117-VAC wall outlet to be converted into a dedicated line. The model 300 clamps high-energy transients and filters RFI from the AC line. Status is continuously monitored by an LED. Price is $135. **MCG,** Deer Park, N.Y. **Circle No 290**

WIDE-RANGE DC SUPPLY. The Series 9N Rev C Superswitcher provides an output selection range of 2 to 12 VDC at 50 to 200A and strap-selectable AC inputs of 90 to 132 VAC or 180 to 264 VAC, or 165 to 230 VAC, 47 to 440 Hz. Other features include brownout settings of 85 or 160 VAC, 30-msec. holdup, a power-fail module option, a logic high/low option, UL-CSA-IEC and VDE safety design, improved overvoltage protection stability and failsafe remote sense. Line regulation is 0.1 percent or 5 mV (whichever is greater) for a +10- to −20-percent line change; load regulation is 0.2 percent or 10 mV (whichever is greater) for a 0- to 100-percent load change. Prices in quantities of 100 start at $495. **Powertec, Inc.,** Chatsworth, Calif. **Circle No 291**

QUAD-OUTPUT OPEN-FRAME SUPPLY. The MPS140W-CP532 open-frame power supply, designed for use with μps, has four outputs, providing ±5 VDC at 0.5A or 15A or ±12 VDC at 3.4A or 25A. Input is 115 or 230 VAC, ±10 percent, 47 to 440 Hz. Line regulation is 0.02 percent for a 10-percent input change; load regulation is 0.02 percent for a 50-percent load change. Maximum output ripple is 3.0 mV peak to peak. Price is $149 in quantities of one to nine. **Condor, Inc.,** Camarillo, Calif. **Circle No 292**



SWITCHING DC SUPPLIES. The SWS 751 line of industrial and commercial switching power supplies is available in five models, providing 5, 12, 15, 24 and 28 VDC from 28 to 150 A. The 750W units, which run on a 230-VAC, single-phase input, have built-in fans and efficiencies as high as 80 percent. The SWS 751 power supplies sell for $695. **Standard Power, Inc.,** Santa Ana, Calif. **Circle No 293**

design aids

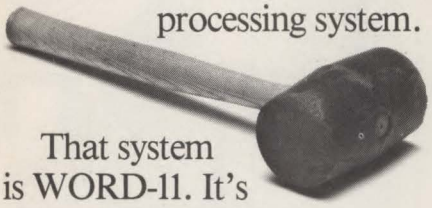
MICROCOMPUTER DEVELOPMENT SYSTEM. Designed to support the 1802, 1804, Z80, 8080, 8085, 8048, 6800, 6809 and 6502 microprocessors, the H800 development system includes intelligent peripheral controllers, memory-management hardware, a real-time clock, real-time emulators and a logic analyzer. Other features include an integral CRT display, a power supply and card cage with an S-100 bus, a universal PROM programmer and a detached keyboard with system function keys. The H800's dual double-density floppy-disk drives store as much as 1M byte of data. Software includes a disk operating system with a file utility package, a screen editor, a relocatable macro-assembler, high-level languages and up- and down-loading capability. An in-circuit symbolic debugger provides real-time execution and includes a disassembler and patch assembler. Price is $16,995. **Hughes Solid State Products Division,** Newport Beach, Calif. **Circle No 294**

MC68000 EMULATOR BOARD. The User System Emulator (USE) board enables a user to extend EXORmacs development-system resources into his target system, providing a connection between the user's non-debugged hardware/software system and the diagnostic facilities within the EXORmacs. These include the MACSbug debugger, the SYMbug symbolic debugger, file management and memory storage. The MC68000 User System Emulator consists of a USE control module, a USE buffer box and an interface cable. Price is $1500 in single-unit quantities. **Motorola Semiconductor Products, Inc.,** Phoenix, Ariz. **Circle No 295**

EPROM PROGRAMMER. The PKW-5000 portable EPROM programmer, designed to program Intel 2704, 2708, 2758, 2716 and 2732 as well as TI 2708, 2516 and 2532 PROMs or their equivalents, includes 16K bytes of RAM, a Z80 microprocessor, a 16-digit, seven-segment LED display and a keyboard with command and 20 data keys. The PROM type to be programmed is selected by setting two slide switches. A zero-insertion-force socket enables easy chip insertion and removal. The unit can load the contents of a master ROM into a RAM buffer, program the contents of the RAM into EPROM, display content of the EPROM or RAM, block-update the RAM and block-transfer data between RAM sections. Users can execute or debug programs in Z80 or 8080 machine code, display the contents of registers, update register contents and designate as many as two breakpoints. Price is $1595. **Energy Electronic Products Corp.,** Los Angeles, Calif. **Circle No 296**

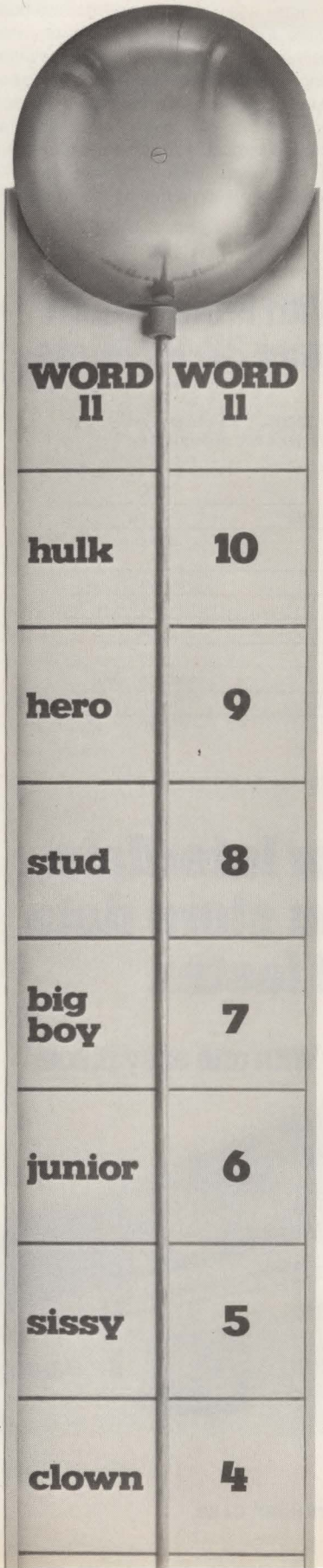
STRONG WORDS.

Make it to the top on the strength of your words. All you need is the right word processing system.



That system is WORD-11. It's powerful. Sophisticated. Responsive. And surprisingly inexpensive.

It's designed for DEC's family of mini-computers. It's flexible, available on several operating systems, including RSTS/E and RSX-11M. It's talented, sharable, and supports a system of up to 50 terminals. And it runs concurrently with data processing.



But most important, it's proven. In hundreds of banks, universities and Fortune 500 companies, WORD-11 has been working hard for years.

So write for our brochure. Or ring our bell, at (714) 993-4160.

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CIRCLE NO. 101 ON INQUIRY CARD

design aids

8051 EMULATION BOARD. The EM-51 emulation board is a functional and electrical equivalent of the 8751 EPROM microcomputer, a member of the vendor's HMOS 8051 family of 12-MHz microcomputers. The EM-51 also can be used to develop prototypes calling for the 8051 and 8031 microcomputers. The 2¾- × 5¼-in. board plugs directly into 8751/8051/8031 sockets and has on-board sockets for 2716 or 2732 EPROMs, which substitute for 8051/8751 on-chip memory during prototype development. A bond-out version of the 8051 chip, identical to the 8051 except that on-chip memory bus lines are accessed through additional package leads, lets the EM-51 EPROM replace the 8751 on-chip EPROM while freeing the I/O ports for operation with peripheral circuitry. The EM-51 can be powered from the prototype 8051 socket, an external 5V supply or both. Price is $950. **Intel Corp.,** Hillsboro, Ore.

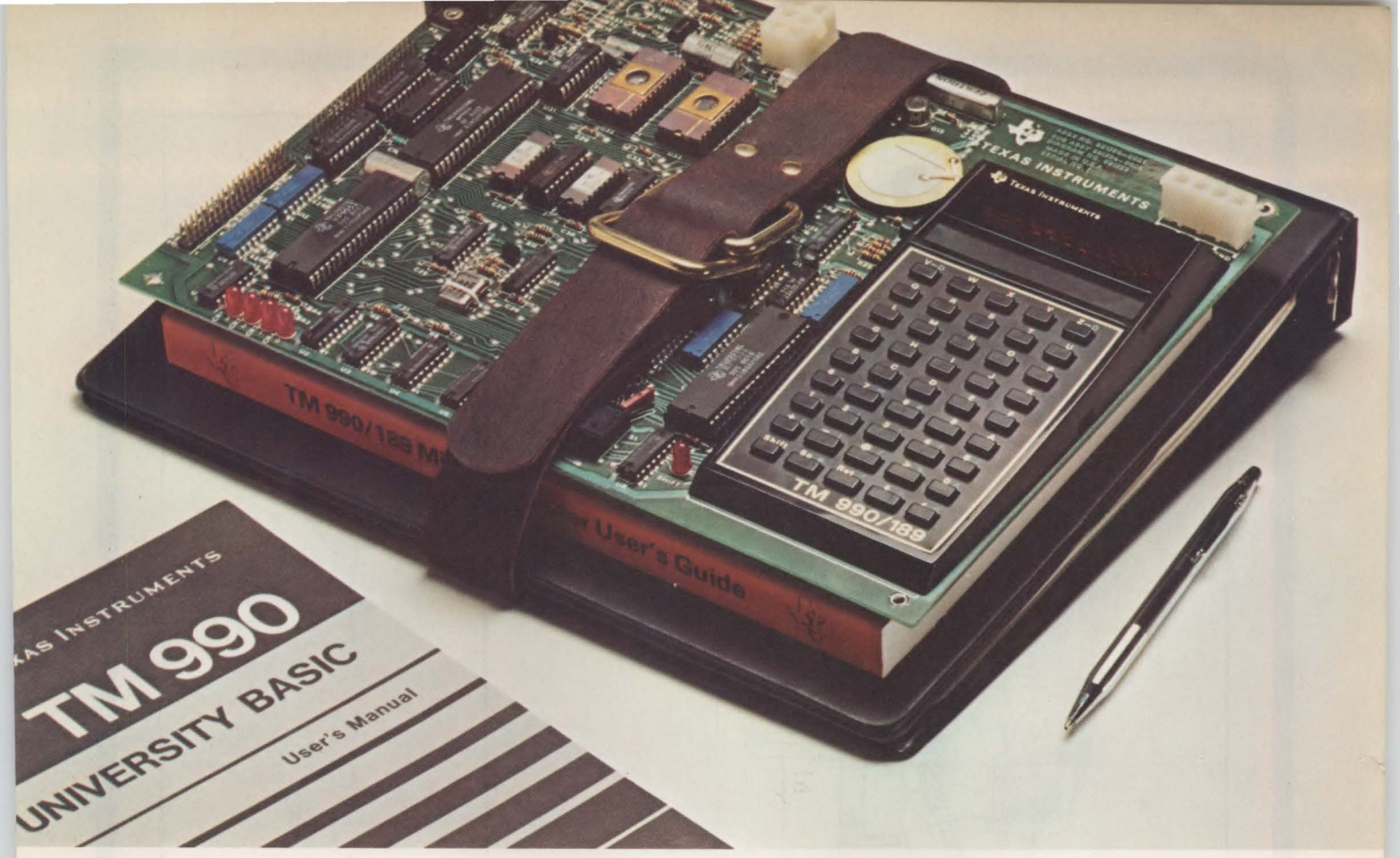
Circle No 297

UNIVERSAL DEVELOPMENT SYSTEM. EZ-PRO, a modular universal development system for bit-slice or fixed-word-length processors, incorporates a multiprocessor architecture, which is said to achieve high performance at a price significantly lower than that of systems having similar performance. The system can accommodate microprogram word lengths of 128 bits and depths of 2K words. With a shorter microprogram word, as many as 8K words can be accommodated. Memory cycle times are better than 60 nsec. Both ECL and TTL PROM-programmer modules are available for programming or reading as many as eight PROMs at a time. In-circuit emulators are available for the 2650, 6502, 6800, 6802, 6808, 6809, 8080, 8085A/A-2 and Z80 and for four members of the 3870 family. Price for a typical fixed-word-length system is $8485; prices for bit-slice systems range from $11,335 for a 16-bit system to $26,800 for a 128-bit system. **American Automation,** Tustin, Calif.

Circle No 298

UNIVERSAL DEVELOPMENT STATION. The Phoenix I universal microprocessor development station supports software development for more than 30 μps, including the AMI S2000, S2200 and S2300 families; the 6800 family; the 9900 family; the 8080A family; and the Z80, 6502 and 2650 μps. Included in the system are a CPU with 48K bytes of RAM, a 12-in. CRT, a full ASCII keyboard and keypad, three 5¼-in. floppy-disk drives with a total capacity of 306K bytes, two RS232C interfaces, the Pascal-based AMIX executive operating system and assemblers for the S2000, S2200, 6800 and 9900 μps. AMIX includes a screen-oriented editor called EDWARD, which is used for every supported μp, and utilities. The Phoenix sells for $5495. **American Microsystems, Inc.,** Santa Clara, Calif.

Circle No 299



University Basic ROM kit. Now available for TM990/189 module. On-board. Or off.

We've added another option to our TM990/189 University Module. Now, in addition to the I/O and RAM expansion kits previously offered, you can buy the TM990/189-1 module with a University Basic ROM kit on-board, and get new hardware features, too. Features like:

- 1K byte of extra RAM
- Asynchronous communication port
- Off-board CRU expansion

All for the attractive price of $399*.

With the TM990/469 Basic ROM kit, standard 189 modules provide "hands-on" training for students and engineers who want to learn a high-level language like Power Basic. The kit also supports a subset of the Power Basic commands and statements including SAVE and LOAD. Unique color commands such as TONE, COLOR, PATTERN and SPRITE work with TI's TMS9918 Video Display Processor. Another feature is the ability to access assembly language routines from the University Basic programs.

When purchased separately, the ROM kit costs only $110*.

Of course, the standard TM990/189 is still available. And, it's still your best ticket into the microprocessor world. For maximum hands-on experience. For ease and simplicity of learning and teaching about microprocessors, hardware, and assembly language.

Outstanding features for the standard fully assembled TM990/189 stand-alone learning tool include:

- Powerful 16-bit microprocessor with minicomputer instruction set.
- 45-key alphanumeric keyboard and 10-digit, 7-segment display for easy *assembly language* programming.
- ROM-resident software
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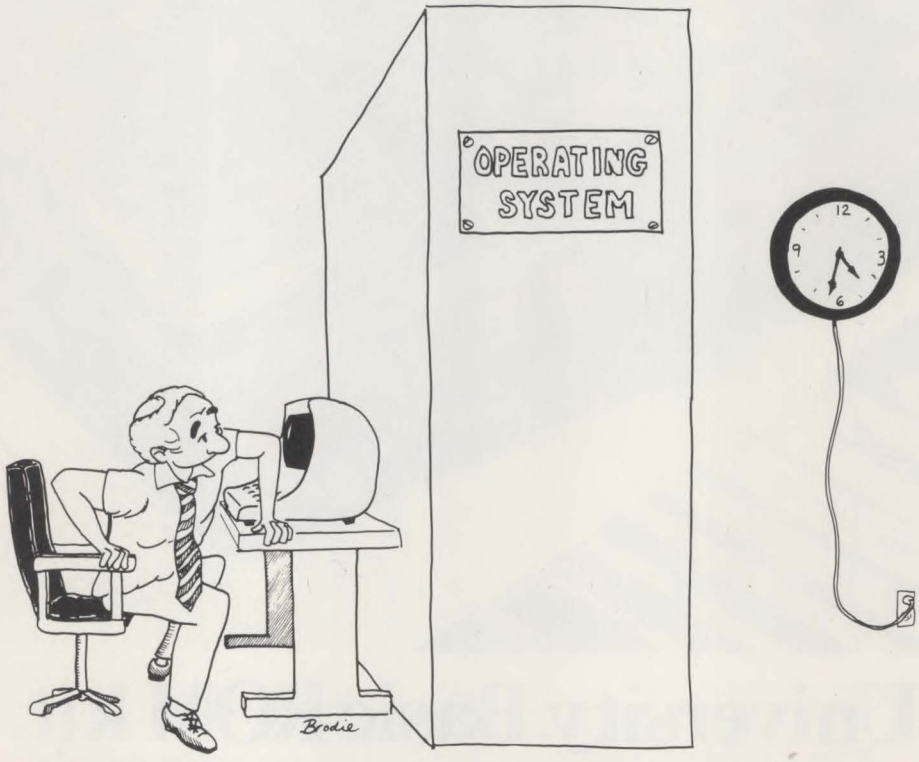

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New Software

PASCAL COMPILER. HA-PASCAL/1, aimed at the OEM industrial market, supports the functions of PL/M-like compilers, but with Pascal Syntax. Intended for coding programs for typical process-control and controller applications, the compiler includes port I/O support, 32-bit arithmetic, access to memory by byte or word, calls to assembler routines, Pascal control structures and provision for interrupts or real-time operations. The compiler runs under HA-SP/68000 or HA-SP/Z8000 operating systems, and produces code that can run stand-alone. Single end-user price is $400. **Hemenway Associates, Inc.,** Boston, Mass.

Circle No 300

μP ASSEMBLERS. These assemblers for the Zilog Z8000 and Motorola M68000 μps provide multi-user support, relocation capability, cross-reference, macro definitions, conditional assembly and subroutine librarian. The assemblers run on the vendor's UMDS line of universal μp development systems, and they can be purchased separately for use on any DEC PDP-11- or VAX-compatible computers. The assemblers support RT-11, RSX-11, RSTS, IAS and VMS operating systems. Prices start at $1200 in quantities of three or more. **Boston Systems Office,** Waltham, Mass. **Circle No 301**

FINANCIAL ACCOUNTING. The Software Fitness Program, written in COBOL, runs on Z80-based μps under the OASIS operating system. Designed for small-business users, the package includes sales order processing, accounts receivable with billing and sales analysis, accounts payable, general ledger, inventory, payroll and job cost. The applications run on single- or multi-user systems supporting disk and diskette storage. Other features include open item and balance forward accounting; LIFO, FIFO and average-cost methods of inventory valuation; single or multiple company processing; revenue and expense accounting by job or phase; and a report generator for financial statements. The user can set interface switches to control the complexity of accounting interactions. **Open Systems, Inc.,** Minneapolis, Minn. **Circle No 302**

RELOCATABLE ASSEMBLERS. M68 for Motorola's 6800, and M18 for RCA's 1802, are relocatable assemblers that run on CP/M-based systems. Each assembler has a macro and conditional assembly syntax and generates a Microsoft-compatible relocatable object file. The format allows relocation of 8-bit expressions. Each package includes a relocatable linking loader and a library manager. M68 and M18 are available on diskettes for $425. **Systems Consultants, Inc.,** San Diego, Calif. **Circle No 303**

DEVELOPMENT SOFTWARE. The System-3870 cross-assembler enables any CP/M system to serve as a development station for the Fairchild F8/3870 single-chip processors. The package includes a macro-assembler, an interactive editor/assembler and a text editor. The assemblers support instruction mnemonics and syntax defined by Fairchild, the chip manufacturer. The macro assembler includes macro and conditional assembly features and the ability to chain a series of source files together during a single assembly. Programs developed under this system must be off-loaded to the target processor for test. Facilities are provided to implement the off-loading mechanism as a direct transfer from memory. System-3870 is available on diskette for $150. **Allen Ashley,** Pasadena, Calif. **Circle No 304**

COMMAND PROCESSOR. The Plato command processor facility for the Plato data analysis and forecasting system allows non-programmers to develop interactive forecasting, modeling, planning or reporting systems. The command processor features include terminal I/O, command tracing, argument substitution, full arithmetic abilities, table lookup, character manipulation, nested calls and error handling. The data analysis and forecasting system also includes a data base facility, terminal graphics and a report generator. Plato, written in a machine-independent subset of FORTRAN, runs on DEC 10, DEC 20, Prime 350 (and up) and IBM mainframe computers. **OR/MS Dialogue, Inc.,** New York, N.Y. **Circle No 305**

REMOTE BATCH EMULATOR. With the remote batch terminal emulator (RBTE), Z80 μcs can emulate IBM 3780, 2780, 2770, 3741 or 2968 remote batch terminals, to transfer data files to and from mainframe computers or other remote batch terminals using the binary synchronous protocol at data rates as high as 19.2K baud. Features include hardware diagnostics, on-line communication trace, attended and unattended operation and user customization. RBTE runs under the OASIS operating system and CP/M as well as several custom vendor operating systems using the Zilog Z80 μp. Price is $500 for a single-user license, with OEM and dealer discounts available. **Winterhalter & Associates,** Dexter, Mich. **Circle No 306**

New Software

PASCAL COMPILER. The AMI-Pascal compiler runs on the Intel MDS, Motorola Exorciser, TI 990/4, Tektronix 8002A and the AMI Phoenix 1 development station, under the AMIX operating system. It includes extensions for business programming and system-level work. Separate modules written in assembly language or FORTRAN-77 can be linked with AMI-Pascal programs. The compiler produces threaded code for use with the resident run-time library of the AMIX system. It can be used as a system implementation language for algorithm design and debugging. AMI-Pascal requires a 48K-byte memory, dual floppy disks and a CRT terminal on the host system. The price for the AMI-Pascal floppy diskette is $275, including a reference manual and six months of software maintenance. **American Microsystems, Inc.,** Santa Clara, Calif. **Circle No** 307

TERMINAL EMULATOR. An emulation package enables Naked Mini computers to function as remote job-entry terminals to any host computer that supports IBM 2770, 2780 or 3780 protocols. Operating under binary synchronous communications protocol, the software makes NM4-based systems appear to a host computer as either an IBM 2770, 2780 or 3780 remote batch terminal. By emulating the data-transmission protocols of IBM terminals, the Naked Mini provides network compatibility and local processing; the IBM terminals do not perform computing functions. The emulators execute under the NM4 real-time executive on NM4/10, 4/30, 4/90 and 4/95 processors equipped with an I/O distributor card, bisynchronous intelligent cable interface and an optional synchronous modem. The three emulators are available on diskette as a package with a user's manual for $1000. **Computer Automation,** Irvine, Calif. **Circle No** 308

AUTOMATED SPELLING. The WordSearch automated spelling system, running on CP/M-compatible word-processing systems, searches text for the occurrence of words that have not previously been validated and placed in the main word library. The system displays these words as a list of words or in context of the original text. Words not found in the library, but identified by a user as valid, are added to the library at the user's command. Default parameter assignments can be overriden at any time to achieve the desired result. Word libraries can be tailored to handle special vocabulary requirements. WordSearch is distributed on an 8-in. single-density diskette with a complete user manual, an initial spelling word dictionary and a demonstration package for $195. **Key Bits, Inc.,** Miami, Fla. **Circle No** 309

New Literature

POWER SUPPLIES. The EMHP series of high-power, three-phase SCR DC power supplies is detailed in a brochure. The six-page catalog illustrates three basic sizes, provides specifications for 27 models and outlines overall features. The brochure also covers applications and provides outline dimension diagrams. **Electronic Measurements, Inc.,** Neptune, N.J. **Circle No 310**

TOUCH SCREENS. Specifications and applications of 12- and 15-in. touch-screen digitizers are detailed in a brochure. The six-page, illustrated booklet also describes kits for installing the systems on existing terminals. **TSD Display Products, Inc.,** Bohemia, N.Y. **Circle No 311**

EDUCATIONAL SYSTEMS & INSTRUMENTS. Educational programs and test instruments for schools, industry, government and self-instruction are described in a catalog. The 40-page publication details 17 courses in electronics, microprocessors, automotive and computer programming. The catalog also includes specifications of more than 40 test instruments, including oscilloscopes, power supplies, signal generators and TV service instruments. **Heath Co.,** Benton Harbor, Mich. **Circle No 312**

ANALOG I/O SYSTEMS. A line of microcomputer analog I/O systems is detailed in an engineering manual. The 192-page publication describes more than 100 modules, interface boards, systems and software subroutine libraries. The guide also contains tutorial articles, prices, dimensions and applications. **Data Translation,** Natick, Mass. **Circle No 313**

ELECTROLYTIC CAPACITORS. A line of tantalum electrolytic capacitors, intended for use in avionics, aerospace and other high-reliability applications, is described in a catalog. The 20-page catalog provides charts, diagrams and ordering information. **Plessey Capacitors, Inc.,** Westlake Village, Calif. **Circle No 314**

IBM-COMPATIBLE TERMINALS. IBM 3270-compatible terminals, ASCII terminals, printers and control units are described in a brochure. The six-page catalog details plug-compatible peripherals, including magnetic-tape subsystems, IBM 3350-compatible disk-storage subsystems and IBM 1403-compatible train printer systems. The brochure also details a finance terminal and a data-entry communication system. **Telex Computer Products, Inc.,** Tulsa, Okla. **Circle No 315**

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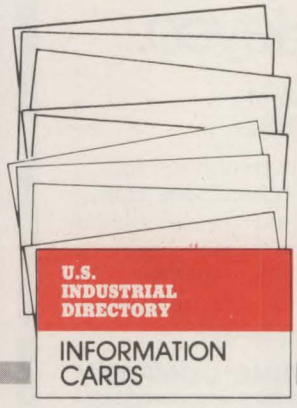

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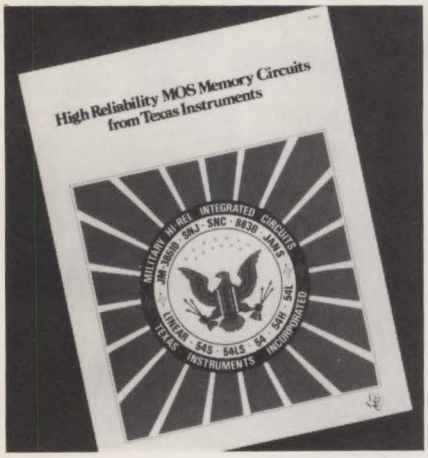
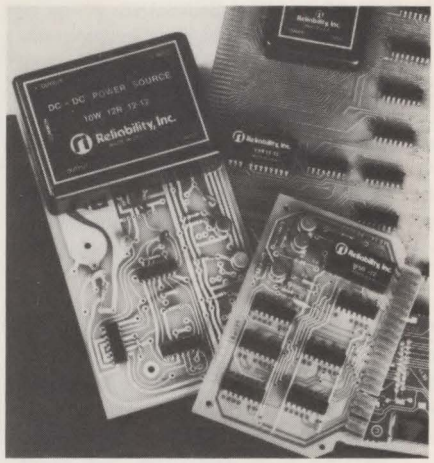


MOS MEMORY CIRCUITS. A line of high-reliability MOS memory circuits is detailed in a selection guide. The six-page publication covers EPROMS, RAMS, the TI SMM military processed, the TI SMC MIL-STD 833B vendor equivalent and the TI SMJ MIL-STD 883 Class B programs. The brochure also outlines the device screening, lot conformance production, test and control conditions and procedures of these programs. **Texas Instruments, Inc.,** Dallas, Texas.
Circle No 316

FORMS DETACHER. The model 385 continuous forms detacher is described in a brochure. The four-page bulletin explains the system's set-up and operation. The brochure also outlines standard features, options and specifications. **Moore Business Forms, Inc.,** Glenview, Ill. **Circle No 317**

TRANSACTION-DRIVEN SYSTEM. The TDS/64 transaction-driven system is described in a brochure. The 24-page publication details writing transaction processing routines, debugging, file access and recovery and system-security features. **Honeywell,** Waltham, Mass. **Circle No 318**

INTERFACE OPTOCOUPLERS. The HCPL-3700 optocoupler, which allows AC or DC input signals, is described in an application note. The 15-page booklet introduces the basics of interfacing AC and DC voltages to a microprocessor and explains threshold switching systems, such as DC motor control, limit switch sensing, AC line monitoring and temperature monitoring. **Hewlett-Packard Co.,** Palo Alto, Calif. **Circle No 319**



POWER SOURCES. More than 120 AC-DC and DC-DC power sources is described in a catalog. The 12-page booklet includes information on input voltage range, output voltage, line and load regulation, output ripple and noise, temperature coefficient, operating and storage temperature ranges and input idle current. The pamphlet provides engineering, production and application information, a selection guide, a price list and a glossary. **Reliability, Inc.,** Houston, Texas.
Circle No 320

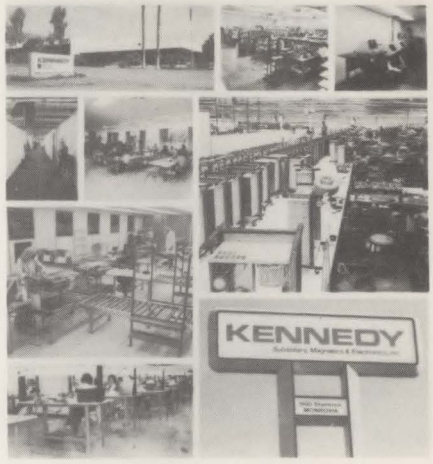
PLUG-IN PROXIMITY SENSORS. A line of plug-in proximity limit switches for programmable controllers and general industrial controls is described in a bulletin. The six-page catalog discusses indexing head switches, a long range sensor and shielded and non-shielded tubular models. The bulletin also provides technical information and operational and wiring diagrams. **Gould Inc.,** Bedford, Ohio. **Circle No 321**

PRINTED-CIRCUIT CONNECTORS. A line of PC connectors and accessories is described in a catalog. The 48-page booklet details dip-solder, wire-wrap, round-tail and selectively plated PC edgeboard connectors. The catalog also describes two-piece connectors, connector blocks and a proprietary selective gold-plating process. The brochure provides charts, diagrams and ordering information. **Viking Connectors, Inc.,** Chatsworth, Calif. **Circle No 322**

TEST AND MEASUREMENT. A line of test and measurement instruments is described in a catalog. The six-page, illustrated booklet covers digital multimeters, thermometers, calibrators, dataloggers, printers, panel mount instrumentation, counter timers, comparators and load controllers. The catalog also details an automatic test system. **United Systems Corp.,** Dayton, Ohio. **Circle No 323**

RECORDER/REPRODUCER. The Sabre 80 portable magnetic recorder/reproducer is described in a brochure. The 16-page, illustrated booklet details operator controls, standard features, servicing procedures, tape transport, direct and FM recording techniques and optional equipment. The brochure also includes block and dimensional diagrams and information on a two-year product warranty. **Sangamo Data Recorders,** Sarasota, Fla. **Circle No 324**

DATA COMMUNICATIONS. A line of data communications products is detailed in a catalog. The 16-page brochure covers the Series II Microplexer, the Alpha Star network management system, the Timeplexer, the Lineplexer II and the Lineplexer Transmission System (LTS-I). The catalog also describes applications and accessories. **Timeplex, Inc.,** Rochelle Park, N.J. **Circle No 325**



TAPES AND DISKS. A line of tape and disk units is described in a catalog. The eight-page booklet details tape transports, disk drives, cartridge transports, asynchronous incremental recorders and control units. The catalog also covers the model 6809 ½-in. Data Streamer transport, model 6450 cartridge data system and the Series 5300 14M- to 70M-byte, 14-in. Winchester-disk drives. **Kennedy Co.,** Monrovia, Calif. **Circle No 326**

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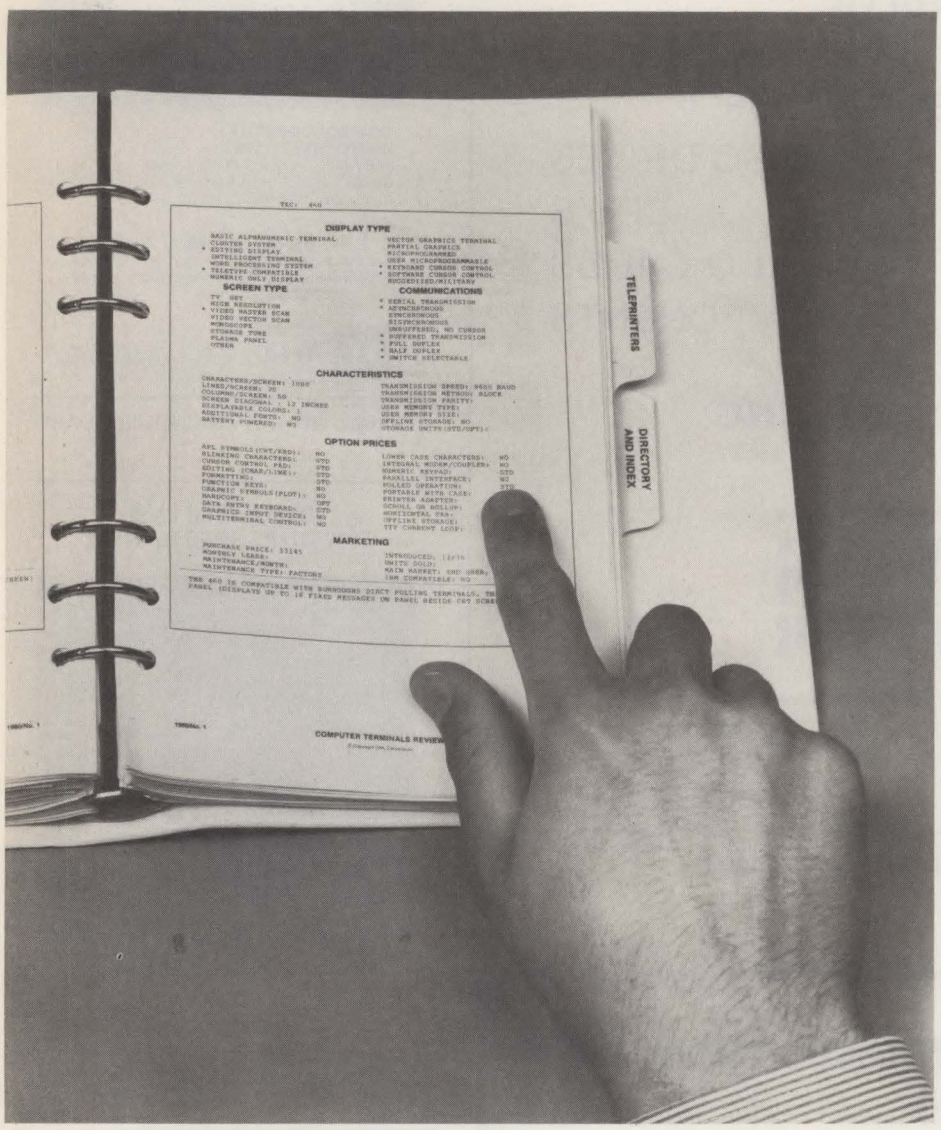

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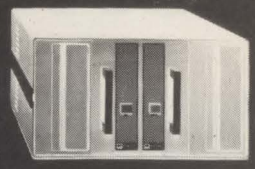

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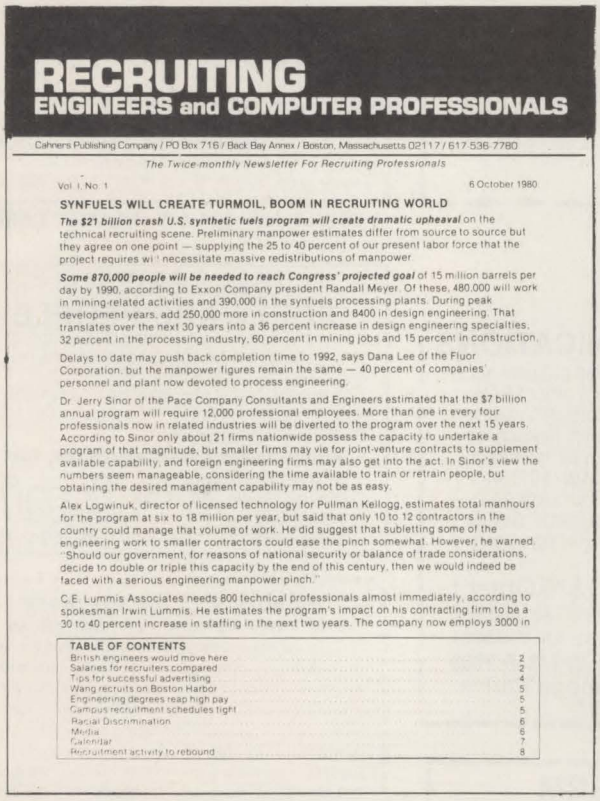

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The Twice-monthly Newsletter For Recruiting Professionals

Vol. 1, No. 1 — 6 October 1980

SYNFUELS WILL CREATE TURMOIL, BOOM IN RECRUITING WORLD

The $21 billion crash U.S. synthetic fuels program will create dramatic upheaval on the technical recruiting scene. Preliminary manpower estimates differ from source to source but they agree on one point — supplying the 25 to 40 percent of our present labor force that the project requires will necessitate massive redistributions of manpower.

Some 870,000 people will be needed to reach Congress' projected goal of 15 million barrels per day by 1990, according to Exxon Company president Randall Meyer. Of these, 480,000 will work in mining-related activities and 390,000 in the synfuels processing plants. During peak development years, add 250,000 more in construction and 8400 in design engineering. That translates over the next 30 years into a 36 percent increase in design engineering specialties, 32 percent in the processing industry, 60 percent in mining jobs and 15 percent in construction.

Delays to date may push back completion time to 1992, says Dana Lee of the Fluor Corporation, but the manpower figures remain the same — 40 percent of companies' personnel and plant now devoted to process engineering.

Dr. Jerry Sinor of the Pace Company Consultants and Engineers estimated that the $7 billion annual program will require 12,000 professional employees. More than one in every four professionals now in related industries will be diverted to the program over the next 15 years. According to Sinor only about 21 firms nationwide possess the capacity to undertake a program of that magnitude, but smaller firms may vie for joint-venture contracts to supplement available capability, and foreign engineering firms may also get into the act. In Sinor's view the numbers seem manageable, considering the time available to train or retrain people, but obtaining the desired management capability may not be as easy.

Alex Logwinuk, director of licensed technology for Pullman Kellogg, estimates total manhours for the program at six to 18 million per year, but said that only 10 to 12 contractors in the country could manage that volume of work. He did suggest that subletting some of the engineering work to smaller contractors could ease the pinch somewhat. However, he warned, "Should our government, for reasons of national security or balance of trade considerations, decide to double or triple this capacity by the end of this century, then we would indeed be faced with a serious engineering manpower pinch."

C.E. Lummis Associates needs 800 technical professionals almost immediately, according to spokesman Irwin Lummis. He estimates the program's impact on his contracting firm to be a 30 to 40 percent increase in staffing in the next two years. The company now employs 3000 in

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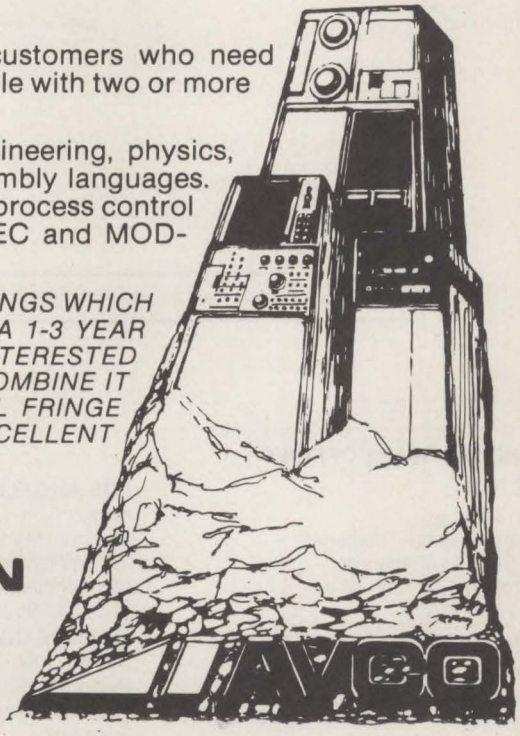

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