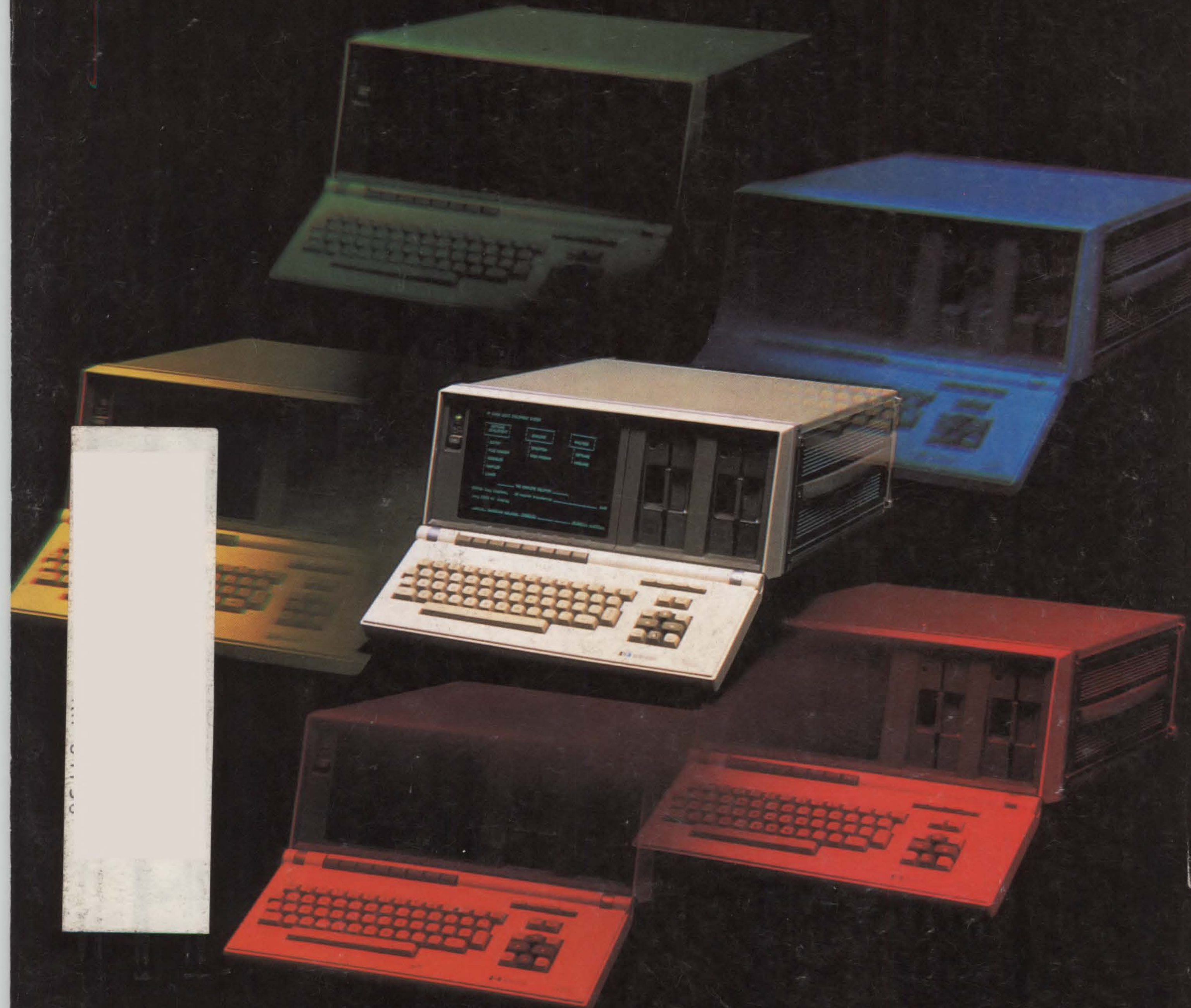
Mini-Micro Systems

A CAHNERS PUBLICATION

APRIL 1982

MINICOMPUTER SURVEY
- OEM mini roundup
- Supermini profile



Integrated system design

#1 **DATARAM M23**
See it first at NCC '82

Dataram M23

The Useable 4.0MB LSI-11®

A dramatic innovation unlocks the power of the LSI-11/23

The M23: The answer to your high-performance LSI-11/23 needs

What controllers can be used?
The key to the M23 System, Dataram's proprietary memory management Q-MAP enables you to use the full 4.0MB power of the LSI-11/23. It provides I/O mapping, which supports a wide range of existing peripheral controllers on an 18-bit bus (Q18). While still maintaining the 22-bit bus (Q22) for 4.0MB main memory addressing.

DEC® software compatibility?
The M23's Q-MAP emulates DEC's KT24 memory management, which means it operates with RSX11-M, RSX11-M PLUS, RSTS, UNIX, and all other DEC operating systems which support the KT24.

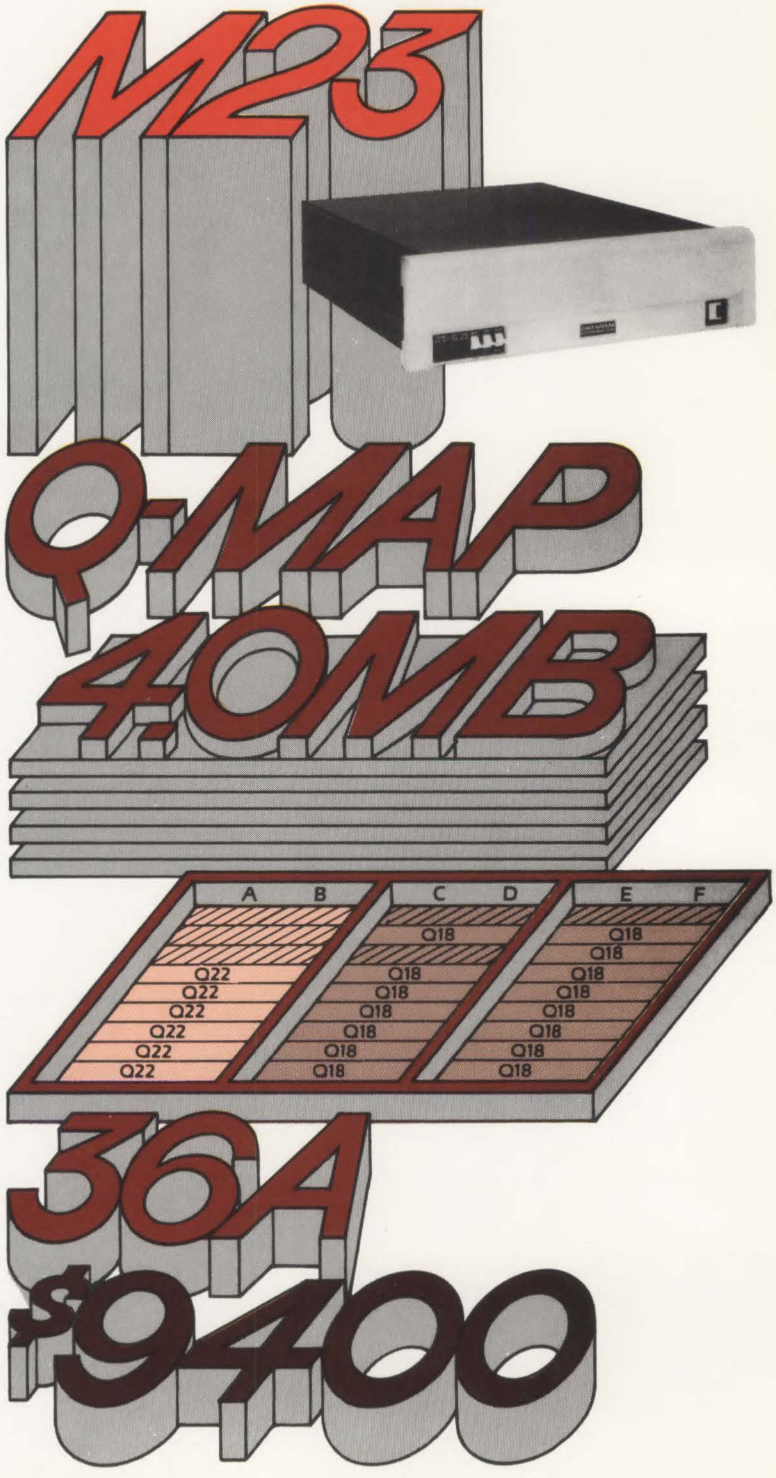
Memory?
A 1.0MB quad board is contained in the basic M23 configuration. Think of it, a full 4.0MB on only four DEC quad boards! And each additional 1.0MB is only $3400.

System configurability?
The 5¼" M23 provides an incredible 27 DEC dual slots. And since the basic configuration (LSI-11/23, OCU, two SLUs, Q-MAP, bootstrap/diagnostic PROMs, and 1.0MB memory) occupies only six of those 27 slots, that leaves you 21 slots to configure a high-performance LSI-11 system.

5.0 volt current?
36 amps.

Price?
$9400 for the basic configuration, with 1.0MB, in single quantity. Yes, only $9400...and considerably lower in OEM quantities.

More information?
Circle the reader service number below, or better yet, call Dataram now at 609-799-0071, or write to Dataram, Princeton Road, Cranbury, New Jersey 08512. Telex: 510-685-2542.



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DATARAM CORPORATION

CIRCLE NO. 1 ON INQUIRY CARD

Time to be bullish on printers.

Three hot tips. We've just cut our prices on three members of T I's proven impact printer family: The OMNI 800* Model 810 Receive-Only (RO) Printer, plus our latest Models 840 RO and Keyboard Send-Receive (KSR). By as much as 17%. That's in keeping with our tradition of reducing cost by improving technology and streamlining production. As a result, you can now get the values you've always been looking for.

A sure thing. And here's the best part: the record of reliability set by our OMNI 800 Family still stands. Integrating any one of these printers into your system is a sure investment that keeps paying off for you. Not just in profits, but equally important, in customer satisfaction.

Plus backup. Responsive service is a natural part of our offer. It gives you the support of factory-trained representatives in our nationwide service network. They're strategically located near all major metropolitan areas and make certain that your OMNI 800 printers are up and running all the time.

For more information on our Model 810, our Models 840 RO and KSR, plus our new lower prices, contact your nearest TI sales office, or write: Texas Instruments Incorporated, P.O. Box 202145, Dallas, Texas 75220. Better yet, call us now:

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TI invented the first integrated circuit, microprocessor and microcomputer.

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CIRCLE NO. 2 ON INQUIRY CARD

291261

Frazzled by the hunt for Winchester backup that's easy to use, trouble-free, economical, compact, plug compatible, which also has 100 + % capacity of 5¼″ Winchester disk drives?

Hunt no more. You just found the solution to your problem. It's the new Amlyn MiniPac Drives, offering all you've searched for, *plus dynamic on-line operation.*

amlyn

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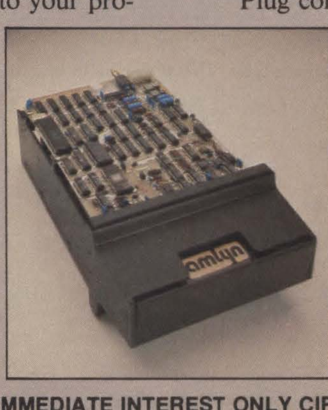


Amlyn's Model A506 and 5850 minifloppy disk drives deliver 8 MBytes of dynamic data storage in a five-diskette, removable MiniPac cartridge. And diskettes can also be removed and replaced even with the drive's power on.

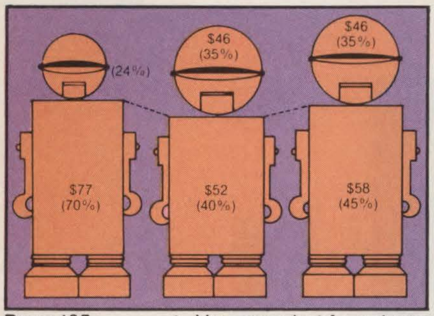
Plug compatible with 5¼″ Winchester or 8″ floppy disk drives, the Amlyn MiniPac Drives not only back up dynamically...they also can assume primary storage responsibility!

Should your Winchester drive fail, the Amlyn A506 or 5850 will still keep your business in business. They will perform all system functions. Perfectly. Not only that, the Amlyn MiniPac drives do it with versatility and reliability unmatched by other minifloppy drives.

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

FOR IMMEDIATE INTEREST ONLY CIRCLE #3
FOR INFORMATION ONLY CIRCLE #4

A new design philosophy implemented through Hewlett-Packard's HP 64000 logic-development system integrates all hardware and software elements of the design and development phases into one system (see p. 165). Cover photo by Bob Rodgers, courtesy of Hewlett-Packard.



Page 105 .... Huge market for robots

Page 117 .... Sorting out minis, micros

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Mini-Micro Systems

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FEATURES

For feature highlights, see p. 125

MINI-MICRO WORLD

INTERPRETER

DEPARTMENTS

We'll back up our disks— and anyone else's.

That's right. Ask any other supplier of peripheral products for system backup, and you'll find that some can supply a disk, some can supply a cartridge recorder, others a streaming transport. But none can supply the choice which Kennedy can offer.

Kennedy is the only company that can offer an SMD compatible, 8" 40 MByte disk drive (Model 7300) and an 80 MByte 14" Winchester disk drive (Model 5380). To back them up, Kennedy has a ¼" cartridge recorder (Model 6450), and Model 6809, ½" Data Streamer Tape Transport.

Kennedy was the first to utilize the ¼" 3M cartridge for disk backup; Kennedy was the pioneer in Winchester disk technology, and was a leader in developing a low cost streaming tape drive.

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CIRCLE NO. 178 ON INQUIRY CARD

ROBOT-CONTROLLER SUPPLIERS CHALLENGE DEC

As the robotics market expands, a battle is shaping up among CPU suppliers, each vying to make its product the most popular robot controller. While several new robot companies, including International Robomation/Intelligence and Automatix, have selected Motorola's M68000, others are reassessing their controllers, possibly to the detriment of Digital Equipment Corp. Two companies—General Electric Co. and Unimation—are deciding whether to stay with DEC's LSI-11 products or move to another vendor. A GE switch to an Intersil product wouldn't come as much of a surprise because Intersil recently was acquired by GE. A company official at Unimation, which commands about 40 percent of the $150-million robot market, confirms that the firm is deciding whether to move to the LSI-11/23 or to a CPU with multiple vendors. A decision is expected within three months. Meanwhile, Westinghouse Corp., another recent entrant in the robotics market, is readying an advanced Multibus-based control system, expected to be introduced in the first quarter of 1983.

XEROX SELLS LASER PRINTER TO COMPETITOR WANG

After suffering through many technical problems with its ill-fated intelligent Image Printer, Wang Laboratories has gone to Xerox Corp. to obtain the printing engine for its new LPS-12 Laser Printing System. The LPS-12 incorporates a Wang-developed interface designed to link the unit to Wang's OIS, Alliance and VS (with word-processing capability) systems. Producing letter-quality output at 12 pages per min., the LPS-12 has a resolution of 300 × 300 dpi and can store multiple character sets on an associated disk. Wang will sell the printer as a shared office-automation resource beginning this month, and has priced the LPS-12 at $27,995.

The surprising element in the Wang/Xerox deal is not that Wang went to Xerox to obtain the laser printers, but that Xerox was willing to sell the units to competitor Wang, says George Colony, an analyst with the Yankee Group, Boston. With Xerox's Ethernet competing in the same office-automation market as Wang's Alliance system, Colony notes that Xerox's strength "was the fact that it puts marks on paper better than anyone else in the business." By sacrificing this technological advantage, Colony says, Xerox may be showing a new corporate strategy. "Corporate is seeing the company less as an office-systems vendor and more as a super OEM, marketing printers and disk drives into the office-systems area." Xerox has no comment about the claims.

VECTOR GRAPHIC 16-BIT MACHINE DUE BY NCC

Rumors that Vector Graphic, Inc., chairman Bob Harp has left the Thousand Oaks, Calif.-based maker of small-business systems to start his own company in nearby Westlake Village are untrue, says Harp. Vector Graphic has established a subsidiary in that location, says Harp, but he declines to comment on its charter. According to one report, the seven-month-old subsidiary is manufacturing the dual-processor (68000/Z80) system Vector Graphic plans to introduce at or before the June National Computer Conference in Houston.

GRAPHICS PROCESSOR TO HAVE VAX POWER

A graphics processor said to have the power of a Digital Equipment Corp. VAX superminicomputer is in development at Ridge Computers, Sunnyvale, Calif. The company was formed in May, 1980, by a group of ex-Hewlett-Packard Co. and ex-Zilog, Inc., employees headed by Ridge president David Folger. First shipments of the system are expected by September.

PORTABLE COMPUTER USES 8085, FLAT-PANEL DISPLAY

GRiD Systems Inc., Mountain View, Calif., a start-up company with roots in Tandem Computers and Xerox's Palo Alto Research Center, this month will introduce a portable computer called Compass that is built around an 8086 CPU and an 8087 math co-processor.

The unit, which weighs 9¼ lbs. and measures only 11 × 15½ × 2 in., includes a keyboard, a display and 250K bytes of RAM and 250K bytes of bubble memory. GRiD will also sell a standard package of software that includes GRiDplan, a three-dimensional electronic spread sheet; GRiDwrite, a text editor; GRiDfile, a relational database; and GRiDplot, a graphics system that will draw bit-mapped graphics on the system's 320 × 240 electroluminescent display. Compass also runs BASIC, Pascal, FORTRAN, PL/M and C. As many as 16 peripheral devices, such as Winchester-disk drives or printers, can be linked via the unit's GPIB interface.

Additionally, GRiD plans to establish GRiD Central, through which Compass customers can send electronic-mail, TWX or Telex messages, receive software updates or maintain databases. A similar setup called Compass Central is planned for customers' in-house use. That will come via a GRiD-built 8086-based central processor sold to multiple Compass buyers. A Compass computer with operating system and BASIC will sell for $8150. The only extra cost will come from the four-package software group, which sells for $800. GRiD expects to start deliveries in September.

PLEXUS DESK-TOP UNIX SYSTEM HANDLES 8, 16 USERS

Plexus Computers, Inc., which last year introduced a Z8000-based, multi-user UNIX system, the P/40, will begin delivering its newest hardware this spring. Called the P/25 and aimed at entry-level to mid-range system users, it too is a Z8000-based UNIX machine. Unlike the 24-user P/40, however, the P/25 is a tabletop system that supports eight to 16 users. Plexus says a 1M-byte P/40 with 72M bytes of disk storage and 16 user ports is priced at $40,000. An eight-user system, with less storage capacity, sells for $27,000. Plexus also says the systems will run UNIX version 7 as well as Bell Laboratories' recently announced System III. Plexus says Systems III will eventually become its standard operating system.

TELEVIDEO WILL UNVEIL FOUR PRODUCTS AT NCC

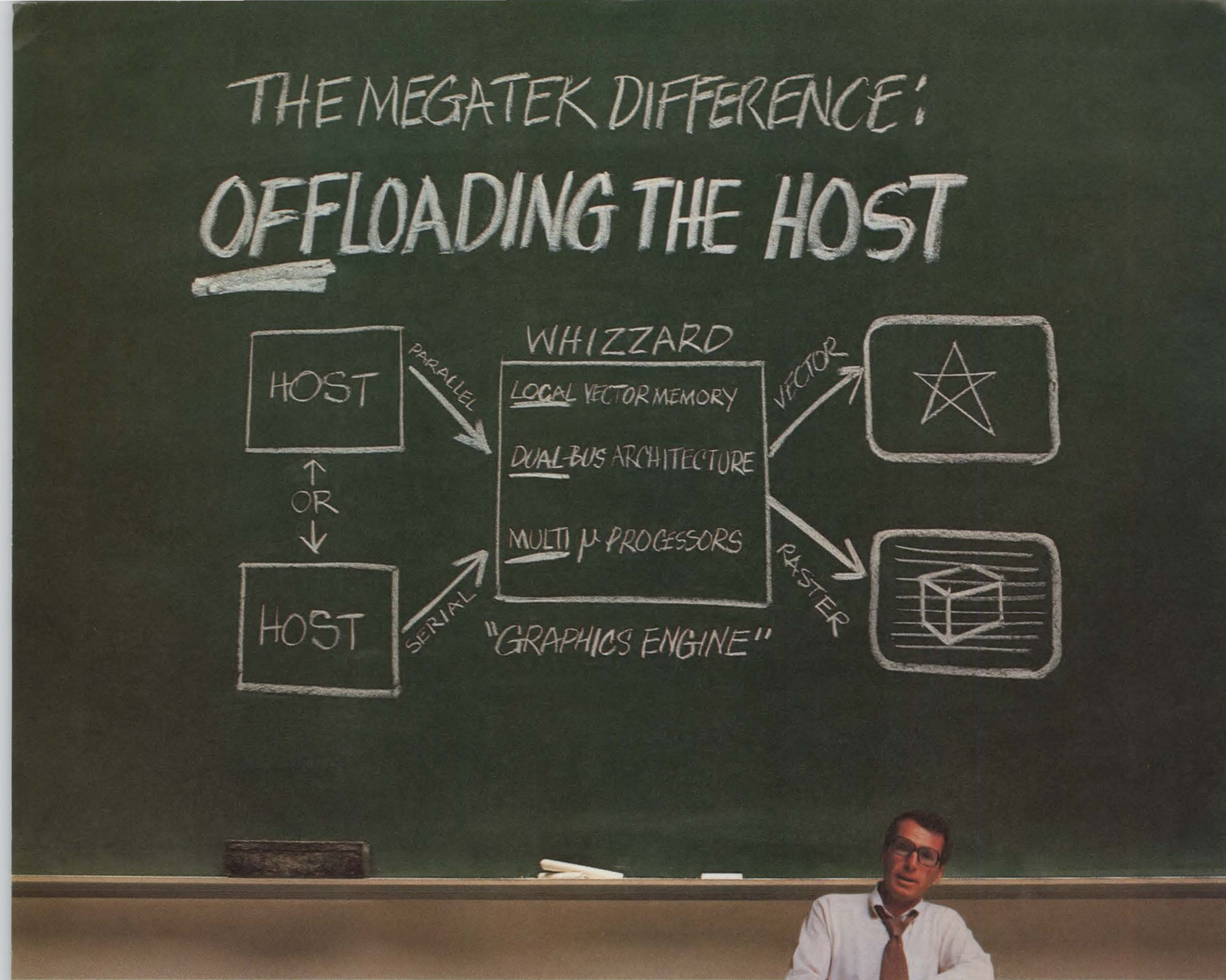
Televideo Systems, Inc., Sunnyvale, Calif., will announce four new products at the upcoming National Computer Conference, including two terminals and two storage devices. The Intelligent I smart terminal contains 64K bytes of RAM, is priced at $1695 and is targeted at local processing applications. The second terminal, the model 970, is part of the company's 950 product line, and is said to offer users expanded memory. The new TS806C and TS806H storage devices are designed for use on the company's TS806 desk-top computer system. The TS860H 5¼-in. Winchester-disk drive provides 10M bytes of storage and is priced at $3995. The TS806C cartridge-tape backup provides 17.2M bytes of storage and is priced at $3995.

SILICON OPERATING SYSTEM FOR 68000

Silicon software components (MMS, March, p. 93) are growing in number. The latest is coming this month from Software Components Group, San Jose, Calif. The pSOS-68K is a real-time, multitasking, multiprogramming operating system nucleus for Motorola's 68000 μp. The 4K-byte kernel is available on EPROM that can be plugged into the target system or on magnetic media that can be configured for a system before loading into PROM. pSOS is priced at $1000 for the first copy, and $300 for each of the next 20 copies. Source code can be purchased for $2000. The company reportedly is developing a similar device for Intel's recently announced iAPX/186 and iAPX/286.

GE READIES LAN FOR FACTORY AUTOMATION

A broadband local-area network for factory-automation equipment is due to be unveiled by General Electric Co. G-Net, developed at the company's Ordnance Systems Department in Pittsfield, Mass., recently was commercialized by Intersil Inc. (which was acquired by GE). G-Net is expected to have data rates of 1M to 5M bps and a capacity of as many as 20 data channels. It will be based on a carrier-sense multiple access/collision detection access method.



Every Megatek Whizzard™ system is a perfect "graphics guest"—allowing your host computer to concentrate on the things it does best. You get powerful, easy to use graphics without adding a burden to your expensive host CPU.

Whizzard's helping hand starts with host-computer software. Megatek's Wand, for example, enables the computer to organize display data into segments and subroutines stored in the Whizzard's own display-list memory (expandable up to 192K bytes). When a segment is extended—or its attributes altered—only the changes have to be transmitted.

Next, the interface. Either a remote-workstation data link or a parallel connection for efficient memory-to-memory transfers. Serial interfaces have their own intelligence, reducing the volume of data transfers and relieving the host from all memory-management responsibilities.

The Whizzard Graphics Engine™ takes it from there. A few simple instructions from the host, and a proprietary 32-bit processor performs translation, scaling, and display-list decoding. The display data itself is stored as 12-bit coordinates, creating a 4096^2 "virtual display space" for high-resolution stroke and real-time dynamic raster displays providing true scaling. Or you can output the data as full-resolution hardcopies directly from the Graphics Engine.

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

CIRCLE NO. 5 ON INQUIRY CARD

The more you know about graphics, the more you lean toward Megatek.

See the Megatek difference. Call or write Megatek Corporation, 3985 Sorrento Valley Blvd., San Diego, CA 92121. 714/455-5590. TWX 910-337-1270. European Headquarters, Megatek, S.A., Avenue du Tribunal Federal, 34, CH-1000 Lausanne, Switzerland, Telephone: 41/21/207055, Telex: 25037 MEGA CH.

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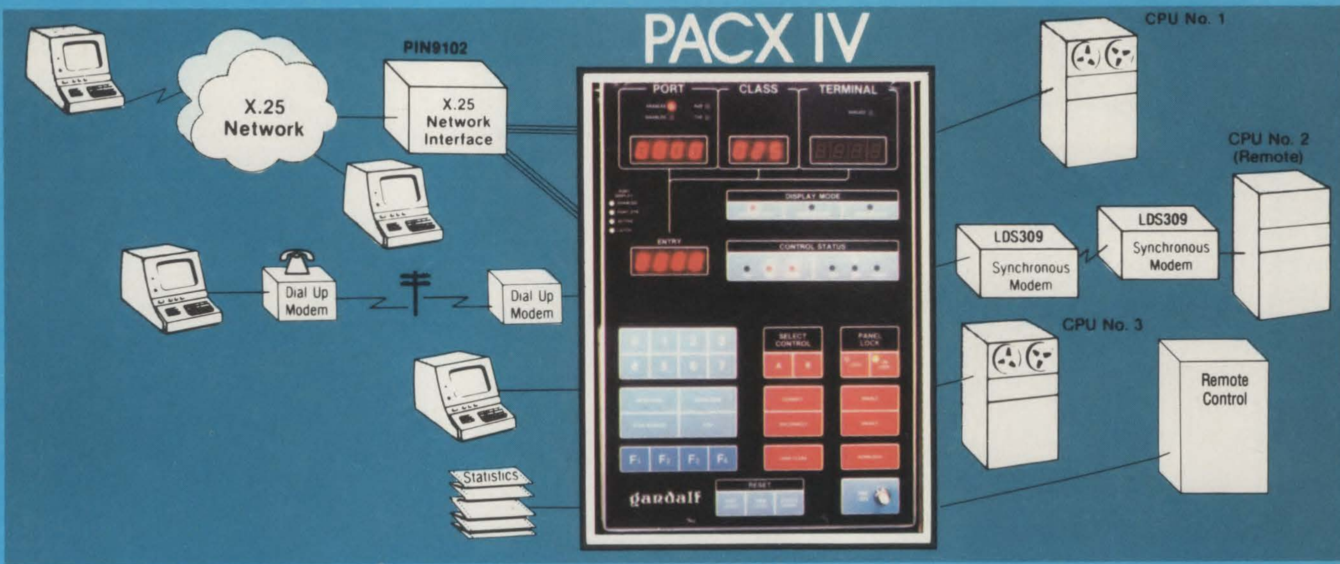
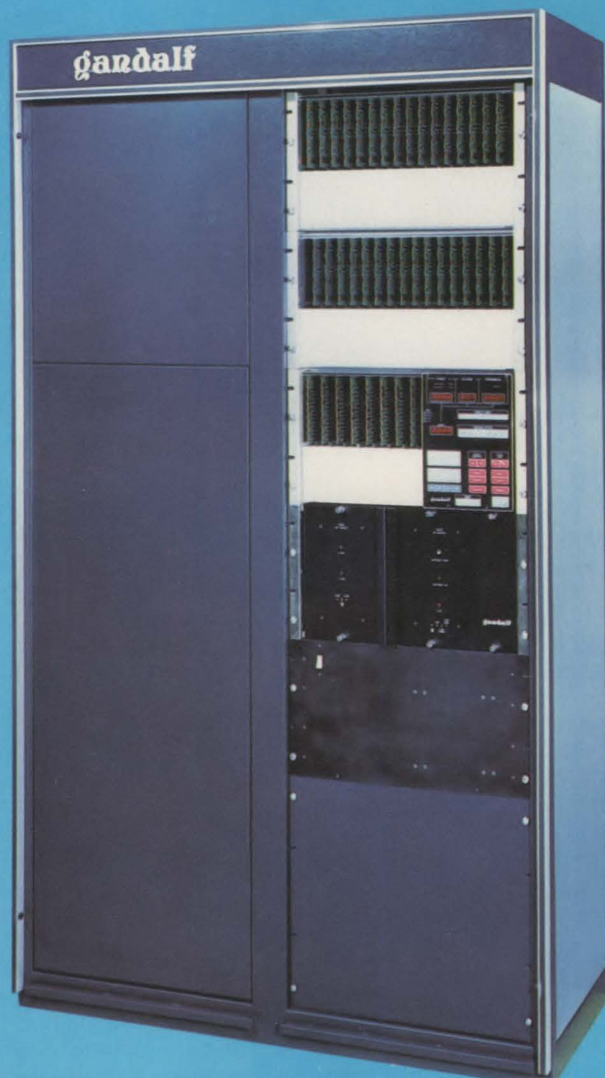


with today's PACX IV



Today multiple terminal users can switch and contend for multiple resources using Gandalf PACXs (Private Automatic Computer eXchangers). PACX IV meets your contention and switching needs **today.**

All Gandalf PACXs are compatible with each other. Easily expandable,too. Modular design allows for your needs **tomorrow.**

Gandalf's microprocessor based design yields high reliability, simplicity, and flexibility. **Over 1200 systems installed worldwide.**

Protocol and speed transparent, PACX IV allows for both asynchronous and synchronous data. Up to 9.6 Kbps asynchronous or 19.2 Kbps synchronous.

PACX IV provides maximum use and control of computer port resources—up to 128 user programmable classes.

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CIRCLE NO. 6 ON INQUIRY CARD

ADDS WILL OFFER LOW-PRICED EDITING TERMINAL

Applied Digital Data Systems, Hauppauge, N.Y., is expected to announced this month a smart terminal, which, the company claims, includes high-level editing features at a dumb-terminal price. Called the Viewpoint 60, the terminal fits in price and performance between the Viewpoint/3A Plus, selling for $650, and the Viewpoint/90, selling for less than $1100. ADDS spokespersons tout the terminal as having the same capabilities as the company's Regent/40 and /60 offerings, priced at $1300 and $1500, respectively.

AT&T ANTELOPE COMBINES PBX WITH OFFICE AUTOMATION

One of the first products reportedly due from American Telephone & Telegraph Co.'s Baby Bell subsidiary when the legal clouds clear is a combination PBX/office-automation system code named Antelope. Designed for businesses with 50 to 300 employees, Antelope is based on the 32-bit μp chip developed by Bell Laboratories. A source says the processors are available in production quantities and have been incorporated into prototype systems running the UNIX operating system. Antelope includes the use of the "getset," a unit consisting of a CRT terminal, a keyboard and a handset that combines phone and terminal functions. The source says getsets have been used for the past year internally at AT&T's corporate headquarters in New York.

FIRE FAILS TO SLOW FAST SAGE MACHINE

Despite a January fire that destroyed the firm's Reno, Nev., facilities and its only working prototypes, Sage Computer Technology reportedly is ready to ship its 68000-based system. The company says its initial commercial offering is the first computer to run Softech's UCSD Pascal operating system for the 68000 μp, and claims a combination of fast memory and a proprietary bus structure allows the computer to run at the 68000's 8-MHz clock speed without wait states. Housed in a box measuring 5 × 12 × 8 in., a basic configuration is priced at $3600 in single-unit quantities. It includes a 5¼-in., 48-tpi Tandon floppy-disk drive and 128K bytes of 150-nsec. main memory. A 512K-byte version with on-line storage of 1.3M bytes in two double-sided, double-density, 5¼-in. floppy-disk drives retails for $6000. A Winchester-based version of the system is due in July.

INTERTEL STRENGTHENS NETWORK-MANAGEMENT OFFERINGS

Late last month, Intertel, Inc., Andover, Mass., added a performance-management application package to its Series 90 line. Designed to help network managers anticipate and identify performance problems, the 90/15 system also serves as a database, storing performance information on a long-term basis. Operating with Intertel's 90/10 network-control system, the 90/15 gives network managers access to real-time performance parameters, as well as information on network line performance and usage statistics. Users can recall stored performance data at the touch of a button. The 90/15 package, slated for delivery this fall, is the first addition to Intertel's Series 90 network systems, announced last September.

RODIME DRIVE BELIEVED TO HAVE HIGHEST CAPACITY TO DATE

The latest claimed top-capacity 5¼-in. Winchester-disk drive was revealed late last month by Glenrothes, Scotland-based Rodime Ltd. The RO 200 series has about 27M bytes of unformatted and 21M bytes of formatted storage on four platters. The capacity boost is the result of doubling the track density of existing RO 100 series drives, which have 16M bytes of unformatted storage on four platters. The new drives use a different read-write head than their predecessors, so existing products cannot be upgraded. The company declines comment on the new head, but does say it uses thin-film technology. Like the RO 100 series, the new family has four models, which add platters to obtain a top-of-the-line model RO 204 with four platters. Rodime markets in the U.S. through an El Toro, Calif., office. Evaluation quantities will be released to U.S. customers in May, with volume shipments scheduled in July.

DIGITAL'S VAX-11/730 WILL BOW AT HANOVER FAIR

Digital Equipment Corp. is expected to announce aggressive OEM discounts for the VAX-11/730, which will be introduced at the Hanover Fair April 21–28 in Germany. The third member of the VAX line (MMS, September, 1981, p. 5) is expected to carry a price tag between $28,000 and $30,000 for single units of the board-level product. The 730 reportedly employs bit-slice μp technology and has 1M byte of main memory. OEM discounts are expected to bring the price of the board-level version below $20,000, while a larger system-level version that includes 120M bytes of disk storage will probably sell for $50,000 to $55,000.

RANDOM DISK FILES

Prototypes of a high-capacity, high-performance, half-high, 5¼-in. floppy-disk drive could be available within 60 days from Orange County, Calif., start-up **Half-High Technology**. The 1M-byte, double-sided drive reportedly will operate at track densities of 96 tpi and track-to-track access times of 3 msec. using a linear positioner. A 2M-byte, 192-tpi version is also expected. Pricing for the 1M-byte drive will compete with standard 5¼-in. hardware.

International Business Machines Corp. reportedly has resurrected its high-capacity Bernoulli-technology floppy-disk drive program and is building 5¼-in. hardware at its Hursley, England, facility. Bernoulli drives use flexible media rotating at high speeds for longitudinal stabilization, and are designed to offer significantly higher bit densities compared to conventional floppy-disk drives. IBM's efforts will incorporate many of the same specifications as those defined for its Tucson, Ariz.-based "Sprat" program, which was canceled two years ago, says one source.

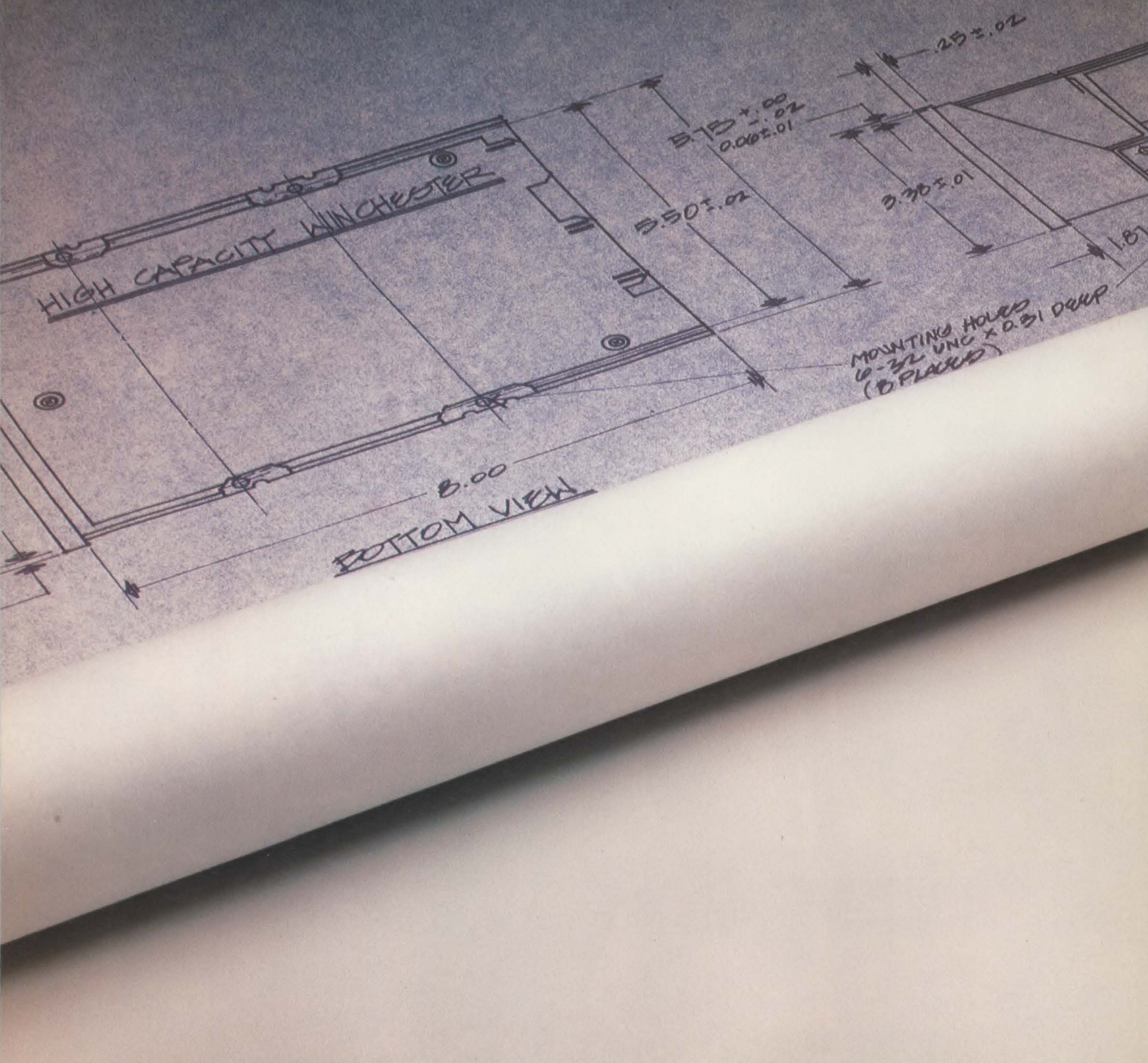
First hardware from San Jose, Calif., start-up **Censtor Corp.** may appear during the third quarter of this year in the form of a line of thin-film read/write heads for OEM disk drives. The new company is headed by Tim Martin, former director of engineering at **ISS/Univac**, and has received its first round of venture financing. Meanwhile, **CalMag** founder Jim Money has shut down operations at his Milpitas, Calif., thin-film head start-up in the wake of difficulties obtaining venture capital. The venture-capital community's lukewarm response to CalMag was the result of a number of factors, says one source close to the company, one of which was the decision by **Seagate Technology** to cancel its 12M-byte ST-512 thin-film, 5¼-in. Winchester.

Ampex Corp., Redwood City, Calif., will broaden its licensing agreement with **Rodime, Ltd.**, Glenrothes, Scotland (MMS, October, 1981, p. 9), and introduce four additions to its Pixis line of stepper-motor technology, 5¼-in. Winchesters at the June's National Computer Conference in Houston. Ampex reportedly plans a high-end, four-platter drive offering capacities in the 27M-byte range and a low-end, single-platter drive. The hardware may be available in evaluation quantities this quarter. Pricing information is not available. Rodime will market the product in the U.S. as well.

What would be the first implementation of the SASI interface may also show up at NCC. Planned for introduction in Houston is the D145, an intelligent, 12M-byte fixed/12M-byte removable, 10½-in. intelligent Winchester subsystem from Palo Alto, Calif.-based **Cynthia Peripheral Corp.** The D145 automatically handles file backup and alternate track assignment. Pricing has not been finalized; evaluation versions are due next quarter.

First hardware from **I Q Systems Corp.**, Brea, Calif., is a 5M- to 28M-byte (formatted), one-to four-drive, turnkey 5¼-in. Winchester system called graymatter. The subsystem will be shipped to dealers and OEMs starting this month. The new venture is headed by industry veteran Wes Theriault, former marketing vice president and co-founder of **Archive, Inc.** The company plans to sell its Seagate-based hardware through dealers supporting the Apple II. Plans reportedly call for expanding the graymatter line to include IBM's personal computer and Xerox's 820 personal computers in the future. Single-unit price is said to be less than $3000.

UNFOR COMPETITION'S ARE ONLY AVAIL



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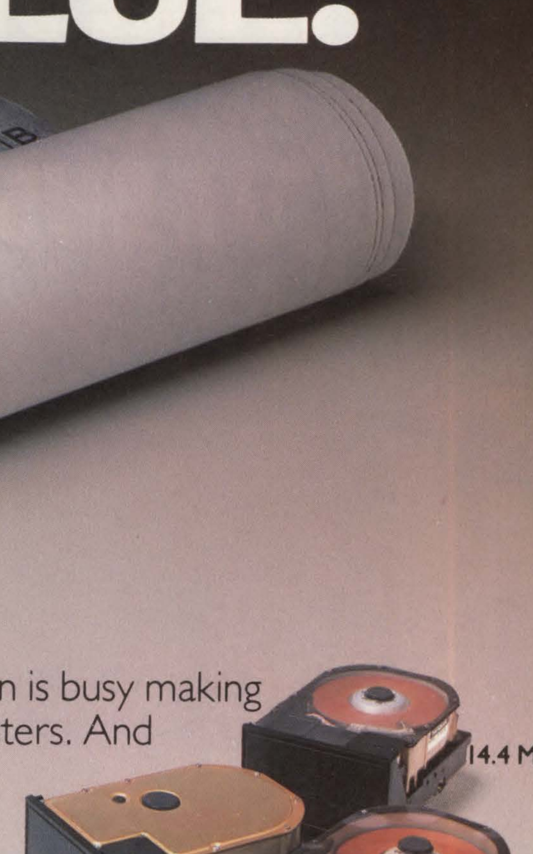
TUNATELY, OUR WINCHESTERS ABLE IN BLUE.

While virtually all of our competition is busy making promises, we're busy making Winchesters. And delivering them. By the thousands.



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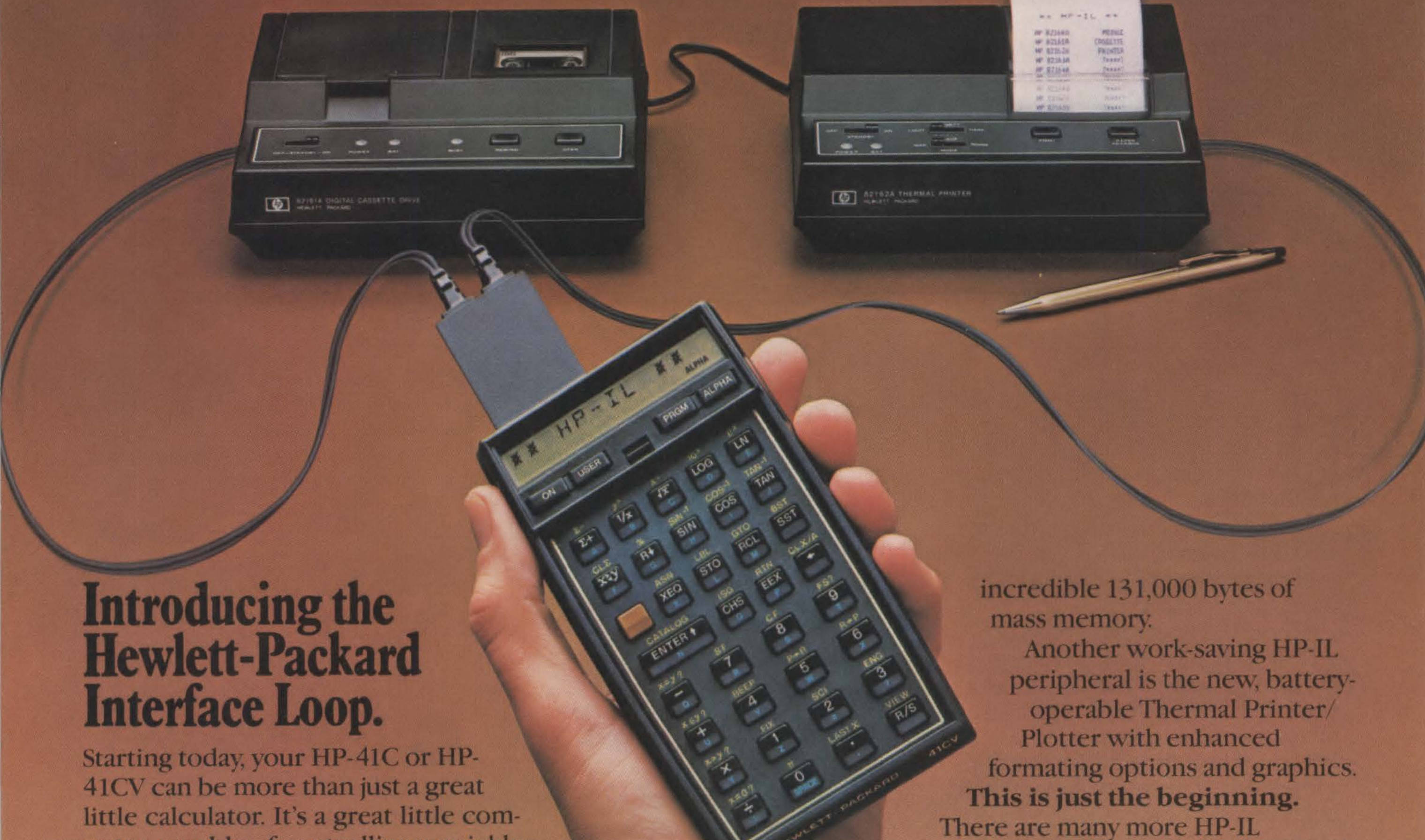

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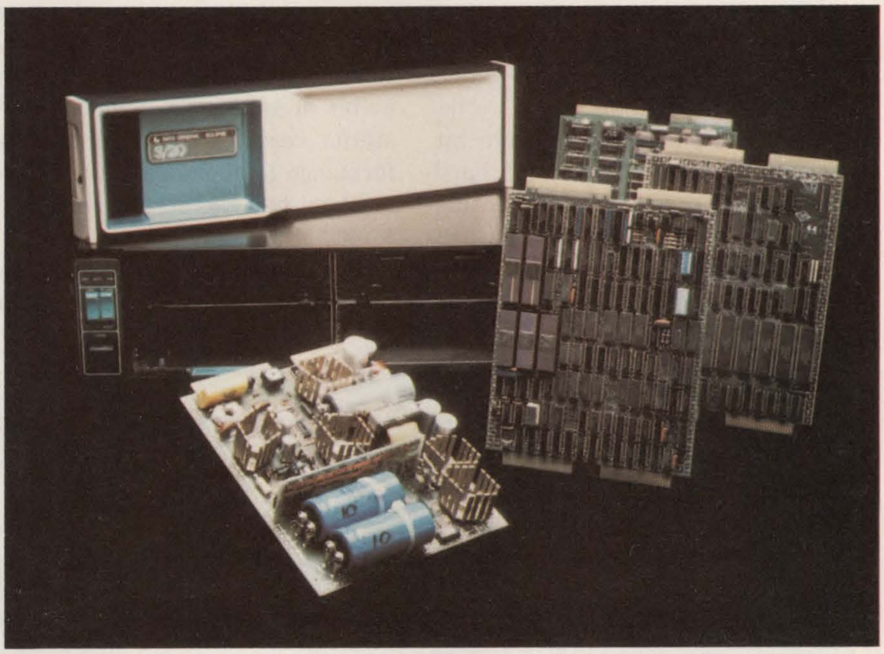
DG's 16-bit Eclipse chip surfaces in technical μcs

A 16-bit μp said to have the function of a 16-bit Eclipse minicomputer forms the core of two new computers introduced in mid-March by Data General Corp.'s technical products division, Westboro, Mass. To the company's OEMs, the μcs are intended to reinforce DG's position in the 16-bit market. They are also intended to emphasize the strong compatibility of DG product lines.

The new systems—the S/20 and the S/120—are based on the microEclipse chip set introduced two years ago (see "microEclipse chip performs high-end functions," p. 18). Each system's board dimensions differ so that the new level of function is physically compatible with a variety of DG products. The S/20 measures 7 × 9 in., and the S/120 measures 15 sq. in.



DG's S/20 μc mounted in a 19-in.-wide rack *consists of five 7- × 9-in. boards—one CPU and four 128K-byte memory boards.*

Compatibility is key to DG's strategy. "We can take an S/120 (board) and plug it into the MV/8000 supermini," says Donald McDougall, director of marketing for TPD. He acknowledges that major competitor Digital Equipment Corp. has a broader configurability range because the microEclipse is

Comparing DG's scientific Eclipse computers

	S/20	S/120	S/130	S/140	S/250
Instructions					
FIS	standard	standard	optional	optional	standard
CIS	standard	standard	optional	optional	optional
MOS memory					
Minimum (K bytes)	128	128	64	128	128
Maximum (K bytes)	512	512	1024	1024	2048
Protection	parity	ERCC	ERCC	ERCC	ERCC
Hardware/floating-point unit	optional	no	no	optional	optional
I/O bus	micro	N/ECL	N/ECL	N/ECL	N/ECL
Input (M bytes per sec.)	0.3	2.0	2.5	2.0	2.5
Output (M bytes per sec.)	0.3	1.3	1.4	1.4	1.4
Board size (in.)	7×9	15×15	15×15	15×15	15×15
Operating system					
RDOS	yes	yes	yes	yes	yes
MP/AOS	yes	yes	yes	yes	yes
AOS	no	no	yes	yes	yes

not available as a stand-alone product. McDougall places the S/120 in competition with DEC's LSI-11/24 and /34 products, and the S/20 with the LSI-11/23.

Both the S/20 and S/120 can be configured with as much as 512K bytes of main memory. Each uses Eclipse architecture and is object program compatible with other Eclipse computers. Both have bit, byte and word addressing; hardware stack; and firmware floating-point instructions. Other features include a real-time clock, a programmable interval timer and asynchronous interfaces.

The S/20 consists of five boards—one CPU and four 128K-byte memory boards. The system uses byte parity and 16K RAMs. It has a standard DG general I/O bus that is compatible with microNova R peripherals.

A hardware floating-point board that handles 56 single- and double-word instructions and has four 64-bit accumulators and one 32-bit status register are optional. Performance is about 250 Whetstones, or about half the performance of the S/140, McDougall says.

The S/120 μc is housed on a single board that is available in 128K-, 256K- or 512K-byte versions. It uses 64K-bit dynamic RAMs from multiple sources, and has ERCC memory. The S/120 has a Nova R/Eclipse I/O bus.

The products' Eclipse instruction set includes the Nova instructions, so that Eclipse functions are spread through the product line into the Nova class. The S/20, for example, is similar in price and performance to the MP200, a two-board system with Nova architecture, McDougall explains. DG will direct sales toward the S/20, but will continue to support the MP200. Similarly, the S/120 fits with the S/140, he notes. The S/20 and S/120 processors have about 70 percent the performance of

MICROECLIPSE CHIP PERFORMS HIGH-END FUNCTIONS

The 16-bit microEclipse chip, which was first presented in a paper at the International Solid State Circuits Conference two years ago, brings the function of the 16-bit Eclipse minicomputer to low-end Data General Corp. μc products. Although not yet released separately, the microEclipse is the basis of DG's two new μc systems, the S/20 and S/120 (see "DG's 16-bit Eclipse chip surfaces in technical μcs," p. 17).

The CPU is grouped in a chip set with a system I/O and several external microcontroller (XMC) parts. It is fabricated using high-density silicon gate MOS technology at DG's Sunnyvale, Calif., semiconductor facility.

"The set has a lot of smarts," says Jan Pieter Scheerder, manager of hardware planning and support at DG's technical products division, Westboro, Mass. He explains that the XMCS are not just ROMS, but that they prefetch many instructions. The CPU is loaded with microcode before execution. Instructions are loaded from memory, so that the microcode does not slow the system's performance.

Instruction prefetching, combined with parallel internal data paths, allows multiple operations to be performed in one cycle. The S/120 system, for example, executes a register-to-register addition in 500 nsec. by simultaneously adding register contents and fetching the next instruction.

The CPU chip contains four 16-bit-wide internal data buses. Data can be

Configurability Chart

Nova/Eclipse bus S/120	
Disks	12.5M-, 25M-, 73M-, 140M-byte Winchester disks 50M-, 96M-, 190M-, 277M-byte disk-pack drives 1.2M-byte floppy-disk drives 10M-, 20M-byte cartridge drives
Tapes	½-in. streaming tape
Terminals	Dasher video terminals G300 graphics terminal Dasher terminal printers
Printers	60- to 180-cps dot matrix 300-, 600-lpm band
Communications	single- and multi-line asynchronous (to 19.2K bps) single- and multi-line character-synchronous and bit-synchronous IBM 2780, 3780, HASP, 3270, X.25 communication protocols depending on operating system
Sensor I/O	DG/DAC sensor chassis A/D, D/A and digital I/O sensor cards
μbus S/20	
Disks	12.5M-, 25M-byte Winchester disks with and without integral 1.2M-byte floppy-disk drives 10M-, 20M-byte cartridge disks 0.5M-byte floppy-disk drives
Tapes	½-in. streaming tape
Terminal	Dasher video terminals G300 graphics terminal Dasher terminal printers
Printers	60- to 180-cps dot matrix 300-lpm band
Communications	single- and multi-line asynchronous (to 19.2K bps) single- and multi-line character synchronous 2780, 3780, HASP, 3270, X.25 communication protocols depending on operating system
Sensor I/O	DG/DAC sensor chassis A/D, D/A and digital I/O cards

The microEclipse chip set, *the basis of the S/20 and S/120 μc systems, consists of a CPU, a system I/O chip and several external microcontroller parts that extend the implementation of Eclipse microprograms and the Eclipse instruction set. The external microcontroller parts communicate with the CPU via an 8-bit microcode transfer bus.*

the S/140.

A typical S/20, including 256K bytes of memory, a 25M-byte Winchester-disk drive, a 0.5M-byte, 8-in. floppy-disk drive backup, the MP/AOS operating system, a band printer, synchronous communications and hardware floating point, is expected to sell for about $35,000.

An S/120, including 512K bytes of memory, a 73M-byte Winchester-disk drive, MP/AOS operating system, a streaming magnetic tape, a 300-lpm band printer, a synchronous interface, ERCC memory and firmware floating-point functions, sells for about $60,000. The products are available now, and delivery time is 90 days after receipt of order. Terminals for both systems are priced at $1500 to $2000 each.

DG introduced two software products with the systems: the MP/AOS operating system and SP Pascal. The higher performance SP Pascal version is true compiled Pascal rather than p-code or interpreted Pascal, the company claims. MP/AOS is a superset of MP/OS, which is used on the MP100 and MP200 products, says Delmer E. Hunter, manager of the operating systems group at DG's TPD. Of the 16-bit μc real-time operating system, Hunter says, "More complex applications are easier to maintain, and there are multiple partitions to segment code."

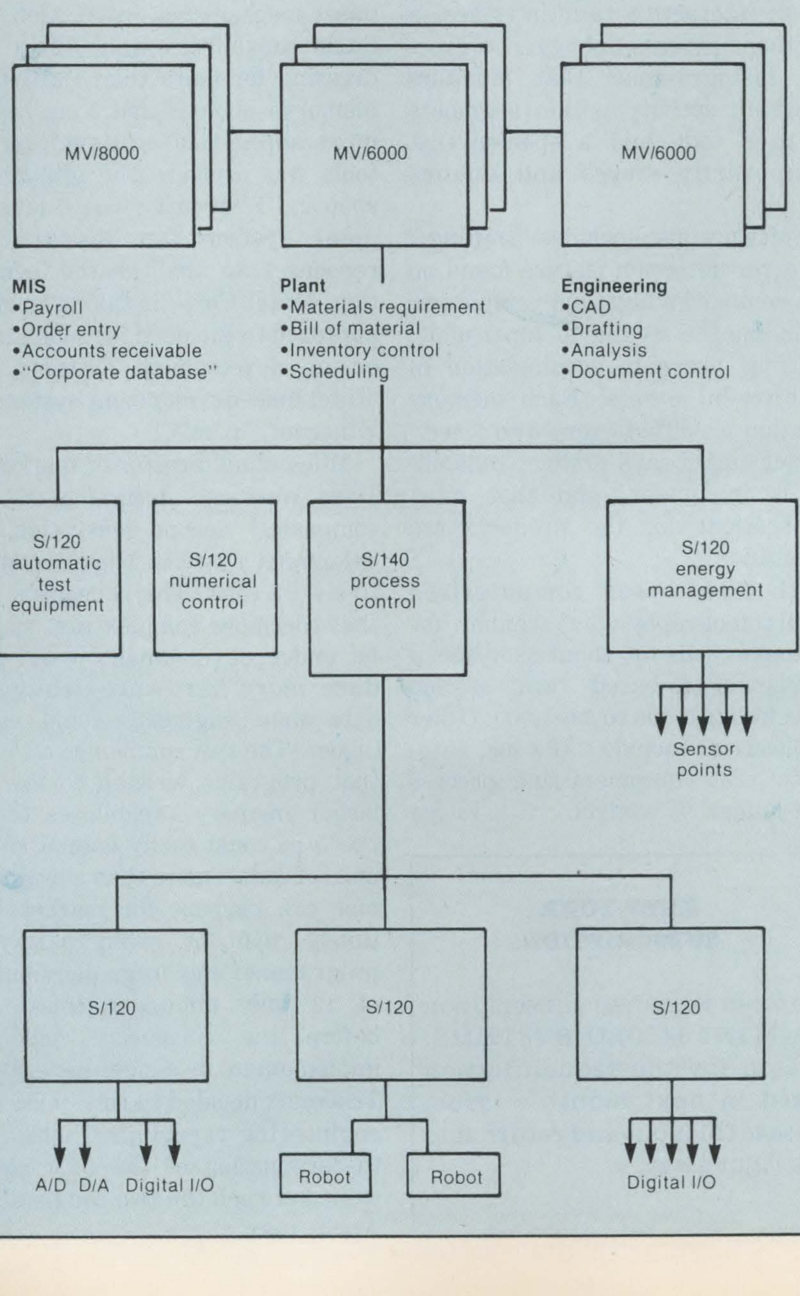
Hunter explains that MP/OS is a single-process, multitasking operating system. MP/AOS is both a multitasking and multifunction operating system that supports as many as 16 64K-byte address segments and as many as 256

concurrently written, read and transferred to internal components. In addition to four program-accessible accumulators and an instruction pipeline, the CPU register file contains four temporary registers that perform increment, decrement, shift right and shift left, independently of an arithmetic and logic unit.

Microprograms, generated from 35-bit horizontal and 18-bit vertical microinstructions, control CPU operations and Eclipse instruction-set implementation. Basic Eclipse microprograms and the kernel of the Eclipse instruction set are implemented by 64 horizontal and 288 vertical microinstructions on the CPU chip.

The Eclipse implementation can be extended further by three high-speed XMC firmware chips, each of which contains 1024 vertical microinstructions. XMC-to-CPU communication is via a dedicated, two-phase time-multiplexed 8-bit microcode transfer bus. External microcode can be executed quickly if the vertical microinstructions are presented to the CPU as narrow 16-bit words before they are modified into horizontal microinstructions.

The chip set can address bits, bytes, words, floating-point numbers, blocks and character strings. Memory cycle time is 500 nsec. Maximum I/O rate is 300K bytes per sec. for the S/20 system. For the S/120 system, maximum input rate is 2M bytes per sec., and maximum output rate is 1.3M bytes per sec.



concurrent tasks in some configurations. The S/20 and S/120 can also use RDOS, thus attracting thousands of RDOS users to the new products.

MP/OS is a true subset of MP/AOS; thus, MP/OS programs can be developed under the new operating system. MP/AOS packages can be developed under the 16-bit AOS operating system via cross-development utility packages.

MP/AOS supports SP Pascal, MP Pascal, MP FORTRAN IV, and MP BASIC. MP/AOS program-development tools and utilities include a command-line interpreter that acts as an interactive user interface, a symbolic process debugger, a process histogrammer that monitors program activity within segments of user code and a spooler that temporarily stores and queues output.

Software also includes "sniffing," an error-detection feature found on the company's high-end computers, including the MV line of superminis. Sniffing prevents accumulation of multiple-bit errors. Each memory location is sniffed every 4 to 5 sec.

McDougall says product reliability is important, and that most applications for the products are scientific.

An S/140-based computerized axial tomography (CAT) scanner, for example, sells for about $500,000; a similar S/140-based OEM system sells for $200,000 to $300,000. Other applications include CAD/CAM, automatic test equipment and process and numerical control. —*L. Valigra*

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Millennium has own approach to μc development systems

Cupertino, Calif.-based Millennium Systems Inc. introduced a universal μc development system with in-circuit emulation (ICE) in 1977, and Tektronix Corp., Beaverton, Ore., became a leader in that field by selling the system on an OEM basis as the 8002A. But the proliferation of 16-bit μps—with sophisticated interrupt handling, multiprocessor-oriented bus-request mechanisms, instruction prefetch capabilities and direct addressing for more than 1M byte of memory—showed that a market for more sophisticated development tools was arising. The Millennium 9500 and Tektronix 8500 μc development system families are the responses to that shared perception. [Intel Corp. is taking another approach to the need for sophisticated μc development systems (see "Intel links development system via Ethernet," p. 22).]

Millennium director of marketing Dave West says designing the two companies' second-generation development systems began cooperatively in 1978. The consensus was that the more complex μcs soon to be under development would produce more hardware-debugging data than engineers could easily digest. The two companies also saw that programs written to use the larger memory capabilities of the new μps could easily exceed 10,000 lines of code—more than a programmer can prepare for market in a timely manner given a typical programmer's average daily output of 12 fully debugged lines. But before the consensus could be implemented in a new generation, Tektronix decided to rely on its own engineering capabilities, which led to termination of the OEM agreement between the two companies in April, 1981.

The two companies' second-generation μc development system families are outwardly similar. Both offer stand-alone, floppy-disk-based software-development systems (the Millennium two-user 9520 and the Tektronix single-user 8550) and stand-alone systems with ICE that allow hardware debugging to be transferred in stages from the emulation processor and memory to the actual prototype. In addition, Tektronix has introduced and Millennium has plans for a hard-disk based, multi-user software-development system with a UNIX-like operating system (the Millennium 9580 and the Tektronix 8560). Both families address single-user, multi-user and host μc design environments, while allowing migration and high-speed communication within the family.

Comparing the two companies' capabilities in hardware-debugging tools and ICE, West points to the Millennium 9516's menu-driven "advanced human interface," less expensive approach to multiprocessor emulation and new dual-bus architecture that he claims puts the 9516 "an order of magnitude and a generation ahead of the competition."

The backbone of the advanced human interface is a menu tree that guides the user through the most likely sequence of desired tasks (see diagram), with soft keys to set up debugging operations. An on-line manual helps inexperienced users, while system commands are directly accessible for experienced users. West says the interface was designed to simplify the task of handling the factor-of-five data increase that occurs when debugging a multiprocessor 16-bit system as compared to a single 8-bit processor system.

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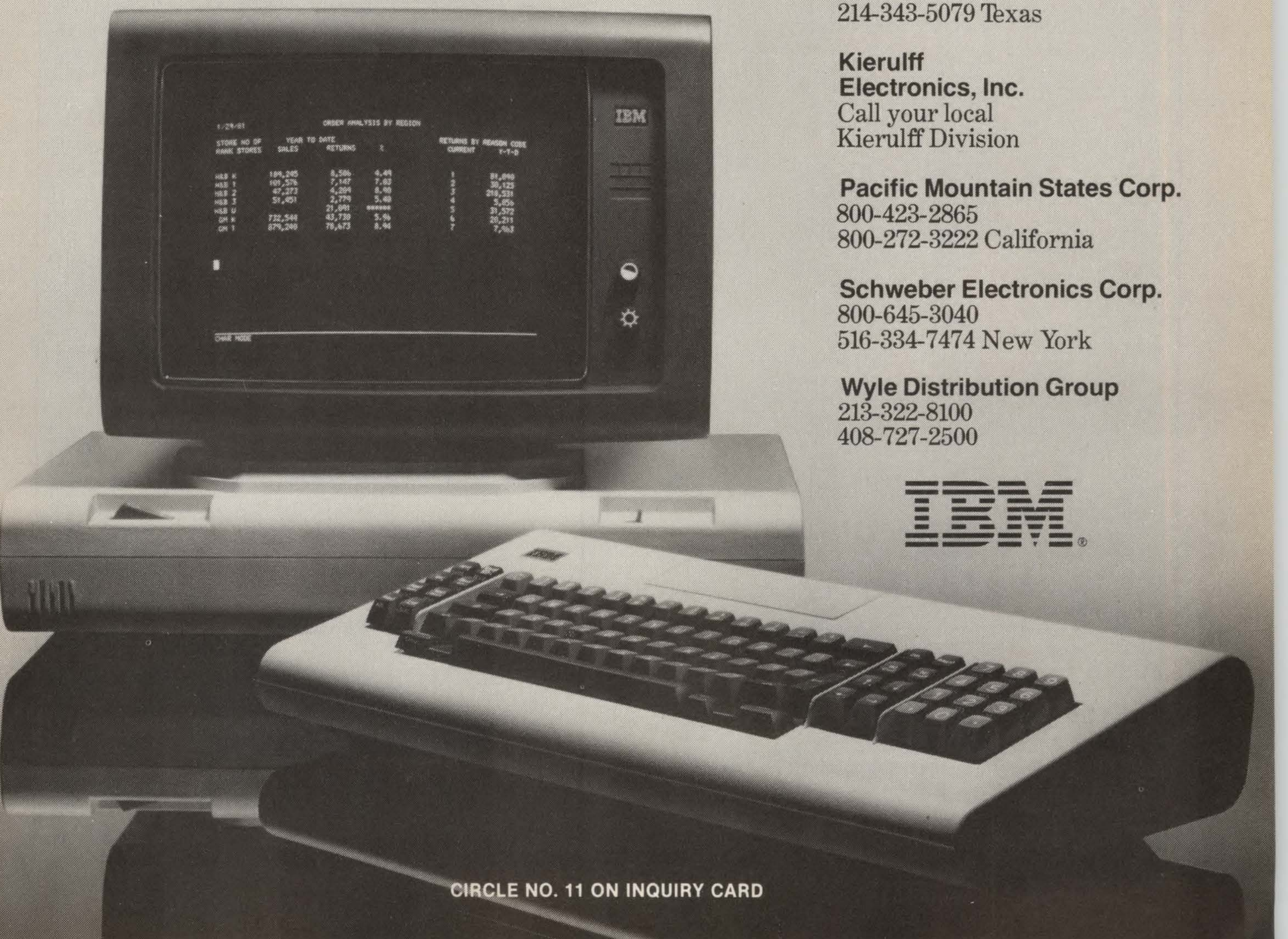


CIRCLE NO. 11 ON INQUIRY CARD

INTEL LINKS DEVELOPMENT SYSTEMS VIA ETHERNET

Tal Hurant thinks it's time users stopped employing the "Adidas Approach" with their µp development systems. With this approach, says Hurant, marketing director for Intel Corp.'s Development System Operation, programmers run from station to station to accomplish necessary development tasks because no stand-alone system is powerful enough to efficiently handle the complex software inherent in many µp applications.

To solve this development-system power limitation and to accommodate the logistics of development teams, which commonly include several people, Intel decided to practice what it preaches about networks. The Santa Clara, Calif., company has announced its first Ethernet-based system, the NDS-II, which ties Intel's Intellec series of development systems into an integrated network.

Aside from a unit called the network resource manager (NRM), the development network uses products already marketed by Intel. Any Intellec models, from the MDS-800 to the Series-III, can serve as work-station nodes on the networks. To interface the Intellec units to the 10M-bps Ethernet network, Intel's two-board, Multibus-compatible communications controller is inserted into the chassis slots normally used for stand-alone disk-controller boards. The development systems can then communicate through transceivers onto an Ethernet coaxial cable or can link directly to the NRM through an "Intellink" cluster controller.

Along with the Intellink controller, the NRM station contains 13 Multibus slots, a power supply, an 8086 µp board, 8088 and 8089 I/O processor boards, a 512-byte memory board, the Ethernet communications controller board set and one 5¼-in. flexible-disk drive. Attached to the NRM cabinet is a unit housing a 35M-byte, 8-in. Winchester disk. Additional Winchester storage will soon be available for the system, as will a cartridge-tape unit that will fit within the NRM and provide archival and backup storage for the hard disks.

Functioning as a network file server, the NRM station runs under a new Intel operating system called INDEX. INDEX replaces the ISIS operating system, which runs on stand-alone Intellec systems. The new operating system provides a distributed hierarchical file structure that is managed on all the network nodes. Actual file locations are transparent to users, who must know only the file names and their contents.

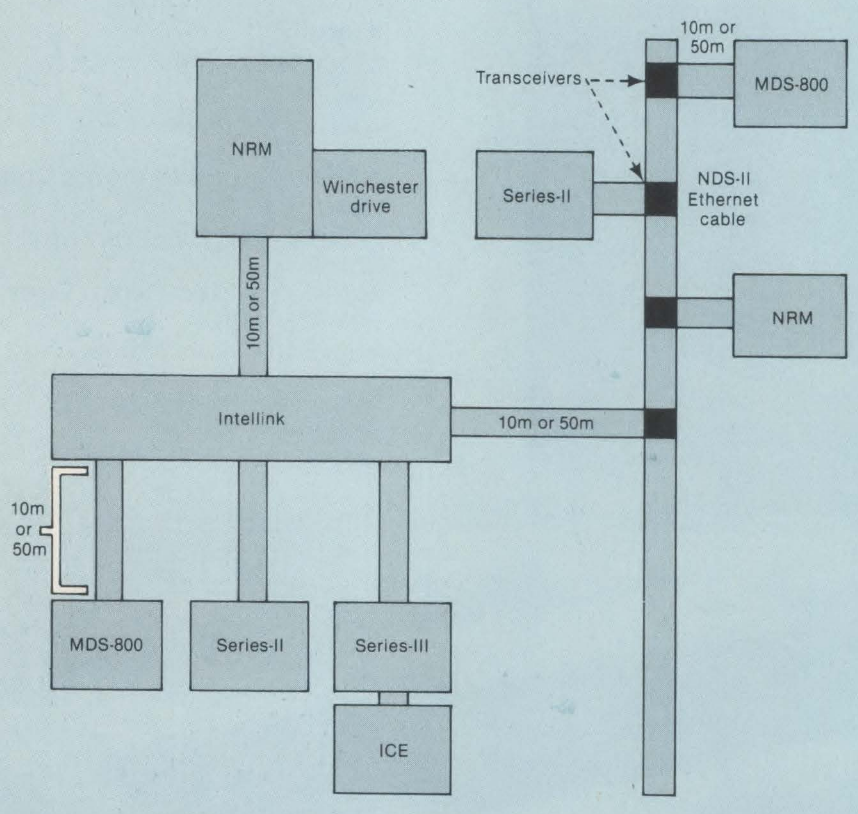
INDEX also provides distributed job control, maintaining queues of activity for each node and managing task routing. A user can export one task onto the network for automatic routing to any available node that can handle it, so that he can work on another task at his station. Because INDEX is essentially a superset of the stand-alone ISIS system, code developed under ISIS runs without modification on the networked NDS-II.

Given the INDEX capabilities and the shared access to large quantities of disk storage, Hurant believes development-system users can substantially cut their products' time getting to market. And he says the network's reliance on the centralized NRM doesn't compromise a key Ethernet benefit—distributed intelligence throughout the network.

Hurant admits that if the NRM node goes down, the network might lose jobs in queue. But because each station contains a resident version of the operating system in RAM, the nodes can continue to operate in a stand-alone fashion if the NRM fails. And, Hurant says, throughput is not strongly diminished by moving into networked configurations.

Hurant says any users operating three or more stand-alone development systems could cost-effectively move to an NDS-II networking environment. The basic NRM station sells for $39,950, and each Intellec node falls in the $20,000 range.

—Dwight B. Davis



As many as eight Intellec development systems *can connect directly to a NRM through an Intellink cluster controller. Alternatively, network nodes can connect through transceivers to an Ethernet cable, which can link any combination of Intellec systems, individual NRM stations or clustered NRM configurations.*

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CIRCLE NO. 13 ON INQUIRY CARD

Mark Astengo, vice president of marketing for Advanced Digital Technology, a Bellevue, Wash.-based commpany that also makes an emulation system (MMS, September, 1981, p. 35), agrees that the menu-driven approach is the wave of the future, but points to the 9516's multi-ICE capability as also being state of the art. The 9516's common control bus with global event lines allows it to emulate a system incorporating two interacting µps (or as many as four with a 12-slot expansion box) at their full 256K bytes of memory each.

"With multiple processor systems, some of the problems are just unreal," says Astengo. "Without multiple emulation, it would take forever to find them, especially the ones caused by timing conflicts."

The Tektronix 8540 also allows tying together as many as eight processors, but one 8540 is required per µp, an expensive proposition, admits Tektronix marketing manager for µc development systems Bob Hunter. He disagrees, however, with Millennium's claim that its advanced human interface is unmatched. Tektronix offers the same capabilities via the UNIX-like TNIX operating system that is part of the LSI-11/23-based 8560 multi-user system. Hunter says a user can set up a menu-driven TNIX shell that is superior to the Millennium interface because it can be tailored to a user's needs. But there is a catch—TNIX needs a more-than-$27,500 bare-bones 8560, and some complex software must be developed.

With the increasing size of µc programs, programming teams are becoming the rule, and the key to the 8560's team orientation is its TNIX operating system. Tektronix uses a menu-driven shell to simplify system operations for a programmer not experienced on the 8560, although TNIX system commands are directly available if a programmer does not need menu prompting. This TNIX, C-based approach is similar to Millennium's C-based human interface for hardware debugging on the 9516. For a programmer with a frequently repeated task sequence, TNIX pipelining allows multiple commands to be coded into macros.

TNIX also provides a hierarchical filing system, which enables a programmer to restrict access to a program module that isn't ready to run, share it with team members who need it to proceed with their work when it's up but not running flawlessly and share it with the entire team when it's finished.

The 8560 also features a utility program called MAKE, which controls creation of programs having many modules to assure the end program is correctly made from the current version of each module. MAKE documents the interdependency of modules and prevents difficult-to-find bugs that could result if a user forgets to reassemble a routine that depended on a modified module.

Software consultant Carol Anne Ogdin lauds the choice of a UNIX-like operating system, calling UNIX the most sophisticated tool kit programmers have. Ogdin also likes the electronic-mail capability that is part of the Tektronix system. She says it can be used to capture all decisions made throughout the design process. "Eventually, someone can take that journal of transactions and easily edit it into usable documentation, which takes care of the normally tough job of documentation," Ogdin says.

Tektronix is confident about the success of its 8560—Micropolis Corp. in Southern California holds an order for 1000 45M-byte, 8-in. Winchester-disk drives intended for the system—but Tektronix might be wise to watch over its shoulder for Millennium. Although Millennium's West won't discuss details of the multi-user software-development system due from the company, Millennium president John Caselli is not as reticent. "The difference between what we are going to do and what Tektronix is doing with the multi-user system is the processor," says Caselli. "Using the MC68000 will increase our system response and throughput."

Regardless of the quality of Millennium's product, industry observers say the company faces a big problem: lack of a strong marketing presence in µc development systems, particularly software development. But Caselli plans to expand the company's field-support staff, and says Millennium's sales are handled "by the best network of independent representatives in the country." And West suggests the impending takeover of Millennium by the much larger Gould Inc. will increase marketing clout for the µc development system family. "We think we can beat Tektronix in the µc development system field," Caselli says, "or we wouldn't be in it."

—Kevin Strehlo

Six companies push MC68000 as most popular 16-bit µp

Moves by six major semiconductor makers are aimed at one goal: making the Motorola MC68000 the most popular 16-bit µp on the market. The companies—Motorola Semiconductor Products, Inc., Mostek Corp., Signetics MOS µp Division, Rockwell International, Hitachi, Ltd., and Thompson CSF—claim that most new product

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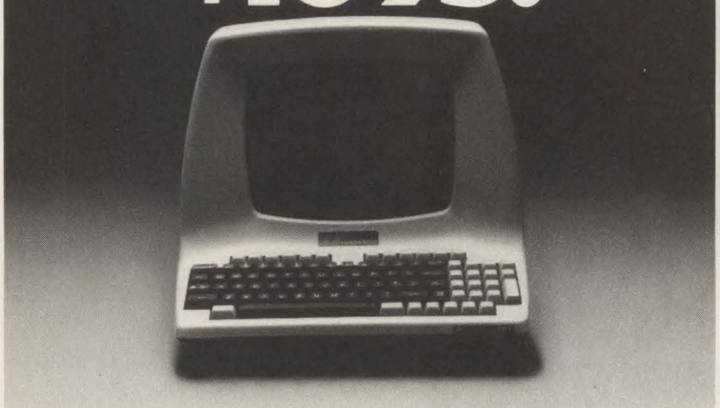

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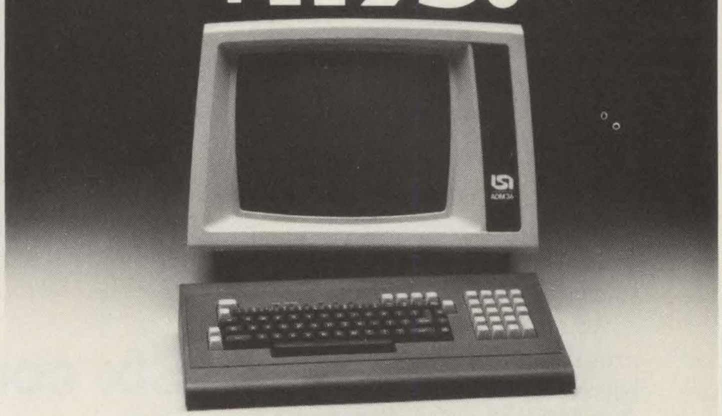

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CIRCLE NO. 15 ON INQUIRY CARD

designs using μps are MC68000 based.

The group believes its commitment to the MC68000 will ensure the companies will not meet the overwhelming competition that has negatively affected U.S. memory operations.

In mid-March, Motorola, Mostek and Signetics jointly announced 15 hardware products that will expand the MC68000 line to 26 products by the end of 1983. A similar major announcement of software-support products is imminent.

"The MC68000 will be the standard 16-bit μp over the next decade," predicts Murray Goldman, vice president and general manager of Motorola's μp division. "The efforts by the six companies are winning more than two-thirds of the design-ins today."

Despite the apparent camaraderie, the companies are aggressive competitors and, in some cases, address different applications. "Each part probably will have two to three vendors," says Goldman. He adds that the group's money and resource commitments assure that software will follow the hardware announcements. Highlights include:

- Motorola's announcement of the 68008, an 8-bit version of the MC68000. The 68008 has 60 percent the performance of the MC68000, is hardware and software compatible with it and has the same clock frequency and instruction mix. It uses a 48-pin package with 1M byte of linear address space, a decrease from the 64M bytes on the MC68000.
- Motorola's unveiling of the 68010 virtual-memory, pin-compatible version of the MC68000. The 68010 has instruction continuation after memory fault.
- The company's announcement of the 68020, which, unlike the MC68000, has a 32-bit data bus. Motorola expects the product to end questions about the MC68000's 32-bit μp status. The 68020 has the same features as the MC68000 and 68010, but has an enhanced instruction set, and address space is expanded from 16M to 4G bytes. Its 1.5 - million - instruction - per - sec. performance places it in the ball park of mainframe computer performance, the company claims. It has 150,000 transistors, 1.8W power dissipation and a 16-MHz clock with 5-nsec. gate delays, and it uses 2.25-micron HCMOS III technology.
- The announcement of another Motorola product, the 68881 floating point co-processor, which is the first 68020 co-processor. It implements the IEEE floating-point specification and supports single, double and extended floating-point values of 32, 64 and 80 bits, respectively. Implemented in HCMOS, the 68881 has 120,000 transistors, 8-MHz clock frequency and 1.5W power dissipation. When the device is a peripheral in systems with other processors, its performance is degraded by a factor of two or four.
- The unveiling by Signetics, which by now should be a qualified MC68000 second source, of five support products including the SC68430 direct-memory-access controller, the SC68454 intelligent multiple-disk controller and the SC68459 disk phase lock loop. Signetics's parent, N.V. Philips, intends to manufacture the 68000 product line in Europe in 1983. This

68000 FAMILY DEVICES

Model	Product type	Availability	Originating company
68000	16-bit μp unit	now	Motorola
68008	8-bit 68000	4Q 82	Motorola*
68010	virtual-memory processor	4Q 82	Motorola*
68020	32-bit 68000	4Q 83	Motorola*
68120	intelligent-peripheral controller	now	Motorola
68121	intelligent-peripheral controller	now	Motorola
68122	cluster-terminal controller	now	Motorola
68200	μc unit	2Q 83	Mostek*
68230	parallel interface/timer	now	Motorola
68430	direct-memory-access interface	4Q 82	Signetics*
68440	dual direct-memory-access controller	4Q 83	Motorola*
68450	direct-memory-access controller	3Q 82	Hitachi
68451	memory-management unit	now	Motorola
68452	bus-arbitration module	2Q 82	Motorola*
68454	intelligent multiple-disk controller	3Q 83	Signetics*
68459	disk phase-lock loop	3Q 83	Signetics*
68561	multi-protocol communications controller	4Q 82	Rockwell
68562	dual universal serial communications controller	3Q 83	Signetics*
68564	serial I/O controller	4Q 82	Mostek*
68590	local-area network controller	3Q 83	Mostek*
68652	multi-protocol communications controller	now	Signetics
68653	polynomial generator checker	now	Signetics
68661	enhanced programmable communications interface	now	Signetics
68681	dual asynchronous receiver/transmitter	2Q 82	Signetics*
68881	floating-point co-processor	4Q 83	Motorola*
68901	multi-function peripheral	4Q 82	Motorola

*announced in March

Compiled from information supplied by Motorola. Each device will have at least one second source. For example, Mostek announced a second source for the 68901. Similarly, Signetics said it intends to be an alternate source for the 68120, 68230, 68451, 68881, 68440, 68010, 68020 and 68008. It has samples out now for the 68000. By agreement, the companies can produce any of the products generated by the others.

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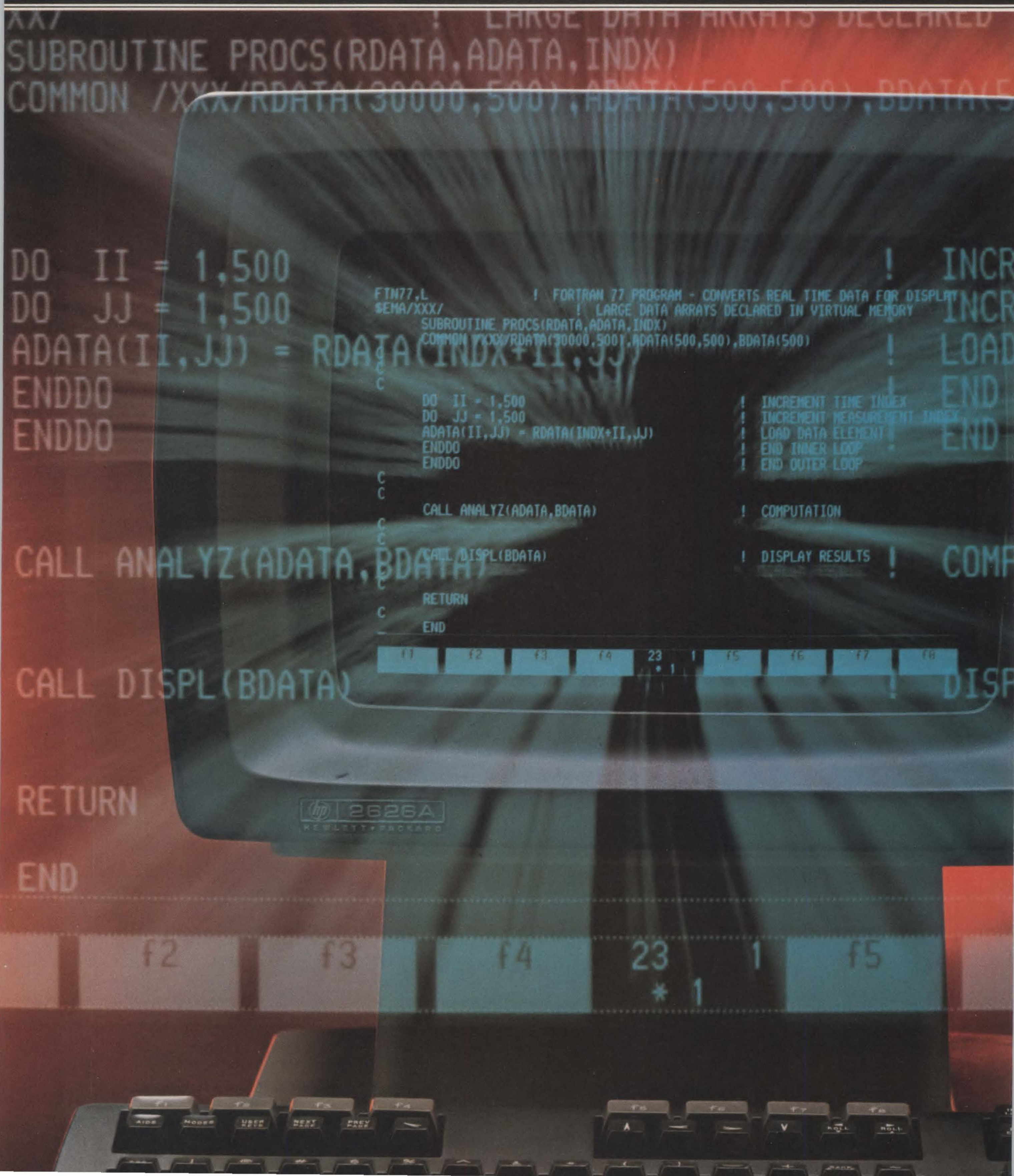
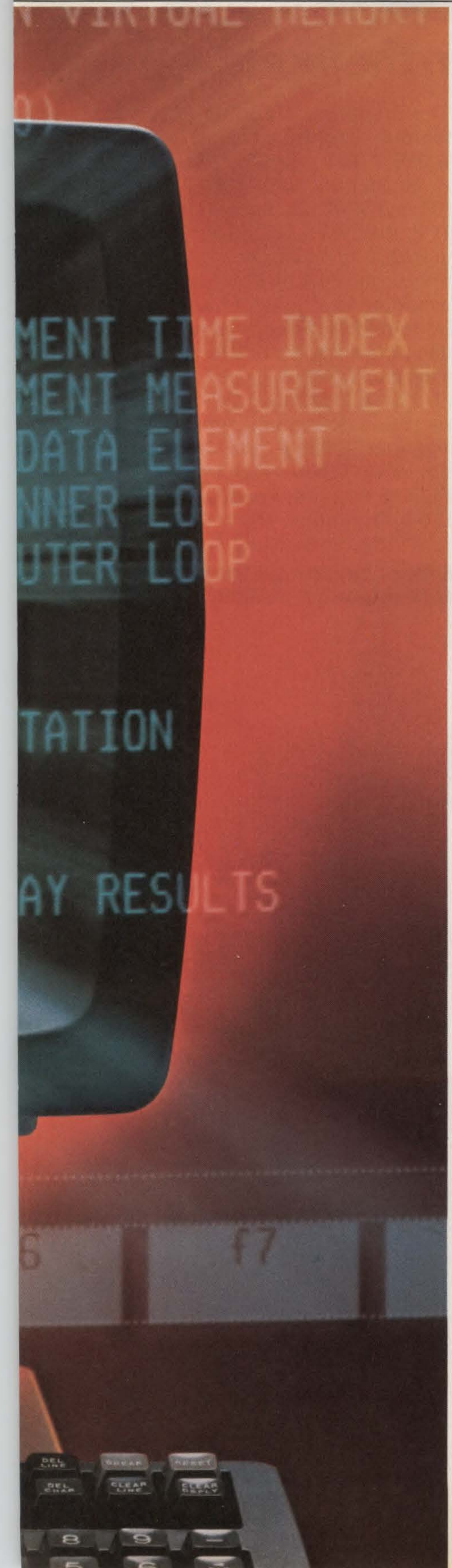


1000 Model 65: sitting at a mainframe.



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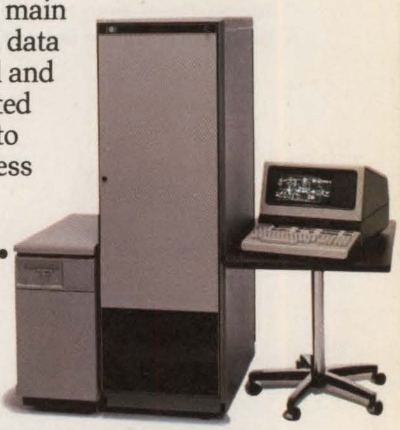

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CIRCLE NO. 17 ON INQUIRY CARD

year, Signetics intends to announce the Computing Nuclei board-level product line for 16- and 32-bit applications. Future offerings include subsystems that extend 68000 applications to data communications and video display controllers.

• The announcement by Mostek, which is developing 10 products for the VME bus touted by the group of companies, of the MK68200 16-bit, single-chip μc and the MK68590 Ethernet local-area network controller. The MK68200 μc has 4K bytes of ROM, 256 bytes of RAM, three 16-bit timers, full-duplex USART on board, 16-bit arithmetic and logic unit. The MK68590, which adheres to the Ethernet specification for LANs, has an integral DMA controller, 24-bit linear address range and a 10M-bit-per-sec. data rate.

Rockwell, which has kept a low profile since its announced second-source agreement for the MC68000, expects to unveil some products this year. Under the agreement with Thompson and Hitachi, it is sampling 4-, 6- and 8-MHz 68000 parts. Thompson is also working on higher speed versions. Hitachi has had an 8-MHz 68000 in volume production for eight months, and will announce a 68450 DMA controller chip this year.

Hitachi also recently announced an agreement with Digital Research, Inc., to develop the CP/-M-68K CP/M operating system and several application languages for the 68000. Expected high-level languages include super PLH, a superset of PLM 86, BASIC, Pascal, ANSI FORTRAN and possibly a C compiler.

—L. Valigra

5M-byte cartridge Winchester set for summer delivery

While the market for lower capacity 5¼-in. fixed-disk Winchesters shows some signs of maturing and becoming a price-dependent commodity business, the market for more specialized drives is still in gestation.

One such emerging market is the one for low-capacity small Winchesters based on the disk-cartridge media developed jointly by Dysan Corp., small-Winchester pioneer Seagate Technology and DMA Systems, Inc. Dysan so far is the only vendor that has announced that it will supply this type of media. Seagate plans to deliver 5¼-in., removable-only, 6M-byte disk-cartridge Winchesters equipped with thin-film read/write heads this year (MMS, November, 1981, p. 46), although the exact definition of this drive, called the ST-706, may be revised in view of its recent decision to put its thin-film program on hold. DMA, however, intends to beat Seagate to the draw and be the first to begin volume shipments of a removable-only 5¼-in. disk-cartridge Winchester.

Called the Micro-Magnum 5,

DMA's Micro-Magnum 5 *supplies high-capacity, high-performance backup for fixed-disk Winchesters.*

DMA's second hardware offering will make its first appearance at the upcoming National Computer Conference show in Houston, and is scheduled to appear in evaluation quantities during the third quarter of this year. Production hardware is slated to be available from the Santa Barbara, Calif., peripherals vendor by the end of 1982. The device is similar in appearance and identical in performance to DMA's earlier fixed/removable offering, and uses the same manganese-zinc ferrite heads.

The Micro-Magnum 5 is designed to supply high-capacity, high-performance backup for fixed-disk Winchesters, says DMA marketing vice president Don Minami, and is aimed at designers planning totally redundant systems. "In this case, we see two of these drives operating side by side," he says. "In the event one drive goes down, the system can continue to run off the second."

Minami also sees the new hardware used in multi-station word-processing systems and in networking environments where one disk drive must be kept continuously on-line. "With two Micro-Magnum 5 drives, you could continue to poll a terminal while at the same time interchanging files," he explains. "If only one fixed/removable device were used in place of two removable-only drives, the drive would have to be shut down and taken off-line while the old file cartridge was removed and a new one inserted."

DMA's latest addition to its product line uses a linear voice-coil head positioner tied to embedded servo data, and Minami feels this is imperative for media interchangeability. Seagate's ST-706 initially used an open-loop system based on a stepper-motor positioner and made up the difference in capacity by using thin-film heads for greater bit density and by extending the number of tracks on the surface of the disks. "We feel it will be difficult to guarantee cartridge interchangeability without a closed-loop servo system," he says. "It solves any centering problems that come up, and allows us to compensate for disk and spindle run-out. It also allows us to take care of any head misalignment that results when a new cartridge is inserted."

Whether Sunnyvale, Calif., Data Peripherals, which is also reported to be working on a 5¼-in. disk-cartridge Winchester (MMS, January, p. 10), will use embedded servo is not known. According to one report, the company will use the Dysan cartridge, and plans to have evaluation versions of a 5M-byte device on the market early next year.

DMA's decision to produce a high-performance drive using embedded servo data and a voice-coil actuator is not without certain trade-offs, however. For example, some modifications to controllers and software drivers may be required, Minami says, because use of this type of servo has the net effect of "hard sectoring" the drive. Use of a linear voice-coil actuator also means that the drive itself is approximately 2 in. longer than hardware based on the de facto industry standard for this type of Winchester, Shugart Associates' SA450 5¼-in. floppy-disk drive. (Priam's high-capacity fixed-disk 5¼-in. Winchester, also slated to be unveiled at NCC, also uses a linear voice-coil motor and is 2 in. longer than other drives.)

Minami concedes that a slightly longer drive may have some disadvantages. "This could be a problem in some systems, especially when it comes to retrofits," he admits. "On the other hand, when it comes to new systems, people can design around it." Minami also feels that the 2 extra in. built into the drives provide added reliability. "When the drive is shut down, the heads automatically retract and clear the disk," he explains, noting that, on conventional Winchesters, the heads come to rest on a dead zone on the media when the drive stops. If the drive is to be moved, the heads are then locked down along with the spindle. "This is OK in shipping," he says, "but people don't want to do this if all they have in mind is moving the system from one desk top to another."

Newark, Calif., industry analyst Andrew Roman points out that despite their appeal, some questions about small disk-cartridge drives remain unanswered at this stage of their development. "This hardware is eagerly awaited and much needed," he says, "but some issues have yet to be ironed out."

For one thing, he says, users will have to deal with the question of loading and updating software. "Software for small systems comes on floppy disks," he points out. "This issue has been completely skirted by drive vendors." Because of this, Roman goes on, disk-cartridge Winchesters may find less acceptance in single-user systems, and instead will very likely find themselves in multi-station environments where one floppy-disk drive will be able to handle the software needs of a number of stations. Nonetheless, Roman anticipates that the market for both fixed/removable and removable-only 5¼-in. drives will grow steadily over the next few years. By the end of 1982, 5000 units of both types will be sold by U.S. vendors; by the end of next year, 30,000 units will be sold. Roman predicts that the market for these drives will grow to 330,000 units by 1986.

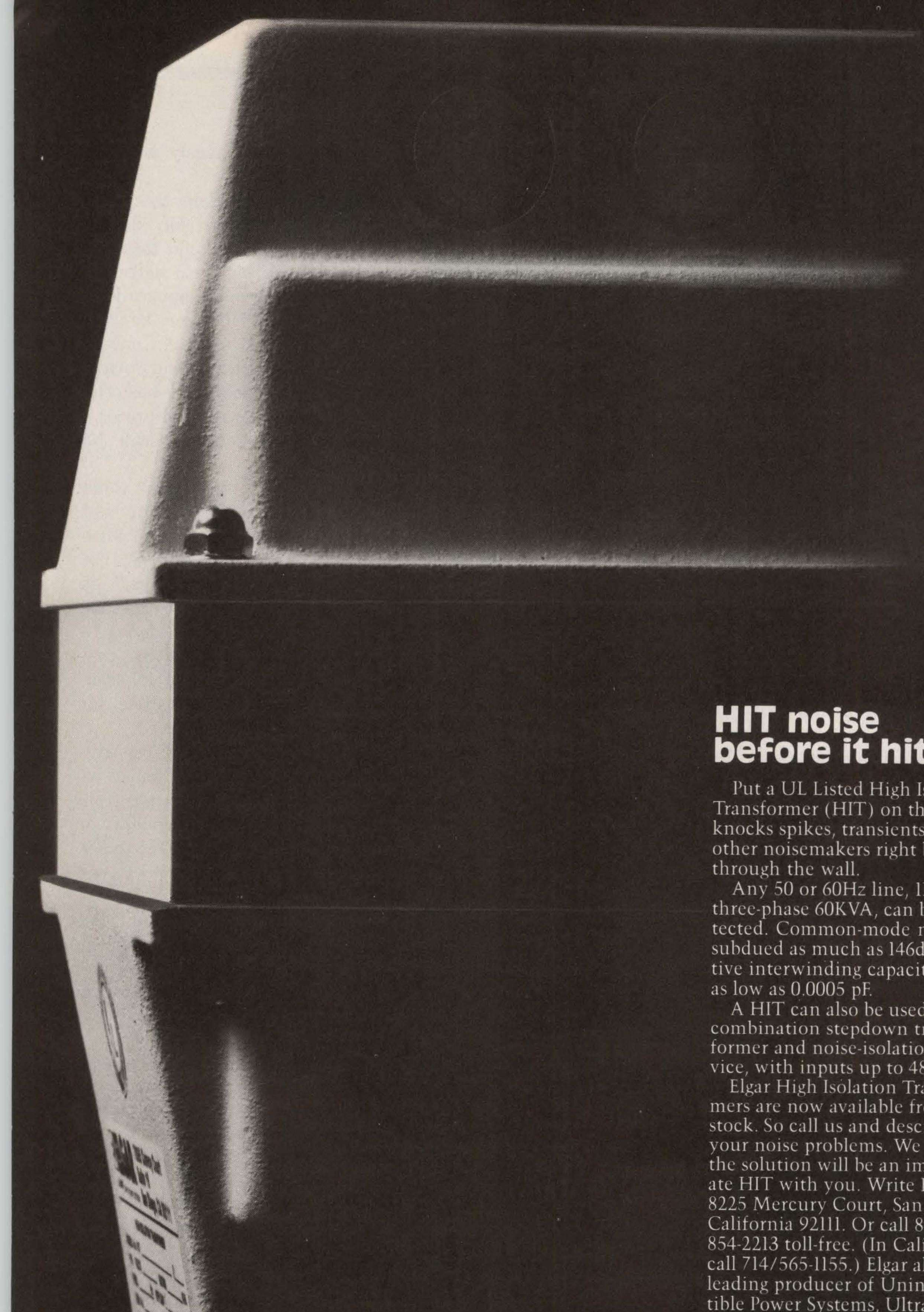
Seagate may be a dominant factor in this evolving market, but the possibility of direct competition with the Scotts Valley, Calif., small-Winchester pioneer doesn't faze Minami. "Right now, they are the largest supplier of 5¼-in. Winchesters," he says. "They have the name, but as far as disk-cartridge drives are concerned, we have the product." Prices for DMA's Micro-Magnum 5 are $1000 in 1000-lot orders. Disk cartridges for the drive are priced at $85 each in 1000-lot orders.

—John Trifari

Wyse boosts intelligence with 16-bit μp-based terminal

Eight-month-old San Jose, Calif., terminal supplier Wyse Technology unveiled what it terms the industry's first 16-bit μp-based intelligent terminal this month, almost a year ahead of other suppliers that still have such products on the drawing boards. Televideo, Inc., plans to announce a 16-bit terminal by year-end, and Beehive International anticipates announcing a family of 16-bit units at the 1983 National Computer Conference.

Incorporating the Intel 8088 μp, the new Wyse WY-200, selling for $1295 in single-unit quantities, is targeted at OEMs for distributed data-processing applications. Larry Lumas, Wyse's vice president of marketing, says the initial version contains 16K bytes of internal memory. A subsequent version, which will be announced as early as next month, contains 64K bytes. Lumas says the memory enhancement gives the terminal enough memory to take advantage of software generated for new 16-bit



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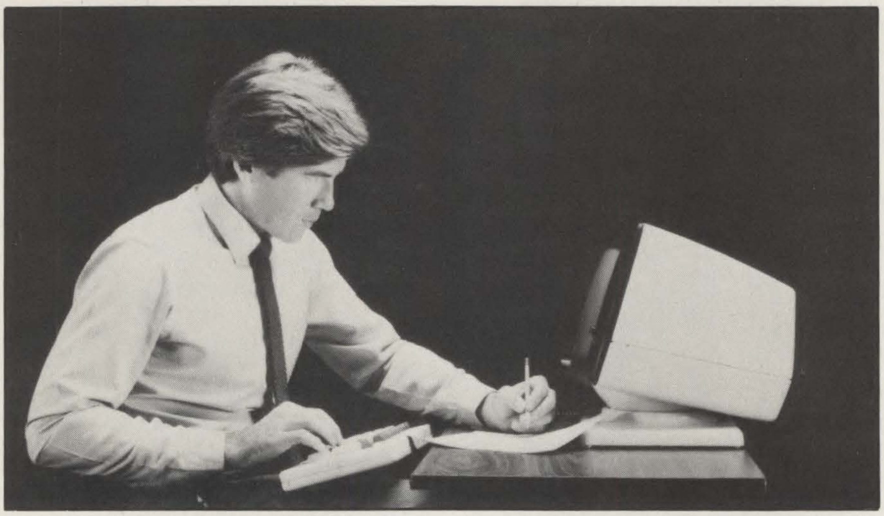

The new Wy-200 16-bit μp-based intelligent terminal *features a detached keyboard and a display that tilts and swivels. The unit is enclosed in an aluminum cabinet that serves as a heat sink and eliminates the need for a fan.*

μcs, such as the International Business Machines Corp. personal computer.

"We see the terminal being used as a work station for distributed data processing," says Lumas. "Programs can be down-loaded from a remote computer and executed locally, giving users essentially a computer at their desks."

Dixon Doll, president of the DMW Group, an Ann Arbor, Mich., telecommunications consulting firm, says more terminal vendors should employ the Wyse strategy as a means to compete with personal-computer manufacturers introducing 16-bit systems. "The most imminent impact on the terminal market will be the personal computer," he says. "A person can buy the IBM unit, add a terminal-emulation package and get the best of both worlds—a terminal and a stand-alone computer. If terminal vendors don't migrate toward adding 16-bit μps to their products, they'll be dead in the water."

The intelligent terminal market is expected to grow approximately 30 percent annually, says Bob Katzeu, an analyst with Gnostic Concepts, a Menlo Park, Calif., market-research firm. Katzeu says that while only 80,000 to 90,000 units were installed in 1980, more than 300,000 will be installed in 1985.

Despite such growth figures, a lack of software for distributed data-processing applications will limit the market for intelligent terminals, according to Ken Bosomworth, president of International Resource Development, Inc., Norwalk, Conn. "People have talked for 15 years about how it would be nice to perform local processing by having an intelligent terminal share the processing load of the mainframe," says Bosomworth. "This turns out to be pretty much of an illusion. Unless the processing task is very specific, repetitive and fixed, it's a big programming job to split the task between the terminal and the computer. In practice, nobody bothers to do it."

Bosomworth says that of the 4 million terminals installed worldwide, only about 150,000 share a part of the processing load with a remote computer. Most of those, he says, are being used as airline-reservation systems. "A terminal is supposed to talk to a remote computer that has all the smarts," says Bosomworth. "In general, the only intelligence ever used is for simple line-at-a-time editing functions—and those functions can be accomplished quite nicely with an 8-bit μp."

Wyse's Lumas concedes that most software is written for dumb-terminal applications, and that the task of retrofitting such software for intelligent-terminal applications is "horrendous." However, he says that as companies such as Convergent Technologies incorporate 16-bit μps into their small-business systems, more distributed-processing application software will be generated.

DMW's Doll agrees. "I don't think that people will redeploy old software to take advantage of some new intelligence in terminals, but they'll design new packages," he says. "Every year, major Fortune 500 corporations are defining a whole slew of applications that require the extraction of information from a central database for local, off-line processing."

Gnostic Concept's Katzeu says that most new software for 16-bit terminal applications will come from either the terminal vendors or system houses. "Anyone who thinks that they can just make the hardware, stick it out onto the marketplace and say 'look at what we got' is kidding themselves," he says. "Terminal vendors will have to become either system houses in their own right or suppliers to system houses on an OEM basis."

While Wyse plans to leave most program-development tasks to OEMs, Beehive International will design many packages for the company's planned line of 16-bit products, says Rubin Longwell, Beehive's director of product planning. "We see the real takeoff point for this market as mid-1984," says Longwell. "The key to that takeoff will be when people realize that they've got to vertically integrate the software to make the intelligent terminal useful to specific applications."

—Frank Catalano

Calendar

SHOWS & CONFERENCES

APRIL

20-22 **AMBEC '82, American Business Equipment & Computer Trade Show,** Hartford, Conn., sponsored by the Data Processing Management Association and the Administrative Management Society. Contact: Ann D. Lazarus, Vice President, Key Productions, Inc., 410 Asylum St., Hartford, Conn. 06103, (203) 247-8363.

20-22 **D-COM Show for the DEC-Compatible Market,** Boston, sponsored by D-COM, Inc. Contact: Ron Davis, D-COM, Inc., 7312 Burdette Court, Bethesda, Md. 20187, (301) 469-7650.

20-23 **Institute of Environmental Sciences' Annual Technical Meeting, "Enhancement of Quality Through Environmental Technology,"** Atlanta, sponsored by the IES. Contact: Institute of Environmental Sciences, 940 E. Northwest Highway, Mount Prospect, Ill. 60056, (312) 255-1561.

21-28 **Hanover Fair '82,** Hanover, West Germany, managed by the German Trade Fairs and Exposition Corp. Contact: Hanover Fairs Information Center, P.O. Box 328, Whitehouse, N.J. 08888, (201) 534-9044.

22-25 **New York Computer Show & Office Equipment Exposition,** Uniondale, N.Y., produced by National Computer Shows. Contact: National Computer Shows, 824 Boylston St., Chestnut Hill, Mass. 02167, (617) 739-2000.

26-28 **1982 Symposium on Security and Privacy,** Oakland, Calif., sponsored by the Technical Committee on Security & Privacy of the IEEE Computer Society. Contact: The Department of Defense Computer Security Center, 9800 Savage Rd., Fort George G. Meade, Md. 20755.

27-29 **Information Management Exposition & Conference for Manufacturing,** Chicago, managed by Clapp & Poliak, Inc. Contact: Banner & Grief, Ltd., 110 E. 42nd St., New York, N.Y. 10017, (212) 687-7730.

29-30 **"An Assessment and Forecast of Computer Graphics" Conference,** Port Chester, N.Y., sponsored by Frost & Sullivan, Inc. Contact: Carol Sapchin, Account Representative, Frost & Sullivan, Inc., 106 Fulton St., New York, N.Y. 10036, (212) 233-1080.

MAY

2-5 **27th Annual College and University Machine Records Conference,** Chicago, sponsored by the University of Illinois. Contact: Joyce Dakter, CUMREC '82 AISS, Room 370 RRB, University of Illinois at Chicago Circle, Box 4348, Chicago, Ill. 60680, (312) 996-8870.

3-5 **CEPA 1982 Conference for Professional Development in the Use of Computers in Engineering, Planning and Architecture,** New Orleans, sponsored by the Society for Computer Applications in Engineering, Planning and Architecture, Inc. Contact: Patricia C. Johnson, Executive Director, CEPA, Inc., 358 Hungerford Dr., Rockville, Md. 20850, (301) 762-6070.


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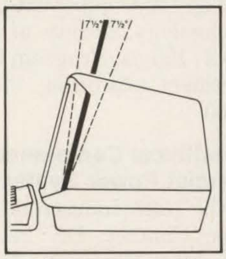

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Hazeltine Executive 80

Answers for the Eighties

CIRCLE NO. 23 ON INQUIRY CARD

Calendar

3-6 **The International Congress on Technology and Technology Exchange,** Pittsburgh, Pa., sponsored by the Engineers' Society of Western Pennsylvania, the International Technology Institute and the U.S. Department of Commerce Pittsburgh Office for Trade Administration. Contact: A. DiBernardo, International Congress on Technology and Technology Exchange, c/o Engineers' Society of Western Pennsylvania, William Penn Hotel, 530 William Penn Place, Pittsburgh, Pa. 15219, (412) 261-0710.

4-6 **Eighth Annual Computer Graphics Conference and Equipment Display,** Detroit, sponsored by the Engineering Society of Detroit. Contact: Carol Lynn, Engineering Society of Detroit, 100 Farnsworth, Detroit, Mich. 48202, (313) 832-5400.

5-8 **29th International Technical Communication Conference,** Boston, sponsored by the Society for Technical Communications. Contact: Laurence A. Lickteig, Applicon Inc., Tech. PUBS 700, 32 Second Ave., Burlington, Mass. 01803.

5-8 **1982 Annual Independent Computer Consultants Association Conference.** Contact: Charles E. Youman, ICCA '82 Conference Publicity Chairman, 4419 N. 18th St., Arlington, Va. 22207, (703) 528-8993.

9-12 **Phoenix Conference on Computers and Communications,** Phoenix, Ariz., sponsored by the Phoenix electronics industry, Arizona State University, the computer and communications societies and the Phoenix IEEE section. Contact: E. David Metz, Motorola Inc., MDBL36, P.O. Box 2953, Phoenix, Ariz. 85062.

10-12 **Electronic Components Conference,** San Diego, Calif., sponsored jointly by the Components, Hybrids and Manufacturing Technology Society of the IEEE and the EIA. Contact: D.J. Bendz, Program Chairperson, IBM Corp., Department 649 014-4, 1707 North St., Endicott, N.Y. 13760.

10-13 **Annual Meeting and Technical Conference of IEEE Industrial and Commercial Power Systems,** Philadelphia, sponsored by the IEEE Industrial and Commercial Power Systems. Contact: Dr. Paul Reece, General Electric Co., 6901 Elmwood Ave., M.D. 06302, Philadelphia, Pa. 19142, (215) 762-2800.

10-14 **20th Annual Convention of the International Association of Educational Data Systems,** Orlando, Fla., sponsored by the Florida Association for Educational Data Systems. Contact: Sharon Lobello, 1311 Executive Center Dr., Suite 220, Tallahassee, Fla. 32301, (904) 878-4178.

11-12 **"The Next Generation of Consumer Electronics" Conference,** New York, sponsored by The Yankee Group. Contact: Lisa Caruso, The Yankee Group, Harvard Square, P.O. Box 43, Cambridge, Mass. 02138, (617) 542-0100, also to be held May 18-19, Palo Alto, Calif.

18-20 **National Aerospace & Electronics Conference,** Dayton, Ohio, sponsored by the IEEE, Dayton Section, Aerospace and Electronic Systems Society. Contact: R.A. Vander Mevlen, Publicity Chairman, NAECON '82, Rockwell International Corp., 1010 Woodman Dr., #210, Dayton, Ohio 45432.

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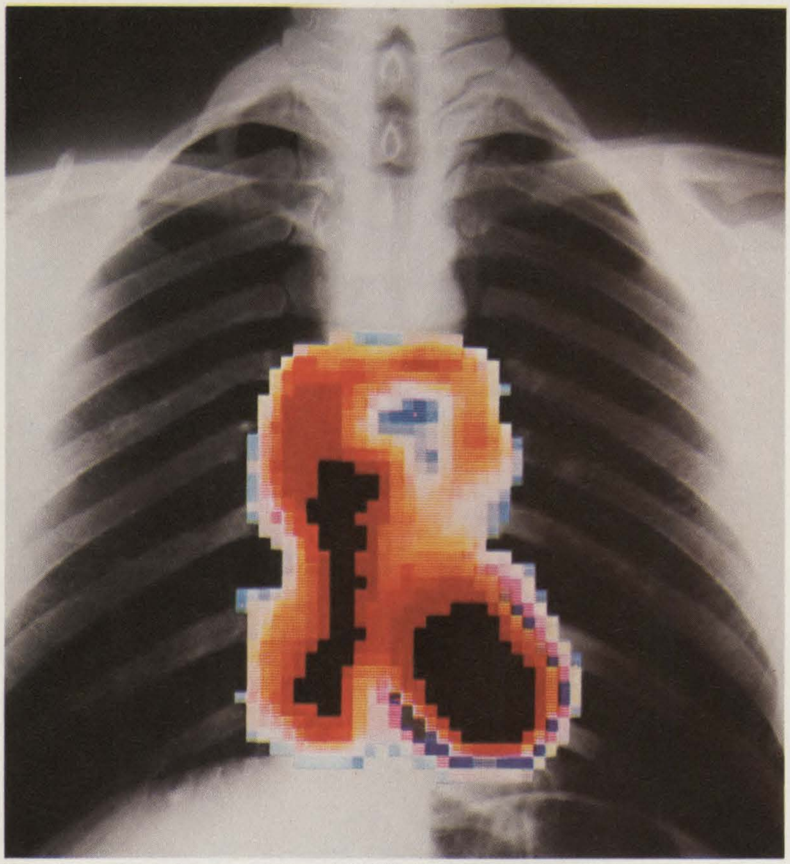

In nuclear medicine, doctors use Shugart's SA851 drive to store and playback images of the heart (shown here superimposed over x-ray). Photo courtesy of Technicare Corporation.

image data, patient annotation, and other crucial information used in heart analysis.

To help brain specialists accurately analyze cerebral blood flow.

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The SA851 offers you twice the capacity of single-sided drives.

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The sum result: reliability. And a high-speed, high-capacity drive able to tackle the most critical applications.

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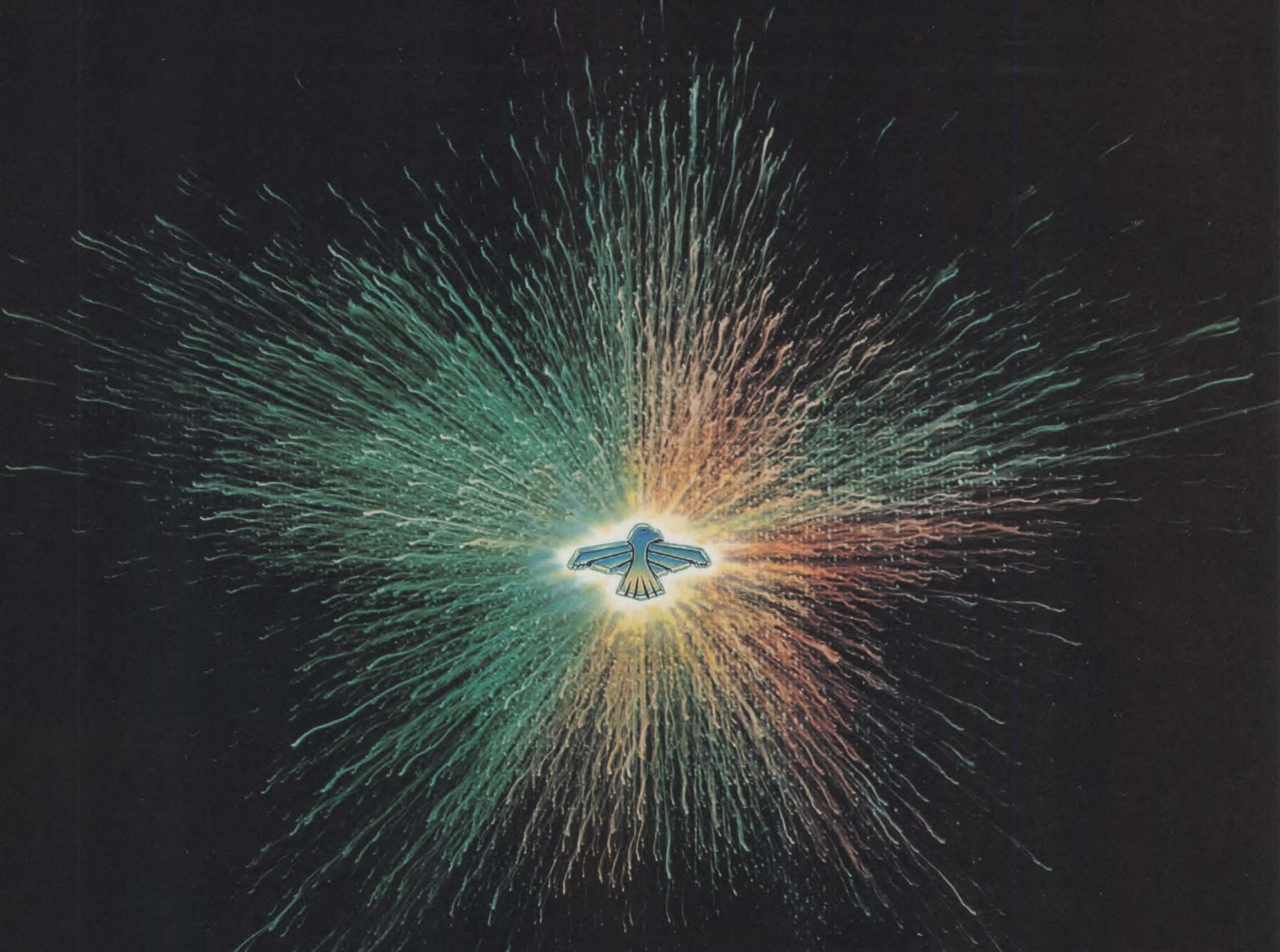

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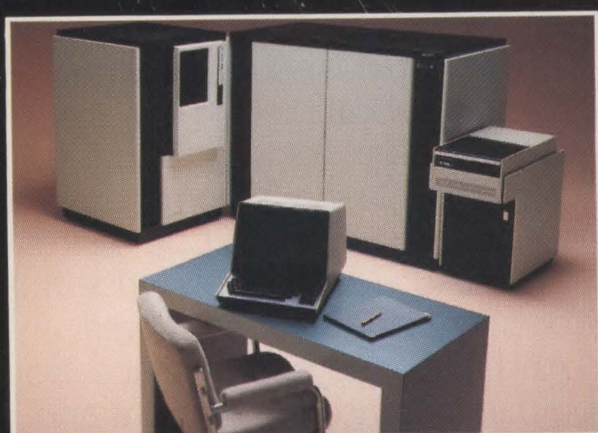

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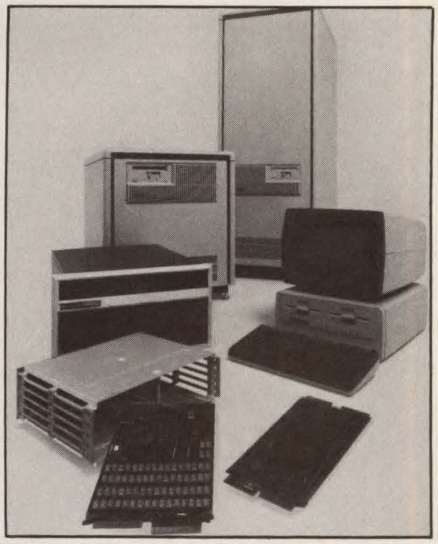
H-P expands 1000 product line with 1-MIPs processors



H-P's A600 μc and A700 mini *are software compatible with the company's current 1000 products. Both use new processors based on four bit-slice devices.*

Hewlett-Packard Co. flexed its minicomputer and μc muscle this month with the addition of two systems to its HP 1000 technical real-time computer family. Called the A-series, the hardware includes the 1-million-instruction-per-sec. A600 μc and the A700 minicomputer. The Palo Alto, Calif., company also introduced its latest real-time operating system, RTE-A.1, aimed at multiprogramming, multi-user systems with virtual memory.

Though they are software-compatible with H-P's current 1000 products, both systems use new processors based on four bit-slice devices. The A600, built around the AMD 2901, is a horizontally microprogrammed machine with a 56-bit-wide microword. Horizontal programming uses a wide microword, an approach that allows the processor to perform several operations in parallel and contributes to overall performance, says system architect Tom Szolyga.

The A700, based on AMD's 2903, is a vertically microprogrammed machine with a 32-bit-wide word. Vertical programming uses a narrow word, and the result is that the A700 is user-microprogrammable, says Szolyga. H-P provides a Pascal-like, high-level "microparaphraser," language, which enables A700 mini-computer users to develop their own microcode, particularly for computation-intensive applications.

H-P offers an optional computation-acceleration processor (CAP) for the A700. The CAP includes a floating-point processor and scientific and vector instruction sets in firmware on a board. H-P says an A700 with a CAP approaches the performance of 32-bit minicomputers in matrix-intensive applications.

A600 and A700 systems support as much as 4M bytes of main memory and as much as 200M bytes of mass storage. The hardware uses H-P's Distributed Intelligence Architecture, which puts an I/O processor on each interface board. The I/O processors give each I/O board access to main memory, the company says, resulting in reduced CPU overhead and simplified I/O programming.

Common to the A600 and A700, the RTE-A.1 operating system is a virtual-memory system. It allows programs to access data arrays as large as 12.6M bytes, regardless of whether the data are in main memory or on disk. An extended memory area permits as much as 2M bytes of data to be stored in main memory for fast processing, H-P says. There are 15 extended memory areas for each user, and each area stores as many as 32 programs.

The company's major software packages run on the new hardware. Among these packages are Graphics/1000/II 2D and 3D graphics software and Image 1000 database-management system with H-P's Query inquiry language. The systems can be linked into the company's distributed-systems network via DS/1000-IV networking software. Further, the A600 and A700 support X.25 packet-switching communications.

The A600, available as a board-level system, includes the CPU and a 128K-byte RAM board. The pair is priced at $3400. An A600 model 16 microsystem, which includes the

A600/700 SPEARHEAD H-P FACTORY AUTOMATION DRIVE

The versatility and performance of Hewlett-Packard Co.'s new A600 and A700 processors are expected to help push the Palo Alto, Calif., firm further into the growing industrial-automation market. Company officials are seeking OEMs in that market that can complement H-P's offering by adding industry-specific hardware and software.

In the factory-automation market, says Orrin Mahoney, market development manager for H-P's technical computer group, H-P will rely heavily on OEMs to complete the solution, even though the processors and their real-time operating system and networking capabilities represent a fairly high-level supervisory and control system.

Mahoney expects that more than 50 percent of A600 and A700 sales will be made in the industrial-automation market. Dataquest estimates the market to be 20 percent of the total general-purpose minicomputer market, which was worth $4.7 billion in 1980.

Mahoney also anticipates that most new HP 1000 system sales will be A600s and A700s. The company, however, has no plans to discontinue any models in the series.

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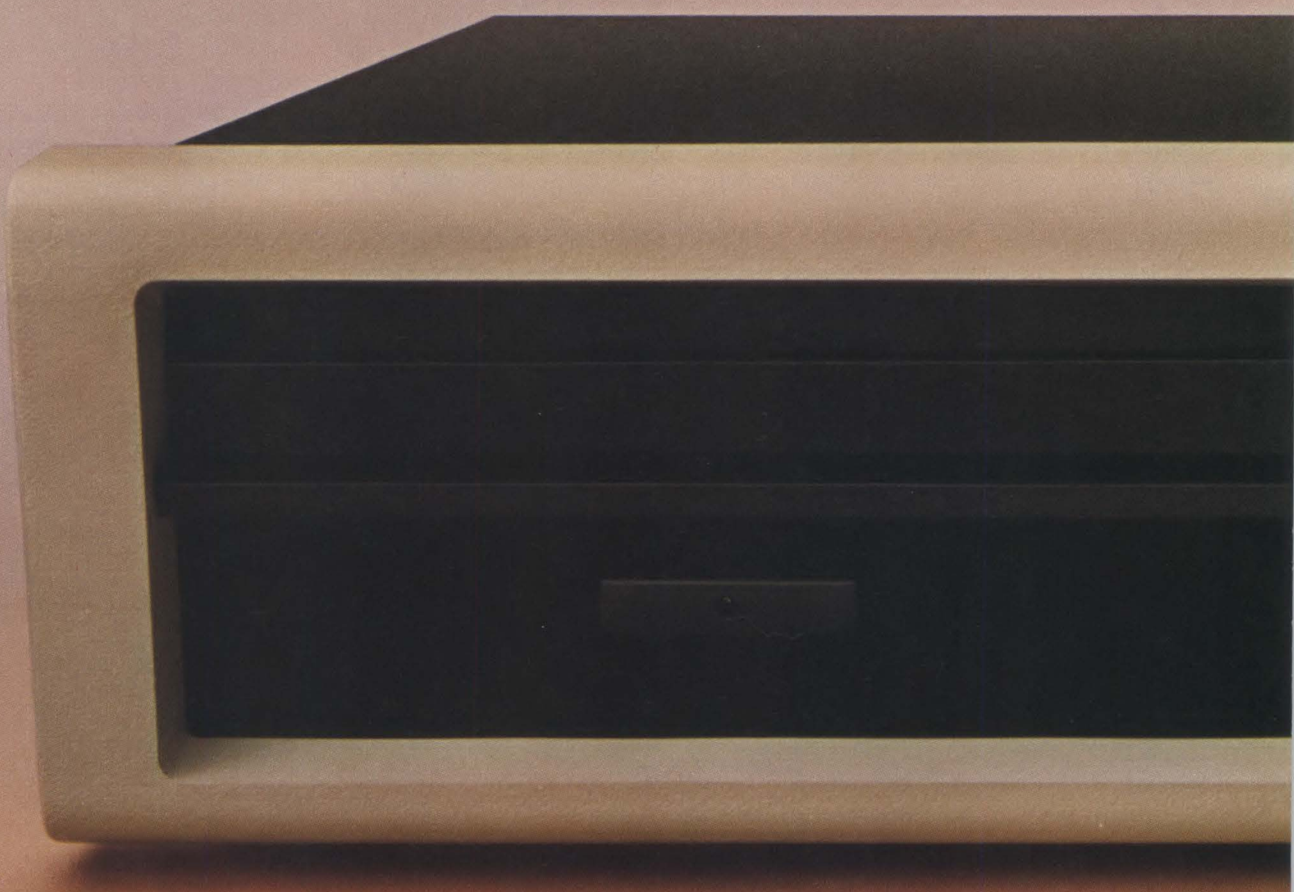

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First of all, they'd make it extremely reliable with extensive testing and by using one of the most reliable storage technologies known, the Winchester.

Next, they'd offer it in different capacities, like 7.8, 20.8, and 31.2 megabytes, with a choice of .5 or 1 Mb floppy back-up, or none at all.

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

And the whole package would be extremely compact, just 5¼ inches high, so it would save space and fit in almost anywhere.

They might even add some on-board self-diagnostics, similar to our exclusive HyperDiagnostics,™ so you could test, exercise, and debug without a CPU. And cut down on your service costs at the same time.

Maybe they'd even institute a module swap program, something like our Rapid Module Exchange,™ which would be designed to get you back up and running within twenty-four hours.

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

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

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

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CIRCLE NO. 29 ON INQUIRY CARD

CPU, a RAM board, terminal and HP-IB interfaces, a video-display terminal, a 16.5M-byte Winchester-disk drive and RTE-A.1 for the A600 board-level system carries a $2500 one-time license fee; $1000 extra buys the right to copy the operating system.

The A700 minicomputer is available as a box computer with CPU, a 256K-byte memory board, a rack-mountable chassis with power supply and 16 I/O slots for $9700. The CAP is priced at $4300. RTE-A.1 for the A700 sells for $5000 for the first copy; $2000 buys the right to make additional copies.

A full-blown A700 system, the model 17, including the CPU and memory boards, serial and HP-IB interfaces, a CAP, operating system, a video terminal, a 4.6M-byte rigid-disk drive and cabinet, sells for $27,100.

H-P expects the A-series processors to be available next month.

—Larry Lettieri

Intel's 286 has power, but software is a question

Intel Corp. has taken the wraps off its iAPX 286 microsystem, the much-ballyhooed big brother of the Santa Clara, Calif., semiconductor maker's successful 8086. The new 16-bit processor seems to be everything the company said it would be, and some observers think it spells the end of its predecessor even though it lacks crucial software.

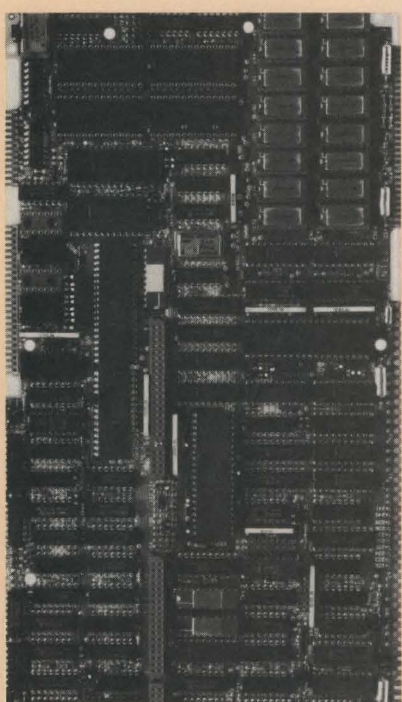
Called "a dramatic evolution of the 8086 family" by μp product marketing manager Jeff Miller, the 286 is as much as six times faster than the 8086 and addresses 16 times more physical memory. The 286 also includes virtual-memory address translation, memory management and protection on the chip. Virtual memory enables the device to address as much as 1G byte of memory per task. Yet, because the 286's instruction set is a superset of those of the 8086 and 8088, it remains compatible with existing 8086 and 8088 software.

Intel is aiming the 286 at three markets. In the long term, the company intends to reach new or evolving multi-user, multitasking applications that need high-performance processors such as the 286, Miller says. Intel will also stress industrial-control applications, specifically robotics. Finally, Miller says, the 286 will suit advanced-communications systems such as PABXs. But for now, Intel will emphasize the 8086 upgrade market. "We will sell the 286 to those 8086 users who want more performance with software compatibility," Miller says.

The introduction of the 286 and the recent 60-percent boost in the speed of the 8088—it is now an 8-MHz processor—raise some questions about the future of the 8086. "Between the 286 and the 8088, there's no room for the 8086," says

INTEL ADDS 8-MHz PROCESSOR TO 16-BIT BOARD LINE

Intel Corp. has begun delivering beefed-up versions of its iSBC 86 16-bit single-board computer. Based on the Santa Clara, Calif., company's 8-MHZ 8086 μp (previous iSBC 86 CPUs used the 5-MHZ processor), the iSBC 86/30 and 86/14 offer increased memory, flexible on-board I/O expansion and improved math capabilities.



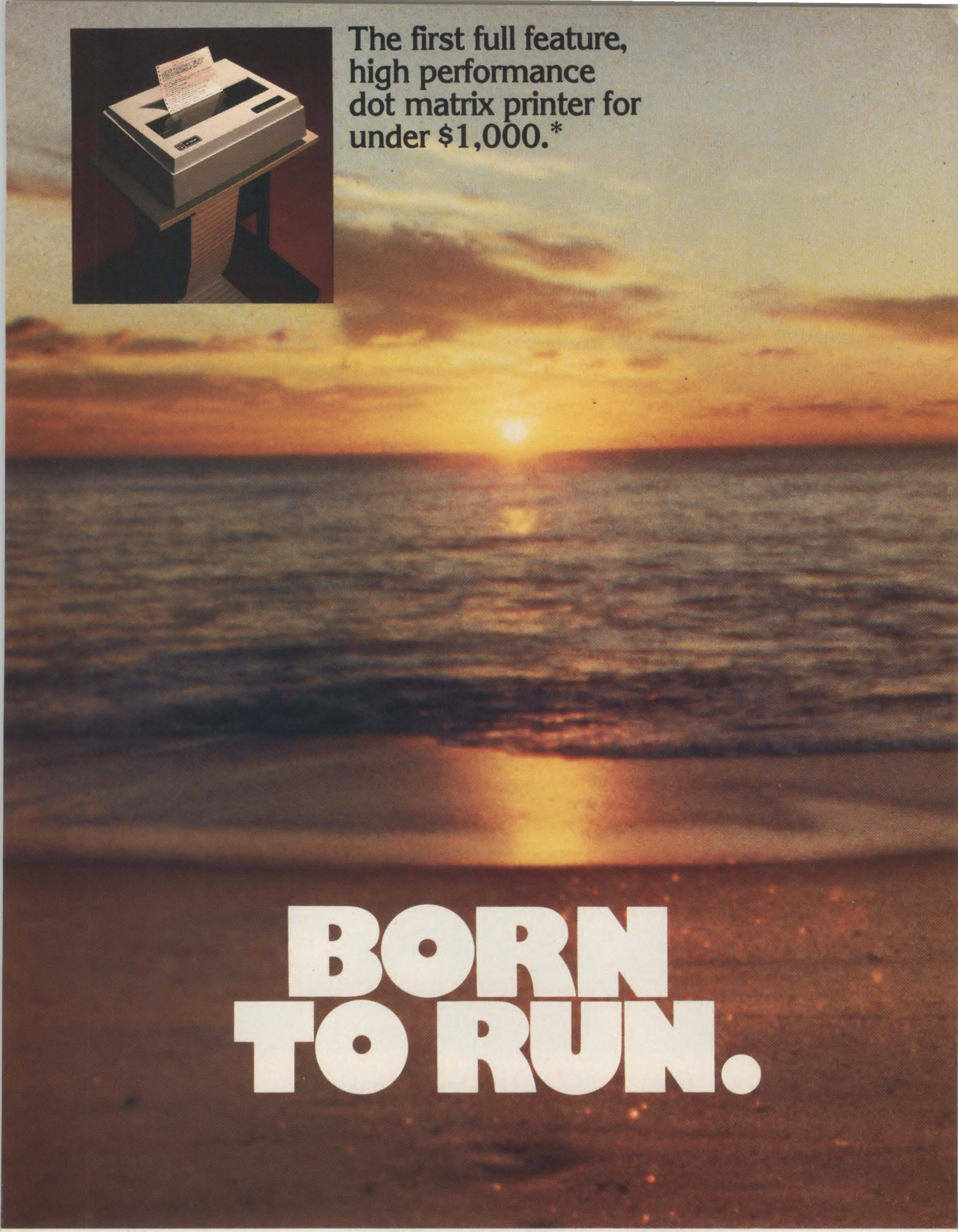
Intel's iSBC 86/30 8-MHz processor board *offers increased memory, flexible on-board I/O expansion and improved math capabilities.*

The iSBC 86/30 and iSBC 86/14 have 128K and 32K bytes of RAM, respectively. Using the iSBC 304 expansion board for the 86/30 and the iSBC 300A RAM board for the 86/14, the memory capacity of each CPU can be doubled.

Computational capabilities can be enhanced as well, says the company. Using the iSBX 337 numeric data processor, more than 60 instructions can be added to the 8086's instruction set to perform logarithmic, exponential and transcendental functions.

Intel thinks the boards will be suited for applications in which their large storage capacities and 8-MHZ processors can be best used, including word processing, small-business systems, instrumentation and industrial automation.

In quantities of one to nine, the iSBC 86/30 sells for $3800, and the iSBC 86/14 sells for $2475. The 128K-byte iSBC 304 RAM board is priced at $1250, and the iSBC 300A 32K-byte board is priced at $750. The iSBX numeric data processor sells for $392.


The first full feature, high performance dot matrix printer for under $1,000.*
BORN TO RUN.

consultant Andrew Allison, Los Altos Hills, Calif. Besides, he says, the 8086 has been losing ground to Motorola's 68000. The 286 is a stronger competitor to the 68000, he adds.

Intel denies the demise of the 8086. Miller says the processor is still getting design-ins, and he expects the device to be around for quite a while "because it suits a lot of applications, especially for stand-alone systems."

For its part, Motorola is planning the 68010, a version of the 68000 that performs like a virtual-memory machine. But the 68010 lacks the on-chip memory-management and protection features of the 286. Those capabilities for the 68010 will be offered by peripheral devices. What's more, the 68010 addresses only 16M bytes. However, it can halt an instruction before it is executed if the memory space for that instruction is not available. It then backs up and re-executes the instruction.

Despite the 286's reported good performance, the processor lacks crucial software support. "If the purpose of the 286 is to run 8086 software faster," says consultant Allison, "it will do it, though it will cost more. But if it is intended to deliver enhanced systems capabilities, it needs software, and there is none specific to the 286 planned."

Jean Yates, senior analyst at Gnostic Concepts, Menlo Park, Calif., says, "The 286 will do a slam-bam job. But vendors of 16-bit systems are looking at µp makers' software knowledge. They consider software crucial. And Intel is not perceived as a software guru."

PIPELINING IS KEY TO 286 PERFORMANCE

Intel Corp.'s iAPX 286 is a significant step in µp design. Besides cramming 130,000 transistors on the chip—that's roughly four times the number on the 8086—the 286 uses a pipelined architecture. Pipelining, says the company, contributes to the processor's two to six times speed advantage over the 8086.

Unlike conventional µps, which must complete the usual sequence of instructions—fetch, decode, execute—before the next instruction can be accessed, one with a pipelined structure can perform these operations simultaneously. That is, while one instruction is being executed, the next is being decoded, and another is being fetched. In the 286, pipelining is accomplished by separating the µp into four logical units—bus, address, instruction and execution.

The bus unit provides a demultiplexed bus interface between chip, system memory and I/O. It monitors the bus for requests, grabs the next instruction and puts it in a code queue to await access by the instruction unit. The instruction unit decodes and formats the instruction and queues it again, this time for the execution unit. The execution unit contains the registers, ALU and firmware for the CPU. Here, the instruction is carried out. Meanwhile, the next instruction has been passed along like the previous one, creating a process that keeps the execution unit functioning.

Memory management and protection are performed by the address unit, which translates virtual addresses to physical address and checks access rights at the same time. An on-chip cache with address mapping and protection data for virtual-memory segments eliminates the need to obtain these data from RAM-based tables, further contributing to the 286's overall performance.

Operating-system software is typically the first step in providing support. Miller says that in the 8086-compatible mode, the 286 will run any operating system written for the 8086, including Intel's iRMX 86 and Digital Research, Inc.'s CP/M-86. But no operating system now runs in the full 286 mode.

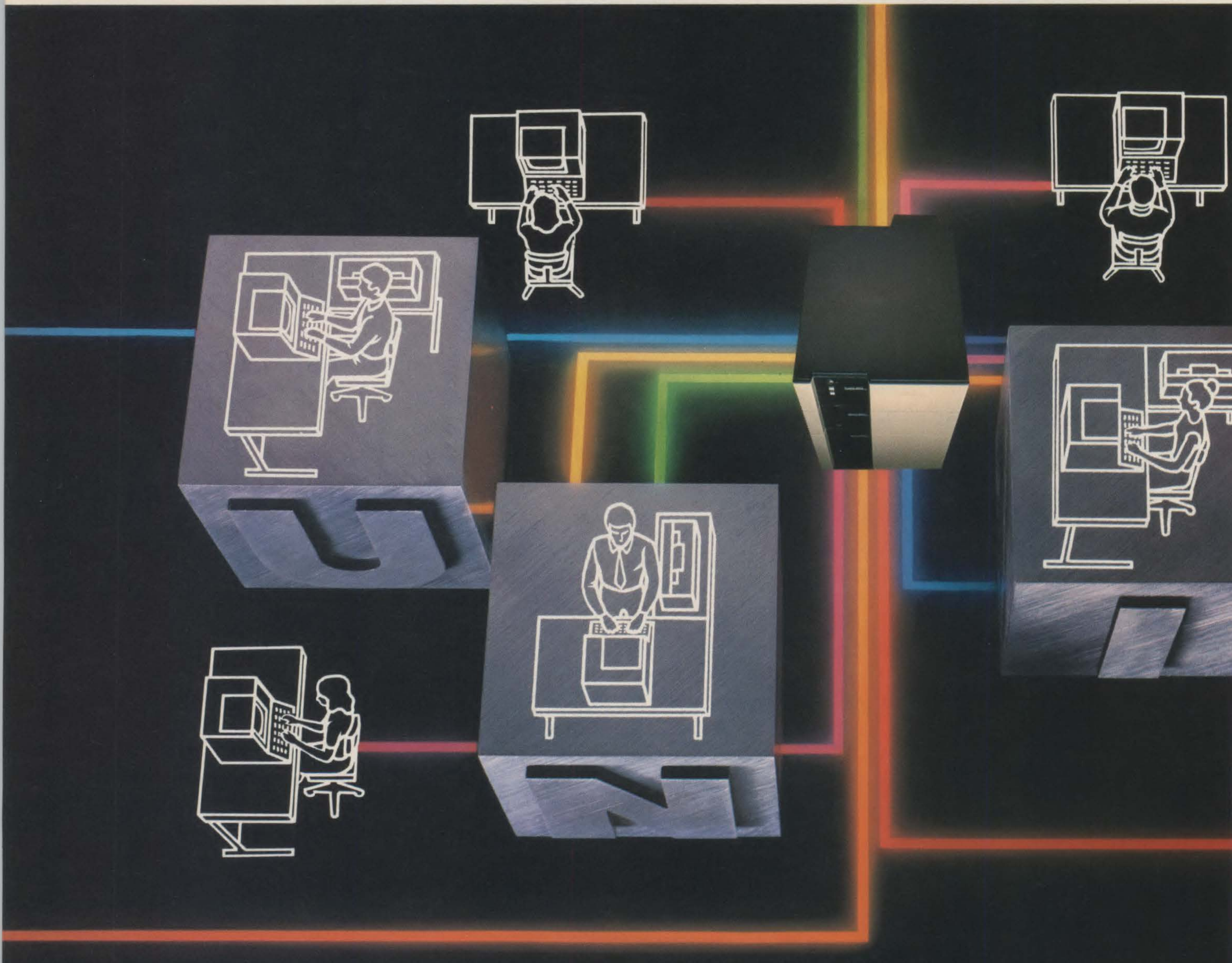
Such an operating system is expected, however, from Digital Research, Pacific Grove, Calif. Intel and the µc-software company have agreed to develop Digital Research's MP/M multitasking system for the 286. It reportedly will take advantage of all of the 286's features, including 1G-byte memory addressability and memory management and protection. It's too early in the development cycle for prices or delivery dates to be known, but a spokesman for Digital Research thinks MP/M-286 could be ready by year-end.

Intel is preparing its own 286 operating system kernel, says Miller, though it isn't clear when it will be available. Additionally, the company is planning an 80130-type operating system-in-silicon device (MMS, March, p. 93) for the 286. Other software products are due this year.

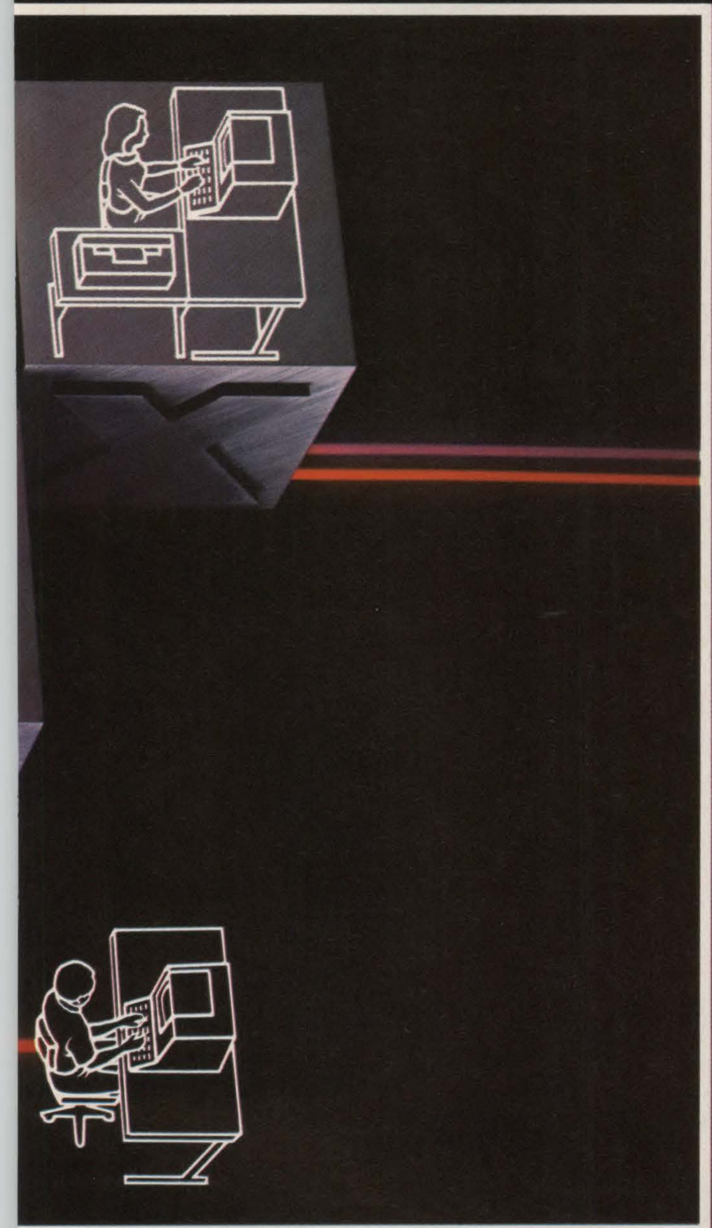
The complete iAPX 286 microsystem hardware family will be unveiled throughout this year. The 80286 CPU is expected to be sampled by July, with production shipments slated for the fall. The 80284 clock chip, the 80288 bus controller and the 80289 bus arbiter are also due then. A 286 version of the 8087 math co-processor is planned for the fourth quarter, Miller says.

In quantities of 100, the 80286 CPU in a 68-pin package sells for $237. *—Larry Lettieri*

In the Microworld, System 8000 is the



alternative to costly minicomputers.



Many people who use minicomputers are looking for a less expensive alternative. Zilog's System 8000, the Supermicro, runs UNIX* with minicomputer performance, but costs far less. For only $29,950, it supports 8 users and expands to 16 or 24.

System 8000 is an entirely new form of computer, featuring 16-bit architecture and modular packaging. It's too powerful to compare to other microcomputers, but it stacks up nicely against systems like the PDP 11/70†. Try it yourself and you'll call it the Supermicro too.

System 8000 is a quiet, compact unit consisting of unique stacking modules for future expansion. For $29,950, it comes complete with system software, 256 KB of ECC memory, a 24 MB Winchester disk, and 17 MB of tape back-up. (1-4 MB of memory and higher capacity disks also available.) Designed to get the most of UNIX, System 8000 supports high level languages such as C, FORTRAN 77, Pascal, COBOL and BASIC.

The Supermicro is based on Zilog's Z8001A 6MHz microprocessor plus memory management units and a 32-bit bus which provide a high performance computational environment. It is fully backed by Zilog's excellent technical support and field service. So if your budget is limited, get the full story about the Supermicro alternative by writing Zilog or calling your local sales office. Zilog, Inc., General Systems Division, 1315 Dell Avenue, Campbell, CA 95008.

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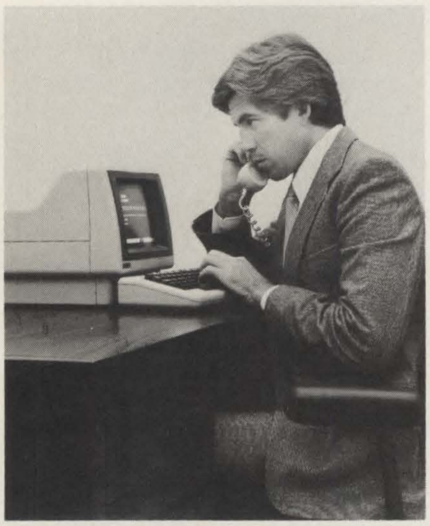
CIRCLE NO. 32 ON INQUIRY CARD

Two electronic-mail packages offered to HP 3000 users

Last fall, when Hewlett-Packard Co. announced its "Interactive Office" program, the Palo Alto, Calif., firm said it planned to add an electronic-mail package to its line during 1982. H-P made good on that promise late last month, when it introduced the HPMAIL software package, slated for delivery this July. HPMAIL follows the release of another electronic-mail package designed for HP 3000 users, which became available to customers in early February.



HP 3000 users suddenly have two choices of electronic mail—*from H-P and Infomedia. Both systems operate on any terminal that can be connected to an HP 3000 minicomputer.*

The "Jenny/3000" software package from Infomedia Corp., San Bruno, Calif., evolved out of that company's six-year background in computer conferencing services. Electronic-mail functions played a supporting role in Infomedia's complex conferencing service, says John Hoiness, executive vice president, marketing, so it was a natural step for the company to develop an unbundled electronic-mail package.

Both H-P and Infomedia are counting on the large installed base of HP 3000 computers to provide a ready market for their electronic-mail packages. H-P estimates there are more than 8000 installed HP 3000 systems with more than 100,000 terminals connected to them. From H-P's perspective, however, HPMAIL is a means not simply of taking advantage of this installed base, but of protecting and expanding these installations.

"What Hewlett-Packard has done with HPMAIL is to keep itself competitive with all the other vendors," says H. Paris Burstyn, electronic-mail analyst at The Yankee Group, Boston. Burstyn views the electronic-mail packages offered by several data-processing manufacturers as an incremental office application designed, in part, to protect their installed hardware bases.

"Users who had to do office automation in the past couldn't get such software from many of the vendors who had supplied their hardware, such as Digital Equipment Corp., International Business Machines Corp., Data General Corp. and H-P," he says. "What the customers ended up doing was buying another processor, which was more often than not a Wang, to do their office automation, and Wang Laboratories, Inc., was cleaning up."

H-P, with a strong penetration in the manufacturing world, hopes HPMAIL will not only help meet its customer's office needs, but will also increase the number of customers who use HP 3000s for office applications. Beth Richardson, North American product manager for HPMAIL, says the product may entice some users to increase communications between the shop floor and the office. "HPMAIL has the potential not only to meet our installed base needs," she says, "but also to expand our systems out of the traditional technical or manufacturing environment to the whole of a company."

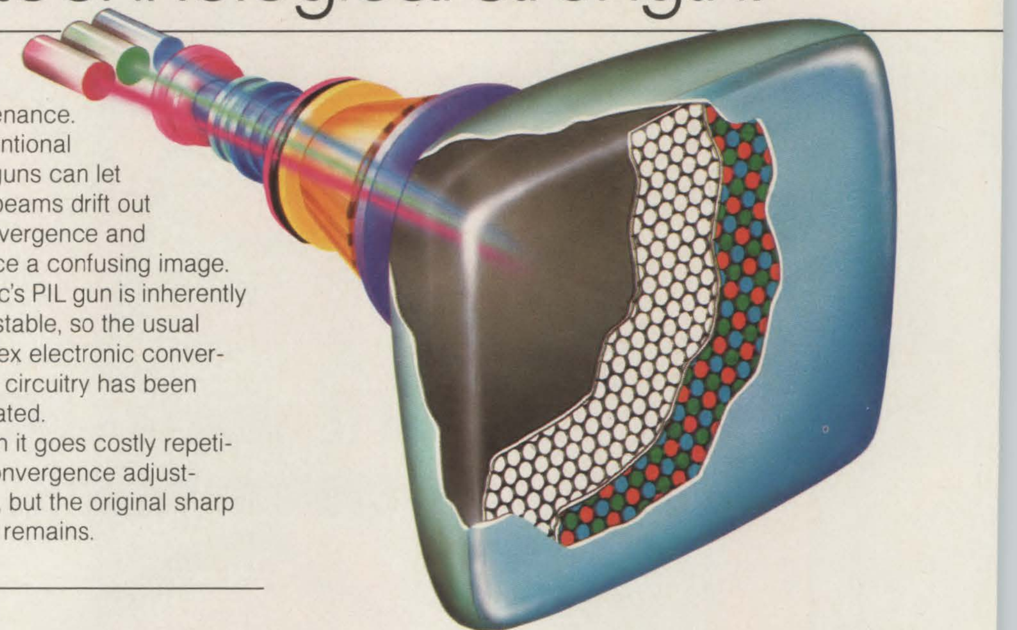
Richardson admits that some similarities exist between HPMAIL and Infomedia's Jenny/3000. For example, both packages provide verification that sent messages have been received and read, automatic message routing, transmission across distribution lists and security features. Prices are also similar, with HPMAIL selling for $10,000 and Jenny/3000 priced at $9800. But Richardson believes HPMAIL offers some significant advantages over the competing product.

"One distinction between ours and Jenny is that Jenny is designed to run on just a single 3000 system, not on multiple 3000s," she says, although noting that a multi-node version of HPMAIL won't be available until late this year. "Also, HPMAIL is designed to allow users to send any file that's resident in a current information base, including programs and graphics." She says she believes that with Jenny, a user can send only the message that is typed on the screen.

Infomedia's Hoiness agrees Jenny is oriented toward transmission of typed messages, but he doesn't view that as a liability, "because 99 percent of the mail usage will be pure and simple messaging." Also, he explains, Infomedia is rewriting Jenny so that it will run on other types of computers, as well as on HP 3000s. "Part of that rewrite will include the addition of multi-node capabilities," he says.

Both electronic-mail packages use single-function keys to initiate activities. On block-mode terminals, HPMAIL displays the function-key assignments on the screen, whereas Jenny uses a template that fits on

CONRAC SERIES 7211.
A display of technological strength.



No other display performs like the high-resolution Conrac 7211 because no other display is built like it. Simply put, this Conrac monitor can give you and your system a technological edge.

Conrac's Precision In-Line Gun: For a clear picture with color convergence locked in.
Conrac's Precision In-Line Gun hits your targets for easy setup and minimal maintenance. Conventional delta guns can let color beams drift out of convergence and produce a confusing image. Conrac's PIL gun is inherently more stable, so the usual complex electronic convergence circuitry has been eliminated.

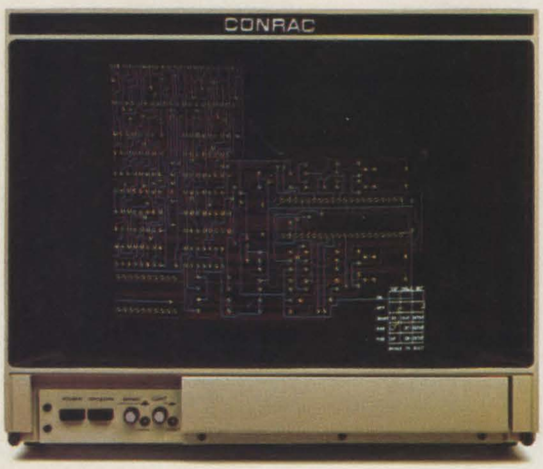
With it goes costly repetitive convergence adjustments, but the original sharp image remains.

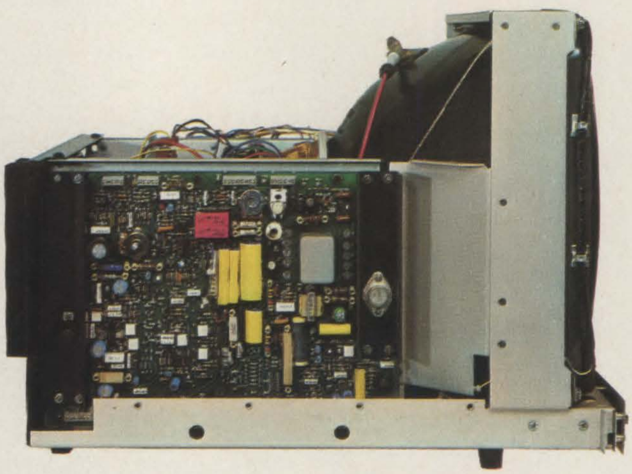
Form factor: The practical side of Conrac displays.
Space savings speed system integration. Besides 17.5" and 15.75" standard front panel heights, the 7211 is available with no front panel and remote controls, reducing front height to 14 inches.

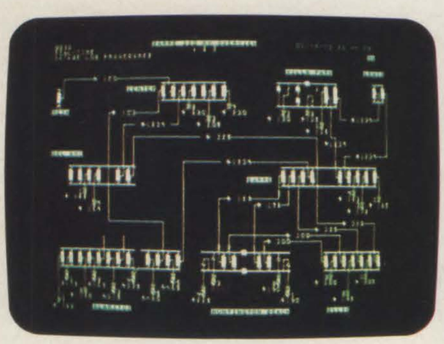
Its low-profile design is ideal for tapered cabinets. And to fit into your manufacturing plans, you can order the 7211 in 13" and 19" models, in cabinet, chassis-only, and rack-slide versions.

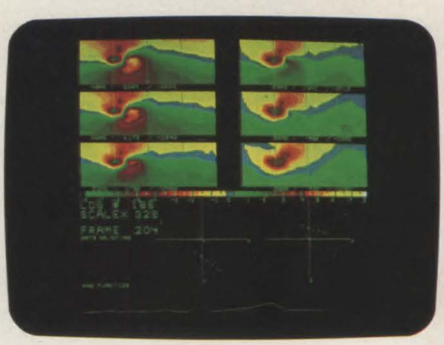
See how the 7211 can improve your image. CAD/CAM, process control, image processing — any application can benefit from the finer quality graphics you see on a 7211.

Screen data courtesy of Megatek Corporation.

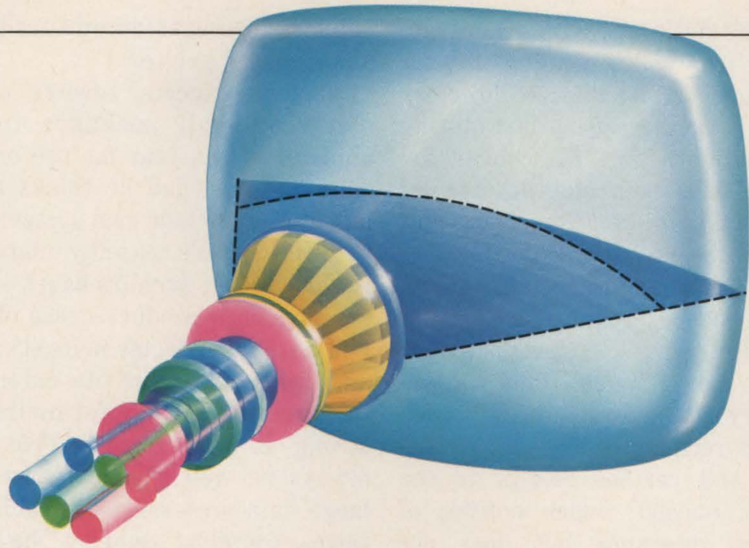








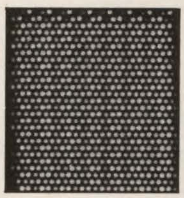
CONRAC



Dynamic focus:
Clearly a Conrac edge.
This Conrac strong point assures center-to-edge image focus for ultimate clarity. Simpler display designs pretend the tube's screen is a concentric circle, with an equal radius from center to edge. The Conrac gun automatically compensates for the different gun-to-screen distances that are actually found in modern tubes. The end product is a consistently sharp image across the entire screen.

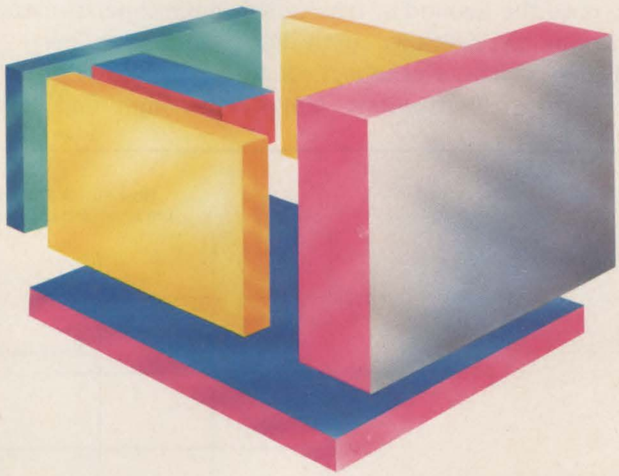
40 MHz

20 MHz

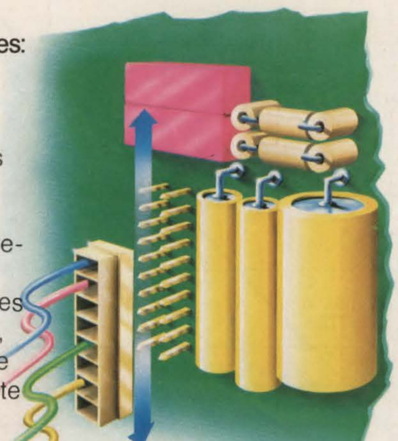


A wideband video amplifier:
Conrac's dedication to detail.
The 7211 has twice the usual video amp bandwidth, reaching up to 40 MHz (-3 db). This capability means you can easily accommodate deflection rates from 64 down to 27 μsec. Result: you get all the performance you've built into your system onto the screen. No more problems with soft edges, poor resolution, and the resulting operator fatigue. Note that the vertical striations are more visible in the 40 MHz display, shown above.

Modular electronics:
No one gets rich servicing
Conrac monitors.
Our modular electronics speed field maintenance. Just trace the problem to the circuit card or module level, remove the old PCB card, then plug in a new one. Less hardwiring in our display means less hard work for your technicians.



Selectable scan frequencies:
Conrac put in a plug for
economy and flexibility.
The 7211 will operate at all horizontal scan frequencies from 15 kHz to 36 kHz — in one convenient package. You select between three preset ranges by changing a jumper plug. Fine tuning does the rest. With this approach, you order and inventory one CRT display for this complete range of scanning frequencies. The 7211 selectable scan frequencies also offer the end user a built-in growth path to higher system capabilities.



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D 6992 Weikersheim
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the keyboard. Richardson claims the screen display provides more aid to users than the template, but Hoiness disagrees. "Essentially, we have the complete user's guide on a little strip that lays right above the numerics on an appropriate terminal," he says. "Our approach makes the system a lot less fearsome to a manager when he sees something already on the keyboard."

In its multi-node version, HPMAIL operates under H-P's distributed-systems network (DSN/DS) software, which allows transparent message routing over any communications path. The system is designed to approximate a typical worker's desk top, with an in tray, an out tray and a pending tray for messages; a distribution directory for constructing, using and storing distribution lists; a file cabinet for storing messages and documents; and a work area for composing and editing messages and for assembling packages of information files.

Jenny/3000 provides a built-in statistical feature to track usage for billing data. It also offers three delivery classes: registered, which notifies recipients of pending messages and verifies receipt to the sender; normal, which notifies of pending messages but does not verify receipt; and express, which delivers messages automatically to a designated printer.

Hoiness expects several other electronic-mail packages to be announced this year for use on HP 3000 systems, and he thinks H-P's move to offer their own system will help Infomedia's cause by informing H-P users that such packages exist. He says each product's ease of use will be a major factor in its success, and Infomedia, with its extensive background in conferencing is strong in this regard. "We will always be well ahead of even the large data-processing companies in terms of product usability," he says.

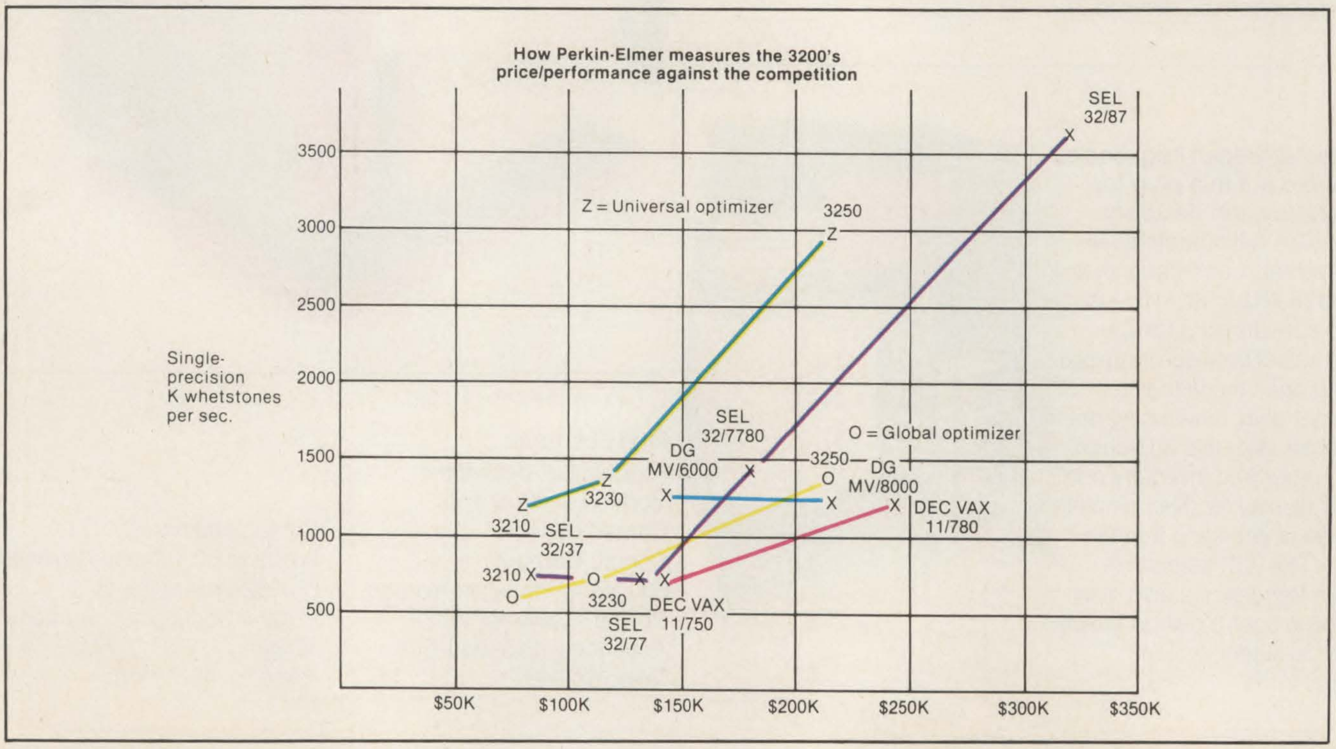
—Dwight B. Davis

Perkin-Elmer, DEC milk more performance out of superminis

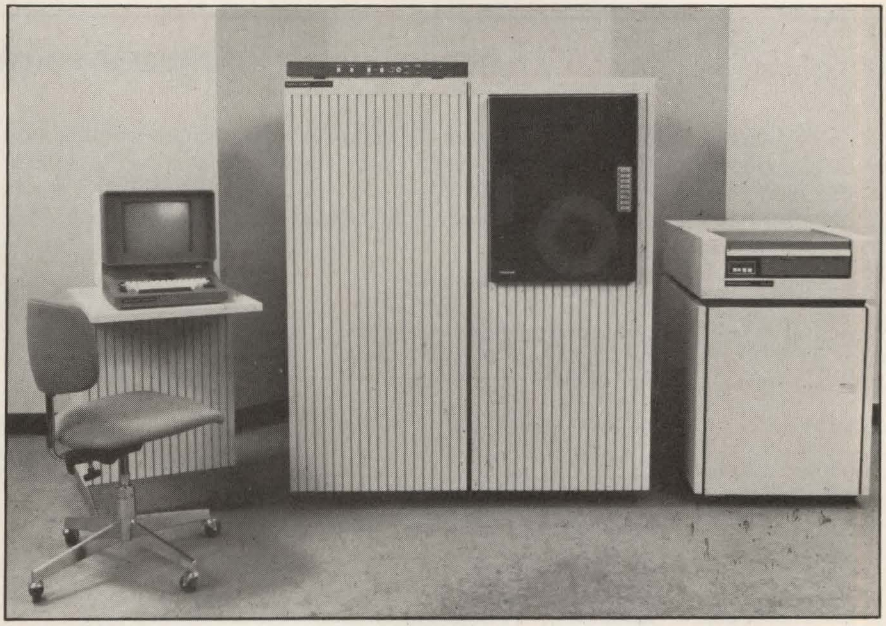
In efforts that encroach even more onto the ground of traditional mainframe applications, both Perkin-Elmer Corp., Oceanport, N.J., and Digital Equipment Corp., Maynard, Mass., are pumping higher performance into their 32-bit minicomputers.

In late February, P-E introduced its high-end model 3250 and an efficient FORTRAN compiler that the company claims improves execution speeds (see "Perkin-Elmer 'optimizes' FORTRAN," p. 70). For its part, DEC introduced the VAX-11/782, a dual VAX-11/780 system with the MA780 shared-memory subsystem.

The P-E model 3250 is available



Digital Equipment Corp.'s VAX-11/782, *which consists of dual VAX-11/780 32-bit processors and 2M bytes of MA780 shared memory, is designed for multistream, computation-intensive applications. One application is structural/mechanical design using a VS11 interactive color-graphics terminal.*



P-E's 3250 supermini *is housed in one cabinet that is three times smaller than the previous high-end model, the 3240. It is available in a variety of configurations with disk drives and tape drives.*

now in a variety of configurations, beginning with a processor and 2M bytes of memory for $150,000. A processor with 2M bytes of memory, a model 550B terminal, an 80M-byte disk, a 75-ips dual-density tape, a floating-point processor, battery backup, loader storage unit and 10 communications lines sells for $190,000.

The company claims the 3250 can perform 3038 single-precision Whetstone statements per sec. The computer has a 64-bit memory bus, and 16M bytes of addressable physical memory, configurable in as many as four interleaved banks. Memory bandwidth is 64M bytes per sec., and throughput is 40M bytes per sec. The computer is housed in one cabinet, which is three times smaller than the previous high-end model, the 3240, says Richard P. Donnelly, senior product manager for computer systems at P-E's Computer Systems Division, Tinton Falls, N.J. Customers can trade in earlier model processors for a 25-percent credit. The 3250 is compatible with the models 3210 and 3230.

The DEC VAX-11/782 basic configuration includes two VAX-11/780 processors, two MA780 shared-memory controllers with 2M bytes of memory, 124M bytes of disk storage, a TU78 magnetic-tape drive, an eight-line asynchronous multiplexer, two LA120 DECwriter III console terminals and VAX/VMS operating system. Prices begin at $395,000. Shipments are scheduled to begin early this summer.

Both the P-E and DEC superminis perform high-speed data analysis for seismic data-processing, large financial-modeling and other scientific and engineering applications. In such markets, they compete not only with large mainframes, but also with array-processor systems, some of which are low cost and linked with μcs (see "Sky finds niche in seismic market," below). The question arises about whether there

SKY FINDS NICHE IN SEISMIC MARKET

One-year-old Sky Computers, Inc., Lowell, Mass., which began shipping its first μc-based array processor six months ago, is finalizing a contract that may open a big portable seismic data-processing market.

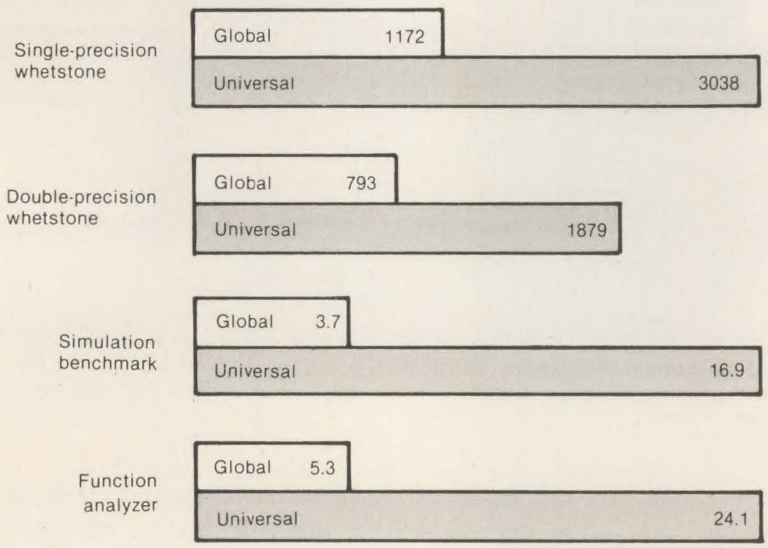
The company's Skymnk floating-point array processor can be linked to Digital Equipment Corp. LSI-11 or PDP-11/23 μcs that have a Q-bus. Support software includes the RT-11 V4.0 and RSX-11M V3.2 operating systems and the XM extended memory monitor for the RT-11. The Skymnk sells for about $4000 in OEM quantities of 100.

Sky's edge in the seismic data-processing market, against such competition as Perkin-Elmer Corp., is the result of the Skymnk's small size. For example, the product can be placed in mobile vans that go to oil or natural-gas sites and help major fuel suppliers decide where to drill. Fuel companies also use mainframes and other computers remotely and centrally for other aspects of seismic processing.

John A. Carbone of Sky, who sells array processors, says Sky has a tentative agreement with a major oil company for a small number of units to be delivered in June. Those processors will be used for development in the field, he says, although he won't reveal details of the application. The final agreement will be worth more than $500,000 over the next two years.

PERKIN-ELMER 'OPTIMIZES' FORTRAN

High-level languages gobble space and speed on a CPU. Recognizing this problem, and a perceived resistance in the market to using large, slow, high-level programs, Perkin-Elmer Corp., Oceanport, N.J., has become a major lobbyist for making such languages more efficient to use. The company introduced an "optimized" FORTRAN compiler called the FORTRAN VII Z for its series 3200 family of 32-bit superminis.



Source: Perkin-Elmer Corp.

P-E benchmarks for its global and universal optimized FORTRAN compiler as performed on the model 3250. *While a global compiler optimizes across 1000 or more individual program modules, a universal compiler optimizes across an entire program and module boundaries. The result is time saved in program use.*

FORTRAN VII Z is aimed at large computational applications. Perkin-Elmer claims the product, a superset of the ANSI X3.9-1978 standard for FORTRAN, has greatly improved execution speeds for FORTRAN-written applications. Price for FORTRAN VII Z is $24,950, and licenses will be available in May.

In 1978, the company introduced a more limited "global" FORTRAN VII optimizing compiler. The new "universal" compiler is broader in scope, says Richard P. Donnelly, senior product manager of computer systems for P-E's Computer Systems division, Tinton Falls, N.J.

Donnelly explains that a global compiler optimizes across 1000 or more program modules. A universal compiler optimizes across an entire program and module boundaries. Donnelly says the universal compiler absorbs subroutines into the main program to save time, rather than handling each individually. A programmer decides which subroutines to globalize or optimize.

is room for all the contenders in this vertical market.

The supermini market is becoming crowded, says Greg Leveille, director of the small computer systems group at the Gartner Group, a Stamford, Conn., analysis and market-research group. "It's the old story of confluence of market directions."

The crowding becomes more evident, in a market such as seismic data processing, he says, because not very many interfaces are required for the various applications. "Different scientific markets have different requirements, and all computers don't necessarily meet them," Leveille says.

Another issue in gaining market share, he says, is that the scientific community typically has more vendor loyalty than does the commercial. This is because a scientific application requires a greater investment in time and training, such as an in-depth knowledge of assemblers for specific machine architectures. "Another vendor can come in with a better, more capable system that has a better price (than an installed system)," Leveille says. "But the user will not buy it because of the time investment required to learn the new system."

Leveille sees limited growth in new accounts for such high-end machines. But the recent push toward industrialization could open new markets, such as sophisticated business modeling in Fortune 1000 companies, especially when the prices of existing machines drop. Leveille says that if such a user pays $300,000 for a machine, plus overhead costs, the price would correct one wrong business decision.

P-E's Donnelly says the company will not pursue the business-modeling market now because it is a limited application, but may do so later. He says many applications still exist in vertical markets such as seismic exploration, an application that requires different machines for different segments.

Donnelly estimates that the high-end 32-bit minicomputer market, which includes the VAXs, the 3250, Gould S.E.L.'s 3287 and Data General Corp.'s MV/8000, is worth about $300 million worldwide this year, and will grow 35 to 40 percent yearly until 1985. *—L. Valigra*

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Why this operating system?

Ask the leading independent software vendors. They know Intel's iRMX 86 well enough to know it's an industry standard; that it allows them to plug into VLSI technology, and to design in a heap of high-performance features.

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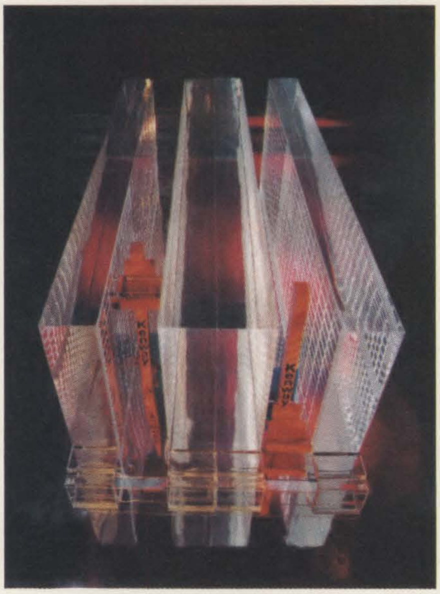
EATON-KENWAY INTRODUCES MINI-LOAD 200

Now you can buy a storage/retrieval system with standard, real-time software control that can be linked to a host computer in an integrated network.

Eaton-Kenway's new Mini-Load 200 costs less and can be delivered faster than custom systems. The new standard ML200 can easily be justified in operations requiring high throughput.

The unique, off-the-shelf software/control package consists of proven modules installed on a small, built-in computer. It maintains stock locations by part number and collects real-time inventory data as parts are stored and retrieved, then transmits



pickers can be cut by half or more. With controlled access, timely, accurate retrieval and accurate picking, you can cut your reserve stock and reduce inventory investment.

The high-density Mini-Load 200 takes about one-third the space used in conventional storage and the steel-enclosed ML200 protects inventories from fire, dust and pilferage. While the hardware is standard, you can configure a system to fit your needs — from one to ten aisles, heights to 40 feet, and up to 300 feet long. The 500-pound capacity storage bins are available in nine sizes.

THE FIRST AUTOMATED SMALL PARTS STORAGE/RETRIEVAL SYSTEM WITH A STANDARD SOFTWARE CONTROL PACKAGE.

this data to a host computer in real-time or in batch. The system generates reports and conversations which are the most popular with distribution and production managers.

ML200 is a stand-alone system which can be easily upgraded through four levels of control with no added software and only minimal additional hardware. This saves time, money, and assures that the system will keep up with your data processing growth.

The easy-to-operate ML200 eliminates the picker's walking and searching time, increasing pick rates by over 100% while reducing picking errors. The number of

Mini-Load 200 is the result of Eaton-Kenway's experience in installing more computer-controlled material handling systems than any one else. To find out more about the new standard in automated small parts storage systems, call or write John Ryder at Eaton-Kenway, 310 South Main Street, Salt Lake City, Utah 84101. Telephone 801-532-2555.

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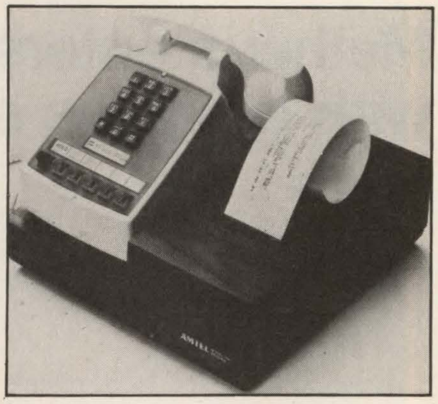
Message system transmits over electrical wiring



Amtel's desk-top printer *produces hard-copy messages of incoming phone calls, TWX/Telex transmissions and information originating at large-scale computers, communication processors and central word-processing facilities.*

Amtel Systems Corp.'s Messenger II system, which transmits messages over 110V electrical wires to desk-top thermal printers, is difficult to classify. The system is part electronic mail, part telephone messaging service and part interface to external networks and computers. Users can configure the system to support one or all of these functions.

In its basic form, Messenger II consists of a Z80-based North Star μc, an Applied Digital Data Systems CRT terminal, a Century Data Systems 18M-byte Winchester-disk drive and a distribution transmitter. Phone messages received by an operator are entered on the CRT, placed on the disk and immediately transmitted over twisted-pair lines to the distribution transmitter.

Essentially an intelligent power-line modem, the distribution transmitter uses an Amtel-developed frequency-shift-key modulation scheme to support 16 channels, each operating at 300 bits per sec. Because the power-line transmissions generally won't propagate between different electrical lines, each floor of a building typically requires its own transmitter for message redistribution.

Don McCook, vice president of marketing at the Sunnyvale, Calif., firm, says the Messenger II circumvents a large portion of a typical network's installation and implementation costs by using a company's existing electrical system for transmissions. The Messenger II, which handles about 2000 users and 1000 messages per hour and stores as many as 30,000 messages on its 14-in. Winchester, evolved from the Messenger I, which handles about 250 users and 200 messages per hour.

Aside from functioning as a phone message-distribution system, the Messenger II interfaces directly to networked computers and to other outside networks such as TWX and Telex. Regardless of where a message originates, it is transmitted directly to a printing unit on a recipient's desk.

Each desk-top printer has a unique internal address, and can therefore be moved to different locations without confusing the distribution system. Incorporating a Texas Instruments Inc. 5 × 5 thermal matrix print head, the 8048-based printers off-load some of the host CPU's networking tasks, McCook says.

Amtel is targeting the Messenger II at large companies where rapid message delivery is critical. "We're not competing head-to-head with other electronic-mail products, but for money to be used for any office-automation expense," says McCook. "We will win orders from less technically oriented companies, such as law firms and CPAs, because of our system's simplicity."

Messenger II stores distribution lists for message broadcasting to specific user groups. Messages can be automatically routed to users temporarily at a location other than their desks, and the status (whereabouts, time of return, forwarding number) of a user not answering his phone can be displayed on a central CRT screen. An automatic calendar reminds users of commitments and meetings on a one-time or a recurring basis.

The system does not automatically purge old messages, but instead automatically notifies the system operator of any user whose number of stored messages reaches 400 or more. Each message carries the date and time of its transmission, simplifying message retrieval or purging.

Amtel offers several printer models, some receive-only and others that allow simple responses (such as indicating to an operator whether to hold an incoming call or to take a message) or message origination. The power-line network uses a carrier sense multiple access with collision detection (CSMA/CD) scheme to moderate messages entering the system from printers.

A basic Messenger II, consisting of the North Star CPU, the ADDS terminal, the Winchester-disk drive and one distribution transmitter, sells for $29,950. Additional distribution transmitters sell for $850 each, and printers start at $550 each for the RO models. Amtel will soon introduce several call announcers, which will display short messages on small screens and replace the printer units at locations where users don't require hard-copy messages.

—Dwight B. Davis

Metheus enters market with graphics subsystem

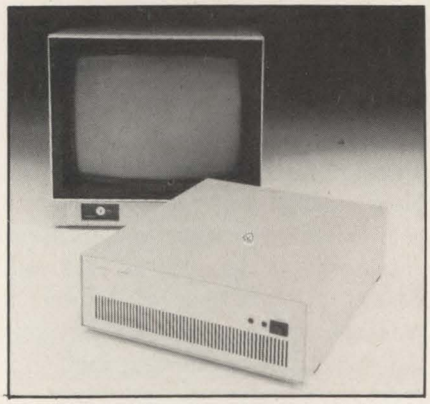
A graphics subsystem, promoted as offering high resolution at a price a user would typically pay for a medium-resolution product, has been announced by Hillsboro, Ore., start-up, Metheus Corp.

Aimed at OEMs and large-volume end users for CAD/CAM and high-end business applications, the 1024 × 1024 resolution Omega 400 interfaces with Digital Equipment Corp. computers. Sam Bosch, director of marketing at Metheus, says that a planned version of the subsystem will interface with Data General Corp. and Honeywell Information Systems machines, as well. "DEC has the largest installed base in our market," says Bosch. "To get out with the product quickly and establish an early market share, we went with the DEC parallel interface first."

Bosch says that Metheus achieved the $22,000 price for the Omega by using 64K-RAM technology, which allows for single-board construction, and by using a modular design. "We've built the subsystem the way the Japanese build cars," notes Bosch. "Japanese cars have a very low sticker price, but everything a driver could want is included in that price," he says.

The Omega 400 subsystem, which consists of a monitor and a display controller, includes four memory planes that display as many as 16 colors, integer zoom, pan, block transfer and an instruction set for vectors, characters and area fill and clear.

With vector and character speeds as high as 1 million pixels per sec. and fill and clear speeds as high as 16 million pixels per sec., the Omega graphics-display controller is one of the three fastest controllers in the industry, Bosch says. He lists the



The Omega 400 subsystem, *consisting of a monitor and graphics display controller that can also be purchased separately, provides 1024 × 1024 resolution and includes built-in diagnostics, a signature analyzer and support software.*

controller's competition as products from Aydin Controls and Genisco Computers. The unit can be purchased separately for $14,000.

The subsystem's competition in the 1024 resolution range, he says, includes products from Advanced Electronics Design, Grinnell Systems and Lexidata Corp. In the 512 resolution range, the competition includes Raster Technologies, Matrox Electronics Systems and AED subsystems.

Rather than attack the low-end sector of the market with a low-resolution product, Bosch says, Metheus decided to exploit the technological expertise of its founders by designing a high-technology product.

That expertise comes from company president and chief executive officer Gene Chao, a former director of research at Tektronix, and from Robert Bruce, the principal designer of the Omega, and a former senior engineer at Tektronix. "The low-end market requires high-volume manufacturing and sales channels through which we'd have to put a terminal in every Computerland store," says Bosch, a former Intel marketing executive. "Our expertise is in the technology-driven segment of the market."

He adds that the low-resolution, high-volume market will receive competition from large data-processing OEMs, such as DEC and DG, but that such OEMs will purchase their high-resolution graphics subsystems from companies such as Metheus. "They (large data-processing OEMs) don't have the expertise to develop high-technology, low-volume products," says Bosch. "They've told us outright that they're going to OEM them."

In attacking the CAD/CAM and high-end business-graphics market, Metheus will miss a large chunk of the burgeoning business market. That market is growing at a 65-percent annual rate and consists primarily of users of low-resolution products selling for less than $5000, according to The Yankee Group, a Boston based market-research firm.

Bosch notes, however, that, as many of the first-time business users gain expertise with low-resolution graphics products, they'll appreciate what higher resolution products can provide. Further, he says, as graphics processor, memory and monitor prices decline, these users will soon be able to afford higher resolution products such as the Omega 400. "This year's high-end product will be next year's mid-range," Bosch says. "I think that in the next year or two, 512 resolution users are going to demand 1024."

Besides the Omega 400 subsystem and the display controller, both of which will be available for distribution in April, Metheus also offers a graphics software package, called Argus. Written in ANSI FORTRAN, Argus includes 62 FORTRAN-callable subroutines and sells for $2000, with an annual subscription rate of $450. *—Frank Catalano*

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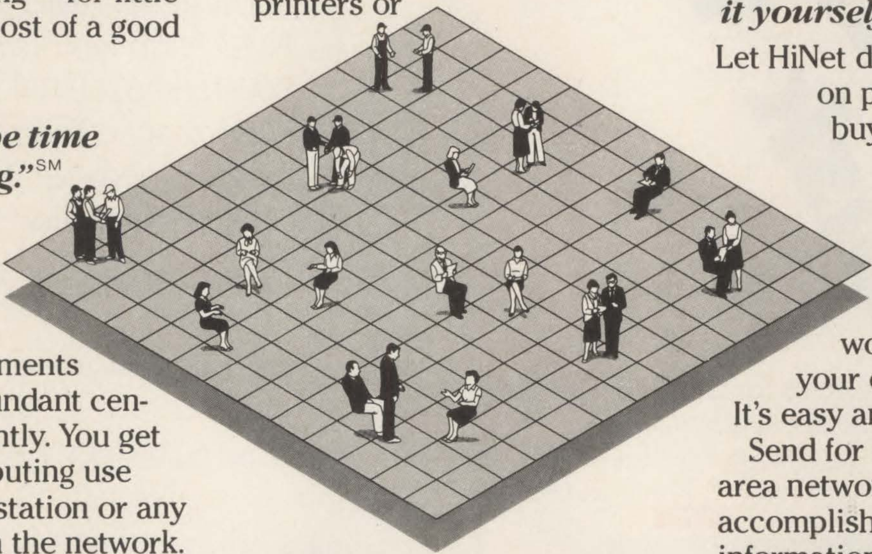

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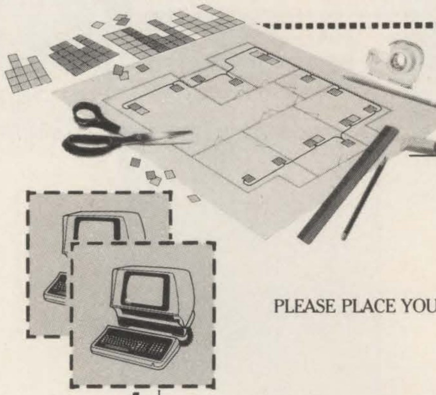

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Software companies will come of age this year

Independent μc software companies, having improved their stature and products, are trying to lay to rest their image as a cottage industry. Companies such as Microsoft, Inc., Software Arts, Inc., VisiCorp and MicroPro International Corp. have gained recognition because of their solid, trend-setting products. Their success has attracted investors, and some companies have accepted cash infusions.

Vern Raburn, vice president of the consumer products group at Microsoft, Bellevue, Wash., says 1982 is the year the μc software industry will mature. "Companies will become more professional than before," he says. "It will be as much a change in attitude as a change in the market."

Until now, Raburn explains, money spent on software has been secondary to that spent on hardware. And, though he expects the installed base of systems to double this year, helped by the introduction of hardware by existing manufacturers, he thinks the hardware side of the business is mature.

Seymour Rubinstein, founder of MicroPro, San Rafael, Calif., says that with the drop in hardware prices, the focus of software companies shifted from technical to end-user products. The reevaluation process of human-versus-computer resources occurred in the early 1970s, as word processors spread computer use into offices. Other milestones in the evolution of the software industry included the development of BASIC for the Altair μc and the 1977 development of CP/M, the first μc operating system. Soon after the CP/M announcement, Microsoft put BASIC and FORTRAN onto CP/M.

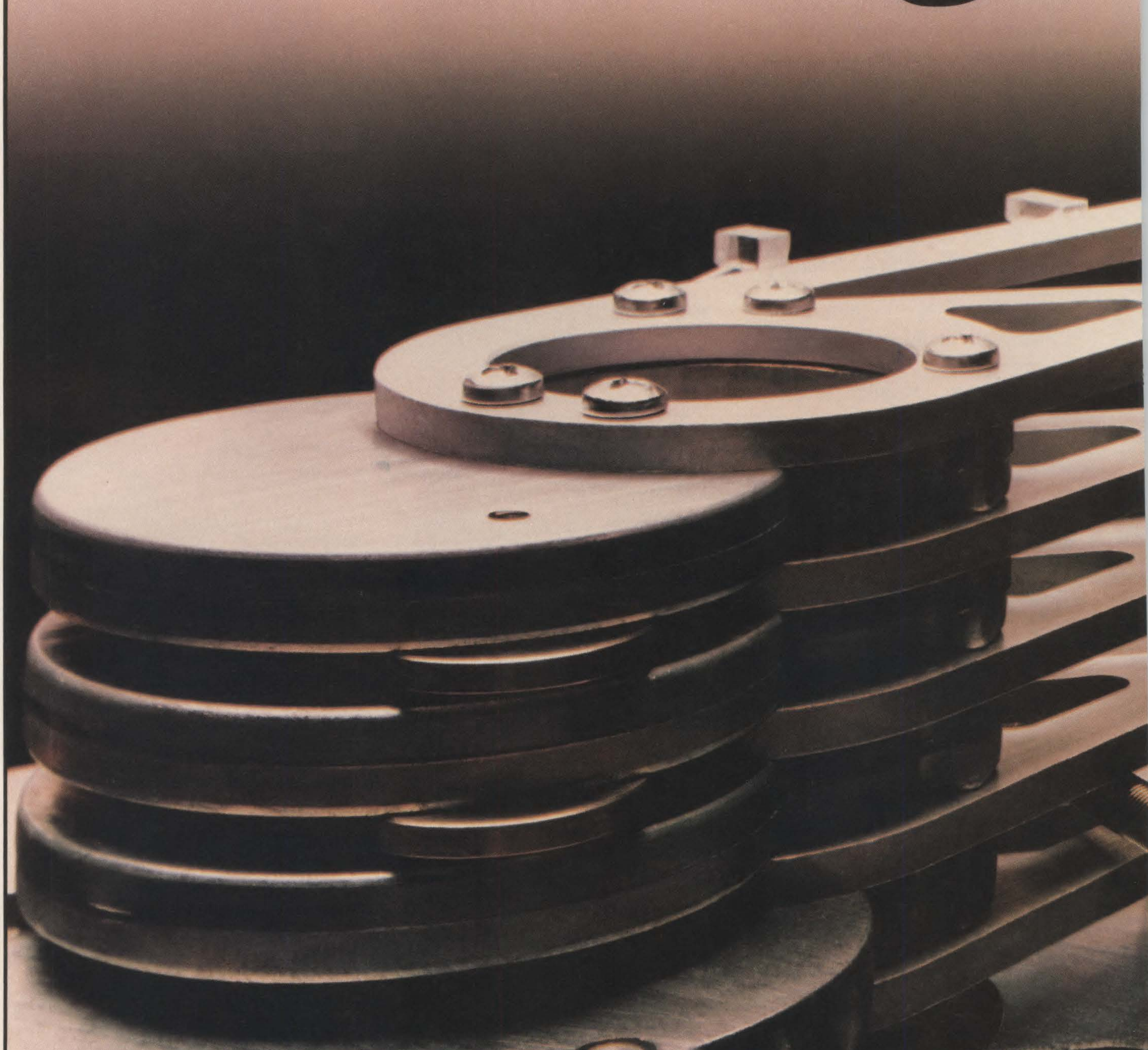
Says Rubinstein, "1977 was a critical year for the foundation work in the μc software industry." Although the basic tools were in place, the μc industry was still a hobby business. Then, products such as VisiCalc from VisiCorp and MicroPro's Wordstar entered the market and showed that software is a marketable product, Rubinstein says.

VisiCalc, developed by Software Arts, Cambridge, Mass., and marketed by VisiCorp, has had remarkable success. More than 200,000 copies were sold in the past two years, and VisiCorp claims that the product is an industry standard. Several VisiCalc look-alikes are on the market. More productivity tools, also expected to be hot sellers, are on the way from a variety of software houses. "This year," says Raburn, "software companies' revenues will be in the 10s of millions of dollars." A large factor in that success is the type of software being introduced. Besides being easy to use, new packages will increase productivity; packages similar to VisiCalc will be introduced for other applications, Raburn says. Such a product is Microsoft's Multiplan, an electronic work-sheet package introduced in November, 1981. It is the first in a series of 10 planned products in the company's Multitool line. Microsoft's Manager series, licensed from Image Producers, Chicago, is designed to improve manager produc-

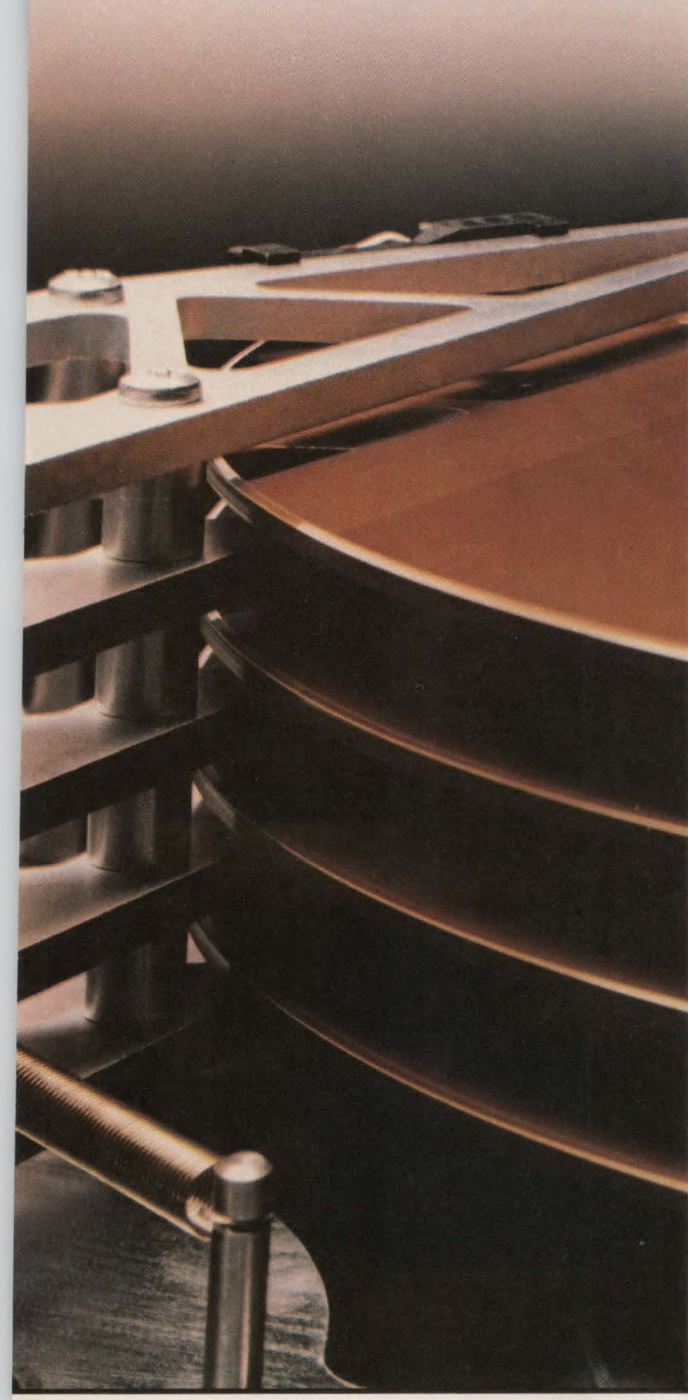
MicroPro's Seymour Rubinstein *says venture capital for software companies has been a long time coming. "The financial community did not understand the value of software, and the companies and software sellers appeared flaky."*

The VisiCalc team, headed by Robert M. Frankston and Daniel S. Bricklin *(front), has produced a trend-setting product that already has spawned look-alikes.*

We couldn't well enough



leave alone.



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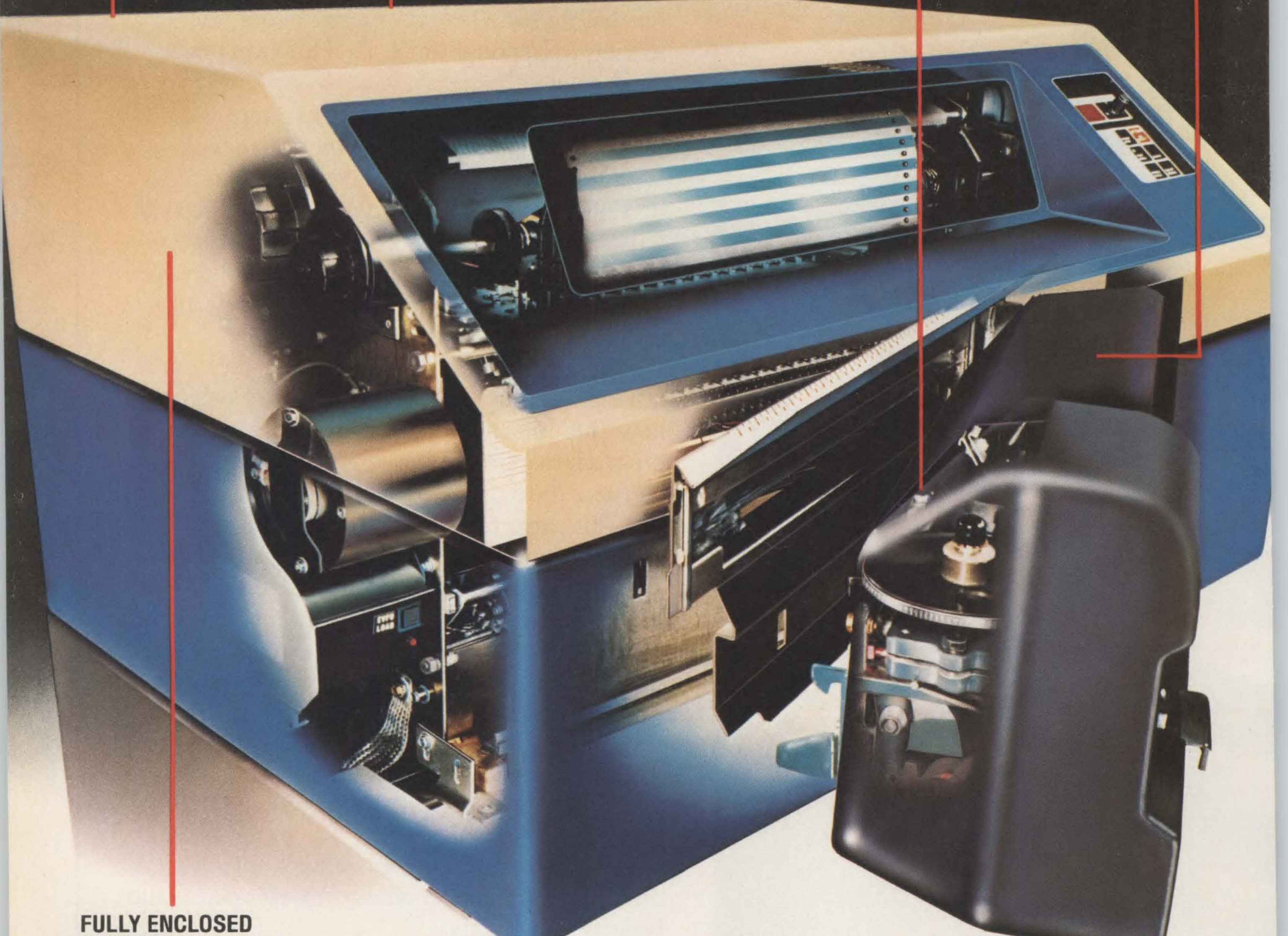

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CIRCLE NO. 42 ON INQUIRY CARD

tivity with time, project and personnel packages.

Some software companies go to great lengths to get an appropriate package to sell. "We'd buy a software company to get a product. Our future is on our software," says Donald V. Fluken, vice president of finance and administration at MicroPro.

MicroPro, however, probably would not be a likely buy for another software house. The company, which had $5.2 million in revenues last year and $3.2 million in the first quarter of this year, plans to go public either this fall or next fall, depending on its needs for building expansion.

A μc software company's going public may seem strange, but MicroPro has already caught the eye of venture capitalists. More than a year ago, it received $1 million in venture money from Data General Corp. backer Frederick R. Adler. That infusion provided advice as well as financial support to MicroPro.

In mid-1978, few, if any, venture moneys were available for software companies, says Rubinstein. "The financial community did not understand the value of software," he says. "And, the companies and software sellers appeared flaky."

Among several companies that have received venture moneys is Microsoft, which does not intend to go public. The 125-employee company was incorporated in July, 1981. Before that, it did business as a partnership since 1976, with co-founders Bill Gates, now company president, and Paul Allen, now executive vice president, as the partners. At the time of incorporation, Microsoft received some venture capital from Technology Ventures, Inc., Menlo Park, Calif. Gates says TVI made a "$1-million investment for a small percentage of the company."

Gates says he has not yet used the venture money. That's probably because Microsoft has been profitable since 1977, and revenues are expected to reach $30 million this year, doubling those of last year. That's also why Microsoft will not go public, at least not within the next few years. "It's too big a drain on management time," Gates says. Besides, "this company means more to us than it could to someone's stock portfolio."

The importance of a company to its employees and its founders may be one source of frustration to investors who want a piece of the software-company action. Software Arts, which went from rags to riches over the past three years, has built a thriving business from its VisiCalc and other products. Revenues were more than $3 million last year. The company is not interested in obtaining venture money or going public. Its founders choose instead to maintain steady, manageable growth and to satisfy employees. "We don't have a cash crunch to require money," says Daniel S. Bricklin, chairman of the board, executive vice president and co-founder. "Our growth is fast. More money to make faster growth makes mistakes. We must hire and train people well."

The success of companies such as Software Arts and all the profits to be gained in the μc software business notwithstanding, Microsoft's Raburn does not see 1982 as fertile for software start-ups. The cost of product marketing is "a couple of thousand times higher than it was a few years ago," he claims.

—L. Valigra and Larry Lettieri

BOX SCORE OF EARNINGS

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

Company	Period		Revenues	Earnings	EpS
Adage	9 mos	1/2/82	18,537,000	1,338,000	.93
	9 mos	12/27/80	10,394,000	383,000	.33
Advanced Micro Devices	9 mos	12/27/81	206,384,000	5,836,000	.36
	9 mos	12/28/80	229,073,000	19,507,000	1.23
Control Data	12 mos	12/31/81	3,101,300,000	170,600,000	4.48
	12 mos	12/31/80	2,765,600,000	150,600,000	4.23
Dataram	9 mos	1/31/82	14,679,000	889,000	.37
	9 mos	1/31/81	18,377,000	1,471,000	.63
Informatics	year	12/31/81	150,327,000	5,120,000	1.47
	year	12/31/80	125,893,000	5,332,000	1.58
Lexidata	3 mos	12/31/81	6,488,700	696,800	.15
	3 mos	12/31/80	1,521,200	(98,000)	(.03)
Logicon	9 mos	12/31/81	44,556,000	1,633,000	1.62
	9 mos	12/31/80	37,974,000	1,653,000	1.70
MSI Data	9 mos	12/26/81	41,023,000	3,439,000	1.40
	9 mos	12/27/80	39,763,000	2,461,000	1.06
NBI	6 mos	12/31/81	43,832,000	4,833,000	.52
	6 mos	12/31/80	24,768,000	2,829,000	.33
T-Bar	year	12/31/81	30,407,000	1,944,000	.95
	year	12/31/80	23,563,000	1,096,000	.53
Triad Systems	3 mos	12/31/81	16,007,000	403,000	.06
	3 mos	12/31/80	15,272,000	1,704,000	.27
Zenith Radio	year	12/31/81	1,275,200,000	15,600,000	.82
	year	12/31/80	1,185,900,000	26,400,000	1.40
Zentec	year	12/31/81	22,500,000	2,540,000	.80
	year	12/31/80	16,500,000	1,587,000	.61

Shires's sales savvy key to his success

Philip Shires, newly appointed president of the Data Products Division of Lear Siegler, Inc.: *"The only news in sales has been good news."*

He graduated with a degree in economics from Claremont College in California and put that education to work at nearby Wayne Manufacturing by applying regression analysis and a computerized parts-inventory system to keeping the nation's Streetsweeping machines sweeping. But Philip Shires thinks his biggest asset as the newly appointed president of the Data Products Division of Lear Siegler, Inc., is nothing so fancy.

"I know about sales, and that's all-important in a sales-driven industry," Shires says about the video-terminal segment that comprises most of the Anaheim, Calif., Data Products Division's business. "Our job is not to develop technology—the semiconductor houses do that—but to sell it. And that requires an understanding of this industry's distribution channels, which are relatively young and thus always changing."

Shires came to Lear Siegler in 1975 after a stint as manager of distribution at Wayne and then five years in various manufacturing management positions at Beckman Instruments. Although the career achievement of which he is most proud is his success in manufactur-

ing, culminated by two years of guiding Lear Siegler's rapid ramping up of terminal production during the mid-'70s, Shires voluntarily switched to sales. "Parts shortages, problems with a vendor—the only news you hear in the manufacturing end is bad news," he says. "Besides, it was obvious who was making the big bucks—and it wasn't the poor devils in materials or manufacturing." His receipt of the salesman-of-the-year award in his first full year of sales was the beginning of an ascent through the positions of central regional sales manager, national sales manager and then vice president of marketing and sales. "The only news in sales has been good news," says Shires with a grin.

Shires says Lear Siegler gives its executives a three-year plan and free rein to achieve the company's goals. Because he heads an excellent team, he says, he doesn't expect any changes in that or in the Data Product Division's consensus approach to decision making.

"The vice presidents and I have offices within about 20 ft. of each other, and we talk pretty informally back and forth," Shires says. "Communications are like that throughout the company."

Shires notes that Siegler holds a 16-percent share of the dumb-terminal market, and says he would be happy to maintain that share and simply grow with the market. But he expects the company to increase market share in the faster growing smart-terminal segment, and looks forward to the generation of "some real excitement" by Lear Siegler's introduction of several new printers at the National Computer Conference.

—Kevin Strehlo

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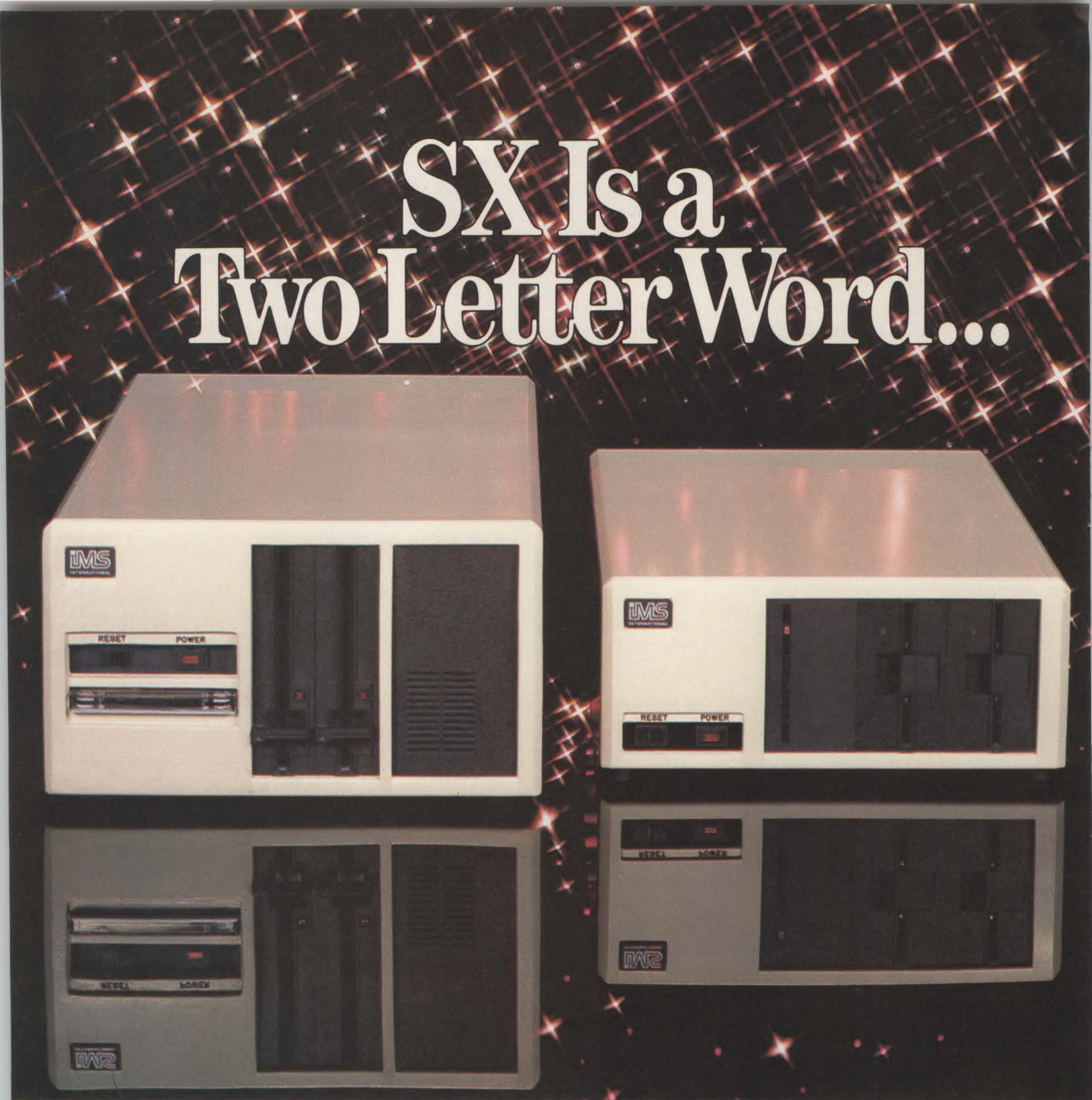

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CIRCLE NO. 47 ON INQUIRY CARD

U.S. computer makers dominate European market

U.S.-based manufacturers of general-purpose minicomputers dominate the West European market for these machines, accounting for about three-fourths of all shipments and installations. Their Europe-based competitors are typically strong only in their native countries.

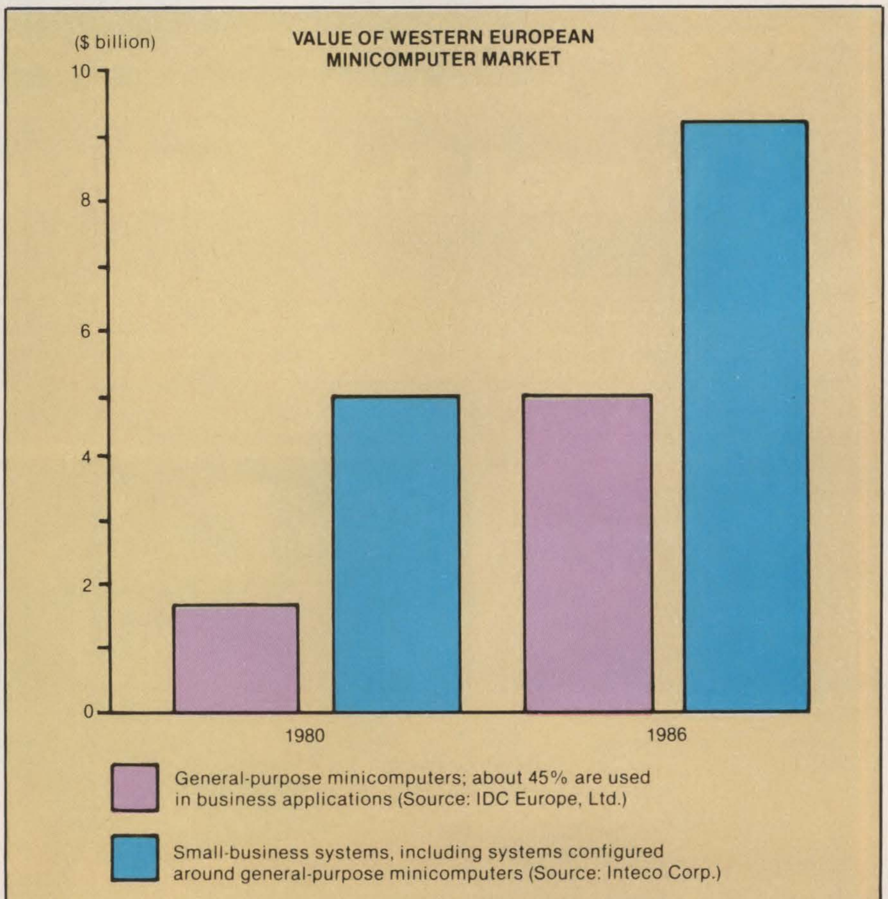
The overall value of the mini market in Europe will triple between 1980 and 1986, from less than $1.7 billion to more than $5 billion at current values, according to a 140-page, $2500 report, "The Minicomputer Marketplace in Western Europe," published by IDC Europa Ltd., the European arm of research group International Data Corp. The report is based on interviews with 25 European minicomputer vendors and 90 system integrators.

U.S.-based market leaders in Europe are the same companies that lead the field in the U.S., says the report. Overall market leader is Digital Equipment Corp., which accounts for about one-fourth of all shipments and machines installed. It is also the top supplier in every Western European country except France. Hewlett-Packard Co. and Data General Corp. are also among the top five suppliers.

The report includes installed-base and shipment figures in both units and dollars for the 15 top minicomputer vendors in Europe in 1980. Figures are based on manufacturers' shipments to end users and OEMs and include the value of peripherals, CPU and memory. The report states that U.S. firms charge about 15 percent more for equipment in Europe than in the U.S. to cover higher marketing costs in Europe.

The report also examines growth rates from 1980 to 1986 of the three main classes of minicomputers. They include low-cost minis such as the DEC LSI-11 line, medium-power machines such as DEC's PDP-11/34 and 32-bit superminis such as DEC's VAX series. IDC's figures show that superminis accounted for more than half of total European revenues in 1980. The report also predicts that sales will grow by an average of 25 percent a year and will account for two-thirds of all revenues by 1986. Minicomputer and μc sales will grow even faster, but the revenue share provided by the traditional mini will drop to less than 20 percent by 1986 because of a relatively sluggish average annual growth rate of around 7 percent.

The report focuses on the general-purpose mini market, largely ignoring the packaged small-business-system market. Thomas Bachman of London, England-based consultancy Inteco Corp., a Dataquest Inc. affiliate that specializes in the European small-business-systems market, points out that small-business-system configurations based on minicomputers under IDC's definition account for a relatively small proportion of total sales in Europe. The small-business-systems market was worth $5 billion in 1980 and should grow more than $9 billion by 1986, Bachman says. *—Keith Jones*



General-purpose minicomputer market in Western Europe is expected to grow *from $1.7 billion in 1980 to $5 billion in 1986. Small-business-system market is larger, and is expected to grow from $5 billion in 1980 to $9.2 billion in 1986.*

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CIRCLE NO. 48 ON INQUIRY CARD

France nationalizes its computer industry

France's socialist government, which took power about a year ago, is nationalizing the country's computer industry, which includes substantial minicomputer and terminal manufacturing operations. The nationalization move has increased suspicion in the industry that non-French companies are less likely to get contracts, although the French government says its involvement makes no difference.

The government has taken control of CII Honeywell Bull, the largest French computer company. CII-HB builds and sells the Level 6 line developed by Honeywell Information Systems. Another company coming under state control is Société Européene de Mini-Informatique et de Systèmes (SEMS), the largest manufacturer of French minicomputers. Also being nationalized is Transac-Alcatel, which builds multiterminal distributed-processing systems and banking terminals.

SEMS is part of Thomson-CSF, a major manufacturer of telecommunications equipment, military electronics and components. Thomson-CSF is 43 percent owned by Thomson-Brandt SA, the largest French electronics conglomerate. The government is buying Thomson-Brandt and acquiring a controlling interest in Thomson-CSF, and hence SEMS. This is because two major French banks—also being nationalized—own approximately 11 percent of Thomson-CSF. Thus, the government will hold more than half of Thomson-CSF's stock.

SEMS generates annual revenues of around $150 million from manufacturing the Mitra and Solar minicomputer products lines. The incompatible lines resulted from the mid-'70s merger of industrial control manufacturer Télémecanique SA, which built the Solar line and which still holds a large minority interest in SEMS, and Compagnie Internationale pour l'Informatique (CII). CII sold its Mitra mini family for communications applications when the company merged with Honeywell Information Systems in France and the rest of Western Europe (except Italy and the U.K.) to form CII Honeywell Bull.

SEMS's revenues are divided approximately equally between Solar and Mitra sales. Both products have 16-bit architecture, and SEMS does not plan to introduce 32-bit machines in either family until 1985. SEMS hopes to offer the 32-bit HIS Level 6 models as a stopgap measure. CII-HB may also start building the 32-bit machines in France this year.

SEMS was also considering a contract with Systems Engineering Laboratories, a division of Gould Inc., until early this year, when the French government demanded the termination of negotiations, which had been under way for about four months. Under terms of the contract, SEMS would have built the SEL family of 32-bit machines under license in France and handled marketing in France and sales of SEL-designed machines in Belgium, Spain and the Middle East. The government, however, insisted that SEMS instead forge closer links with French computer manufacturers, including CII-HB.

On the other hand, the government has not raised objections to two other deals with U.S.-based companies. Under one, a Thomson-CSF-owned display-terminal manufacturer, Department des Activités Péri-Informatique (DAP) will build a 16-bit μc under license from Convergent Technologies Inc. DAP, which is merging with SEMS, will sell the Intel 8086-based machine under the name Corail as a multifunction work station with word-processing abilities. Thomson-CSF has also taken a minority share in Fortune Systems Corp. of California. Fortune Systems is building a machine configured around Motorola's 16-bit 68000 μp that will run under UNIX. Thomson-CSF will sell the machine in France under the name Micromega.

Another major Thomson-CSF operation is Compagnie Internationale Militaire, Spaciale et Aeronautique (CIMSA), which builds military and avionic systems. Many of those systems are configured around ruggedized versions of SEMS minicomputers.

Thomson-CSF's non-French competitors cite strong government preference for Thomson-CSF products when placing public-sector contracts. But Thomson-CSF says that a preference policy does not exist.

Meanwhile, about 70 percent of Transac-Alcatel's orders depend on public-sector contracts, says the company. Transac-Alcatel's main product line is the distributed-processing 1527 family, introduced last year. The company had revenues of around $120 million last year.

The government has also acquired a controlling interest in CII-HB, rather than 100-percent ownership, and has taken over industrial conglomerate St. Gobain Pont-a-Mousson, which owns 51 percent of Compagnie des Machines Bull, a holding company that owns most of CII-HB. *—Keith Jones*

CORRECTION

The article "Coping with off-track errors" by Y-E Data, Inc. (MMS, February, p. 191) contained several errors on the first page.

- The article referenced "Winchesters" four times—including once in the subhead. In fact, Y-E Data's YD-280 is a 5¼-in. floppy-disk drive.
- The reference to the first floppies should have stated that they stored 100K bytes on an 8-in. disk.
- Information in the table on that page was correct, but the type was misaligned. As a result, specification data appeared in the wrong categories. Also, the caption under the table was misplaced. The caption pertained to a photo that was dropped from the story.

Mini-Micro Systems apologizes to its readers and to Y-E Data for these errors. Reprints of the corrected article will soon be available. If you would like a free copy, please contact Phyllis Anzalone, 221 Columbus Ave., Boston, Mass. 02116, or call her at (617) 536-7780, ext. 338.

GRAPHICS ADDITION

To the editor:

Lexidata Corp. was disappointed to see that it was not listed in the survey of general-purpose graphics terminal manufacturers (MMS, December, 1981, p. 81).

Lexidata designs, manufactures and services a family of medium- to high-speed, medium- to high-resolution raster-scan display systems used in a wide range of graphics and imaging applications. One of the graphic arts areas served by Lexidata is business graphics.

Lexidata's end-user and OEM customers, such as General Motors, Interchart and General Electric, fulfill some of their business-graphics needs by using Lexidata's System 3400 display processor. The 3400's modular design allows them to select a graphic processor capability that economically meets their performance requirements. Raster technology enables photographic detail, selective updating and an unlimited range of colors (as many as 4096 colors can be displayed simultaneously out of a pallet of 17 million).

Joyce M. Anderson
Marketing Communications
Lexidata Corp.
Billerica, Mass.

VOICE MESSAGING

To the editor:

Regarding the article "Voice store and forward—is the message getting through?" (MMS, January, p. 105), I would like to correct an obvious typographical error made regarding Delphi Communications Voice Messaging System. Our maximum Voice Messaging System supports more than 10,000 users, not 100 users as stated in your article.

Dr. Lawrence A. Lotito
Vice President, Marketing
Delphi Communications Corp.
Inglewood, Calif.

INGRES EVALUATION

To the editor:

I am writing to commend Harvey Weiss of Weiss & Associates for his article, "INGRES: a data-management system for minis" (MMS, January, p. 231). Apart from minor inaccuracies resulting from a delay in printing, we thought the article to be generally balanced in presentation and uncommonly accurate factually. Even the evaluation matrix—always a sore spot with vendors—gave, in our opinion, a generally accurate presentation of the product.

We believe that your readers are well served by such articles.

Gary J. Morgenthaler
Executive Vice President
Relational Technology
Berkeley, Calif.

UNDERSTANDING DIGITIZERS

To the editor:

I just finished reading "Understanding digitizer resolution and

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Letters

accuracy" by Kathy Dunn of Summagraphics Corp. (MMS, December, 1981, p. 111). This otherwise informative article on digitizers is misleading in places.

Dunn states, "A common misconception is that the digitizer with the greatest resolution (0.001 in.) is best suited for every application." She gives three faulty arguments to justify a preference for 0.005-in. resolution digitizers (of which Summagraphics is probably the largest manufacturer) versus superior 0.001-in. resolution digitizers.

She says that high-resolution tablets are generally more expensive. This is not necessarily true. Today's electromagnetic digitizers offer 0.001-in. resolution at a cost equal to or lower than Summagraphics's older 0.005-in. resolution technology.

Dunn goes on to say that high-resolution tablets are poorly suited for low-resolution applications because they use more memory and CPU time to process more digits. This has never been true. GTCO Corp. and most other high-resolution tablet manufacturers have switch-selectable, low-resolution output modes for low-resolution applications.

Finally, she says, "In a production environment, typical operator positioning skill drops to ±0.015 in." Despite Dunn's lack of confidence in an operator's accuracy, it has been proven that it is humanly possible to position a cursor to within ±0.001 in. accuracy, and some applications do require this skill in a production environment.

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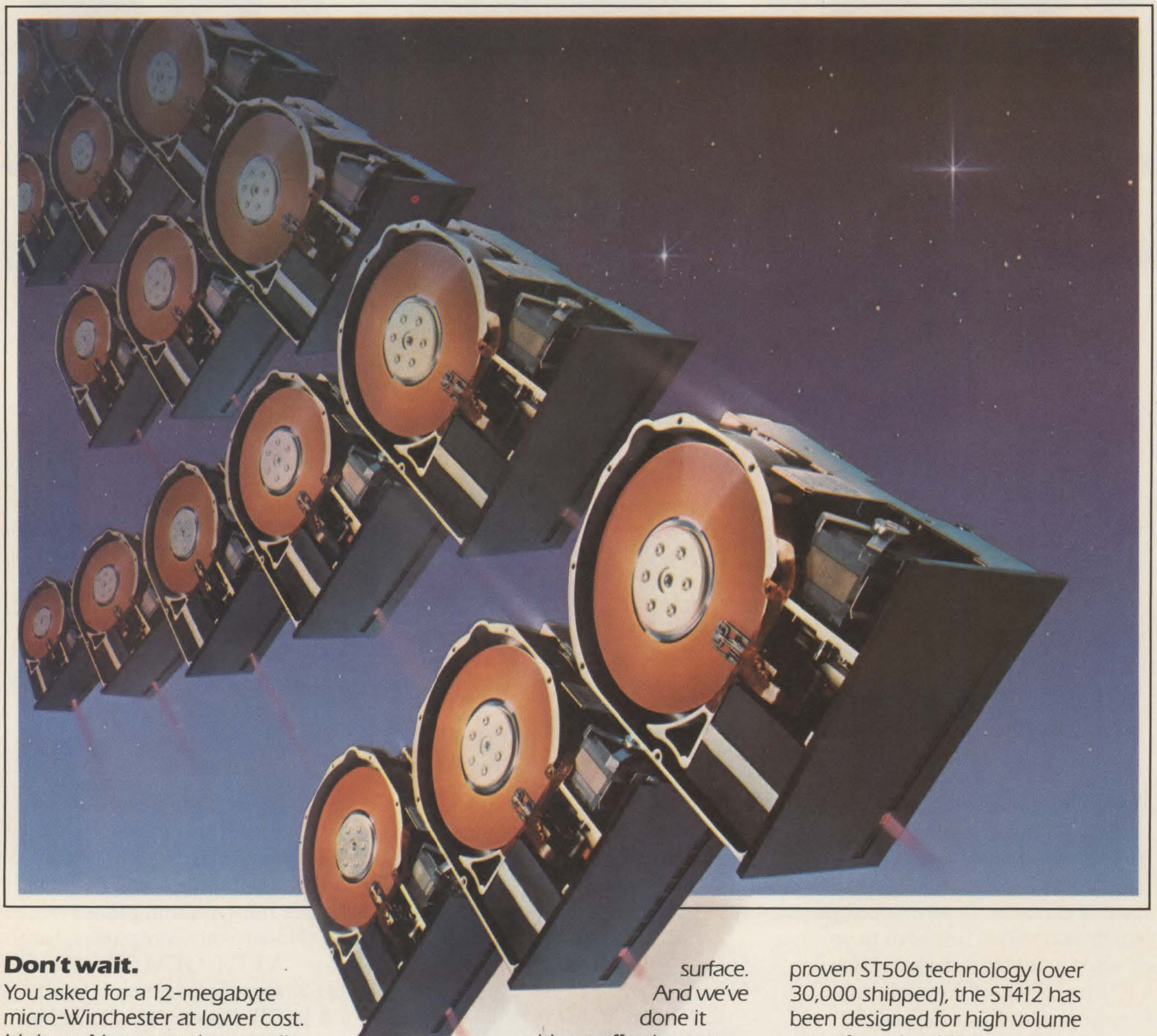

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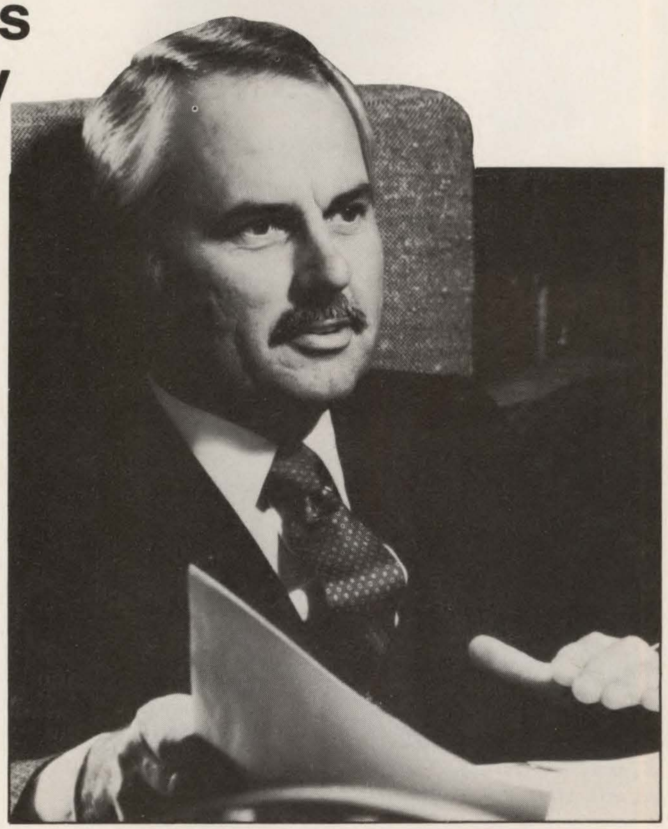
"Turning the tide in disc technology"

5¼-in Winchester prices are dropping drastically

By John Trifari
West Coast Bureau Manager



Tandon Corp.'s Jerry Lembas: *"We haven't brought the price of our Winchesters down simply for the sake of doing it. We're in business to make money."*

A price war is shaking the market for low-end 5¼-in. Winchesters, and threatens to relegate many vendors of 6M-byte hardware to low-volume orders and secondary positions behind industry leaders Seagate Technology and Tandon Corp.

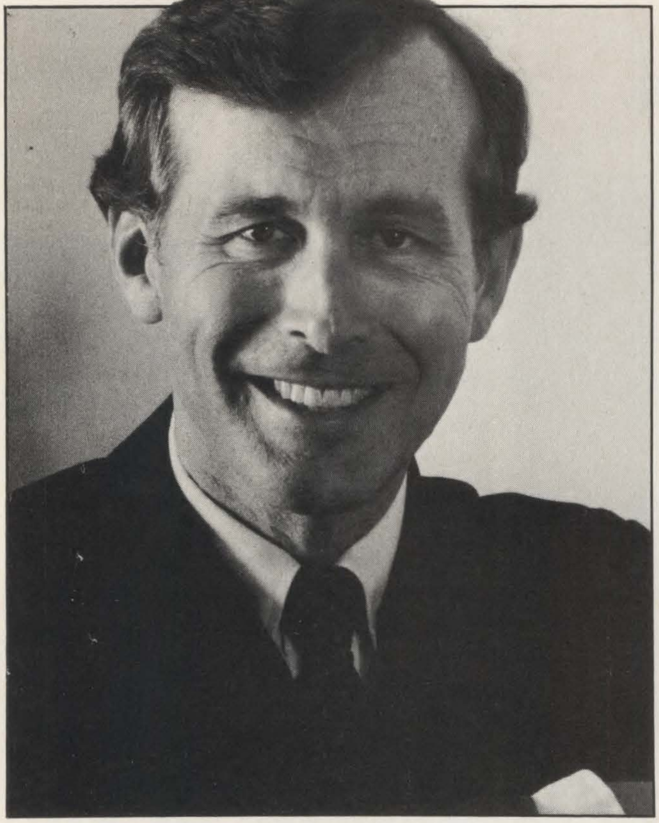
Volume prices for 5¼-in. hardware are in the $825 range in 1000-lot orders. At higher order levels, prices have routinely dropped to $700 a unit, with quotes of $650 per drive common. Some observers fear, however, that instead of an orderly decline in prices, an auction mentality is creeping into the market, as 5¼-in. Winchesters become commodity items and as drive vendors bid on the high-quantity, multi-year contracts typical of those being placed by a number of desk-top μc vendors. Reports are circulating that in one case, the bidding for a large quantity order of 5¼-in. Winchesters started at a low of "five-and a-quarter for five-and-a quarter," with $550 per unit quoted and finally accepted. Prices for 5¼-in. Winchesters without electronics have gone even lower in large quantities, with pricing in the $460 range reported.

As a result, say a number of industry observers, low-end Winchester vendors whose economies of scale do not match those of Seagate and Tandon may be pushed to the sidelines and closed out of the large-volume 6M-byte business for good. "Price cutting has turned this market into the sole property of Finis and Jugi," says Menlo Park, Calif., consultant James McCoy, referring to Seagate executive vice president Finis Conner and Tandon president Sirjang Lal "Jugi" Tandon. "There may be some business left for other vendors of 6M-byte hardware, but not what these companies think there will be."

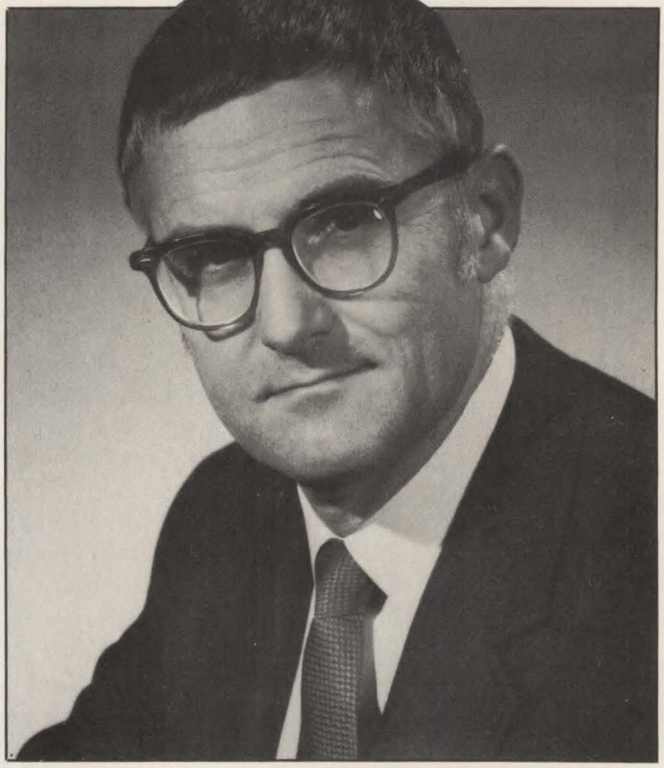
Mike Kirby, marketing vice president of small-Winchester vendor Rotating Memory Systems, Inc., Milpitas, Calif., agrees that the hardball pricing strategies that have become characteristic of the 6M-byte Winchester market since the beginning of the year may bode ill for low-end hardware vendors not already established in the market or not prepared to bomb prices even more than Seagate or Tandon. "If all I had was a 6M-byte drive, I'd just walk away from the business," Kirby says. "To my knowledge there are no major accounts left where drives of this capacity are an issue."

Setting the pace for volume pricing of 6M-byte, 5¼-in. Winchesters—and incurring the wrath of many industry executives in the process—is Chatsworth, Calif.-based Tandon Corp. with Scotts Valley, Calif., small-Winchester pioneer Seagate Technology not far behind. "The 6M-byte Winchester is a short-lived product," says Andrew Roman, Newark, Calif., industry analyst and publisher of *The OEM Disk Pricing Report*. "These vendors have a window—a limited time in which to land the major accounts that will provide their future business. They must bring prices down."

The use of price cutting as a technique to gain market share is nothing new in hardware marketing circles, but many feel that the vehemence accompanying the round of 5¼-in.-Winchester price chopping is a bit startling—even for an industry that has become as fast-paced as the OEM rotating-memory business. "I would classify these price cuts as simply uncalled for," says George Sollman, marketing vice president at Shugart Associates, Sunnyvale, Calif. "At the prices I've heard quoted, you wonder where the bottom line is coming from."



Industry Analyst Raymond Freeman Jr.: *"You need high quality to get on a buyer's bid list, then you go for price."*



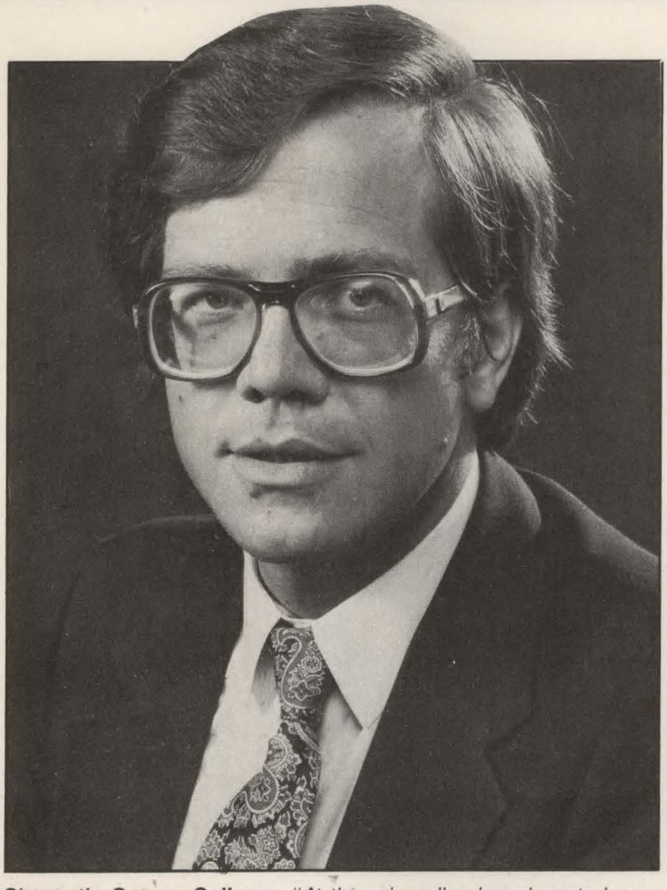
Industry analyst Jim Porter: *"If orders reach the 100,000-unit level, then (suppliers of higher capacity drives) may find themselves under the same pricing pressures that competitors of Seagate and Tandon find themselves under in the 6M-byte market."*

Sollman says the pricing battle is a reflection not merely of the use of pricing as a tactic to gain market share, but also of a temporary slowdown in the demand for lower capacity small Winchesters. When Seagate and Tandon are involved, he goes on, the price war can be reduced to a scenario that he calls the "I'll do you 50" deal. "Seagate quotes a price to a customer," he explains, "and then Tandon comes in and quotes $50 less." RMS's Kirby also feels that motives underlying the price cutting are partially the result of the realization that despite its youth, the market for 6M-byte 5¼-in. Winchesters may have temporarily run out of steam. "Things have leveled off for a moment, and buyers are looking into higher capacity drives," Kirby explains. "Under those circumstances, all you can do to move lower capacity hardware is to drop the price even more."

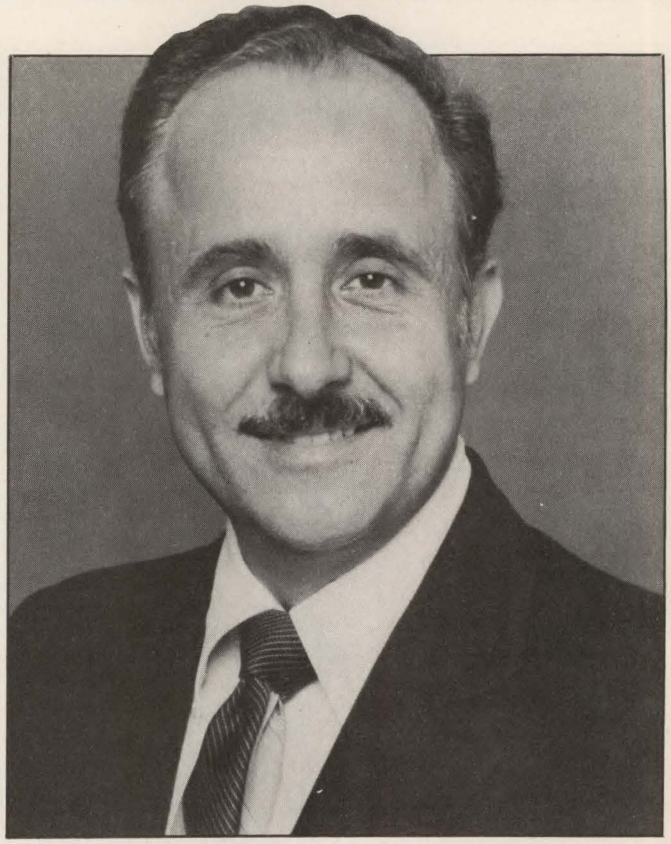
Still, Kirby is puzzled by the aggressive pricing of lower capacity drives and by Tandon's moves in particular. "With Seagate, it's never a giveaway," he says, "but Tandon doesn't have to do this. They're leaving a lot of money on the table." Roman also points to the price that Tandon is paying for the privilege of supplying low-cost 5¼-in. fixed-disk drives. "At the 5000-unit level, Seagate is quoting $725 a drive," he reports. "At the 4999-unit level, Tandon is charging $650 for the same piece of hardware.

Seagate's Finis Conner feels, however, that more is involved than a simple price difference between companies. "The net effect of Tandon's pricing policies is to destabilize the marketplace," he says. "They are causing confusion in the market by going in and attempting to buy the business by bombing prices and accepting ridiculously low margins." Conner says that he has seen 1000-lot orders quoted at 5000-lot prices, and that he has been told that Tandon has tied Winchester orders to sales of its 5¼-in. floppy-disk drives. "Essentially, Tandon has told customers dependent on it for floppy-disk drives that they will have to take both or take nothing," he says. "To me, that smacks of unfair competition if it's true."

Tandon senior vice president Jerry Lembas says that his company's Winchester pricing strategies are based simply on sound business practices,and that allegations that his company is forcing Winchesters down customers throats by making the sale of floppy-disk drives contingent on acceptance of fixed-disk hardware are simply untrue. "We haven't brought the price of our Winchester down simply for the sake of doing it," he says. "We're in business to make money." Lembas also



Shugart's George Sollman: *"At the prices I've heard quoted, you wonder where the bottom line is coming from."*



Micro Peripheral's Ralph Gabai: *Higher performance drives may be immune to low-ball pricing, but "If the price baseline is lower, that just makes things all the more difficult."*

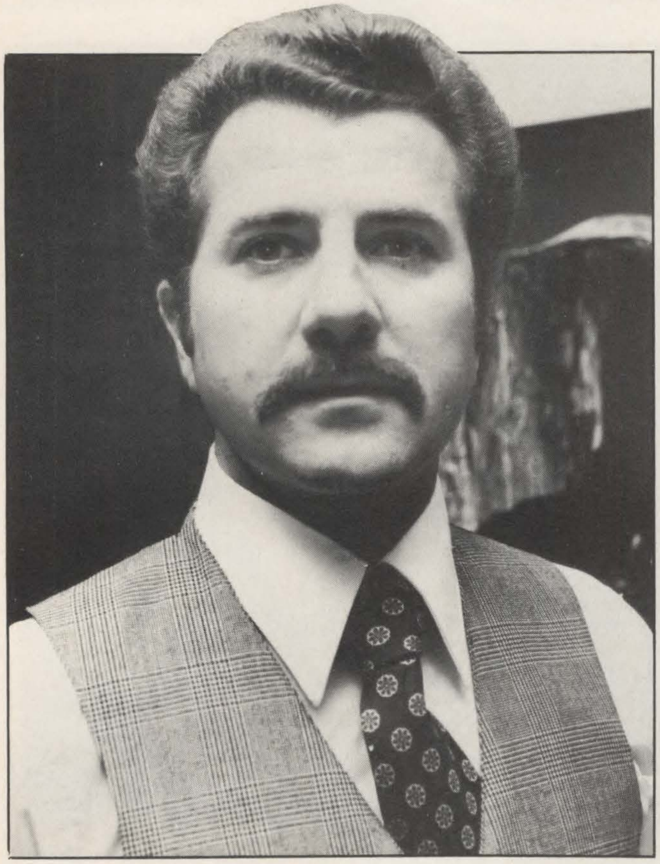
denies that his company is trying to buy its way into the market. "The companies that we're signing with are the ones that dictate price—not us," he explains. "They know what the price of this hardware has to be."

As an example, he points to Seagate's contract with Apple Computer, Inc., to supply fixed-disk drives for that company's Apple III desk-top μc. "The hard-disk option for the Apple III was originally priced at $4000 because they were paying Seagate $750 to $800 for the drive," he explains, calling this price "a license to steal" on Seagate's part. "But even at $3500, there weren't any takers for that subsystem," he goes on, "and now they're trying to move it at $2500." Lembas says, however, that the market price of that subsystem should be in the $2000 range, "and that means that the drive itself has to be priced around $500."

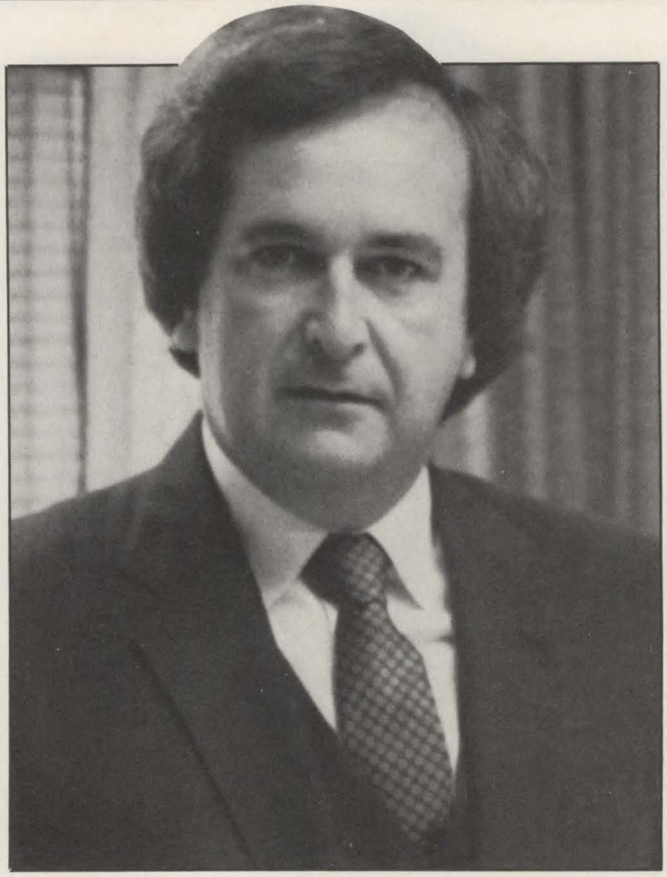
Lembas is also sensitive to allegations that his company is the only low-ball pricer in the fiercely competitive small-Winchester market. "We're seeing a lot of pricing pressure from the little guys even if they don't have a product to deliver in quantity," he says. "I've also heard rumors of buy-in pricing from Seagate." Conner thinks that this is nonsense. "There will continue to be normal price reductions of our hardware," he says. "This is a responsible business approach as volumes grow, and it will be our approach."

Lembas stresses that whatever the price of his company's hardware, margins will not be sacrificed in the process because, he says, "There is no one in this industry that can build 6M-byte hardware as inexpensively as we can," pointing to Tandon's policy of vertical integration and to its offshore subassembly facilities, where labor costs are lower than in the U.S. "The key point is who can afford to make money at lower prices," he says. "Our motors and actuator assemblies are done offshore, and that can save us around $25 to $30 per drive compared to the competition." Conner thinks this argument is specious. "It doesn't take much to figure out what one of these drives costs," he says. "Nobody will keep taking business at 20-percent margins. Later on, Tandon will be forced to raise prices."

Others believe that as a result of rapidly declining prices, hardware quality may suffer. "As you move to these lower price levels, someone has to take shortcuts," says Shugart's George Sollman, "and quality is Jugi's Achilles' heel." Sollman reports that from what he's heard from Shugart customers, Tandon drives have a higher DOA rate, and that many people, including himself, believe that of the two, Seagate offers a higher quality device.



Industry analyst Andrew Roman: *"These vendors have a window—a limited time in which to land the major accounts that will provide their future business. They must bring prices down."*



Seagate Technology's Finis Conner: *"(Tandon is) causing confusion in the market by going in and attempting to buy the business by bombing prices and accepting ridiculously low margins."*

RMS's Kirby also wonders if Jugi Tandon and crew were cutting corners to bring low-cost hardware to market. "A Winchester isn't like a floppy, and I don't think Jugi knows what his drives are really costing him," Kirby says. "You need a lot more testing and quality control when dealing with Winchesters, and once you seal one of these drives up, you just can't have any more problems."

He says RMS has tested Tandon Winchesters and compared them to other 6M-byte hardware, including his company's own product line, and the results left a little to be desired. "We read the inner, middle and outer tracks on all the drives to measure bit shift," he explains. "On the 10-point scales used by the tester, Tandon's hardware was in the 2 to 3 range; our hardware was in the 8 range. Seagate showed up in the 6 to 8 range." Unfortunately, Kirby says, there are some customers who don't understand the significance of these figures, "and I'm not sure that Jugi understands their significance either. He's going to need quality, and quality costs money."

Seagate's Conner says that his company has closed a number of high-volume contracts on the basis of quality and not low price, and that, "You get what you pay for. It is unreasonable for a customer to expect that we will price our product the same as anyone else's with less commitment to quality."

Lembas feels that his company is taking a bum rap on the quality/pricing issue as it relates to 5¼-in. Winchesters, and one of his customers backs him up. One report circulating through the San Francisco Bay Area indicates that Televideo Systems, Inc., had expressed dissatisfaction with the quality of Tandon's hardware, but one Televideo spokesman says, "There is no truth to that report. Tandon's Winchesters are above reproach."

Santa Barbara, Calif.-based industry analyst Raymond Freeman Jr. also wonders about the extent to which quality is a determining factor in selecting one drive over another. "Quality may be the most important issue of all," he says, "but you don't sort out vendors on that basis. You need high quality to get on a buyer's bid list, then you go for price." Low-quality products simply won't be accepted, he says, "and it would be out of character for Jugi Tandon to offer a low-quality drive." Freeman has no comment on quality comparisons between Seagate and Tandon hardware.

Issues of what is and what is not good for the market and whether quality is taking a backseat to pricing aside, many observers are concerned about the extent

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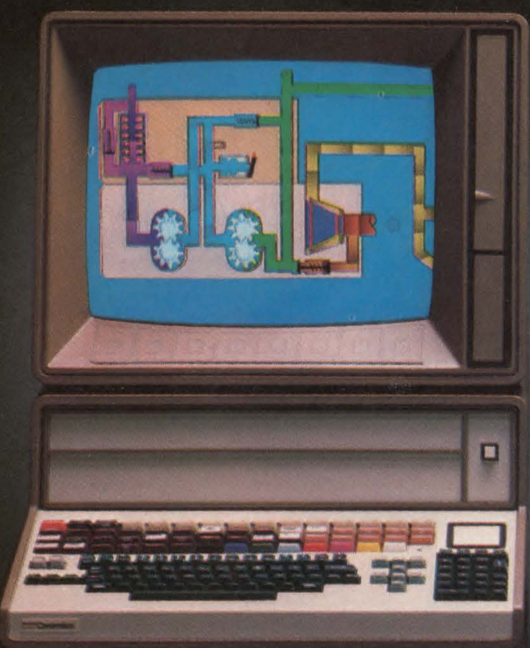

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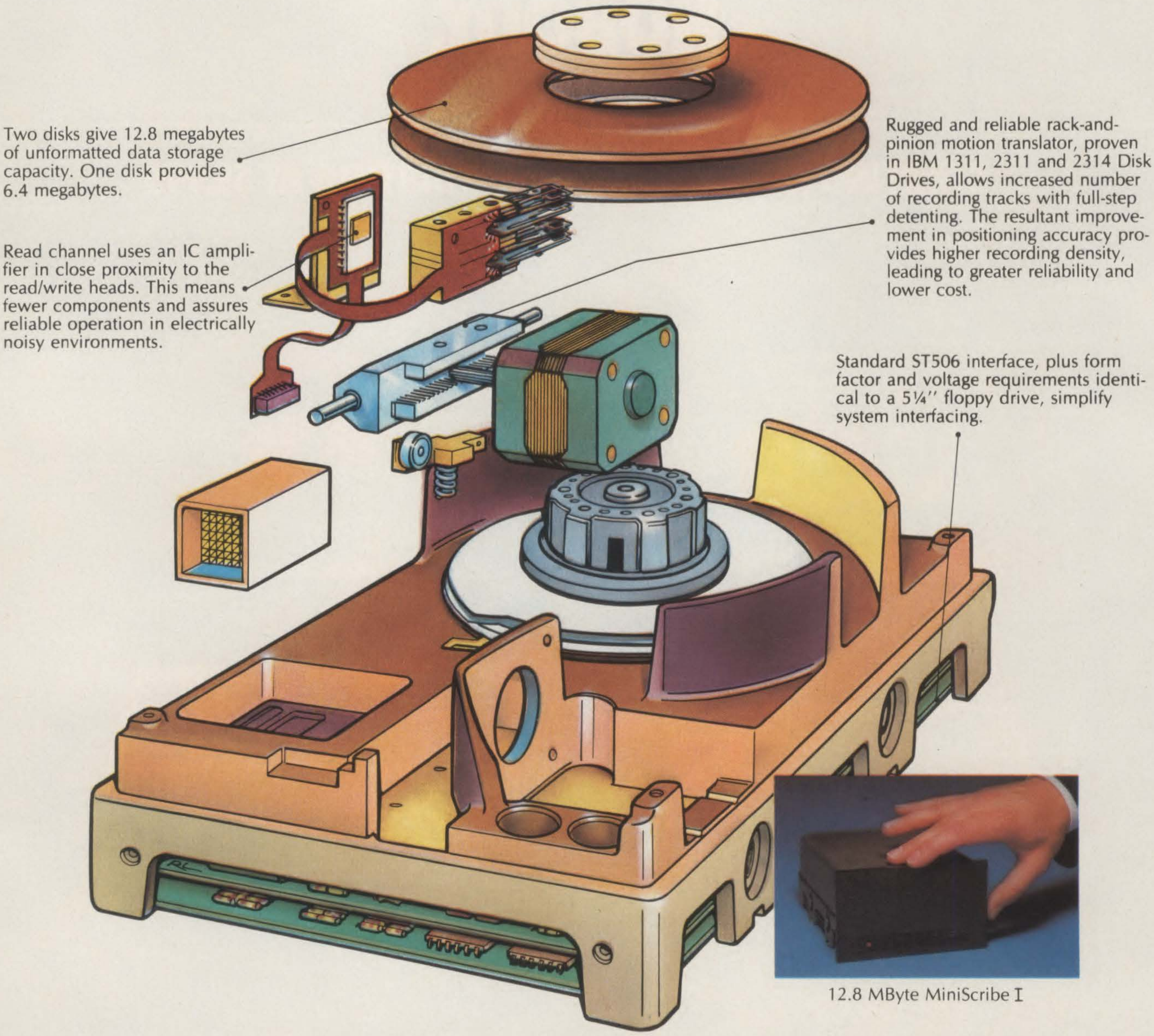

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to which the commodity pricing policies of the low-end market will impact vendors that have not yet entered the 6M-byte fray in volume. Two such vendors are Shugart and MiniScribe Corp., Longmont, Colo.

Shugart's Sollman is emphatic when he says that his company intends to be an active contender for 6M-byte business despite the forebodings of many who feel that Shugart has too much catching up to do. Shugart has not yet delivered large quantities of its SA600 series 5¼-in., 3M-, 6M- and 12M-byte Winchesters (MMS, January, 1980, p. 20), and one company source confirms that the single-platter, 3M-byte SA602 will most likely be dropped (MMS, March, p. 10).

Kirby doesn't think Shugart stands a chance in the 6M-byte market, and that the 12M-byte business is already cluttered with companies that are delivering hardware. "I don't see how Shugart will succeed unless everyone else rolls over and dies," he says. Analyst Roman believes that the Sunnyvale, Calif., Xerox subsidiary will stay in the 5¼-in. business, but that it will not be a major supplier of OEM hardware. "There is no way that they will impact this market," he says. "Their hardware is priced too high, and besides, the majority of their drives will be earmarked for Xerox's 820 computer."

Shugart's Sollman disputes claims that his company will not actively participate in the 5¼-in. OEM Winchester market. "We are prepared to compete for this business, and we will cut prices to do so if necessary," he reports. "If you want to participate and that's where prices are, then you lower prices to that level." He will not comment about to what extent Shugart is prepared to cut prices to compete for large-volume orders. He says Shugart will produce 30,000 5¼-in. Winchesters this year, and could hit 60,000.

Bill Westlake, marketing vice president at MiniScribe, feels that his company will be able to compete for large-volume business a year from now. "There are certain realities in this business," he says, "and we're about a year away from being able to bid on some of the large volumes that are being talked about." He says Miniscribe will be shipping about 1000 units a month by June, and will focus on 5000- to 10,000-unit orders. "There are a lot of those out there," he says, "and we intend to be a significant factor in that market." Westlake is firm, however, in stating his company's resolve not to buy business. "I have nothing to fall back on," he explains, "I have to survive on one product."

MiniScribe is taking a pricing lead in the 12M-byte sweepstakes, however, and it is to this arena that the battle for small-Winchester dominance may soon shift. Key players again promise to be Seagate and Tandon, the former with its 12M-byte ST-412, a two-platter device announced this year as a replacement for the two-platter ST-512, the first 5¼-in. Winchester equipped with thin-film read/write heads (MMS, January, p. 17). A super-low-cost single-platter version of this drive, the ST-406, reportedly will be ready around mid-year. The ST-412 is now being shipped in evaluation quantities. Tandon, meanwhile, says it is shipping 14M-byte hardware in volume.

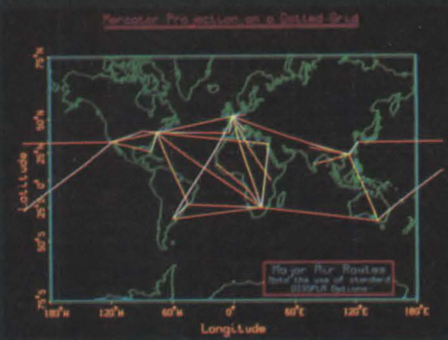
Right now, prices for this hardware are stable, says Shugart's Sollman, although 6M-byte pricing policies will have a percolating effect on higher capacity drives. Kirby too reports that pricing for higher capacity 5¼-in. Winchesters has not yet been impacted by the discounts characteristic of the low-end market. "But," he says, "Jugi isn't there yet. Once he is, all bets are off."

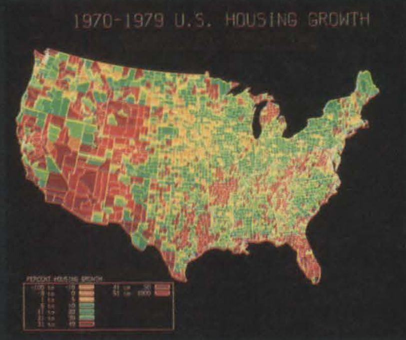
Jim Porter, Mountain View, Calif., industry analyst and publisher of *Disk/Trend Report*, notes that companies such as RMS will be able to compete effectively when it comes to lower quality orders. "There are a lot of system designers out there who will order 12M-byte hardware at the 5000-lot level," he says. "But if 100,000-lot orders are discussed, the rules change." The reason, he says, is that, "Essentially, we're talking about a 6M-byte technology drive. If orders reach the 100,000-unit level, then these companies may find themselves under the same pricing pressures that competitors of Seagate and Tandon find themselves under in the 6M-byte market."

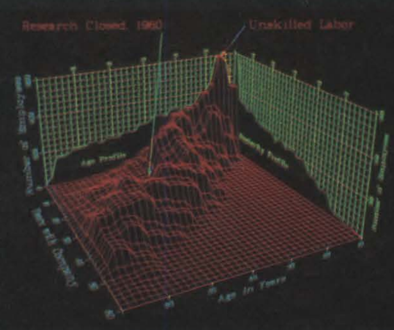
Ralph Gabai, chairman of Micro Peripherals, Inc., Chatsworth, Calif., also looks to lower prices for higher capacity drives, and anticipates that Tandon will take the lead in this regard. "They have always had the approach of being the price leader," he says. "They're very aggressive." Gabai anticipates that, like 6M-byte 5¼-in. Winchesters, stepper-motor-driven, 12M-byte drives may ultimately become a commodity item.

Higher performance drives such as those aimed at the multi-terminal market may be immune to low-ball pricing, he says. "When you start talking about these drives you have to start explaining price differentials in terms of drive performance," Gabai explains, "and you pay for performance." Nonetheless, despite his company's announced intentions to offer higher performance hardware and staying out of the commodity hardware market, Gabai is looking over his shoulder. "If the price baseline is lower," he says, "that just makes things all the more difficult."

Others share Gabai's sentiments: "I don't need this aggravation," says Shugart's Sollman. "There's a lot of hype going on, and I wonder what good it does to get into these pricing battles." Kirby also has a philosophical outlook on the subject of Winchester price cutting: "It's unfortunate that this is going on the way it is," he says. "It could really screw things up for all of us." ■







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CIRCLE NO. 56 ON INQUIRY CARD

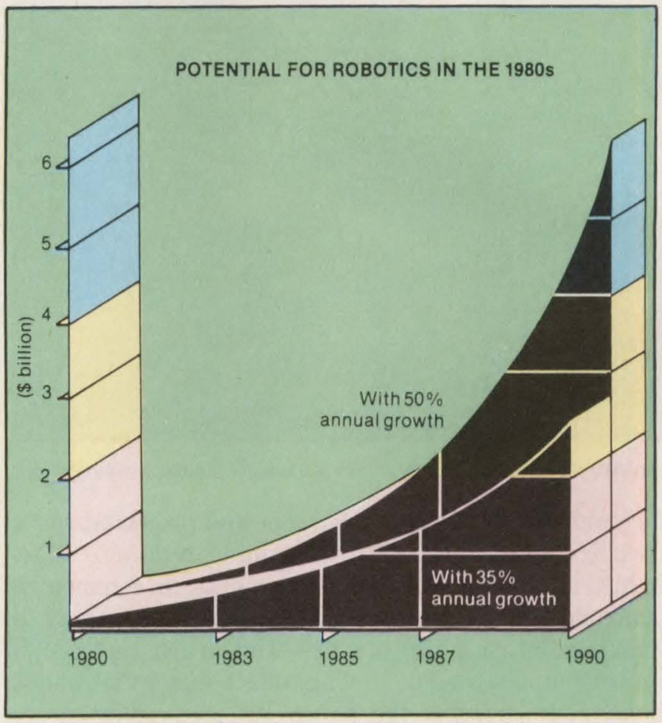
Potentially huge market developing for robotic systems

By Eric Lundquist
Associate Editor

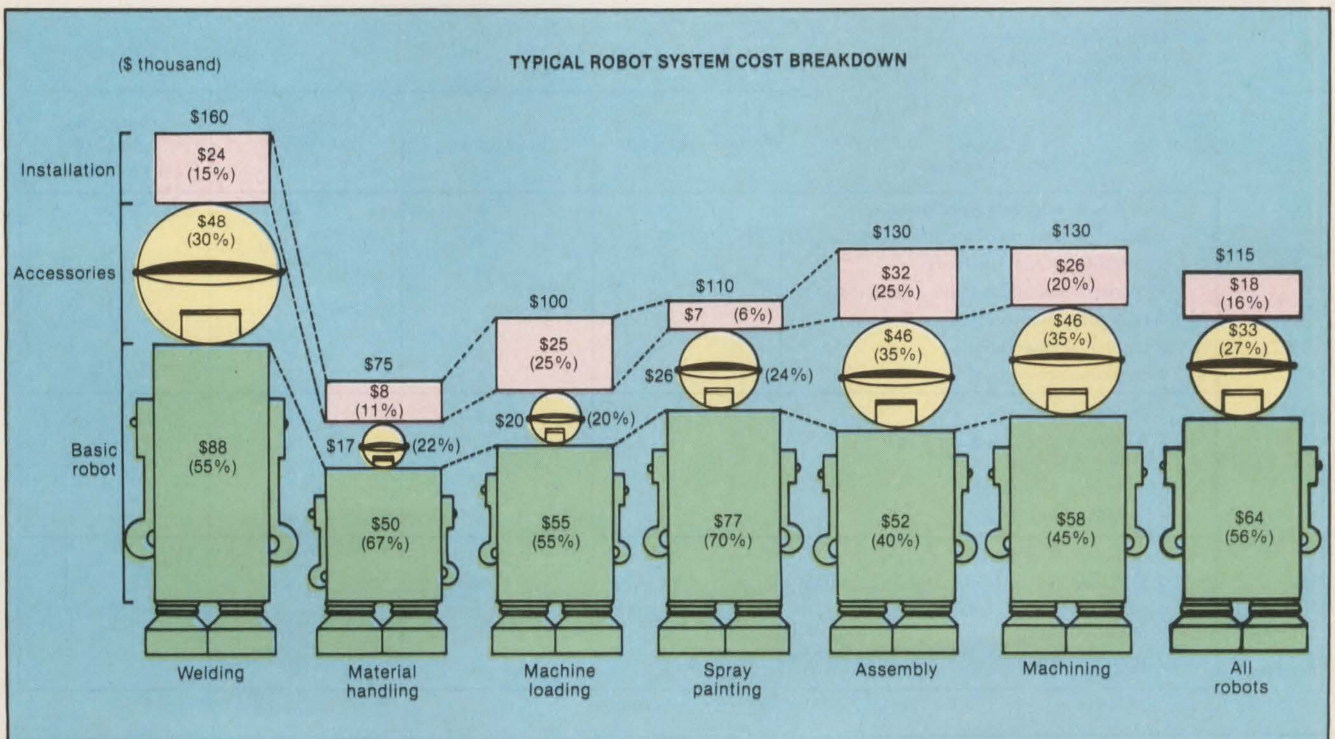
The huge potential market for robot systems aimed at increasing productivity on America's factory floors has spawned a new breed of system integrators intent on garnering a profitable share of the industrial-automation business. But these new robotic system builders face a host of obstacles as they maneuver through an unstable economy to establish an early market position.

If there is one characteristic common to many of the emerging robot system companies, it is a belief that their expertise in computer and communication technology will be a major factor in technologically outdistancing established vendors. The robot business has been compared to the early years of the minicomputer market when a large number of new companies arose to challenge the mainframe mentality with minicomputer technology. The challenge was successful, as evidenced by the remarkable growth rates of companies such as Digital Equipment Corp., Data General Corp. and others, but that competition was not without casualties.

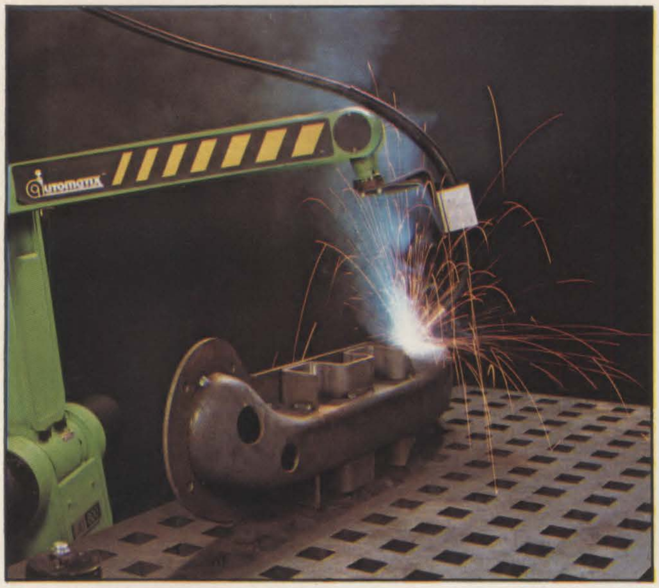
With the definitions of robots and robotic systems up



Dramatic growth for the robot market is predicted *by the Yankee Group, which forecasts at least a 35-percent annual growth.*



Robot prices will decrease *as the number of installations rises, according to Tech Tran Corp.*



An AID 800 industrial robot *from Automatix tackles a welding job.*

for debate, the number of current and projected robot installations varies with the interpretation. Most industrial robots have three elements in common: a controller for programming the robot's movements, a manipulator consisting of a base and an arm that allows movement and the end tooling, which forms the robot's hand and performs the work. As the requirements placed on the robot become more intricate, the controller becomes more sophisticated. In design, today's robots are sturdy rather than sleek and are built for fixed installation rather than movement.

As the Boston-based Yankee Group consulting firm states in a recent report on automated intelligence, "Robots are blind, one-armed imbeciles. They are incapable of either setting up their own work or adjusting to changes in their work environment. Today's robot requires extensive human supervision and cannot function effectively outside of a highly controlled work environment."

The networking and integration of robots into manufacturing is a common goal of robot builders and integrators. But the means for achieving that goal differ among companies. The Yankee Group contends there are five elements to a turnkey robotic system: robots, computers for control, advanced sensors for feedback, computer programs for intelligence and fixturing and material-handling elements.

Few customers are willing to install complete automated systems, particularly at a time of economic recession and considerable unused manufacturing capacity. But many customers are willing to investigate and invest in a modest degree of automation. Many new robot-system houses are aiming initial sales at companies that might be overlooked by large, established robot firms.

"We are starting to see the beginning of the

● —Major problem/need
● —Moderate problem/need
● —Minor/no problem

	Problem/area improvement needed	Manufacturers	Researchers	Companies planning to use robots	Companies that use robots
Capabilities	1. Low-cost, effective vision-sensing	Major	Major	Major	Major
	2. Easier, standardized programming	Major	Major	Moderate	Major
	3. Improved gripper dexterity	Major	Minor/no	Moderate	Moderate
	4. Greater flexibility (number of applications)	Minor/no	Moderate	Moderate	Moderate
	5. Low-cost, effective force-sensing	Minor/no	Moderate	Moderate	Minor/no
	6. Lighter, smaller robots	Moderate	Minor/no	Minor/no	Minor/no
	7. Improved control systems	Minor/no	Moderate	Minor/no	Minor/no
Performance	1. Greater speed	Moderate	Minor/no	Minor/no	Moderate
	2. Improved positioning accuracy (within +.005 in.)	Moderate	Moderate	Minor/no	Moderate
	3. Improved repeatability	Moderate	Moderate	Minor/no	Moderate
	4. Improved reliability	Minor/no	Minor/no	Minor/no	Moderate
Other needs	1. Reduced robot cost	Major	Moderate	Major	Major
	2. Improved ability to interface with existing equipment	Moderate	Minor/no	Minor/no	Moderate
	3. Improved safety	Minor/no	Moderate	Minor/no	Minor/no
	4. Turnkey systems	Moderate	Minor/no	Moderate	Minor/no

Improvements in robot performance are still needed, *according to a Tech Tran Corp. survey of robot manufacturers, researchers and users.*

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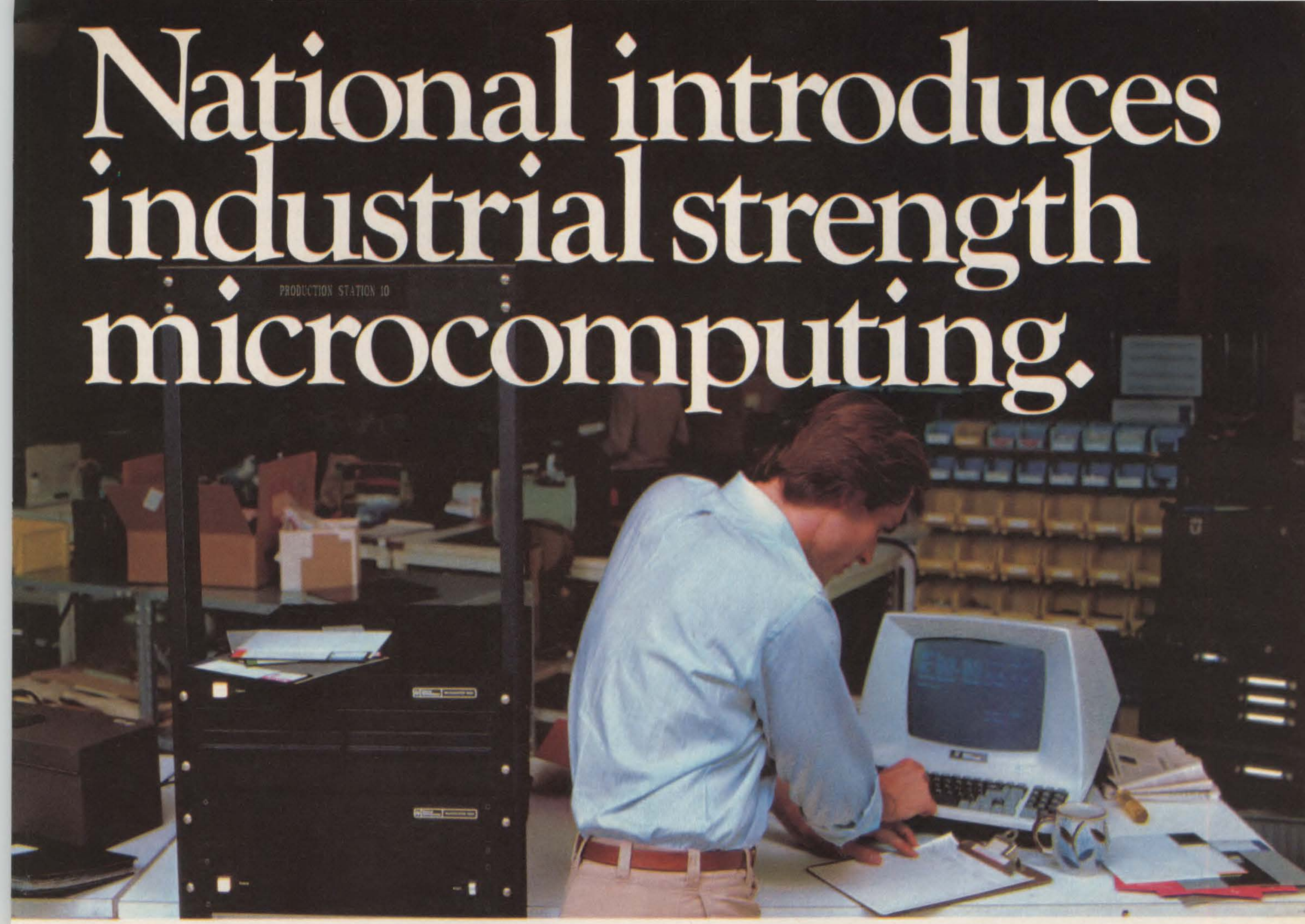

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system-house concept, bridging the (robot) builders with the end users who desperately need the technology but are not equipped to use it," says Jerry W. Saveriano, vice president of marketing and applications for LTI Robotic Systems, Torrance, Calif. "There is a niche that needs to be filled, and there are system houses coming that understand the technology and can transfer it to the end user."

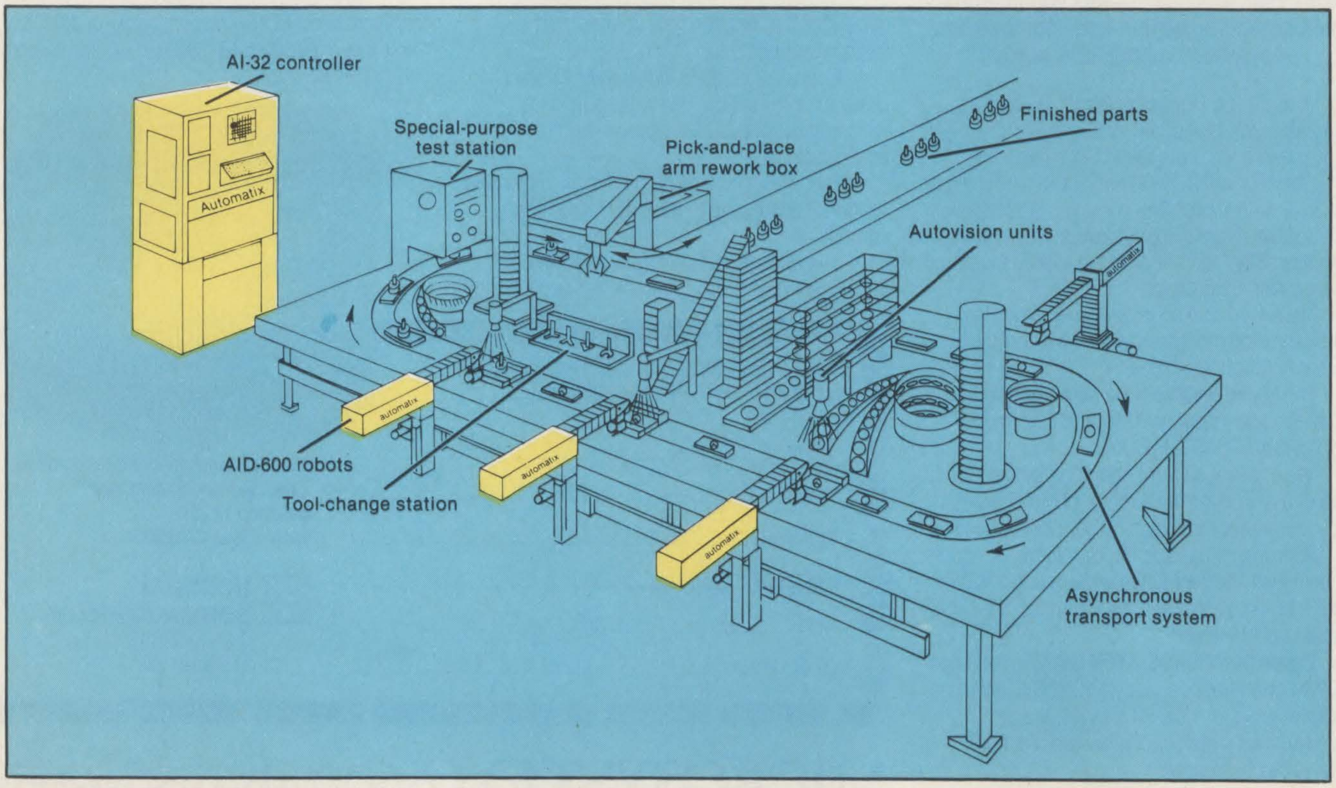
Saveriano says standard robot components tend to be "80 percent ready to go to work, but somebody has to take the remaining 20 percent home for a specific application." He believes that, within several years, system houses that buy the robotic front-end components and incorporate their own proprietary software and processing units will account for a substantial share of the robot market, although he won't predict how large that share will be.

LTI is not wholly altruistic in its hopes for a blossoming system-house business—the company is a system house. Saveriano says he is working with the Robot Institute of America "to start a system-house council as part of the institute so we can negotiate better OEM agreements with the builders and work toward standardization of some components."

Recent entries into the robot market—including Control Automation, Princeton, N.J., Automatix Inc., Burlington, Mass., and United States Robots, Conshohocken, Pa.—are vying against some firmly established competitors in what is still a small market. Laura C. Conigliaro, a robotics analyst with Bache Halsey Stuart Shields Inc., estimates that the 1981 U.S. robot segment represented $155 million in sales. Much of that business is owned by robot industry leaders Unimation Inc. (a subsidiary of the Condec Corp.) and Cincinnati Milacron Inc. Conigliaro predicts that this year, the U.S. robot market will total $215 million in sales. She also forecasts that, during 1982, Unimation's market share will drop from 1981's 42 percent to 35 percent, and Cincinnati Milacron's will drop from 32 percent to 25 percent. While unit sales and revenues are small, healthy growth is predicted over the next 10 years.

Tech Tran Corp., a market-research firm based in Naperville, Ill., projects that the number of U.S. robot installations will rise from an installed base of 4500 in 1981 to 250,000 by the end of 1991. Most of that growth is predicted to come after 1985. By 1991, annual unit sales will be between 60,000 and 80,000, reaching $2 billion by 1991, Tech Tran predicts. As the number of robot applications increases, prices are expected to decrease, and Tech Tran estimates that the average price of a typical robot installation will decrease 15 to 20 percent over the next 10 years.

The Yankee Group estimates that, at its worst, the robot market will grow 35 percent annually, and, at its



Automatix takes a systems approach to the robot market, *using front ends from Hitachi and building its system around the AI-32 control processor.*

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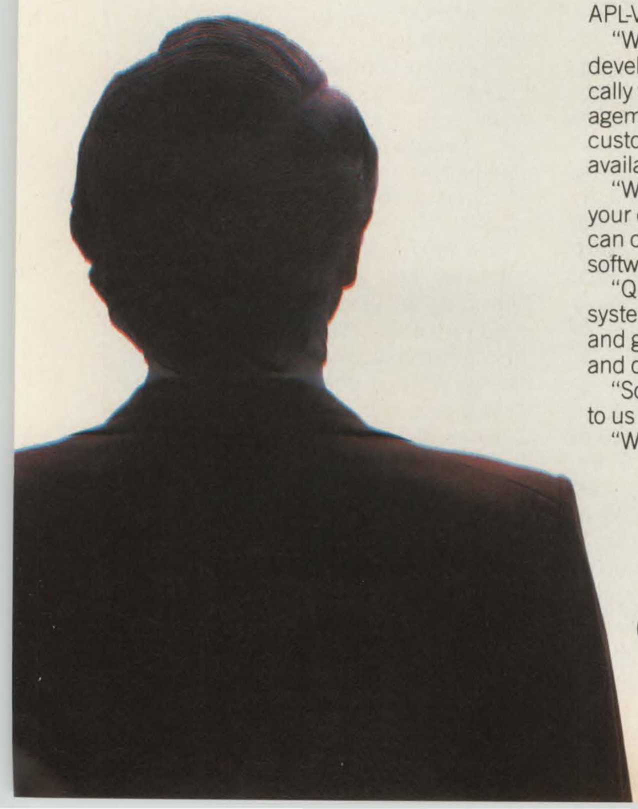

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best, the market could grow 50 percent a year. Using those projections, the 1990 market could range from \$2.5 billion to \$6 billion, The Yankee Group predicts.

The Yankee Group believes two factors will determine the extent of the robotics market: "The market growth will be directly related to the degree to which acceptable advance sensors are developed," and, "beyond technology advances, the manner in which corporations overcome present middle-management and labor resistance will affect market growth," the report states.

Through improved sensors, particularly vision sensors, and the incorporation of advanced μps with sophisticated software and communications channels, many new robot builders and robotic-system houses hope to outdistance the entrenched competition. Some new firms build entire robots, including manipulators and end tooling. Other companies, including some of the country's largest corporations, incorporate proprietary controllers into the mechanical robot front ends, which are purchased under rights agreements from other firms.

"I think we probably make more extensive use of computers than other people do. We have designed our system to be 100-percent digital," says Gordon Robertson, president of Control Automation. In March, the company introduced a three-armed robot, a vision module and controller.

Robertson and his colleagues have designed the system based on a hierarchial control structure. The robot's physical movements are driven by brushless DC motors, each of which is controlled by a dedicated 8-bit μp. The dedicated μps are orchestrated through a central path-control computer, built around an Intel 8086. A third control level—at which decisions are made about which movement the robot should make next—is overseen by a Hewlett-Packard Co. 9915 and transmitted via an RS232 line. The system uses HP BASIC because, "It's the language that most people who know anything about computers are most familiar with. It's not the most powerful or fastest language, but you don't need power or speed in this application," Robertson says.

The hierarchical structure and use of the RS232 line enables users their own controllers and permits a modular design, Robertson says. The vision processor acts as a peripheral to the overall system and can act as a stand-alone unit.

Robertson says that the computer and electronic components required twice the development time of the mechanical components. But the company can use advanced electronics, and that sets firms such as Control Automation apart, he says. "Some of the other manufacturers have a lot of expertise coming out of the machine-tool industry or some similar background. As such, they are not immediately familiar with the possibilities and capabilities of the μp or μc," Robertson says.

IBM MAKES EARLY MOVE INTO THE ROBOT MARKET

A formidable competitor entered the robot business in February when International Business Machines Corp. introduced its first two systems. Some view those systems as IBM's attempt to establish an early lead in developing standards and protocols in a largely nonstandardized industry.

"I'm in awe of what IBM is doing," says Laura Conigliaro, an analyst with Bache Halsey Stuart Shields Inc. "In a sense, they have turned a huge battleship around. They always seemed to be late in everything from personal computers to computer-aided design, and, therefore, they were not able to write the protocols or the standards for the industry. But the whole area of computer-aided manufacturing is untouched. Wouldn't IBM like to write the standards for the CAM industry because, when it is ultimately integrated and you put the robots, machine tools and everything else together, the overall integration ultimately falls to the mainframe? They are coming in early because they realize they have been late in other areas, and they want to be the ones to write the protocols for this one," Conigliaro says.

The simpler of IBM's two systems, the model 7535 manufacturing system, is built to IBM's specifications by Sankyo Seiki Manufacturing Co., Ltd., and is sold under a rights agreement. It consists of a jointed arm that moves in four directions and a control unit that stores as many as 6000 characters of information. The unit, aimed at pick-and-place assembly work, is capable of five types of routines. The IBM personal computer can program the robot using an IBM-developed robotics language named A Manufacturing Language (AML). The computer only loads the instructions and is not an integral part of the system. The 7535 is priced at \$28,500, and the company offers a 15-percent discount for buyers of 50 or more units. It is due to be shipped in the fourth quarter of this year. The system is developed and sold by the company's Automation Group in Boca Raton, Fla. An IBM spokesman says the company has exclusive rights to sell the system.

The second robotic system, the RS I, is much more sophisticated than the 7535, is built solely by IBM but is not yet marketed by the company. A spokesman says he doesn't know when or if the RS I will reach the market.

The RS I uses a modified Series/I computer and operates under AML. The company uses the robot internally and in several test-market locations. It uses a hydraulically powered arm that moves in six directions. The end tooling is a two-fingered gripper with tactile and infrared optical sensors. The RS I can tell an operator when a feeder box is empty, and the tactile sensors allow it to maneuver parts carefully into place, the company claims. "We view the robot as a computer with a tool on the end of it," an IBM spokesman says.

The Interpreter

Robertson's view is supported by S. Stanley Mintz, president of Intelledex, Inc., Corvallis, Ore. "Most established robot companies came out of the machine-tool industry. Those companies are users of computers; we are inventors of computers," Mintz says. Intelledex, formerly Lesta Co. was incorporated in September, 1981. Several of the company's officials, including Mintz, were formerly with H-P, where Mintz was an R&D section manager. Mintz is reluctant to disclose the company's plans, but he does say the company will build a complete robot aimed at the light industrial-assembly market and having a variety of vision systems. The system will probably use an Intel 8086 or a Motorola 68000.

The 68000 also proved attractive to Phillipe Villers, president of Automatix. Villers has also taken a system approach to the robotic market. His company has used front ends from Hitachi and built the system around the AI-32 control processor, using dual 32-bit control processors. Automatix, a privately held company, has seen sales climb from $400,000 in 1980 to $3 million last year.

Regarding the company's decision to use the 68000, Villers says, "People want to transcend the 32K- to 64K-word addressing limit. Also, as you get more sophistication, you want more compute power, and you want to do arithmetic with a wider-than-16-bit word without the slowing associated with double precision."

The competition is not standing idly by while new companies launch their technological challenges. Some analysts feel that the test for new companies is how well they can translate their computer knowledge into a factory environment. "In general, once they get their feet dirty on the factory floor, they have a shot at being successful. You don't always need the latest electronic gadgetry because sometimes the mechanics and ruggedness are more important," says Bache's Conigliaro.

There is also competition from companies with a long history of factory experience. Established robot vendors are incorporating more advanced technology into their products. Cincinnati Milacron and Unimation say they plan to use higher level electronics in their robot systems. Unimation intends to begin using DEC's LSI-11/23 central processor in place of the LSI 11/03 within the next six months. General Electric Corp. and Westinghouse Electric Corp. also hope to be big players in the robot market. GE has signed licensing agreements with Italy's DEA and Japan's Hitachi. GE officials also indicate plans to develop their own in-house-developed robots on the market.

Considerable speculation continues about whether established computer firms, including Texas Instruments Inc. and DEC, are ready to enter the robot market. International Business Machines Corp. unveiled its first two robotic systems shortly before the Robot VI show in March in Detroit. ■

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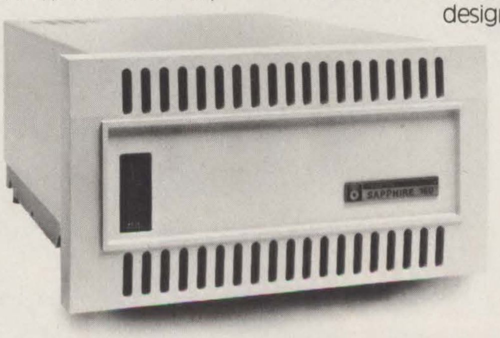

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Federal regulators weigh microband proposal

By Arthur Hill
Washington Correspondent

The turmoil created by the dramatic announcement that Bell Laboratories and the Department of Justice had reached a proposed settlement in their long-standing antitrust battle has caused policymakers to consider alternatives to local telephone companies or cable systems as providers of information to and from the home. An example is the attention a proposal by a subsidiary of Tymshare, Inc., is receiving in regulatory circles.

The proposal was filed by Microband Corp. of America, a Federal Communications Commission-regulated common carrier in the Multiple Distribution Services. Microband holds MDS licenses in most major U.S. markets. Two years ago, Tymshare, which provides value-added packet-switched data-communications services, bought Microband with the intention of providing business users an over-the-air local-loop alternative to the telephone company.

The future holds great promise for MDS, particularly as a local-loop service for data communications, but for its potential to be realized, the fledgling industry must overcome several market and regulatory obstacles. Until then, MDS will probably remain one of the three principal means of distributing pay television to hotels, motels and large apartment complexes in cities and towns where cable TV or subscription television services do not exist.

No one had planned such a fate for MDS. When the FCC created the service in 1962 by reserving the 2150- to 2160-MHz band (the FCC later expanded the allocation to 2162 MHz), policymakers believed MDS would be a major new way of disseminating business and educational information and would meet what they then considered a potentially lucrative market largely overlooked by commercial broadcasters.

Microband endorsed those rosy projections. But despite the company's best efforts, the major demand for MDS has been for entertainment services. MDS channels are leased to customers providing pay-TV services to subscribers in 44 states (MDS licensees cannot also be program marketers). Industry statistics state that approximately 25 operating MDS stations exist, with 25 more under construction. FCC has awarded licenses to operators in 66 other markets but have not started building transmission facilities.

In spite of the profusion of entertainment services that dominate the MDS market, some customers have been using the transmission facilities to provide a local data-communications network. In Urbana, Ill., the University of Illinois uses a system owned by Chicago Communications, Inc., as a comparatively inexpensive way of joining its disparate computer systems.

Nevertheless, business applications in the service have developed slowly, primarily because the FCC has limited capacity to only two channels, one in each market.

Two years ago, the FCC issued a notice of proposed rulemaking to expand MDS to seven channels and to increase transmitter power. But because the rule would have reallocated precious spectrum from the Instructional Fixed Television Service to MDS, filings in opposition to the proposed action quickly filled the FCC's library. Members of the FCC's staff have promised MDS representatives in Washington that a decision on the rulemaking was forthcoming. But they admit privately that unless the industry can provide a sound engineering and market study indicating a need to expand the service, no action will be taken.

The Microband proposal filed in February to the FCC provides the information FCC staffers require. It is a 600-page document that promises a wide array of entertainment and information services that Microband insists the public would support. In addition, Microband states that the total cost of constructing a seven-channel system in each of the 50 major markets would be $35 million—billions of dollars less than the cost of building interactive coaxial-cable systems.

One of the major advantages of the Microband proposal is that it does not involve the introduction of new technology, only the expansion of existing MDS wireless microwave transmission facilities combined with in-place telephone-based data-communications facilities. Furthermore, Microband has assured the FCC that once authorized, fully constructed networks in some of the nation's largest cities could be available within six months.

Microband's unexpected bid to construct "wireless cable systems" in the nation's major urban areas was prompted by financial and other problems that the cable-TV industry has faced in wiring the top telecommunications markets. But with an unleashed American Telephone & Telegraph to consider, regulators and legislators are weighing rules and laws designed to limit the impact AT&T could have on the markets it serves. If approved, Microband's proposal may provide yet another market opportunity for minicomputer and μc manufacturers eager to tap the growing home market. ■

Distinctions between minis and μcs blur with new 16-bit products

By Lori Valigra
News Editor

With the debut of Tandy Corp.'s 16-bit μc, the TRS-80 model 16, the definitions of minicomputers and μcs become more clouded. Tandy's Radio Shack division and International Business Machines Corp. have not shunned the traditional 8-bit μc with their new personal computers, but the 16-bit performance of the machines approximates some low-end minicomputers, particularly in the ability to add multiple terminals. "The low end is going through a revolution. Definitions and concepts (understood now) will not hold true over the next 12 to 18 months," says Peter A. Wright, director of portfolio programs at the Gartner Group, Inc., a Stamford, Conn., research group.

Minicomputer manufacturers are also confused. Digital Equipment Corp. has a tough time defining its high-end models in its LSI-11 μc line, the multitasking LSI-11/23 and /24 products, and Data General Corp.'s CS/50 minicomputer will eventually be based on a one-chip engine. Some 16-bit μc vendors prefer to skirt the issue by using the term "solution" when tagging their computers.

Despite their small size, the Radio Shack and IBM 16-bit μcs have minicomputer features and performance. The MC68000 μp-based Radio Shack model 16 handles as much as 512K bytes of internal RAM, 2.5M bytes of floppy-disk storage and four added 8.4M-byte hard-disk drives (MMS, March, p. 17). The MC68000's 16-bit data path and 32-bit internal operations aid in processing complex data. A Z80A is included to act as a link to the 8-bit software from Radio Shack and as an I/O processor. With its half-8-/half-16-bit chip, the Intel 8088, IBM's personal computer has user memory ranging from 64K to 256K bytes. The machine can address 1M byte, although the practical limit on user-addressable ROM is 640K bytes.

The most notable similarity between 16-bitters and minis is the ability to add multiple terminals. Three terminals can be hooked to the model 16, allowing users to access programs and information simultaneously. The product has a multi-user operating system. Other Radio Shack peripherals can be added via two RS232C interface ports and one parallel port. A hard-disk port must be added for the 8.4M-byte drives. Although IBM's personal computer was introduced as a stand-alone product, it can use as many as three terminals. The μc has two RS232 cards for adding terminals and software controllers.

Three terminals hooked to a limiting architecture present some performance problems. (see "IBM personal computer is efficient," below). "You can run three terminals on either the IBM or the Tandy. The question is whether the computer can respond to those terminals fast enough to service all of them at once," says Mel Hallerman, senior programmer at IBM. Hallerman says simple applications, including inquiry on one database

IBM PERSONAL COMPUTER IS EFFICIENT

IBM claims to have done a lot of little things to boost the performance of its personal computer, which can perform about 700,000 instructions per sec., depending on the mix of instructions, says Mel Hallerman, senior programmer at IBM. For example, the printer can print asynchronously with the CPU. The 8088 μp allows for multiplies to be done directly. An 8-bit μp does multiplication rather than a loop of adds, which slows business applications.

The same commands are used for single- or dual-diskette drive operation. The Disk Operating System (DOS) prompts users to change diskettes. Files are chained, so diskettes do not have to be compressed. Users can have data-only diskettes. As a result, 6K to 8K is not wasted having DOS on each diskette. Additionally, users need not put information into a contiguous space on the diskette. When fragmented information is copied onto a fresh diskette, separated files are presented contiguously. Disk backup is about 31 sec. for a 64K, two-drive system.

Some highlights of the personal computer are ROM tables and routines that are RAM vectored to allow overrides and interceptions for user customization and a 16-key buffer, enabling users to type the next command while one is being executed or if a user types too quickly. Video buffers are located on video cards and not taken from user memory.

The personal computer has a 40K ROM—32K is the BASIC interpreter, 6K is for low-level devices, and 2K is for power-on diagnostics. Diagnostics include 14 major tests and subtests that are done in 5 to 6 sec., or in as much as 1 min. on a 256K machine. Memory on the machine and cards is parity checked, and a message appears on the screen in case of an error.

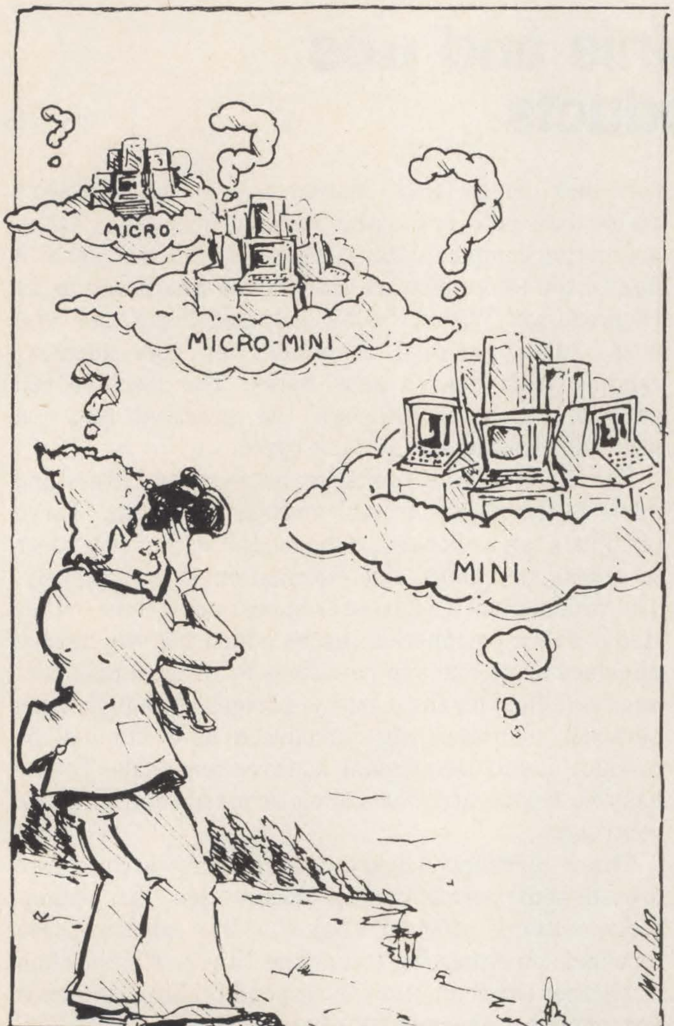

Illustration by Mark Fallon

The Radio Shack TRS-80 model 16 can run 8- or 16-bit software, *yet its multiterminal capability seems like a minicomputer feature.*

or word processing, probably will work with three users. But the same is not true in an engineering or a scientific application. "If an engineer does a matrix inversion on a three-terminal system, the other two users will sit there and look at blank screens," he says.

An additional consideration is response time. Hallerman says three people using data from one drive may have to wait 5 to 10 sec. A minicomputer, he says, has about a 1- to 2-sec. response time because the data are split onto several drives.

Hallerman questions whether it is better to have three users on one system or for each user to have his own low-cost personal computer. Radio Shack's catalog prices for a model 16 with three user terminals, a hard disk and a floppy disk are $10,000 to $11,000. The average price per user on such a system is $3500. The IBM personal computer with dual 5¼-in. floppy-disk drives, color graphics and a printer, is priced at $4500. Without the printer, price is about $3500. "Wouldn't each person rather have a $3500 personal computer than interfere with each other on a three-terminal system?" Hallerman says. IBM does not offer a hard-disk option. A model 16 with an 8-in. floppy-disk drive is priced at $4999, and a dual-drive version with a total of 2.5M bytes of storage is priced at $5798.

Hallerman says μcs are not as flexible or fast with I/O as minis, and as a μc grows, I/O problems develop. "On the low end, the Series/1 minicomputer's processor runs slower than that of the IBM personal computer, but I/O is faster and more expandable," says Hallerman.

Jon Shirley, Radio Shack's vice president of computer merchandising, doesn't believe that attaching several dumb terminals to a mini is practical. He says that dispersed processing on a network is effective and that the communications rate, rather than the number of terminals, is the glitch. "If a user does intensive word processing, for example, screen formatting at 9600 baud is visibly slower," Shirley says. "It is far better to network than to hook a bunch of dumb terminals." Radio Shack will offer compatibility with Datapoint Corp.'s Arcnet local-area network in June, which will allow as many as 255 model II and model 16 computers to be networked.

Making the break to 16 bits

While Radio Shack and IBM tout 16-bit μcs, the two companies may not be able to take full advantage of those higher level processors for some time. IBM's use of the 8088 processor limits the company somewhat to the 8-bit realm because the 8088 uses an 8-bit external bus. But the 8088 gives IBM more readily available software than that provided by the 68000. Further, the lack of 68000 software gives Radio Shack a reason to include the Z80 for 8-bit compatibility.

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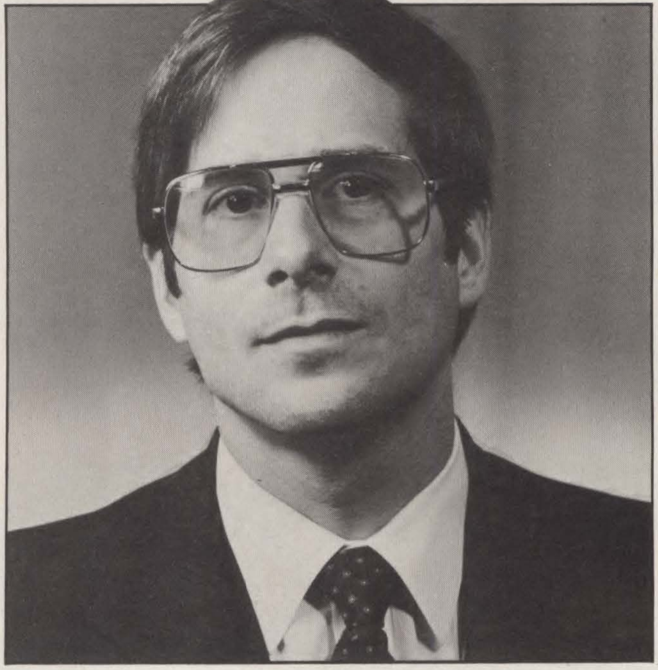
Data General's Jim Ryan says some 16-bit minicomputers and μcs are complementary *and give users a choice of the level at which they want to enter the computing power curve.*



Data General's James Tuttle avoids using "minicomputer" and "μc:" *"The cost/performance ratio matters, not how you get there."*

"I've never seen any machine introduced with enough software. The IBM personal computer did not have enough," Shirley says. When the model 16 project began two year ago, Tandy faced a choice of three 16-bit processors—the 68000, the 8086 and the Z8000. The 68000 was chosen, Shirley says, "because it could code faster than the other two, and it is a beautiful processor for which to program."

Radio Shack does not have many performance figures available for the model 16. Shirley says that in one COBOL programming demonstration with the 68000 processor in a number-crunching application, the model 16 showed a 2:1 speed advantage over the model II.

As for software, Shirley claims Radio Shack will have a full inventory-control package with its first shipments in the second quarter of this year. He says the model 16 can be used with a DEC VAX to support programming and to run UNIX and C.

IBM did not announce its personal computer with a full complement of software, but it plans to add the CP/M operating system and obtain software from outside authors. The personal computer's software repertoire includes VisiCalc, DOS, BASIC interpreter, EasyWriter word-processing software and Peachtree Software, Inc.'s general-ledger, accounts-payable and accounts-receivable packages. Recent additions include programs to help students learn arithmetic, Typing Tutor to help refine typing skills, general accounting by BPI Systems, Inc., a macro assembler, FORTRAN and UCSD Pascal compilers and UCSD p-systems with Pascal and FORTRAN-77.

Other vendors have helped stabilize IBM's position in the μc market by introducing compatible products (MMS, October, 1981, p. 64). At least 10 vendors offer products for the personal computer. Those products include floppy-disk systems, expansion boards for as much as 1M byte of memory, interfaces to Winchester-disk drives and local-area networks and a graphic-analysis package.

The Gartner Group estimates that 20,000 personal computers have been shipped worldwide since September, and that the number will grow to 175,000 this year.

IBM is building a strong software coffer, and with the help of Intel Corp., its personal computer will not suffer any performance penalties by incorporating the 8088. A co-processor socket next to the 8088 can be designated for Intel's 8087 numeric processor extension. Although IBM's Hallerman won't comment about use of the 8087, he says an 8088 with an 8087 "could run rings around the 68000."

Although Intel recently boosted its 8088 to 8 MHz, providing a 60-percent performance improvement over the 5-MHz version, IBM will likely stick to the lower speed chip. Hallerman notes that the 8087 is a 5-MHz part, and must be run with 8088. A faster processor, he adds, will not do much good if users don't add faster memory on the system, which could cost about $1500 to $2000. Hallerman won't comment about use of Intel's new 16-bit 286 μp, which is available in 8- and 10-MHz versions.

Do users care about whether a μc is 8, 16 or 32 bits? "The cost/performance ratio matters, not how you get

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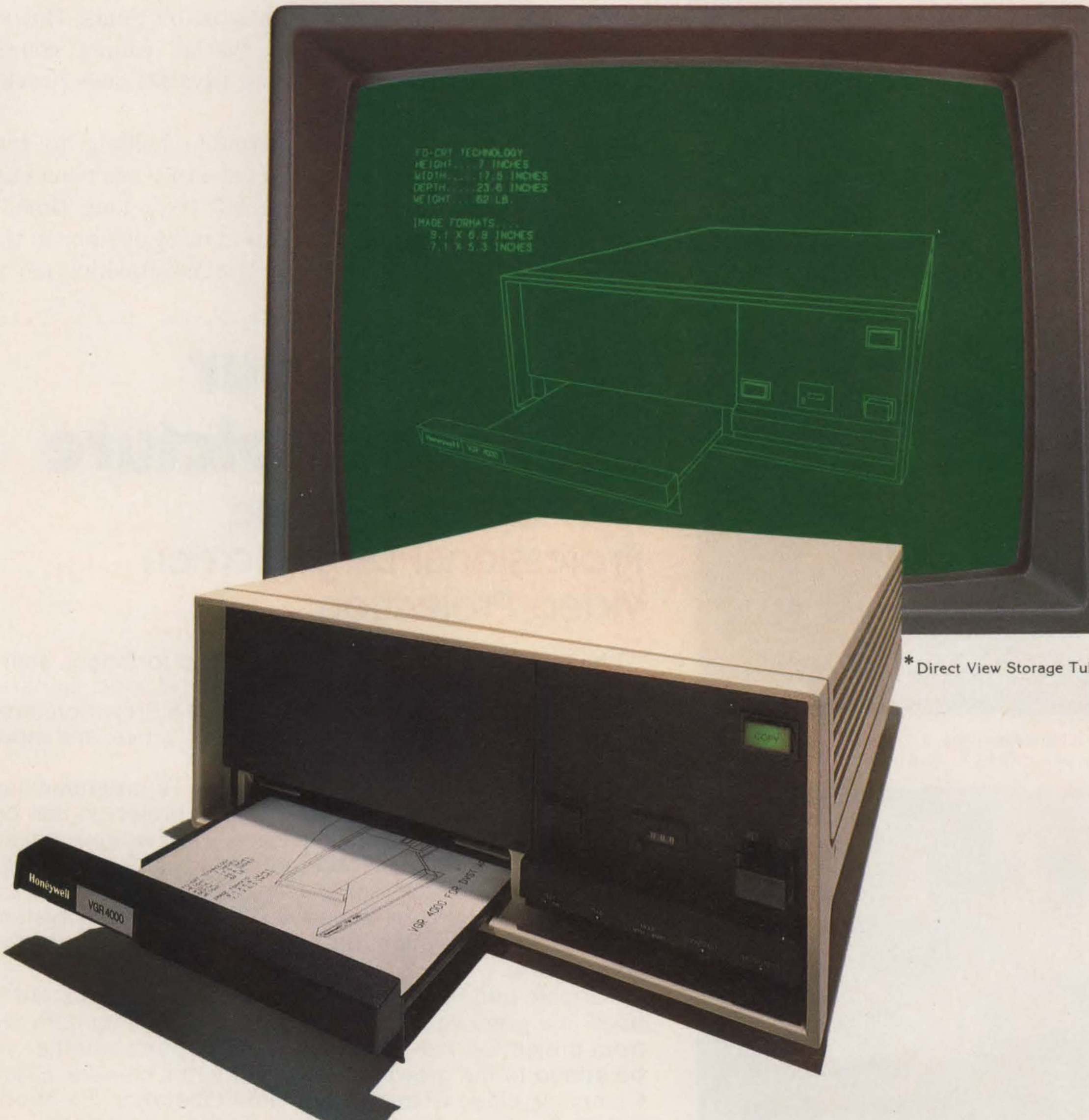

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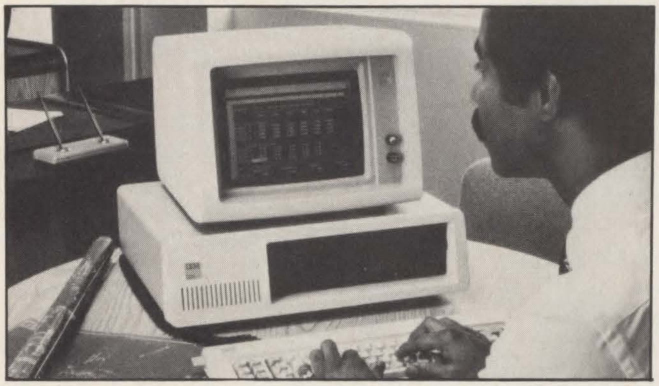


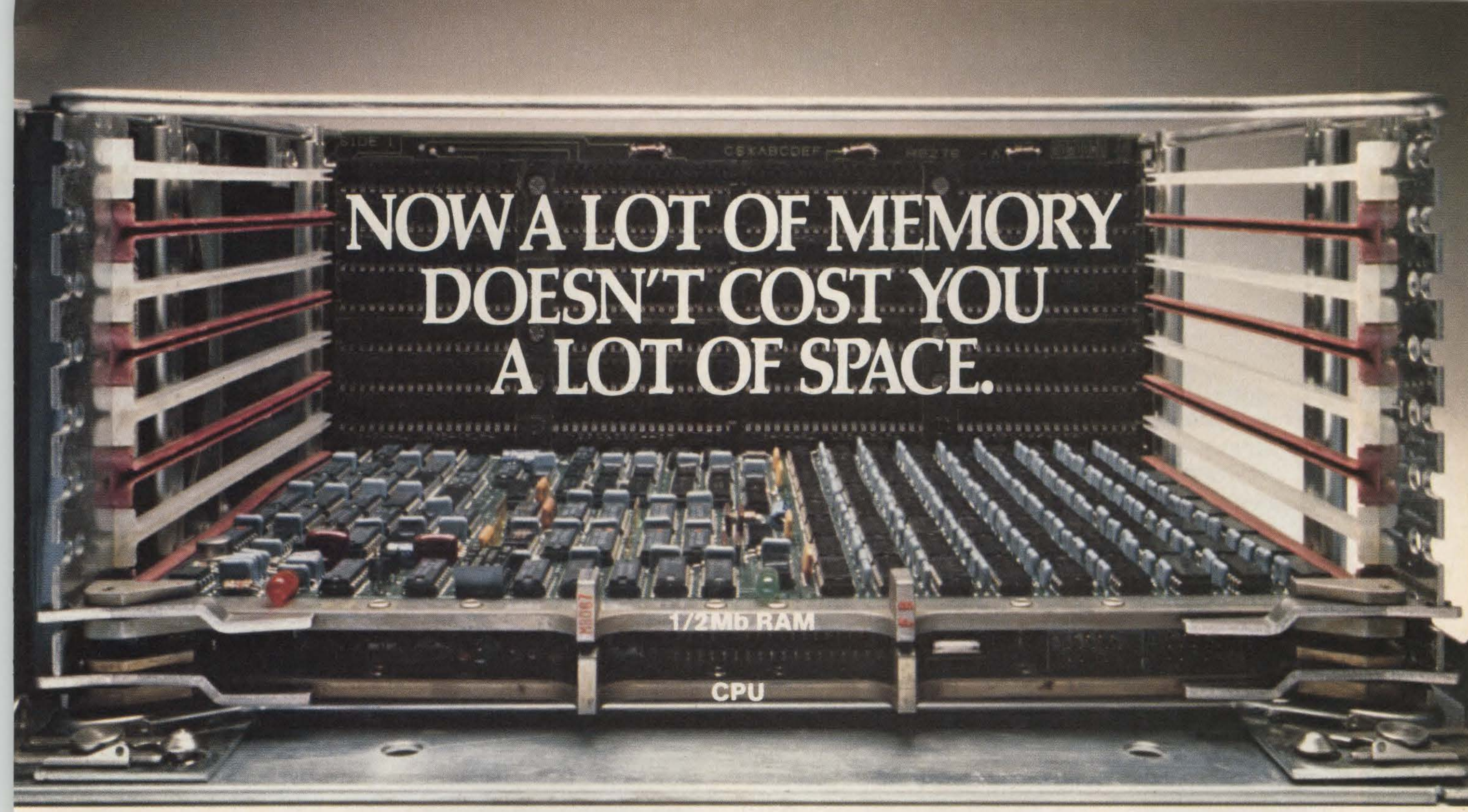
The IBM personal computer runs three terminals, *but an IBM programmer questions whether it is better for users to have individual low-cost μcs or share a database.*

there," says James Tuttle, director of development for DG's small-business systems division. "A good share of business data processing is comparing one number or character with another. You don't need, for example, a 32-bit address register to do this—8-bits is good enough." He adds that there is some advantage to a wider bus width in memory addressing.

Tuttle says definitions of minicomputers and μcs are blurring. "If you draw a distinction on the engines in the two, a μc is a one-chip processor, while a mini can expand over memory sizes and peripherals. But some minis, such as the CS/50 from DG, will someday have one-chip engines. You have to look at the capability of the machine—the number of terminals and bytes of memory—rather than whether it has a 16-bit engine."

DG director of marketing Jim Ryan concurs, saying that 16-bit μc power is complementary to that of some small-business minis. The difference he sees is the level at which a user enters the computing power curve. "The Tandy top of the line is the Tandy top of the line. There is no place to go with the IBM personal computer except to link it to a mainframe." DG's Enterprise systems, which are low-end small-business computers based on a 16-bit microNova chip, are compatible with products ranging as high as 32-bit minis. However, the stand-alone Enterprise system cannot communicate with those systems. Ryan says DG does provide users with a growth path.

DEC is also having trouble holding to traditional product definitions. "the LSI-11 μc has been pushing on the wall (of minicomputers) for a long time," says a company spokesman. This is most obvious in the larger LSI 11 products, such as the multitasking LSI-11/24. ■



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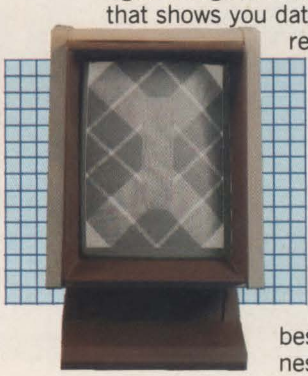

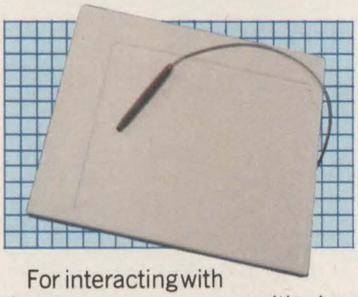

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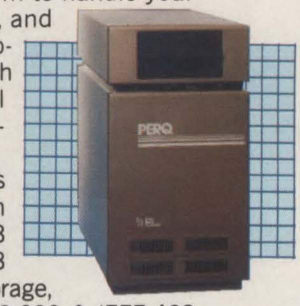

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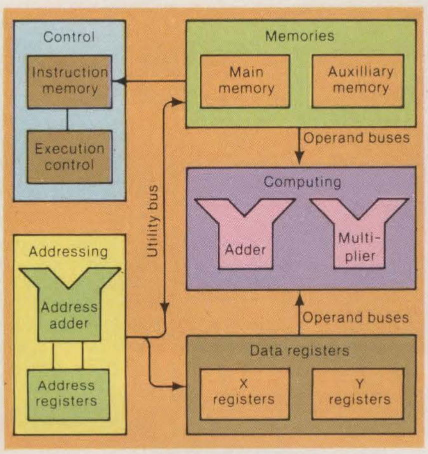
MINICOMPUTERS: Fear not for the minicomputer; it is alive and well and selling like crazy. Despite the recent attention given in the media to new μcs and superminis, the market has not yet relegated the mini to the scrap heap. Various market forecasts put the mini on an annual growth path of more than 20 percent through 1985. Contributing editor Malcolm L. Stiefel takes an in-depth look at the minicomputer market and surveys OEM products, starting on **p. 127** . . . At the high end of the minicomputer market, 32-bit superminis are compared to mainframes as often as to other minis. More than two dozen superminis are on the market, and they are the fastest selling class of minis. But their performance levels vary greatly. For a comparison, see the profile by Data Decision on **p. 143** . . . The need for automated tech-control systems is evolving as the complexity and data speeds of communications increase. Now testing and fault isolation can be automated by combining test equipment with minicomputers. An explanation begins on **p. 159** . . . The product-development industry has been content to test for proper system integration with separate and unrelated instruments. A new design philosophy implemented through Hewlett-Packard's HP 64000 logic-development system integrates all hardware and software elements of the design and development phases into one system. The cover story begins on **p. 165.**



ARRAY PROCESSORS: CSP, Inc., and Floating Point Systems manufacture the most popular lines of array processors on the market, but their products use radically different architectures: synchronous and asynchronous. A look at the two architectures—showing how APs work, what programming and system integration problems they create and why they serve some applications better than others—begins on **p. 179** . . . A local-area network allows even the smallest computer or intelligent terminal to access large databases, fast line printers and long-distance communications networks. But designing an LAN that satisfies user demands is not simple. It requires choosing a configuration, a medium access and link-control methods, and deciding how to package the interface and which industry standards to observe. See **p. 219** for a guide to designing LANs.

POWER SUPPLIES: A computer must get its power from a source a user can afford and on a schedule a user can tolerate. Most important, the power source must work with a system to provide the most cost-effective and efficient interface with the user's local power grid. A power-supply selection guide for system integrators starts on **p. 191** . . . The tremendous increase in minicomputer and μc operating speeds has been accompanied by a proportionate increase in sensitivity to power-line disruptions. A vast array of portable power-protection equipment has been developed, but manufacturers' different standards and test procedures produce different results. A guide to evaluating power-protection equipment begins on **p. 201.**

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Minis are still king of the hill

MALCOLM L. STIEFEL, Contributing Editor

Minicomputers are fighting a two-front war against µcs and superminis—and are surviving

Fear not for the minicomputer; it is alive and well and selling like crazy. Despite the recent well-deserved attention given in the media to jazzy new µcs and superminis, the market has not yet relegated the mini to the scrap heap. The 1981 edition of *Mini-Micro Systems' Computer Market Report* compiled by Dataquest, Inc., estimated nearly 400,000 minis were installed in the U.S. alone as of 1980, an increase of 140 percent from the 167,000 that were on site in 1976, and almost 25 percent more than the 332,000 on hand in 1979. In another study, MSRA, Inc., pegs the mini market at $9.85 billion, and forecasts an annual growth rate of 23.6 percent, bringing sales to $23 billion by 1985.

These rosy figures stem from the effects of technological progress, which has quietly boosted the performance and functions of minis even as it has created the µc and inspired the supermini. Minicomputers are faster, more flexible and more capacious than ever, yet physically smaller and less power hungry. More and more applications are migrating from mainframes to minis, and new applications are opening in such areas as office automation, CAD/CAM and graphics.

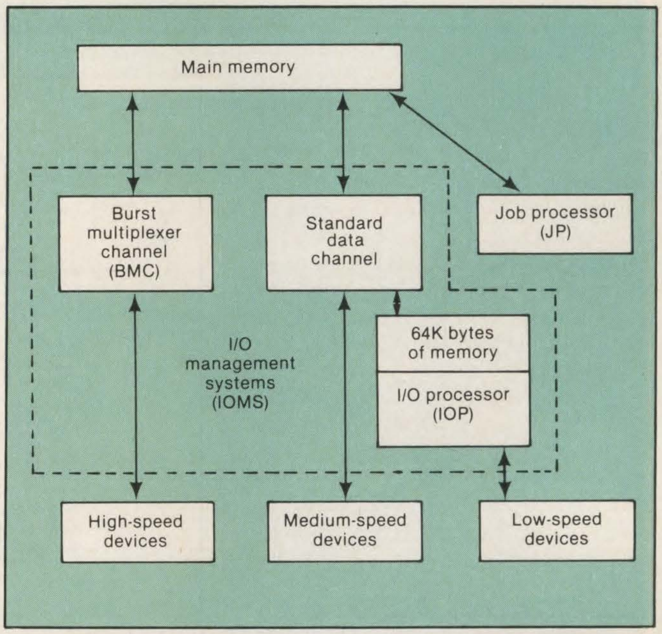


Fig. 1. Data General Corp. Eclipse M/600's separate I/O management system permits an input rate of 10M bytes per sec. *and an output rate of 6.67M bytes per sec. over the burst multiplexer. The rates on the standard data channel are 2.5M bytes per sec. on the input side and 1.4M bytes per sec. on the output side. Freed from most interrupt processing, the M/600's job processor can spend more time processing 16-bit and double-word 32-bit instructions.*

Evolution of hardware

The first minicomputer, the Digital Equipment Corp. PDP-1, introduced in 1959, had 28 instructions, an 18-bit word length, and 4K words of memory. Today, a high-end 16-bit mini such as the Honeywell Information Systems' DPS 6/76 addresses as much as 2M bytes of main memory and as many as 28 registers and works with 184 instructions. The Data General Corp. Eclipse M/600 (Fig. 1) has a mainframe-like architecture, with separate processors for I/O and job execution. Hewlett-Packard Co.'s A700 (Fig. 2) goes a step further: it may be the first 16-bit machine with virtual addressing, allowing programs to access as much as 12.6M bytes of storage. The A700 also executes as many as 450,000 floating-point operations per sec. (2.2 µsec. per operation) with its optional computation-acceleration processor board.

By way of contrast, Computer Automation's Naked Mini Scout takes 81 to 133 µsec. to execute one of its optional floating-point addition instructions. The Scout is the smallest member of the Naked Mini family, a popular series of OEM minis that spans an order of magnitude or more in processing power, memory capacity, and I/O speeds.

The availability of such families of minicomputers is vital to OEMs, which need to match CPU capabilities to

OEMs consider microprogramming because their investment in the code can be amortized over many sales, and because a microcoded application will execute as much as 10 times faster than the same application coded in a conventional manner.

their applications at the lowest possible cost. OEM minicomputer vendors go to great lengths to give the OEMs as much design flexibility as possible. Memory is incrementally expandable, large processors are software-compatible with smaller processors, and extensions are offered to instruction sets. Several manufacturers provide arithmetic computation options to implement arithmetic (when even fixed-point multiplication and division are not in the standard instruction set) or to make it run faster (as in the H-P computer-acceleration processor).

A few vendors go still further by furnishing user-microprogrammable CPUs. This feature is aimed squarely at OEMs because microprogramming requires skills that lie beyond the reach of a typical end-user's staff. Moreover, microprogramming is a painfully slow process, typically averaging fewer than 1000 designed, coded, tested and documented microinstructions per programmer-year. These rates compare most unfavorably with typical application-programming rates of 3000 lines of code per programmer-year. Further, if the 3000 lines of code are written in a high-level language, they translate into approximately 15,000 lines of machine-level instructions. On the other hand, 1000 microinstructions translate into fewer than 1000 machine-level instructions because each machine-level instruction is typically composed of several microinstructions.

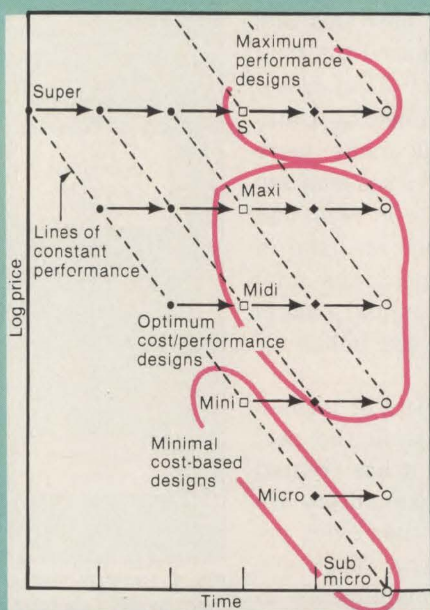
OEMs consider microprogramming because their investment in the code can be amortized over many sales, and because a microcoded application will execute as much as 10 times faster than the same application coded in a conventional manner. For image

THE EVOLUTION OF MINICOMPUTERS

In the first chapter of their informative and readable book, *Computer Engineering: A* DEC View of Hardware Systems Design (Digital Equipment Corp., 1978), authors C. Gordon Bell, J. Craig Mudge and John E. McNamara develop a market view of computer classes. They point out that classes can be distinguished by price and named: submicro (to come in the next generation), micro, mini, midi, maxi and super. The classes midi and maxi are sometimes referred to by the single term mainframe. They also point out that, "When one distinguishes computer classes by price, a new range of price can be made possible by new technology and create a new class."

This situation is illustrated above. Each new class adopts the performance level that was initially realized by its predecessor one time interval earlier. Following its introduction, improvements in the functions and performance of each class are made over time as technology advances, without changing the price range of the computers in the class. To understand the notion, consider that the performance of today's μcs easily matches or surpasses those of the earliest "super" computers in the 1950s, and that their prices are three to four orders of magnitude lower (the vertical scale in the figure is logarithmic).

Performance advances within the classes can be seen in the characteristics of such long-running families as



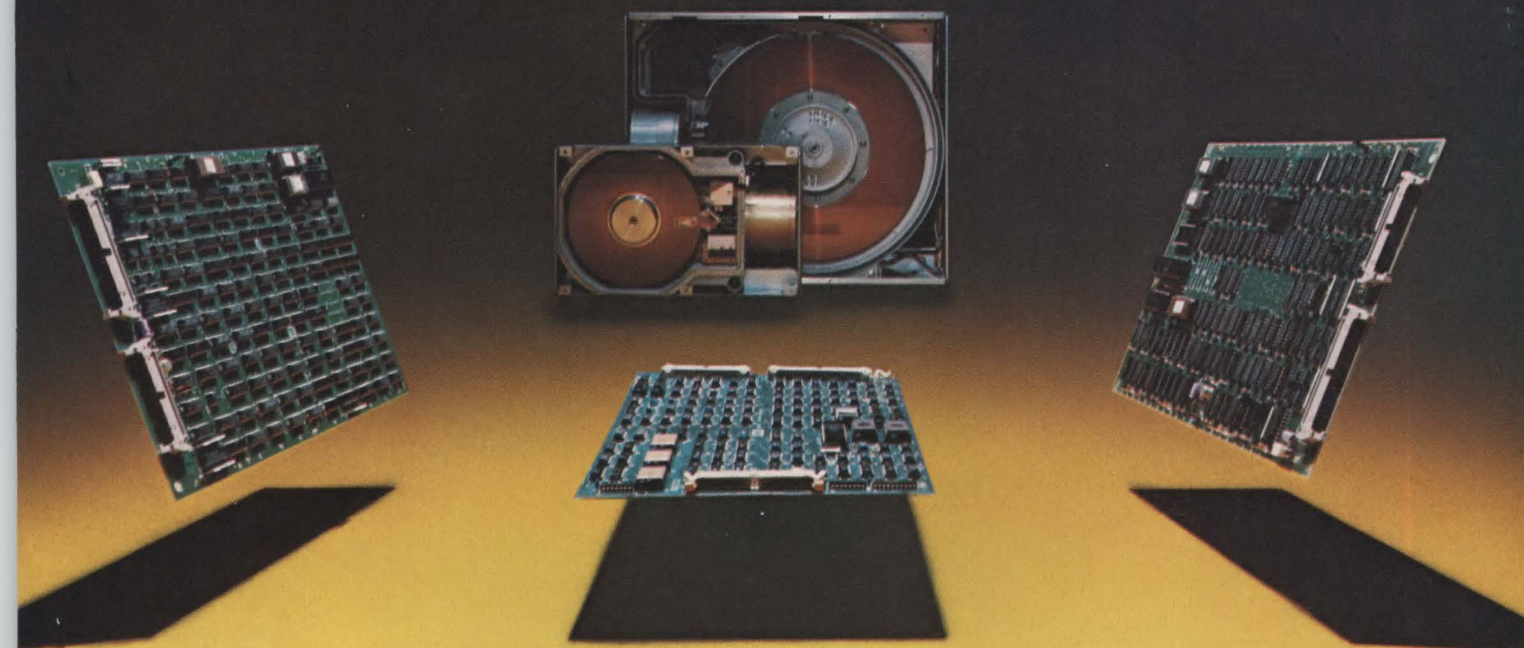
Evolution of computer classes is driven by hardware advances and by vendors' pricing strategies. *New machines provide better performance than earlier machines at the same price (horizontal arrows) or the same performance as earlier machines but at lower prices (diagonal lines). Source: Bell, Mudge and McNamara, "Computer Engineering: A DEC View of Hardware Systems Design," p. 13, Digital Equipment Corp., 1978.*

the DEC PDP-11 and the Data General Corp. Nova, which have steadily advanced in execution speed, memory capacity and I/O capability over the years, while prices have stayed in the less-than-$50,000 range. Before μcs, all machines in this price range were called minis, whether they had 8- or 16-bit words or anything in between. Today all 8-bit CPUs sell for less than $5000 and are called μcs, and the new 16-bit μcs have usurped the low end of the 16-bit minicomputer market. CPU class definitions, then, are not hard and fast, but vary with time.

Vendors agonize over whether to characterize each new product as a mini or a μc because the designation affects the positioning of the device in the market. Thus, Hewlett-Packard Co. names the A600, one of its two newest entries in the HP-1000 series, a full-function μc, while it calls the other, the A700, a minicomputer.

The distinction is based on selling price, not on the level of performance or the fabrication technique of the boards that comprise the CPU. That is, a minicomputer can be based on large-scale integrated technology, and a μc can be built with medium-scale integrated components.

At the upper end of the minicomputer scale lie the superminis, which have effectively replaced the "midi"-computers, (a term that never caught on). Today's superminis are 32-bit machines, selling for $50,000 to $300,000. The Perkin-Elmer Corp. 32 series, the Gould S.E.L. 32 series, the DEC VAX-11s and the DG MV/8000 16-bit machine selling for $5000 to $50,000, occupying the middle ground between μcs and superminis.



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effectiveness. And we back them up with our new Virgo 1/2" 40 megabyte IBM format compatible streaming tape drives and our fixed/removable media Superwinchesters in 16/16, 48/16, and 80/16 megabyte capacities. We're high performance in our technical support, too, as well as in clean-room production capabilities that mark us as a major manufacturer committed to Winchester technology now and in the future.

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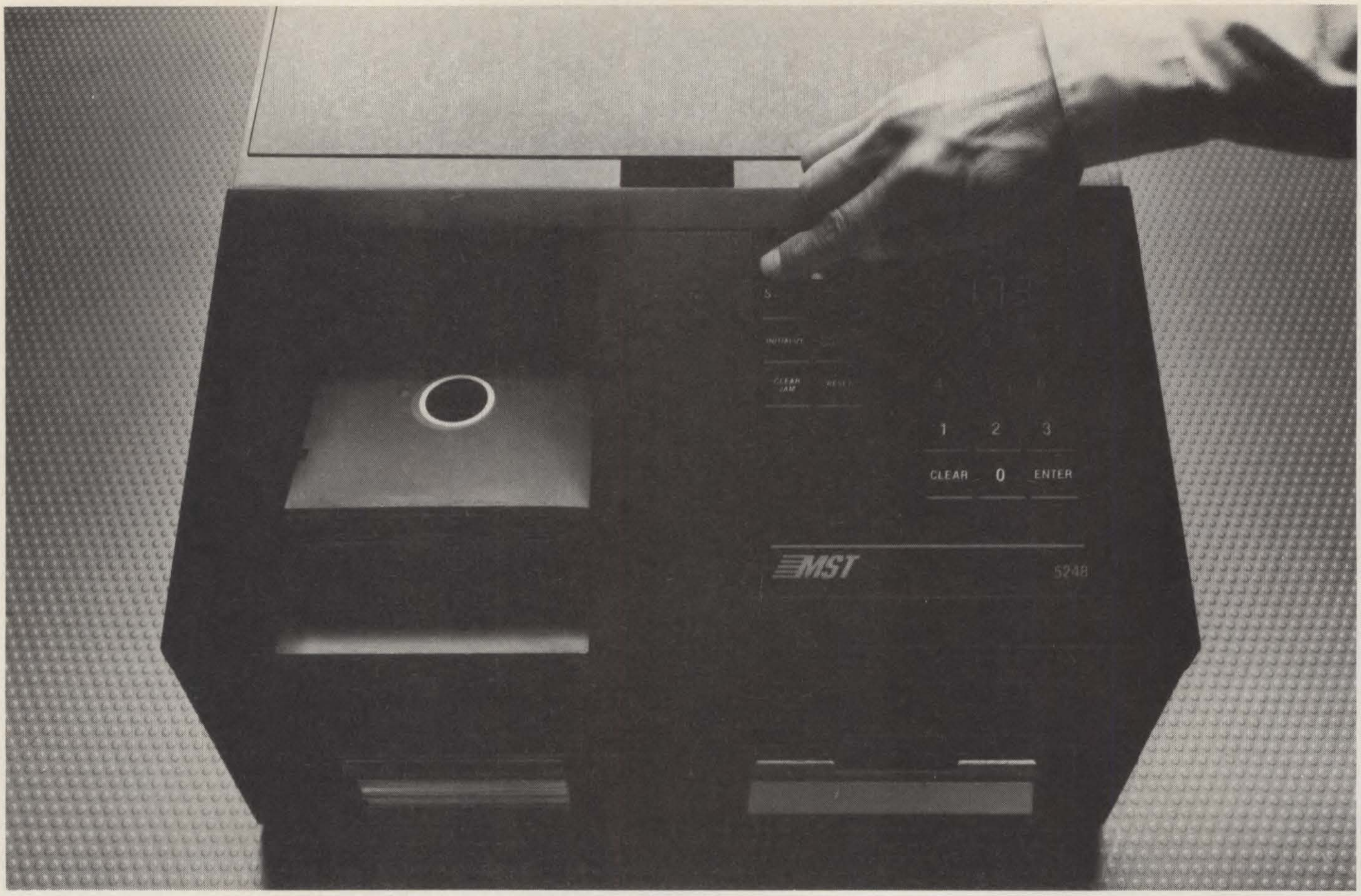
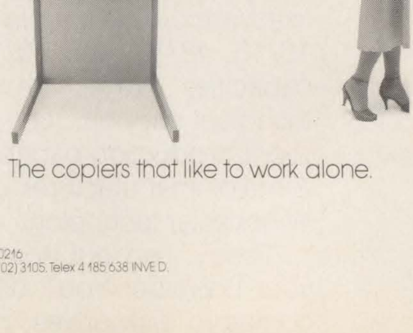
The Designer's Choice.


1 2 3
CLEAR 0 ENTER
MST
5248



The hit ratio can exceed 95 percent for cache memories of 4K words or more, thereby substantially increasing the throughput of the CPU.

processing, signal processing and other applications in which stringent real-time performance is required, the only way to implement a system may be by microprogramming. DG's Eclipse S/130, H-P's A600 and A700 and DEC's PDP-11/60 are user-microprogrammable machines.

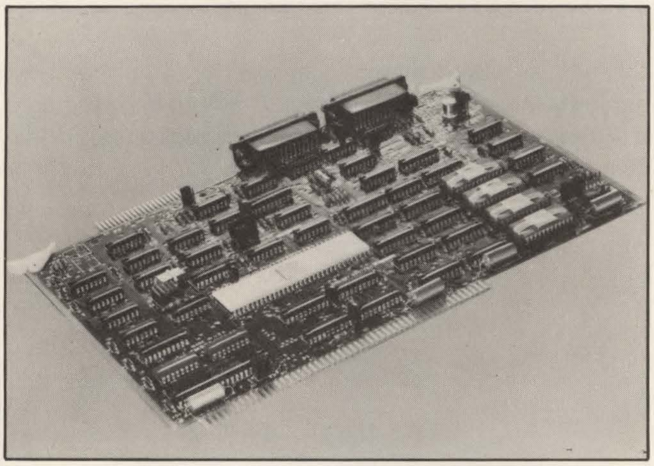
Another wrinkle that has become popular in the larger minis, such as the DEC PDP-11/70 and the CA SyFA 2000, is the use of cache memory. A cache memory is a small (4K bytes is typical), fast memory, usually implemented with bipolar technology, that acts as an adjunct to main memory. The CPU makes reference to cache, with typical access times lower than 100 nsec., before it looks in main memory, with access times of 400 nsec. to 1 μsec. When a word is retrieved from main memory, it is placed in cache for subsequent reference. The "locality of reference" principle for computer programs states that programs tend to use the same data over and over again instead of constantly using new data. Thus, once data are placed in cache, the probability that they will be retrieved from cache (before being overwritten by another data item) is fairly high. The hit ratio—the probability that a given word will be retrieved from cache rather than main memory—can exceed 95 percent for cache memories of 4K words or more, thereby substantially increasing the throughput of the CPU.

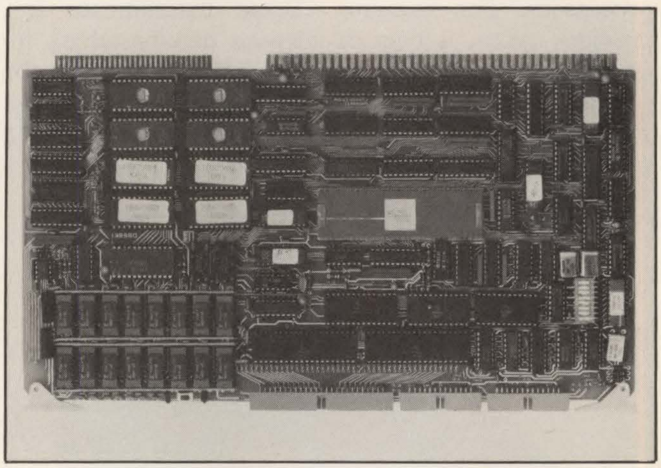
Some vendors offer hardware features that enhance maintainability. For example, the CA Naked Mini Scout includes a diagnostic function called Isolite that automatically tests and identifies any malfunctioning boards by lighting an on-board red lamp.

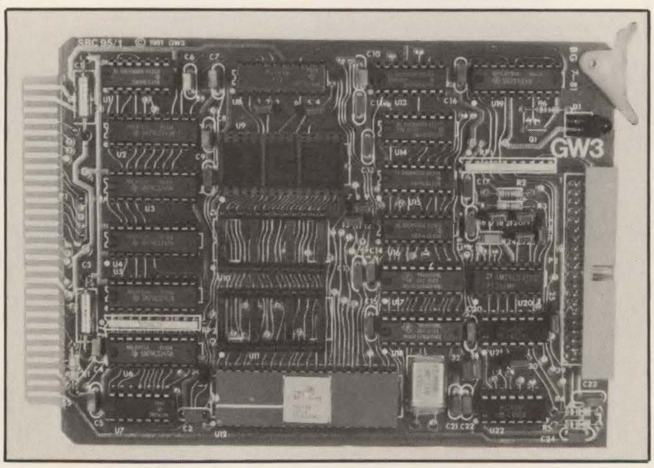
Evolution of software

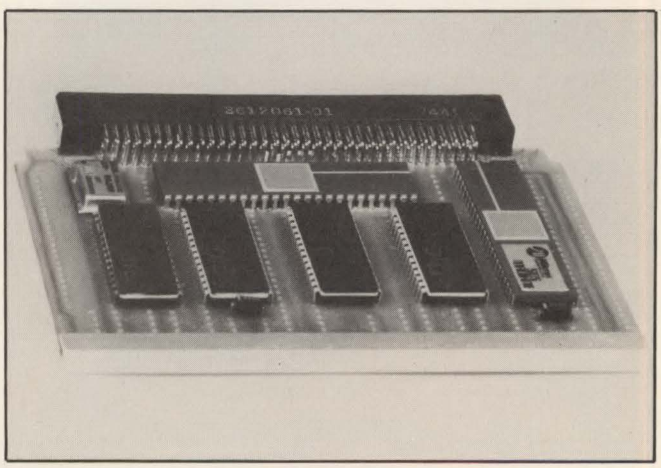
In the early days, when mini makers were known only as "iron" suppliers, the only software they provided was an assembler. Users were expected to be technically proficient professionals who could figure out how to program their hardware. The vendors took this tack because they did not have software experts to help the users.

The number of technically proficient users was









Board-level 16-bit minis are available for STD-bus, VME-bus, Multibus and other bus standards. *The new board-level minis provide more processing power and memory than before and feature lower parts counts and power requirements. Clockwise from top left are the industrial-grade TM990 from Texas Instrument Inc.; the 128K-byte, MC68000-based OB68K1 from Omnibyte Corp., the $349, TI990/9900-compatible SBC 95/1 from GW3 and the radiation-resistant, militarized, silicon-on-saphire Mk-r16 from Mikros Systems Corp.*

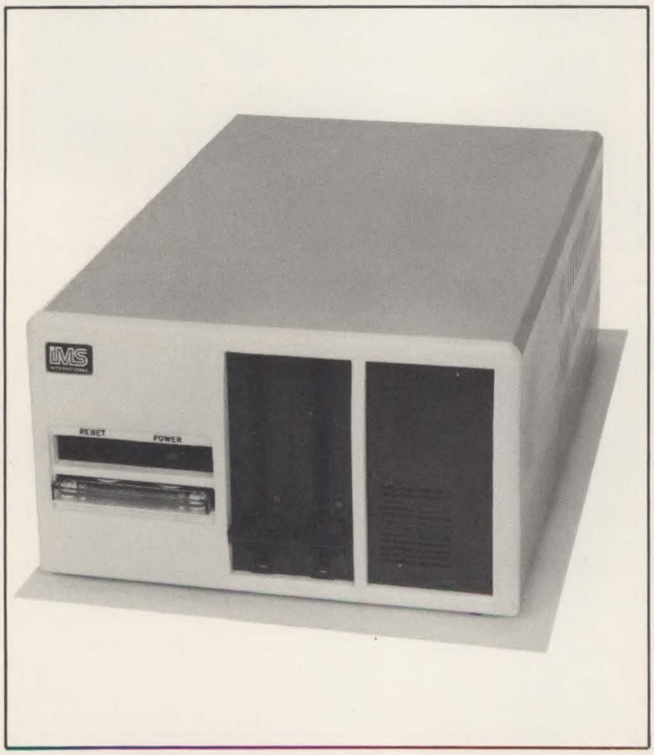
Ada is designed to make the development tools and the compiler transportable to computers of all shapes and sizes.

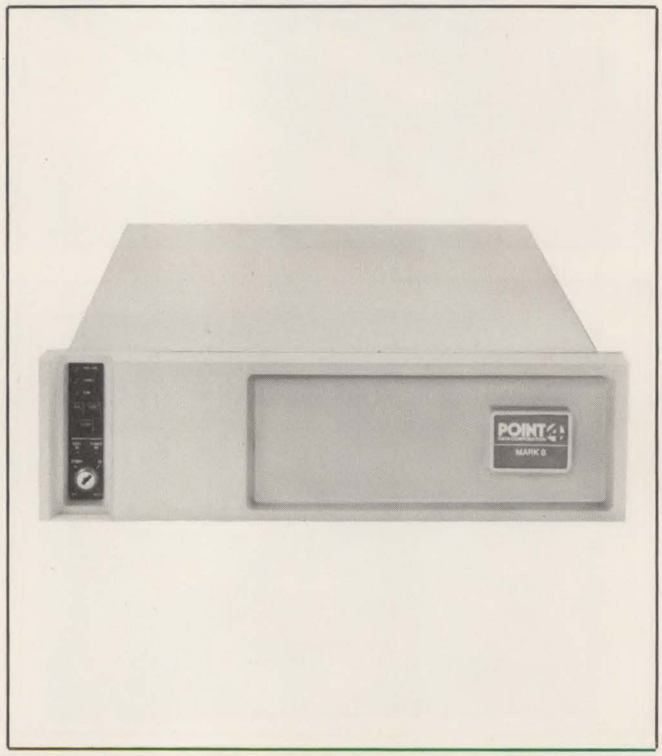
limited, and many of them were unwilling to spend 80 percent of their waking hours debugging programs. International Business Machines Corp. had established a standard for customer relations, offering software to help users get started. It was only a matter of time before the mini vendors jumped on the bandwagon.

Today, the availability of complete system software from OEM minicomputer vendors is taken for granted. Assembly language has been supplanted in most applications by such high-level languages as FORTRAN, COBOL and Pascal, and most OEM mini vendors now offer these languages along with sets of utilities for sorting, testing, copying of files and communication. Evey mini on the market includes an operating system that is tailored for the task at hand, supporting single or multiple users in a real-time, batch or interactive mode.

For the most part, the vendor has supplied operating systems tailored to the characteristics of specific processors. For example, Texas Instruments Inc. provides DX10, a general-purpose disk-based OS for commercial and scientific applications, running on models 4, 7, 8 and 9 of its DS990 minicomputer family. Another TI operating system, called DNOS, is designed for distributed-network applications on DS990 models 4 through 30. Like many other vendors, TI supplies a database-management system, a query language, word-processing software and a data-entry-and-display system for the DS990 family.

Fig. 2. Hewlett-Packard Co.'s new OEM A600 µc and A700 minicomputer *are available in board, box and system configurations.*





Today's box-level OEM minicomputers are packaged units *that include processor, expandable memory, I/O control, power supply and cabinet. Most are supplied with operating system, utility and high-level language software, and many offer integral storage with appropriate backup. At left is the IMS International 8000SX; at right is the Point 4 Data Corp. Mark 8.*

UNPRECEDENTED DESK TOP CAPABILITIES

The AP445-HP9845 Connection

Now you can add the proven, high-speed computation abilities of Analogic's AP400 Series array processors to your Hewlett-Packard HP9845 Desk-Top Computer.

Augmenting the HP9845 with an AP445 creates a powerful engineering tool. The combined ease of use of a desk-top and high computation speed of an array processor gives design engineers new flexibility for analysis and simulation. Similarly, test engineers now have a computing system which can test filters, A/D converters, and other components and subsystems at speeds compatible with real-time test signals. The rapid computation of FFT's, correlations, and convolutions provides wide latitude for the design of test algorithms. Programs in HP BASIC control all this computing power.

• High Throughput Speeds

With the same powerful computing capabilities of the AP400, the AP445 can boost the throughput rates of the HP9845 several hundred times, without sacrificing the "friendliness" of the desk-top computer.

• High Performance Computing with a Portable System

This powerful, yet economical, computing system is also portable. The AP445-HP9845 combination can handle real-time signal processing in the field or at remote stations. The flexibility provided by the ruggedness of this high performance computing system also permits real-time signal analysis out on the factory floor or in high-performance test cell operations.

• HP Basic Programming

The high-speed computing power of the AP445 is accessed by programs written in HP BASIC, including data acquisition inputs directly to auxiliary ports of the AP445.

Free Information

Write today for further information on the AP445 and AP400 Series array processors. Our data sheet includes typical system throughput speeds and a sample program using the AP445-augmented HP9845. Or call Marketing Manager at (617) 246-0300 X2217.

AP445 Features

- **Fast—** Computes a 1024-point real FFT in 7.2 ms.
- **Large On-Board Memory—** 64K words of 24-bit bipolar RAM is standard.
- **Simple Hookup—** Connects to the HP9845 with a single cable and HP98032A interface (included).
- **Low Power Consumption—** Requires 130 W, nominal, from 117 Vac or 240 Vac @ 50/60 Hz (100 Vac optional).

ANALOGIC®

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CIRCLE NO. 74 ON INQUIRY CARD

OEM MINICOMPUTERS

Manufacturer Model	Memory (K bytes) Minimum	Maximum	Cycle time (nsec.)	Maximum I/O devices	Software Operating system
Alpha Micro					
AM-1021, -1041, -1061	64	1000	350 (clock)	24	AMOS
Charles River Data Systems					
MF211E	64	1000	1000 (clock)		RT-11, RSX-11
Computer Automation					
Naked Mini-Scout 4/04	32	128	1051 (memory)		OS4-RTX4
Naked Mini 4/10		128	520-3000 (memory)		OS4-RTX4
Naked Mini 4/30		128	520-3000 (memory)		OS4-RTX4
Naked Mini 4/90		128	520-3000 (memory)		OS4-RTX4
Naked Mini 4/95		8000	550 (memory)		CARTOS
Data General					
Nova 3/D	32	128	700 (memory)	61	RDOS, DOS, RTOS
Nova 3/4	32	32	700 (memory)	61	RDOS, DOS, RTOS
Nova 3/12		128	700 (memory)		RDOS, DOS, RTOS
Nova 4/C	16	64	400 (memory)		RDOS, DOS, RTOS
Nova 4/S	32	64	400 (memory)		RDOS, DOS, RTOS
Nova 4/X	64	256	400 (memory)		RDOS, DOS, RTOS
Dataram					
M23	256	4000	300 (clock)		RSX-11M, UNIX
Digital Equipment					
LSI-11/2	8	32			RT-11, RSX-11S
LSI-11/23	32	256			RT-11, RSX-11M, RSX-11S
PDP-11/23	32	256			RT-11, RSX-11M, RSX-11S
PDP-11/24	128	1000			RT-11, RSX-11M, RSX-11S, RSTS/E
PDP-11/34	64	256			RT-11, RSX-11M, RSX-11S, RSTS/E IAS, DSM-11
PDP-11/44	256	1000			RT-11, RSX-11M, RSX-11S, RSTS/E IAS, DSM-11, RSX-11M plus
PDP-11/70	512	4000			RSX-11M, RSX-11S, RSX-11M plus, RSTS/E, IAS, DMS-11
MBC Series		64			MP/OS
Eclipse C/150	64	1024	600 (memory)	59	AOS, RDOS
Eclipse C/350	64	2048	500 (memory)	57	AOS, RDOS
Eclipse S/130	128	1024	200 (clock)	59	AOS, RDOS, RTOS
Eclipse S/140	128	1024	200 (clock)	61	AOS, RDOS, RTOS
Eclipse S/250		1024	500 (memory)	57	AOS, RDOS
Eclipse M/600		2000	500 (memory)	57	AOS
MPT/100	64			1	MP/OS
MP/100		64	960 (memory)	61	MP/OS, DOS, RTOS, AOS
MP/200		64		61	MP/OS, DOS, RTOS, AOS
Dual Systems Control					
CPU/68000	64	1600			
General Automation					
GA-16/110	8	128	2100		
GA-16/220	8		2100		
GA-16/330	64	128	780		
GA-16/460	64	512	500		
GW3					
SBC95/1	8	65			

Software Languages	Price	Notes	Circle no.
BASIC, Pascal Lisp, Micro Assembler	1500-35,000	includes 64K-byte RAM, printer terminal	415
FORTRAN, BASIC	$8500	includes 128K-byte RAM, dual floppies, chassis	414
		includes 32K-byte RAM, I/O, chassis	413
FORTRAN IV, FORTRAN 5, ALGOL, BASIC, Macro Assembler			412
FORTRAN IV, FORTRAN 5, ALGOL, BASIC, Macro Assembler			
FORTRAN IV, FORTRAN 5, ALGOL, BASIC, Macro Assembler			
FORTRAN IV, FORTRAN 5, ALGOL, BASIC, Macro Assembler			
FORTRAN IV, FORTRAN 5, ALGOL, BASIC, Macro Assembler			
FORTRAN IV, FORTRAN 5, ALGOL, BASIC, Macro Assembler			
none	$9400	includes IBM, RAM, QMAP, 2 serial lines	439
Macro-II , FORTRAN IV, BASIC II			440
Macro-II , FORTRAN IV, BASIC II			
APL, BASIC, COBOL, COBOL 66, FORTRAN, RPG 11, Macro Assembler, DSM-11			
APL, BASIC, COBOL, COBOL 66, FORTRAN, RPG 11, Macro, DSM-11, DIBOL			
APL, BASIC, COBOL, COBOL 66, FORTRAN, RPG 11, Macro Assembler, DSM-11, DIBOL		PDP-11/23 plus address, 1M-byte cache memory optional	
APL, BASIC, COBOL, COBOL 66, FORTRAN, RPG-11, Macro Assembler, DSM-11, DIBOL		8K-byte cache standard	
APL, BASIC, COBOL, COBOL 66, FORTRAN, RPG-11, Macro, DIBOL, DSM-11		2K-byte cache standard	
Pascal, Assembler, FORTRAN			
FORTRAN 5, PL/1, BASIC, COBOL, RPG11			
FORTRAN 5, PL/1, BASIC, COBOL, RPG 11			
FORTRAN II, FORTRAN 5, BASIC, ALGOL, PL/1, DG/L			
FORTRAN II, FORTRAN 5, BASIC, ALGOL, PL/1, DG/L			
FORTRAN II, FORTRAN 5, BASIC, ALGOL, PL/1, DG/L			
BASIC, ALGOL, FORTRAN IV, PL/1, DG/L			
FORTRAN IV, BASIC, Pascal			
BASIC, Pascal, FORTRAN II			
BASIC, Pascal, FORTRAN II			
	$3685	includes 32K-byte RAM, 32K-byte EPROM, serial I/O ports	441
			442
PDOS, BASIC	$349		443

Manufacturer Model	Memory (K bytes) Minimum	Maximum	Cycle time (nsec.)	Maximum I/O devices	Software Operating system
Hewlett-Packard					
1000/A600	128	4000	454 (memory)	64	RTE-A.1
1000/A700	128	4000	500 (memory)	64	RTE-A.1
Honeywell					
DPS 6/31	256	1024	135 (memory)	16	GCOS6/MOD 200, /MOD 400
IBM					
Series/1	16	256	660		
Ithica Intersystem					
DPS-8000	256	1600			Coherent
Mikros Systems					
MK-R16	64				Pascal
Mini-Computer Systems					
MICOS 100	64	128	150 (memory)	8	MICOS
MICOS 200	128	256	150 (memory)	16	MICOS
MICOS 300	128	320	150 (memory)	32	MICOS
Mizar					
VME 8000	128	128			
National Semiconductor					
MSC-6608	160	1000		1	CP/M-86
Omnibyte					
OB68K1	32	1600			
Perkin-Elmer					
Sixteen 10	16	64	660		
Sixteen 20	32	256	850		
Sixteen 30	32	256	660		
Point 4 Data					
Mark 3	64	64	200 (clock)	4	IRIS
Mark 3E	128	128	200 (clock)	8	IRIS
Mark 5	64	128	33 (clock)	128	IRIS
Rolm					
1602B	32	128	250 (clock)	2	RDOS, RTOS
MSE/14	128	2000	100 (memory)		AOS, ARTS
1666B	16	512	660 (memory)		
Sperry Univac					
V72	16	512	660 (memory)		
V73	16	512	330 (memory)		
V77-200	16	64	660 (memory)		
Texas Instruments					
990/10 Models 4, 5, 7, 9, 16	128	2000	250 (clock)	10-20	DX-10, DNOS
990/12 Models 26, 29, 36	256	2000	222 (clock)	20-30	DX-10, DNOS
Wang Laboratories					
2200 LVP, LVCP	32	256, 512	600 (memory)	13	BASIC-2, BASIC-3
Western Digital					
SB1673, 74, 75	128	128	200 (memory)	1	PAKOS, UCD, Pascal III.0
ME1673, 74, 75	128	128	200 (memory)	1	PAKOS, UCD, Pascal III.0
Xylogics					
	96	4000			

Software Languages	Price	Notes	Circle no.
			444
Pascal, FORTRAN 77, BASIC, MACRO 100	$2450		
Pascal, FORTRAN 77, BASIC, MACRO 100	$1000		
			445
COBOL, BASIC, FORTRAN, RPG	$24,900	256K-byte RAM, video terminal, 13M-byte disk, serial printer, software	
			446
			447
Pascal, C	$2000	256K-byte RAM, floppy controller, disk controller, 1.2M-byte disk	
			448
		a MIL-STD-833B radiation-resident single-board mini	
			449
Extensive BASIC	$26,000	includes 64K-byte RAM, CRT, 10M-byte disk, 150-cps printer, software	
Extensive BASIC	$4700		
Extensive BASIC	$143,000		
			450
	$2350	includes 128K-byte RAM, system control board, motherboard, debug monitor	
			451
Pascal, FORTRAN, BASIC, COBOL	$7625	includes 160K-byte RAM, I/O, rack, software	
			452
	$1495	includes 32K-byte RAM	
			453
			454
Business BASIC	$6821	includes 4-port multiplexer, disk controller, tape controller, software	
Business BASIC	$8921	includes 7-port multiplexer, disk controller, tape controller software	
Business BASIC	$11,970	includes 4-port multiplexer, disk controller software	
			455
FORTRAN IV, BASIC	$60,000	includes 128K-byte RAM, cartridge disk (a militarized unit)	
FORTRAN 77, CMS2M			
			456
			457
FORTRAN, COBOL, Pascal, BASIC, RPG-11	$25,950	includes 128K-byte, RAM, 10M-byte disk, CRT terminal	
FORTRAN, COBOL, Pascal, BASiC, RPG-11	$7000	includes 256K-byte RAM, 80M-byte disk, tape drive, 2 terminals	
			458
BASIC-7, BASIC-3, 2200 COBOL,			
			459
Pascal, Ada, BASIC	$7000	includes 128K-byte RAM, 2 diskette drives	
Pascal, Ada BASIC	$9000	includes 128K-byte RAM, 2 diskette drives	
			460
	$15,700	includes 256K-byte RAM	

The history of the minicomputer has been characterized by steadily improving price/performance ratios: more performance for the same price, and equivalent performance at a reduced price.

The UNIX operating system is an exception to the rule: it is transportable among processors of various vendors. Developed at Bell Laboratories for the DEC PDP-11, it is now licensed for a variety of mainframes, minis and μcs. Gnostic Concepts, Inc., predicts that the market for UNIX-related hardware, software and services will climb from $1 billion in 1981 to more than $9 billion in 1986.

Another bit of software that emphasizes transportability is the Ada language, which includes a programming environment. Ada is designed to make the development tools and the compiler transportable to computers of all shapes and sizes. Western Digital Corp. and others are preparing Ada packages for validation by the Department of Defense, sponsor of the new language.

Transportability is a concern for minicomputer users who have seen their software investments climb steadily over the years. Upward compatibility within mini families helps, but highly transportable software allows users more freedom to take advantage of new advances in hardware capability and gives them some leverage in dealing with vendors.

The mini vendors are adopting software that was first developed for mainframes—a trend evident in the widespread availability of database-management sys-

System-level OEM minicomputers are furnished with complete hardware, software, educational and maintenance support. *From left to right are system-level OEM minis from Wang Laboratories Inc. (the 2200), Honeywell (6/31) and TI's (the 990/12).*

tems for minis. A recent DEC announcement underscores this migration of mainframe software technology to minis: DEC provides a mainframe-like performance monitor called SPM-11M for PDP-11s running under the RSX-11M operating system. The monitor tracks the use of CPU, memory, I/O and peripherals to help locate performance bottlenecks and tune the system.

The history of the minicomputer has been characterized by steadily improving price/performance ratios: more performance for the same price, and equivalent performance at reduced price. Given the expanding market for mini-based products, there is every reason to expect this trend to continue unabated in the foreseeable future. The downward migration of mainframe-based software will continue, and the advances in packaging will continue, putting more and more power into user stations.

Another trend, barely under way, is toward fault-tolerant systems. Tandem Computer, Inc., has a competitor for its NonStop 16-bit system. Stratus Computer, Inc., Natick, Mass., recently announced a fault-tolerant 32-bit business processing system. Others are sure to follow. DEC is reportedly working on a fault-tolerant VAX, although it has not been announced.

Still another element just getting off the ground is the local-area network. Baseband and broadband proponents are already wrestling to determine which technique will prevail. When the dust clears, look for most minis to provide interfaces to the surviving networks for office-automation and other business-based applications. It all adds up to continued vigorous growth and health for the minicomputer market. ■

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.

PRODUCT PROFILE: SUPERMINIS

Competitive market gives users a wide choice

JOSEPH DEVLIN and ELINOR GEBREMEDHIN, Data Decisions, Inc.

Superminis compete with mainframes, but comparing the two can be like comparing apples and oranges

The giants of the minicomputer world—32-bit superminis—are compared to mainframes as often as to other minis. More than two dozen superminis are on the market, and they are the fastest selling class of minicomputer. Performance levels vary greatly among models, and each supermini vendor advertises price/performance levels based on differently bundled software/processor/peripheral configurations. These diverse configurations resulted from the way the supermini market developed—not under the leadership of one vendor, but by the frantically competitive, parallel efforts of many.

A busy beginning

In 1974, Interdata (now Perkin-Elmer Corp.) introduced the 7/32, a 32-bit minicomputer, as an alternative to offering a memory-management unit for its line of 16-bit minicomputers. With this decision, Interdata gave birth to the "supermini" market. The 7/32 was a pseudo 32-bit computer in that the memory data path was only 16 bits wide, but words as defined by operands, registers and instructions were 32 bits long. The 7/32 sold so well that Interdata immediately began work on a true 32-bit computer, the 8/32 Megamini, first delivered in 1975.

Meanwhile, Systems Engineering Laboratories (now Gould S.E.L.) had launched two 32-bit real-time minicomputers (models 85 and 86) that competed in the OEM systems market with the Interdata 7/32. In 1975, Gould S.E.L. marked its entry into the end-user supermini market with the S.E.L. 32/55. The 32/55 was a µp-based, bus-centered system with the 86/65 instruction set implemented in microcode. In addition to its 32-bit orientation, 32/55 was distinguished by a 26.7M-byte-per-sec. effective bus data rate, while the Digital Equipment Corp. PDP-11 Unibus data rate was about 6M bytes per sec.

Interdata and S.E.L. had the 32-bit supermini market to themselves for a number of years. Their nearest competitors were the 24-bit Datacraft Slash/4, /5, and /7 (which evolved into the Harris S110/0, S100/5 and S200, respectively) and high-performance 16-bit minicomputers such as DEC's PDP-11/45 and PDP-11/70, Data General Corp.'s Eclipse and Modular Computer Systems' Modcomp IV.

Gould S.E.L. and Interdata both enhanced the total performance of their systems by implementing shared-memory configurations. The Interdata 8/30 Megamini allowed as many as 15 processors to share a memory block, while Gould S.E.L. as a rule linked four

The Interdata 8/30 Megamini allowed as many as 15 processors to share a common memory block, while Gould S.E.L. as a rule linked four processors to a common memory.

processors to a common memory. On an individual basis, S.E.L. also built more complex configurations that were essentially unlimited in size. These configurations bear some resemblance to Burroughs Corp.'s global memory mainframe systems, but differ in being only "loosely coupled" that is, each processor runs under its own operating system.

In 1978, DEC introduced its first 32-bit computer, the VAX-11/780. Coming from the leading vendor in the minicomputer market, DEC's introduction confirmed that minicomputer users wanted more power. The VAX-11/780 was compatible with the PDP-11 when running in emulation mode, and its processing power was equal to that of the International Business Machines Corp. 370/158-3. In Whetstone benchmarks, the VAX-11/780 achieved slightly more than 1 million Whetstone instructions per sec. in single-precision FORTRAN-based problems.

User migration from 16 to 32 bits almost became a prerequisite for increased minicomputer power because of the limitations 16-bit words impose on memory capacity. The alternative to larger word size is a memory-mapping scheme that combines portions of addresses residing in more than 16-bit word, but this procedure takes processing time and degrades performance.

Consequently, minicomputer vendors had to develop 32-bit systems to upgrade their user base or develop a local-networking/multiprocessing interconnection arrangement to achieve greater throughput, as Datapoint Corp. did with its ARC. Most chose to provide the 32-bit supermini upgrade path. These new superminis advertise prices lower than most mainframes of comparable power and, from the outset, have been sold as "mainframe alternatives" as well as minicomputer upgrades.

The supermini/mainframe battle

Mainframe vendors claim that simple comparisons of basic configuration prices are deceptive: direct factors, such as the availability of low-cost software and ease-of-use features, and indirect factors, such as the time wasted reprogramming incompatible systems, must enter into true costs. Nevertheless, the rapid expansion of the 32-bit supermini market shows that many users have evaluated superminis and mainframes, and have decided that superminis can do the job.

IBM's early 1979 introduction of the 4300 shook the budding supermini market by setting new price/performance ratios for the industry and by drastically lowering per-megabyte memory prices. The PCM memory market was affected, but the pace of new supermini introductions continued unabated; 13 minicomputer vendors introduced 25 new models with word sizes of 32 bits or more between early 1979 and late 1981.

Part of the foundation for this rapid growth comes from the developing distributed-market segment, in which customers buy superminis as well as mainframes. Low supermini prices have let users in branch offices with both local- and centralized-processing requirements justify dedicated local superminis that communicate with a host. Such local systems usually perform interactive and transaction processing best served by table-driven asynchronous subsystems. When more than 10 or 12 work stations are involved, the local system must have low-end mainframe power. Mainframe vendors with interactive and transaction processing products and supermini vendors with interrupt-driven real-time products are both trying to adapt their systems and software to the new requirements.

Mainframe vendors, especially IBM, claim greater expandability and the availability of more packaged software as indirect cost savings because mainframes require less programming time and expertise. Minicomputer vendors counter with claims of lower prices for equal performance and lower overhead in their simpler operating systems. The rapidly declining mainframe prices appear to make these price claims questionable. Furthermore, IBM has announced the SSX/VSE version of DOS/VSE and other simplified, user-friendly integrated operating packages.

These trade-offs are difficult to evaluate. Each manufacturer includes a different set of system features, different performance and capacity parameters and unique architectural characteristics that make its system better for some applications than others. Exaggerated differences tend to obscure basic similarities, and even general comparisons are difficult.

The tables

The accompanying tables describe representative 32-bit superminis as well as two competitive IBM systems. They allow distinguishing software/hardware

32 BITS NOT LIMITED TO SUPERMINIS

Besides the superminis covered in this survey, a new class of 32-bit systems is emerging. Called "supermicros" by Mini-Micro Systems, these 32-bit μp-based systems are roughly half as expensive and half as powerful as superminis, but their price/performance ratios should be attractive to a new spectrum of small-system users. MMS will be following up on these new systems and plans a supermicro product profile after the National Computer Conference in June. Look for coverage of new systems from Apollo Computer, Convergent Technologies, Fortune Systems, Spartacus Computer and Wicat Systems.

While there is considerable argument about the value of MIPS as a measurement of system power, IBM's and others' MIPS figures are averages based on a variety of benchmarks of all types and, hence, are rough indications of system power, not just processing power.

features, including price/performance ratios and millions of instructions per sec., to be compared.

- **MIPs index.** While there is considerable argument about the value of MIPS as a measurement of system power in the face of other factors (I/O throughput, architectural orientation and software environment, for example), IBM's and similar MIPS figures are averages based on a variety of benchmarks of all types and, hence, are rough indications of system power, not just processor power.

MIPS figures are approximate indexes, and manufacturers vary as to the methods used to derive them. Mainframe vendors frequently take the average of a number of runs with a multiplicity of job types, usually predominantly COBOL batch programs, some of which are compute-bound and some of which are I/O-bound. Supermini vendors frequently run standard FORTRAN-based Whetstone benchmarks that tend to do especially well on systems with fast floating-point processors and cache memory. In view of these inconsistencies, it is more realistic to express approximations of processor power as ranges. This approach is reflected in the rough groupings presented in the tables.

- **Price/performance index.** In addition to the basic system price and a summary of what it includes, a price/performance index gives a rough guide to processor price as related to system power. Separated out of this index is the per-megabyte memory price.

The P/PI is calculated using the same MIPS rating for all processors within a power range, that is, the median of the two extremes expressed in the range. The biggest headache in performing a calculation of price/performance is stripping the basic system price to a configuration that is comparable for each manufacturer. This is more difficult than arriving at a rough figure for performance because of the differences in basic architectures as well as packaging methods. DEC's VAX-11/750 includes CPU, memory, the operating system, basic I/O bus slots and a disk drive in its basic system price. IBM's 4331-2 includes CPU, memory and integrated adapters but no operating system or disks in the basic price. To normalize the systems as much as possible, the cost of the basic memory based on the cost of equivalent add-on components and the equivalent cost of any embedded peripherals has been subtracted, and the cost of the operating system, if separately priced, has been added.

The operating system is added in, if unbundled, because system software prices vary so much that it is impossible to determine what to subtract when the price is bundled with the basic system package. If a peripheral is bundled with the basic price and information from the manufacturer on a comparable peripheral was unavailable, the average price of two comparable peripherals from different manufacturers is used.

Some systems use integrated adapter/controllers, some use channels, some have bus slots, and some have "loops." All of these add a capacity to the basic system that is very difficult to normalize. No attempt is made to adjust this aspect of the basic system in the index. The index expresses the relative cost of processing power and price without regard to the I/O attachability.

The value of price/performance indexing

The foregoing discussion does not exhaust the number of variables that are largely ignored by this index, but it should show that price/performance calculation is a crude approximation that has a certain slant. Every manufacturer who reads this article will find an objection prefaced with "but you are comparing apples and oranges because you didn't account for...," and the objection will be valid. Hence, the calculations have been explained, and much information has been provided in the charts on overall environments, I/O capabilities and processor architectures. It should be noted that most supermini MIPS ratings are based on FORTRAN Whetstone single-precision benchmarks, while IBM and most mainframe vendor MIPS are based on an average of a wider variety of jobs that are usually COBOL-based.

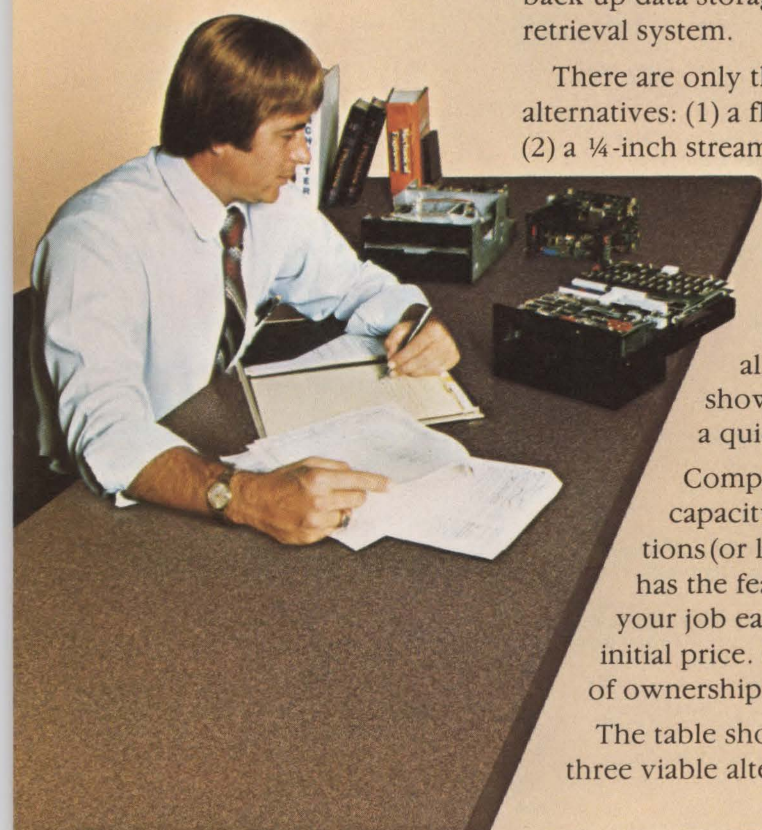
It is often difficult to tell from minicomputer-vendor literature what mainframe ball park a system is contending in. Does it compete with the 4321, the 3081 or the 3033S? When a manufacturer claims a system competes with the 4331-1, and IBM then retires the 4331-1 and produces a 4321 and 4331-11 instead, the user feels he is shooting at a moving target. The MIPS index and related price/performance ratios provide a set of conceptual hooks that can be used to narrow system comparisons to a set of most-likely comparable systems. They should never be used as absolute definitions of system performance. ■

Joseph Devlin and **Elinor Gebremedhin** are editors and analysts with Data Decisions, Inc., Cherry Hill, N.J., publisher of *Computer Systems*, a monthly electronic data-processing information-reference service from which the data in this article are extracted.

LOOKING AT WINCHESTER BACK-UP SYSTEMS?

Then you'll want to compare all 3 alternatives

Device	Formatted Capacity (MB)	Cost/MB (Qty. 500)	Number of Media Required	Total Media Cost	Recording Time (Min.)	Operator Involvement
8″ Floppy Disk DS/DD	1.3	$400	16	$80	34	Multiple media insertions
Archive ¼″ Streaming Cartridge Tape	20.0	$31	1	$30	4 (90 IPS) 12 (30 IPS)	One media insertion
¼″ Start/Stop Cartridge Tape	8.6	$140	3	$90	60 (30 IPS)	Multiple media insertions



You're sold on the Winchester drive. Now you're looking for a back-up data storage and retrieval system.

There are only three viable alternatives: (1) a floppy disk drive, (2) a ¼-inch streaming cartridge tape drive, and, (3) a stop/start cartridge tape drive.

As you'll naturally want to evaluate all three, the table shown here gives you a quick overview.

Compare speed. Compare capacity, automatic functions (or lack of). See which has the features that make your job easier. Compare initial price. Compare cost of ownership.

The table shows there *are* three viable alternatives.

But there's only one choice: The ¼-inch streaming cartridge tape drive.

There's only one successful ¼-inch streamer in the world today—only one being mass-produced—the Sidewinder™ by Archive Corporation.

So that makes your choice even easier.

Make sure you include the Sidewinder in *your* evaluation. Call Archive today for further details.

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Making Things Happen in Tape Technology

CIRCLE NO. 78 ON INQUIRY CARD

REPRESENTATIVE 32-BIT SUPERMINICOMPUTERS

	Data General Corp. Eclipse MV/6000	Data General Corp. Eclipse MV/8000
GENERAL		
MIPS Index (performance class)	0.3 to 0.50 — comparable to IBM 4331-2	1.1 to 1.5 — comparable to IBM 4341-2
Basic system purchase price	$172,000 — includes 1M-byte memory, 1600-bpi tape drive, 73M-byte disk, console, 16 terminals, 300-lpm printer, OS (Sept., 1981)	$154,220 — includes 0.5M-byte memory, I/O processor, control processor, 800-1600-bpi magnetic tape, 96M-byte drive (March, 1981)
Memory price per megabyte	$32,000	$32,000
Price/performance index	115	54
First delivery	1982	Oct., 1980
SOFTWARE		
Operating environment	AOS/VS 32-bit demand paging OS; concurrent timesharing, batch and online interactive applications; 2.5G bytes logical address space; 64 user application programs; AOS/RT32 OS, subset of AOS/VS, supports as many as 64 parallel processes with 32 tasks each; 512M-byte logical address space; AOS OS supports 16-bit addressing	AOS/VS 32-bit demand paging OS; concurrent timesharing, batch and online interactive applications; 4.3G bytes logical address space; 128 user application programs of as much as 512M bytes each; as many as 255 users/processes independently, concurrently; AOS/RT32 OS, subset of AOS/VS, supports as many as 64 parallel processes with 32 tasks each; 512M-byte logical address space; AOS OS supports 16-bit addressing
Database	DG/DBMS based on 1978 Codasyl recommendations; supports network and hierarchical data structures; Cincom TOTAL DBMS supported under AOS/VS	DG/DBMS based on 1978 Codasyl recommendations supports network and hierarchical data structures; Cincom TOTAL DBMS supported under AOS/VS
Communications	AOS/VS supports local/remote sync and async point-to-point, or multipoint communications; IBM BSC 3270 2780/3780, HASP II emulations; supports IBM System Network Architecture, X.25 packet-switching protocol; S/S, BSC	AOS/VS supports local/remote sync and async point-to-point, or multipoint communications; IBM BSC 3270 2780/3780, HASP II emulations; supports IBM System Network Architecture, X.25 packet-switching protocol
Languages	APL (32-bit only), BASIC, COBOL, FORTRAN, PL/1, RPG-II, Macro Assembler; DG/L (16-bit only), MPL (16-bit only), Macro Assembler	APL (32-bit only), BASIC, COBOL, FORTRAN, PL/1, RPG-II, Macro Assembler; DG/L (16-bit only), MPL (16-bit only), Macro Assembler
HARDWARE		
CPU	four-way instruction pipeline; four 32-bit registers	four-way instruction pipeline; four 32-bit registers; optional floating-point processor; 220-nsec. instruction-execution time; 16 priority interrupts; 16-byte block, 29.1M/36.4M-bytes-per-sec. write/read
Memory	512K- to 4M-byte main memory; 32-bit word	512K- to 4M-byte main memory; 32-bit word; 16-byte cache memory
I/O control	16.2M/14.5M-byte-per-sec. I/O burst multiplexer channel; 2.27M-byte-per-sec. data channel; 1.3M-byte-per-sec. I/O processor	16.2M/14.5M-byte-per-sec. I/O burst multiplexer channel; 2.27M-byte-per-sec. data channel; 1.3M-byte-per-sec. I/O processor
Communications	64K-byte I/O processor interfacing with cache memory; 1- to 16-line async, 1-, 2-, 4-line sync multiplexers	64K-byte I/O processor interfacing with cache memory; 32K-byte data-control units supporting 256 lines; 16-line programmable multiplexer; 1- to 16-line async, 1-, 2-, 4-line sync multiplexers
Storage	12.5M- to 277M-byte disk drives; 2.5G bytes total	supports as many as 24 disk drives; 12.5M- to 277M-byte disk drives; 6.65G bytes total
Terminals and printers	supports as many as 64 local/remote terminals	supports as many as 128 local/remote terminals; as many as four system printers
Circle no.	**417**	**418**

REPRESENTATIVE 32-BIT SUPERMINICOMPUTERS

Digital Equipment Corp. VAX-11/750	Digital Equipment Corp. VAX-11/780 and 11/782	Gould S.E.L. 32/27
0.5 to 0.7 — comparable to IBM 4341-10	0.8 to 1.0 for 11/780; 1.6 to 2.0 for 11/782; comparable to IBM 4341-11, 3031AP, respectively	0.5 to 0.7 — comparable to IBM 4341-10
$92,600 — includes 512K bytes memory, 2 28M-byte disks, console, OS (Dec., 1981)	$219,100 — includes 11/780 CPU, 1M-byte memory, 800-1600-bpi tape drive, console, OS; $402,900 includes 11/782 dual CPU, 2M-byte memory, 800-1600-bpi tape drive, console, OS (Feb., 1982)	$25,000 — includes 32/27 CPU, 256K-byte memory, I/O processor with 7 SelBUS and 5 MP slots
$13,800	$13,800	$29,000
90	136 for 11/780; 168 for 11/782	38
1980	1978 for 11/780; 1982 for 11/782	1980
VAX/VMS OS supporting concurrent batch and realtime processing; to 4.3G bytes virtual address space, 2G bytes user program space; as many as 32 interactive users; Bell UNIX OS and support facilities	VAX/VMS OS supporting concurrent batch and realtime processing; 4.3G bytes virtual address space, 2G bytes user program space; as many as 96 interactive users; Bell UNIX OS and support facilities	MPX-32 OS for concurrent realtime, batch, timesharing, interactive applications; as many as 255 concurrent tasks; 512K bytes virtual address space per user
VAX-11 DBMS based on Codasyl recommendations; Datatrieve data-management system supports sequential, indexed or relative data organization, variable length records	VAX-11 DBMS based on Codasyl recommendations; Datatrieve data-management system supports sequential, indexed or relative data organization, variable length records	Cincom TOTAL DBMS
DECnet supports local/remote, async/sync, point-to-point, multipoint communications; IBM BSC 2780/3780, 3271, RJE emulations; DECnet supports IBM SNA and X.25 protocols	DECnet supports local/remote, async/sync, point-to-point, multipoint communications; IBM BSC 2780/3780, 3271, RJE emulations; DECnet supports IBM SNA and X.25 protocols	TS5 for async/sync, point to point, multipoint communications, IBM HASP emulation
BASIC, COBOL, FORTRAN, Pascal, PL/1, CORAL 66, BLISS-32, Macro Assembler	BASIC, COBOL, FORTRAN, Pascal, PL/1, CORAL 66, BLISS-32, Macro Assembler	BASIC, COBOL, FORTRAN, Pascal, Micro and Macro Assembler
32-bit data word; 16 32-bit registers; 10K bytes writable control store, 4K words ROM control store; optional single-board floating-point processor; 320-nsec. micro instruction-execution time; 32 priority interrupts	32-bit data word; 16 32-bit registers; 12K bytes writable control store, 6K words ROM control store; floating-point processor; 200-nsec. micro instruction-execution time; 32 priority interrupts; 11/780 has 1 CPU; 11/782 has 2 CPUs	32-bit CPU with 26.7M-byte/sec. bus-centered architecture; 8 general-purpose registers, 96 hardware priority interrupts; 180 instructions; integral floating point
256K to 2M bytes main memory; 32-bit word; 640- to 800-nsec. read/write 32-bit cycle time; 4K-byte cache memory	512K to 8M bytes main memory; 32-bit word; 800- to 1400-nsec. read/write 64-bit cycle time; 8K-byte cache memory; 256K to 4M bytes shared memory; 11/782 has 2M to 8M bytes main memory	256K to 16M bytes main memory, 4-way interleaving; 600-nsec. cycle
5M bytes-per-sec. aggregate on memory/sync backplane interconnect	13.3M bytes-per-sec. aggregate on memory/sync backplane interconnect	7 SelBUS slots, 5 medium-speed MP bus slots
DMC-11 network linkup sync interface with I/O buffers; 1, 4, 8, 16 async/sync multiplexers	DMC-11 network link up sync interface with I/O buffers 1, 4, 8, 16 async/sync multiplexers	16-line async/sync multiplexer
1M to 176M bytes per drive; 7.2G bytes total	28M to 516M bytes per drive; 9.6 bytes total	2.4M bytes per subsystem
supports as many as 32 interactive terminals	supports as many as 96 interactive terminals	64 interactive terminals; 2 system printers
419	**420**	**421**

REPRESENTATIVE 32-BIT SUPERMINICOMPUTERS

	Gould S.E.L. 32/87	Harris 300
GENERAL		
MIPS Index (performance class)	3.0 to 3.8 — between IBM 3033S and 3033N	0.5 to 0.7 — comparable to IBM 4341-10
Basic system purchase price	$265,000—includes 32/8720 CPU, 1M-byte main memory, 32K bytes cache, 26.7M-byte/sec. SelBUS, floating-point processor, IOP, printer/floppy controller with 2 floppy drives, console, 12 SelBUS slots, 6 MP 10P slots	$104,950 — 192K-byte memory, 80M-byte disk, 1600-bpi tape, CRT, OS (Sept., 1981)
Memory price per megabyte	$29,000	$20,176
Price/performance index	67	106
First delivery	1981	introduced 1981
SOFTWARE		
Operating environment	MPX-32 or older RTM OS for concurrent realtime, batch, timesharing, interactive applications; 255 concurrent tasks; 512K bytes virtual address space per user	Vulcan OS supporting real-time processing multi-programmed batch, on-line interactive operations; 12M bytes of logical address space; 48 interactive users; 48 priority interrupts
Database	Cincom TOTAL DBMS	Cincom TOTAL DBMS supporting network structure
Communications	TSS for async/sync point-to-point, multipoint communications; HASP emulation	Supports local/remote async/sync communications; IBM BSC 2780/3780, HASP, CDC, Univac emulations
Languages	FORTRAN, BASIC, COBOL, Pascal, Micro and Macro Assemblers	APL, BASIC, COBOL, FORTRAN, Pascal, RPG-II, SNOBOL, Macro Assembler
HARDWARE		
CPU	32-bit CPU with 26.7M-byte/sec. bus-centered architecture; 8 general-purpose registers; 96 hardware priority interrupts, 206 instructions; integral floating point	five 24-bit registers; accumulator extension provides 48-bit length; floating-point processor; 48-data and 20-address line bus; 19M (input)/7.9M (output) bytes-per-sec. I/O bus rates
Memory	1M to 16M bytes main memory, 4-way interleaving; 600-nsec. cycle, 16K to 32K bytes cache	192K to 768K main memory; 400-nsec. read/write cycle time
I/O control	30 SelBUS I/O slots, 14 medium-speed MP bus slots can be expanded in 16-slot increments per SelBUS slot	as many as 24 programmed I/O and/or DMA block channels; 3.2M/7.5M byte-per-sec. I/O rates per channel
Communications	16-line async/sync multiplexer	DMA communications processor supports as many as 16 devices; eight-line communications multiplexer; async/sync line controllers
Storage	2.4M bytes per subsystem	11M to 675M bytes per drive; as many as 8 drives per subsystem
Terminals and printers	64 terminals; 2 system printers	supports as many as 48 interactive terminals
Circle no.	**422**	**423**

REPRESENTATIVE 32-BIT SUPERMINICOMPUTERS

	Harris 500	Harris 800	Hewlett-Packard Series 3000-64
	0.8 to 1.0 — comparable to IBM 4341-11	1.1 to 1.5 — comparable to IBM 4341-2	0.5 to 0.7 — comparable to IBM 4341-10
	$99,600 — includes 384K-byte memory, 6K cache, 40M-byte disk, 1600-bpi tape, CRT, OS (Sept., 1981)	$165,900 — 384K-byte memory, 6K cache, 40M-byte disk, 1600-bpi tape, 2 CRTs, OS (Sept., 1981)	$164,700 — includes 2M-byte memory, OS, DBS (Nov., 1981)
	$20,176	$20,176	$16,000
	59 introduced 1979	91 March, 1980	221 1982
	Vulcan OS supporting real-time processing, multiprogrammed batch, on-line interactive operations; 12M bytes of logical address space; 64 interactive users; 48 priority interrupts	Vulcan OS supporting real-time processing, multiprogrammed batch, on-line interactive operations; 12M bytes of logical address space; 128 interactive users; 72 priority interrupts	MPE OS supporting concurrent batch, transaction, online program development and communications processing; 110 active sessions
	Cincom TOTAL DBMS supporting network structure	Cincom TOTAL DBMS supporting network structure	KSAM/3000 indexed sequential-access method, IMAGE/3000 DBMS based on KSAM/3000, allows data to be accessed by serial, direct, chained and calculated-access methods
	supports local/remote, async/sync communications; IBM BSC 2780/3780, HASP, CDC, Univac emulations	supports local/remote, async/sync communications; IBM BSC 2780/3780, HASP, CDC, Univac emulations	Distributed Systems Architecture provides extensive support for network communications; IBM 2780/3780, 3270 and HASP II terminal emulation; IBM SNA and X.25 and X.21 protocols
	APL, BASIC, COBOL, FORTRAN, Pascal, RPG-II, SNOBOL, Macro Assembler	APL, BASIC, COBOL, FORTRAN, Pascal, RPG-II, SNOBOL, Macro Assembler	APL, BASIC, COBOL, FORTRAN, Pascal, RPG, Macro Assembler
	five 24-bit registers; accumulator extension provides 48-bit length; floating-point processor; 48-data and 20-address line bus; 19M (input)/7.9M (output) bytes-per-sec. I/O bus rates	five 24-bit registers; accumulator extension provides 48-bit length; floating-point processor; 48-data and 20-address line bus; 19M (input)/7.9M (output) bytes-per-sec. I/O bus rates	dual 16-bit ALUs perform 2 16-bit or single 32-bit operation in single CPU cycle; 40K writable control storage; floating-point arithmetic
	385K- to 3M-byte main memory; 400-nsec. read/write cycle time; 6K-byte, 150-nsec. cache memory	384K- to 3M-byte main memory; 400-nsec. read/write cycle time; 6K-byte, 150-nsec. cache memory	2M to 8M bytes main memory; 8K byte cache; 134-nsec. average memory access time with cache
	as many as 24 programmed I/O and/or DMA block channels; 3.2M/7.5M byte-per-sec. I/O rates per channel	as many as 31 programmed I/O and/or DMA block channels; 3.2M/7.5M byte-per-sec. I/O rates per channel	2 intermodule I/O buses; 10 general I/O channels; 56M byte-per-sec. overall bandwidth on 32-bit central bus
	DMA communications processor supports as many as 16 devices; eight-line communications multiplexer; async/sync line controllers	DMA communications processor supports as many as 16 devices; eight-line communications multiplexer; async/sync line controllers	16 intelligent network processors providing 16 synchronous communications lines for system-to-system and multipoint terminal communications; single advanced terminal processor
	11M to 675M bytes per drive; as many as 8 drives per subsystem	11M to 675M bytes per drive; as many as 8 drives per subsystem	16 disk drives with 1920M bytes total storage
	supports as many as 64 interactive terminals	supports as many as 128 interactive terminals	supports as many as 144 interactive terminals, 10 printers
	424	**425**	**426**

REPRESENTATIVE 32-BIT SUPERMINICOMPUTERS

	Honeywell DDS 6/92 — DPS 6/96	IBM 4331-2
GENERAL		
MIPS Index (performance class)	0.8 to 1.0 — comparable to IBM 4341-11	0.3 to 0.5
Basic system purchase price	$110,000 — includes 6/92 CPU, 1M-byte memory, 4K-byte cache, multiline communications controller, disk controller; $130,000 — includes 6/96 CPU with additional slots, 1M-byte memory, 4K-byte cache, multiline communications controller, disk controller (Oct., 1981)	$125,000 — includes 1M byte memory, no cache, display/printer adapter (Dec., 1981)
Memory price per megabyte	$28,000	$15,500
Price/performance index	94 for 6/92; 113 for 6/96	273
First delivery	1981	1980
SOFTWARE		
Operating environment	GCOS 6/200 for transaction-processing intelligent-terminal operation, GCOS 6/400 for multiple online foreground and one batch background processing; GCOS 6/600 for concurrent online, timesharing and batch; all distributed	DOS/VSE and SSX/VSE partitioned virtual-memory operating systems with 12 partitions; OS/VS1 single virtual-memory operating system; VM/SP and VM/BSE operating systems running in stand-alone mode with CMS small system timesharing, or with other DOS or OS as full-facility virtual machines
Database	Cincom TOTAL under GCOS 6/400; Honeywell IDS/II under GCOS 6/600	DL/1, DL/1 Entry and SSX/DL/1 hierarchical databases; SQL relational interface
Communications	all can operate as async or HASP terminal; GCOS 6/400 supports RJE, remote batch GCOS 6/600 supports IBM 2780, 3780 and 3270 emulation, RJE	SDLC bit-oriented, BSC synchronous, S/S protocol; SNA network architecture as host or distributed mode; multiple access methods
Languages	BASIC, COBOL in all versions; FORTRAN, RPG-II, Assembler under GCOS 6/400, 600	Assembler, BASIC, Pascal, COBOL, FORTRAN IV, APL, RPG-II, PL/1
HARDWARE		
CPU	bus-oriented, 32-bit microprogrammed CPU with commercial and scientific instruction sets standard. 300-nsec. asynchronous bus with 13M byte/sec. transfer	32-bit data word, 16 32-bit registers, 128K bytes reloadable control store
Memory	1M to 4M bytes on 6/92; 1M to 16M bytes on 6/96; 300-nsec. cycle; 4K-byte cache on both processors	1M to 2M bytes, 32-bit word
I/O control	20 slots for 6/92, 40 slots for 6/96; 1 to 6 peripheral ports, 1 to 6 multiple-device ports, 0 to 4 tape ports	6 integrated adapters, 1-byte multiplexer channel, 3-block multiplexer channels with 1.86 M bytes/sec. data rate
Communications	1 to 64 lines on 6/92, 1 to 112 lines on 6/96	3- to 8-line integrated adapter
Storage	2G bytes on 2 to 8 ports for 6/92, 3G bytes on 2 to 12 ports on 6/96	3310 (64M bytes), 3370 (0.5G bytes) and 3340/44 attach to integrated disk adapter
Terminals and printers	64 or 112 terminals, on 6/92 and 6/96 systems, respectively; 4 system printers on either	no specific limit; about 100 practical limit
Circle no.	**427**	**428**

REPRESENTATIVE 32-BIT SUPERMINICOMPUTERS

IBM 4341-2	Perkin-Elmer 3210, 3220, 3230	Perkin-Elmer 3250
1.1 to 1.5	0.8 to 1.0 — comparable to IBM 4341-11	3.0 to 3.8 — between IBM 3033S and 3033N
$359,000 — includes 4341-2 CPU, 2M bytes memory, 16K bytes cache, 6 I/O channels (Dec., 1981)	3210: $49,900 includes 0.5M byte memory (Sept., 1981) 3220: $36,000 includes 256K bytes memory (Sept., 1981) 3230: $65,900 includes 524K bytes memory (Sept., 1981)	$150,000 — includes 2M-byte memory, console, 8K-byte cache (Feb., 1982)
$15,500	$23,900	$23,900
253	45 for 3210, 39 for 3220, 43 for 3230	32
1979	3210 in Sept., 1981; 3220 in April, 1979; 3230 in March, 1981	1982
DOS/VSE partitioned virtual memory system with 12 partitions; OS/VS1 single virtual OS; MVS/SP (MVS/370) multiple virtual OS; VM/SP and VM/BSE with CMS in stand-alone time-sharing mode or with other DOS/OS SCPS as full-facility virtual machines ACP/TPF transaction-processing OS	OS/32 OS supporting concurrent time shared, batch, online interactive applications; as many as 255 concurrent tasks; Edition VII/VIII Workbench version of Bell UNIX OS and support facilities	OS/32 OS supporting concurrent batch, online interactive applications; 64 users; as many as 255 concurrent operations; Edition VII/VIII Workbench version of Bell UNIX OS and support facilities
IMS/VS; DL/1, DL/1 Entry hierarchical databases, SQL relational interface to DL/1	DMS/32 indexed file structure DBMS; records referenced by one or more indexes	DMS/32 indexed file structure DBMS; records referenced by one or more indexes
SDLC bit-oriented, BSC synchronous and asynchronous protocols; SNA network architecture as host or distributed mode; multiple-access methods	OS/32 supports local/remote, async/sync, point-to-point, multipoint communications; BSC/SDLC protocols; IBM BSC 2780/3780, HASP emulations; ZDLC manager supports HDLC, SDLC, ADCCP protocols	OS/32 supports local/remote, async/sync, point-to-point, multipoint communications; BSC/SDLC protocols; IBM BSC 2780/3780, HASP emulations; ZDLC manager supports HDLC, SDLC, ADCCP protocols
Assembler, BASIC, Pascal, COBOL, FORTRAN IV, APL, RPG-II, PL/1	BASIC, COBOL, FORTRAN, Pascal, RPG-II, CORAL 66, CAL Assembler, CAL Macro Processor	BASIC, COBOL, FORTRAN, Pascal, RPG-II, CORAL 66, CAL Assembler, CAL Macro Processor
32-bit word with 64-bit data paths; pipelined	32-bit data path; 128 32-bit general registers; 2K words fixed control store, 2K words 32-bit writable control store; optional floating-point processor; four priority interrupts	32-bit data path; 128 32-bit general registers; 2K words fixed control store, 2K words 32-bit writable control store; optional floating-point processor; four priority interrupts; central bus, 40M byte/sec. data rate
2M to 16M bytes; 16K bytes cache	256K- to 4M/1M/16M-byte main memory on 3210/3220/3230; 32-bit word; 400/340/340-nsec. access time on 3210/3220/3230; 1K-byte cache on 3230 (option on 3220)	2M- to 16M-byte main memory; 32-bit word; 8K-byte cache memory
6 channels, 1- or 2-byte 4- or 5-block multiplexer; 12M-byte/sec. 210 throughput; 48 subsystems	8M/5.7M-byte-per-sec. burst read/write EDMA bus; 40M-byte-per-sec. aggregate on four DMA buses; 400K-byte-per-sec. multiplexer bus supporting 1023 devices; EDMA plus multiplexer or DMA plus multiplexer configurations	40M-byte-per-sec. aggregate on four DMA buses; 400K-byte-per-sec. multiplexer bus supporting 1023 devices; 64M-byte-per-sec. peak system bandwidth
3705/3705 front ends attaching to lines	DMA I/O subsystem supports as many as 64 56-bps lines; async controller supports as many as 23 19.2K-bps lines; 1-, 4-line sync multiplexers, 2-, 4-, 8-line async multiplexers	DMA I/O subsystem supports as many as 64 56-bps lines; async controller supports as many as 23 19.2K-bps lines
variety of disk types; 40G bytes per subsystem (3380/3880); can attach disk cache	16M- to 96M-byte disk on 3210, typical maximum of 50G bytes total on 3220/3230	typical maximum of 50G bytes
no specific limit; about 400 practical limit	supports as many as 64 interactive terminals	supports as many as 64 interactive terminals
429	**430**	**431**

REPRESENTATIVE 32-BIT SUPERMINICOMPUTERS

	Prime 150-II	Prime 250-II
GENERAL		
MIPS Index (performance class)	0.3 to 0.5 — comparable to IBM 4331-2	0.3 to 0.5 — comparable to IBM 4331-2
Basic system purchase price	$39,000 — includes 256K-byte memory, OS (June, 1981)	$48,500 — includes 512K-byte memory, 2K-byte cache, CRT, OS (June, 1981)
Memory price per megabyte	$40,000	$40,000
Price/performance index	60	55
First delivery	1981	1981
SOFTWARE		
Operating system	Primos OS supporting timesharing, batch, on-line interactive applications; 512M-byte virtual address space, 32M-byte private user address space; 32 users/processes independently, concurrently	Primos OS supporting timesharing, batch, on-line interactive applications; to 512M bytes virtual-address space, 32M bytes private user address space; 32 users/processes independently concurrently
Database	DBMS based on Codasyl recommendations; network, hierarchical, cyclical, ordered, random combination, hybrid	DBMS based on Codasyl recommendations; network, hierarchical, cyclical, ordered, random combination, hybrid
Communications	Primos supports local/remote, async/sync, point-to-point, multipoint communications; IBM 3271/3277, 2780/3780 and HASP II emulations; Univac, Honeywell, CDC, ICL emulations; Primenet CCITT X.25 protocol	Primos supports local/remote, async/sync, point-to-point, multipoint communications; IBM 3271/3277, 2780/3780 and HASP II emulations; Univac, Honeywell, CDC, ICL emulations; Primenet CCITT X.25 protocol
Languages	BASIC, COBOL, FORTRAN, Pascal, PL/1, RPG-II, Macro Assembler	BASIC, COBOL, FORTRAN, Pascal, PL/1, RPG-II, Macro Assembler
HARDWARE		
CPU	32-bit arithmetic unit; four address registers, seven index registers; floating-point arithmetic in firmware; 64 priority interrupts	32-bit arithmetic unit; four address registers, seven index registers; floating-point arithmetic in firmware; 64 priority interrupts
Memory	256K to 1M bytes main memory; 32-bit word; 600-nsec. cycle time; 2K-byte cache memory	512K to 1M bytes main memory; 32-bit word; 600-nsec. cycle time; 2K-byte cache memory
I/O channels	2.5M bytes-per-sec. DMA channel; 960K bytes-per-sec. DMT channel; DMC supports as many as 32 controllers	2.5M bytes-per-sec. DMA channel; 960K bytes-per-sec. DMT channel; DMC supports as many as 32 controllers
Communications	DMC channel supports as many as 2048 device ports; 2-, 4-line 19.2K bytes-per-sec. DMA link controller; 8-, 16-line async or 2-, 4-line sync multiplexers	DMC channel supports as many as 2048 device ports; 2-, 4-line 19.2 bytes-per-sec. DMA link controller; 8-, 16-line async or 2-, 4- line sync multiplexers
Storage	12M to 300M bytes per drive; as many as two subsystems; 4.3G bytes maximum, to 8 drives per subsystem	12M- to 300M-bytes per drive; as many as two subsystems; 4.3G bytes maximum; to 8 drives per subsystem
Terminals and printers	supports as many as 32 interactive terminals, as many as 4 system printers	supports as many as 32 interactive terminals; as many as 4 system printers
Circle no.	**432**	**433**

REPRESENTATIVE 32-BIT SUPERMINICOMPUTERS

Prime 550-II	Prime 750-II	Prime 850
0.5 to 0.7 — comparable to IBM 4341-10	0.8 to 1.0 — comparable to IBM 4341-11	1.6 to 2.0 — comparable to IBM 3031AP
$89,000 — includes 512K-byte memory, 8K-byte cache, CRT, OS (June, 1981)	$154,000 — includes 1M-byte memory, 16K-byte cache, CRT, OS (June, 1981)	$295,000 — includes 2M-byte memory, 32K-byte cache, CRT, OS (June, 1981)
$40,000	$40,000	$40,000
104	125	164
1981	1979	1981
Primos OS supporting timesharing, batch, on-line interactive applications; to 512M bytes virtual-address space, 32M bytes private user address space; 64 users/processes independently, concurrently	Primos OS supporting timesharing, batch, on-line interactive applications; to 512M bytes virtual-address space, 32M bytes private user address space; 96 users/processes independently, concurrently	Primos OS supporting timesharing, batch, online interactive applications; to 512M bytes virtual address space, 32M bytes private user address space; 128 users/processes independently, concurrently
DBMS based on Codasyl recommendations; network, hierarchical, cyclical, ordered, random combination, hybrid	DBMS based on Codasyl recommendations; network, hierarchical, cyclical, ordered, random combination, hybrid	DBMS based on Codasyl recommendations; network, hierarchical, cyclical, ordered, random combination, hybrid
Primos supports local/remote, async/sync, point-to-point, multipoint communications; IBM 3271/3277, 2780/3780 and HASP II emulations; Univac, Honeywell, CDC, ICL emulations Primenet CCITT X.25 protocol	Primos supports local/remote, async/sync, point-to-point, multipoint communications; IBM 3271/3277, 2780/3780 and HASP II emulations; Univac, Honeywell, CDC, ICL emulations; Primenet CCITT X.25 protocol	Primos supports local/remote, async/sync, point-to-point, multipoint communications; IBM 3271/3277, 2780/3780 and HASP II emulations, Univac, Honeywell, CDC, ICL emulations; Primenet CCITT X.25 protocol
BASIC, COBOL, FORTRAN, Pascal, PL/1, RPG-II, Macro Assembler	BASIC, COBOL, FORTRAN, Pascal, PL/1, RPG-II, Macro Assembler	BASIC, COBOL, FORTRAN, Pascal, PL/1, RPG-II, Macro Assembler
32-bit arithmetic unit; four address registers, to seven index registers; floating-point processor; 64 priority interrupts	32-bit arithmetic unit; four address registers, to seven index registers; floating-point processor; 64 priority interrupts	multiple instruction stream-processing architecture; 32-bit arithmetic unit; four address registers, to seven index registers; floating-point processor; 64 priority interrupts
512K to 4M bytes main memory; 32-bit word; 60-nsec. cycle time; 8K-byte cache memory	1M to 8M bytes main memory; 32-bit word; 600-nsec. cycle time; 16K-byte cache memory	2M to 8M bytes main memory; 32-bit word; 600-nsec. cycle time; 32K-byte cache memory
2.5M bytes-per-sec. DMA channel; 960K bytes-per-sec. DMT channel; DMC supports as many as 32 controllers	2.5M bytes-per-sec. DMA channel or 8M byte-per-sec. DMA burst mode channel; 960K bytes-per-sec. DMT channel; DMC supports as many as 32 controllers	2.5M bytes-per-sec. DMA or 8M byte-per-sec. DMA burst mode channel; 960K bytes-per-sec. DMT channel; DMC supports as many as 32 controllers
DMC channel supports as many as 2048 device ports; 2-, 4-line 19.2K byte-per-sec. DMA link controller; 8-, 16-line async or 2-, 4-line sync multiplexers	DMC channel supports as many as 2048 device ports; 2-, 4-line 19.2K bytes-per-sec. DMA link controller; 8-, 16-line async or 2-, 4-line sync multiplexers	DMC channel supports as many as 2048 device ports; 2-, 4-line 19.2K bytes-per-sec. DMA link controller; 8-, 16-line async or 2-, 4-line sync multiplexers
12M to 300M bytes per drive; as many as two subsystems; 4.3G bytes maximum, to 8 drives per subsystem	12M to 300M bytes per drive; as many as two subsystems; 4.3G bytes maximum, to 8 drives per subsystem	12M to 300M bytes per drive; as many as two subsystems; 4.3G bytes maximum, to 8 drives per subsystem
supports as many as 64 interactive terminals; as many as 4 system printers	supports as many as 96 interactive terminals; as many as 4 system printers	supports as many as 128 interactive terminals; as many as 4 system printers
434	**435**	**436**

REPRESENTATIVE 32-BIT SUPERMINICOMPUTERS

	Wang VS 90	Wang VS 100
GENERAL		
MIPS Index (performance class)	0.3 to 0.5 — comparable to IBM 4331-2	0.5 to 0.7 — comparable to IBM 4341-1D
Basic system	$73,000 — includes VS90 CPU, 1M-byte main memory but no cache, 1 disk IOP, 1 work station/printer IOP, 1 tape IOP, one 3-port datacomm IOP, VS operating system, 1 compiler and one work station as console	$103,000 — includes VS 100 CPU, 1M-byte main memory, 32K-byte cache, 1 disk IOP, 1 work station/printer IOP, 1 tape IOP, one 3-port datacomm IOP, VS operating system, 1 compiler and one work station as console
Memory price per megabyte	$16,000	$16,000
Price/performance index	135	140
First delivery	1982	1980
SOFTWARE		
Operating environment	VS/OS virtual storage OS for interactive and remote batch	VS/OS virtual storage OS for concurrent interactive and remote batch
Database	Cincom TOTAL DBMS bundled with VS/OS; sequential indexed file structures, hierarchical, tree and network data structures	Cincom TOTAL DBMS bundled with VS/OS; sequential indexed, file structures; hierarchical, tree and network data structures
Communications	WangNet network architecture; remote WangNet facility, remote work station; IBM 2780/3780, 3271, 3274, 3777 BSC synchronous emulation; TTY asynchronous	WangNet network architecture; remote WangNet facility, remote work station; IBM 2780/3780, 3271, 3274, 3777 BSC synchronous emulation; TTY asynchronous
Languages	COBOL, BASIC, FORTRAN, PL/1, RPG-II, Assembler, Procedure	COBOL, BASIC, FORTRAN, PL/1, RPG-II, Assembler, Procedure
HARDWARE		
CPU	32-bit word with 64-bit fetch on universal bus; 16-bit IOPs; reloadable control storage; four 64-bit floating-point registers, 16 32-bit general-purpose registers	32-bit word with 64-bit fetch on universal bus; 16-bit IOPs; reloadable control storage; four 64-bit floating-point registers; 16 32-bit general-purpose registers
Memory	1M to 4M bytes 2-way interleaved main memory; no cache	1M to 8M bytes 2-way interleaved main memory, 32K bytes cache
I/O control	I/O bus adapter attaching as many as 8 IOPs	2 I/O bus adapters attaching to 16 IOPs total
Communications	2 3-line IOPs	3-line IOPs, total of 128 lines
Storage	to 2.3G bytes on 8 drives; to 4 drives per disk IOP	to 4.6G bytes on 16 drives; to 4 drives per disk IOP
Terminals and printers	to 3 16-terminal IOPs for a total of 48 work stations as serial printers	to 8 16-terminal IOPs for a total of 128 work stations or serial printers
Circle no.	**437**	**438**

The 9406-4

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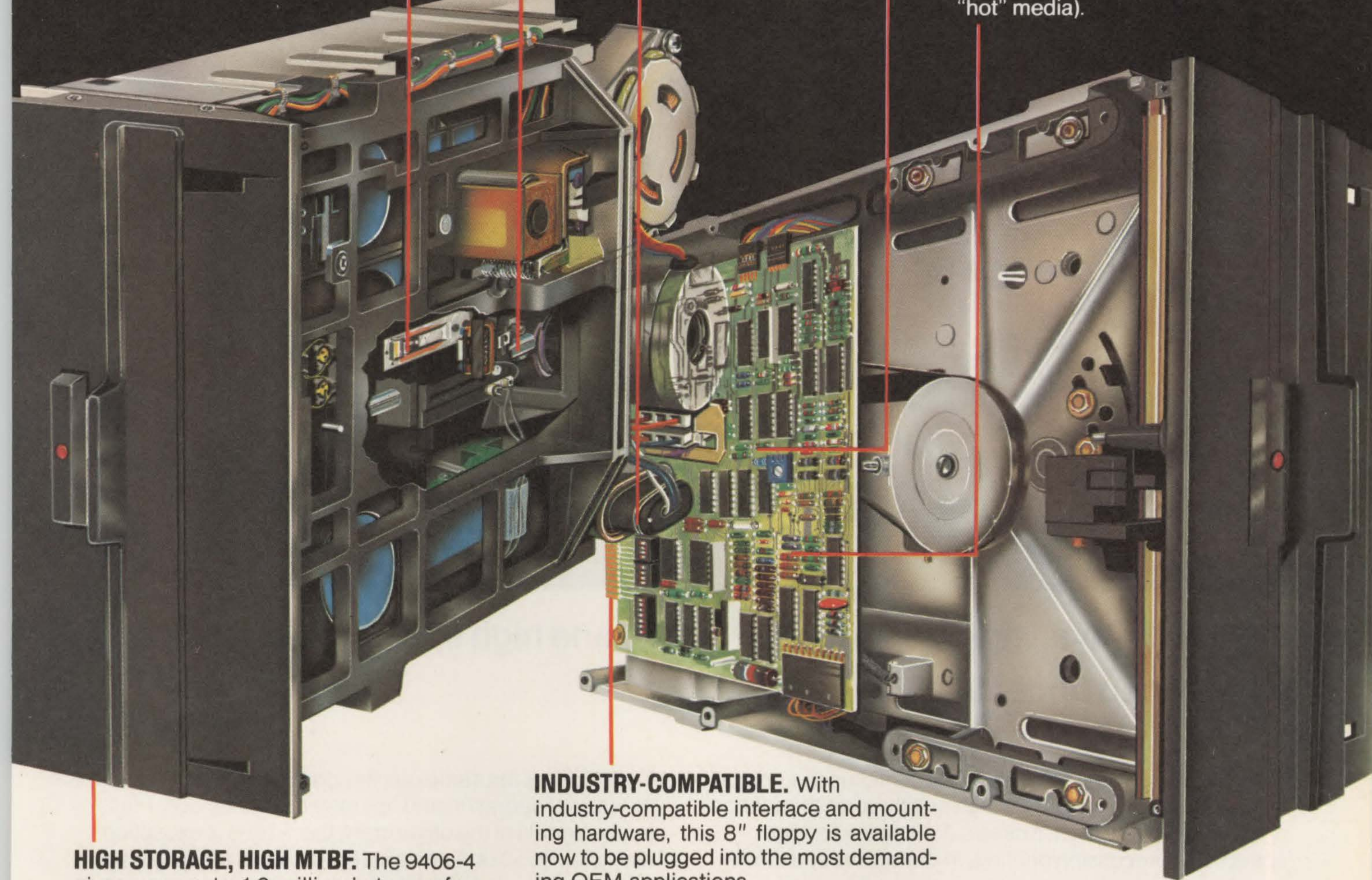

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CIRCLE NO. 80 ON INQUIRY CARD

DATA COMMUNICATIONS

Minicomputers automate network maintenance

PETER FRIGON, Dataproducts New England, Inc.

Tech-control systems increase uptime and reduce technical-personnel requirements with fault isolation

The need for automated tech-control systems is evolving as the complexity and data speeds of communications increase. Only a few years ago, data-communications circuits consisted of point-to-point facilities terminating in simple machines at both ends. Now they involve distributed-processing systems and intelligent networks. Lagging behind this surge of technology has been the maintenance capabilities of the communica-

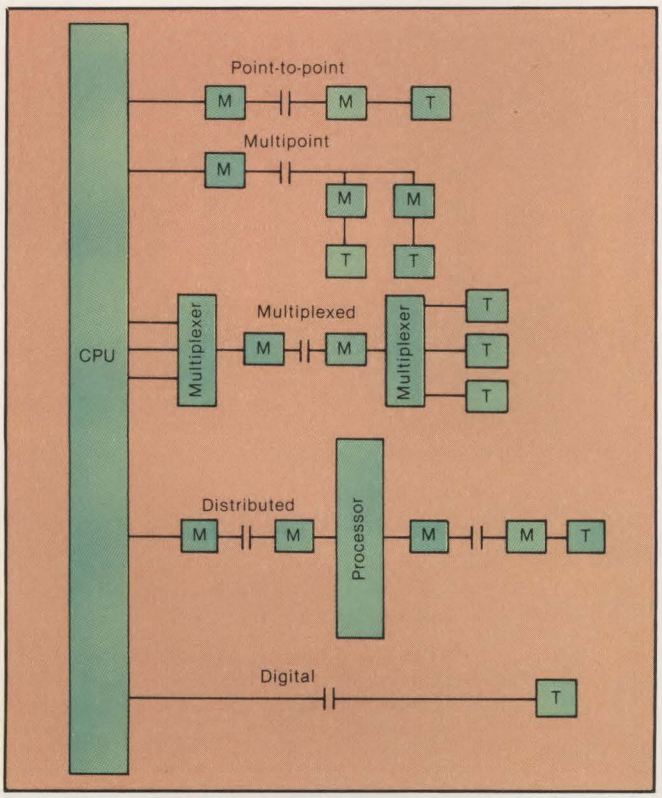

Fig. 1. Complexity of data networks *has evolved from simple point-to-point arrangement (top) to include combinations of branched multi-point, multiplexed and distributed-processor configurations. The "simple" all-digital CPU-to-terminal connection (bottom) represents the latest and most complex step in this evolution because the network itself provides the intelligence to perform those functions previously handled by modems (represented here as "m"), multiplexers ("muxes") and intermediate communications processors.*

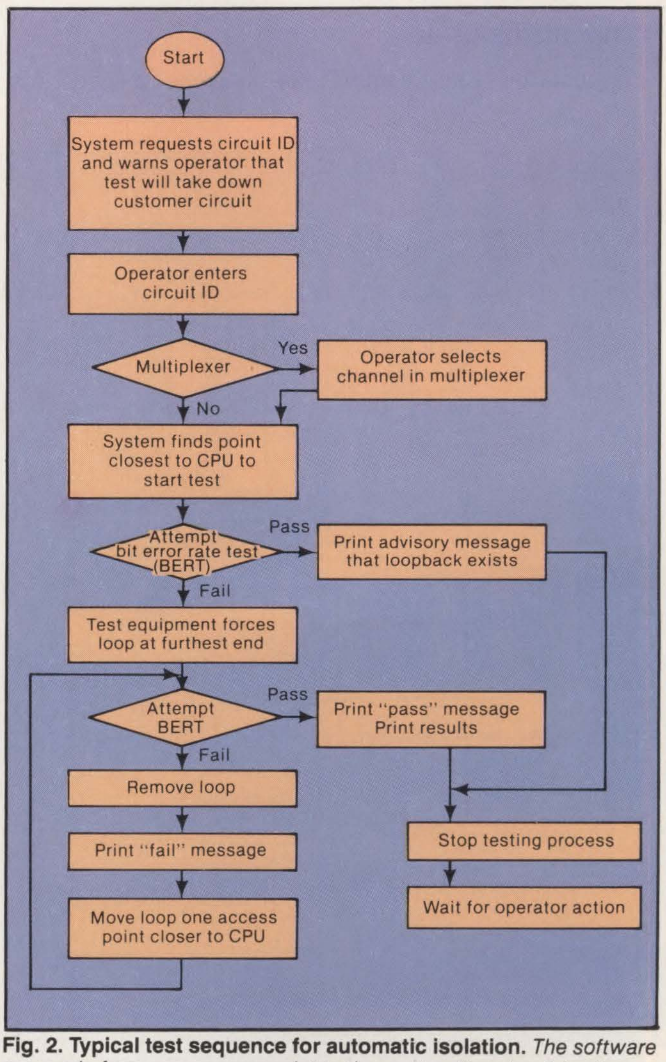

Fig. 2. Typical test sequence for automatic isolation. *The software proceeds from one access point to the next until a circuit is clear or transmission will not proceed further in that circuit, indicating an equipment failure.*

Automated tech control has become a necessity because manual tech-control methods are proving inadequate for modern data networks.

tions stations themselves, usually a manual patch facility. Data networks conceived in the 1970s have been kept alive by equipment made in the 1950s. Much of that equipment was based on even earlier designs. To compound this situation, the data-processing and communications equipment may be widely dispersed, making manual circuit testing and fault isolation even more difficult.

Now, testing and fault isolation can be automated by combining test equipment with minicomputers. A new class of equipment called tech-control systems locates and corrects failures from a central location. Automating relieves operators of repetitive manual tasks, which translates into maintenance-cost reductions and more efficient use of technical personnel. Effective use of tech-control systems requires a knowledge of the problems that arise and how they get solved.

Where the faults lie

Automated tech control has become a necessity because manual tech-control methods are proving inadequate for modern data networks (Fig. 1). Efforts of specialized technicians at various sites must be coordinated, sometimes requiring dispatching personnel to remote sites. When leased facilities or multivendor equipment are involved, too much time is consumed in finger pointing.

The major problem area is related to the complexity of the communication path between a terminal operator and central-site equipment. Minicomputers have proven ideal for this task because they can be easily programmed to perform automatic test sequencing to fault-isolate each circuit of a data systems. The results of each test are analyzed automatically, while the system's database determines the next test to be run. Information stored in the database includes transmission rates, types of protocols and circuit configurations. A typical sequential testing cycle is illustrated in Fig. 2.

The recovery process

The operator learns of the need to initiate testing in one of two ways. Either an error message is output on the log printer, or a user calls in a problem. In either case, the operator then invokes the automatic fault sequences on the circuit in question to identify the failing components.

Each automated testing procedure is designed so

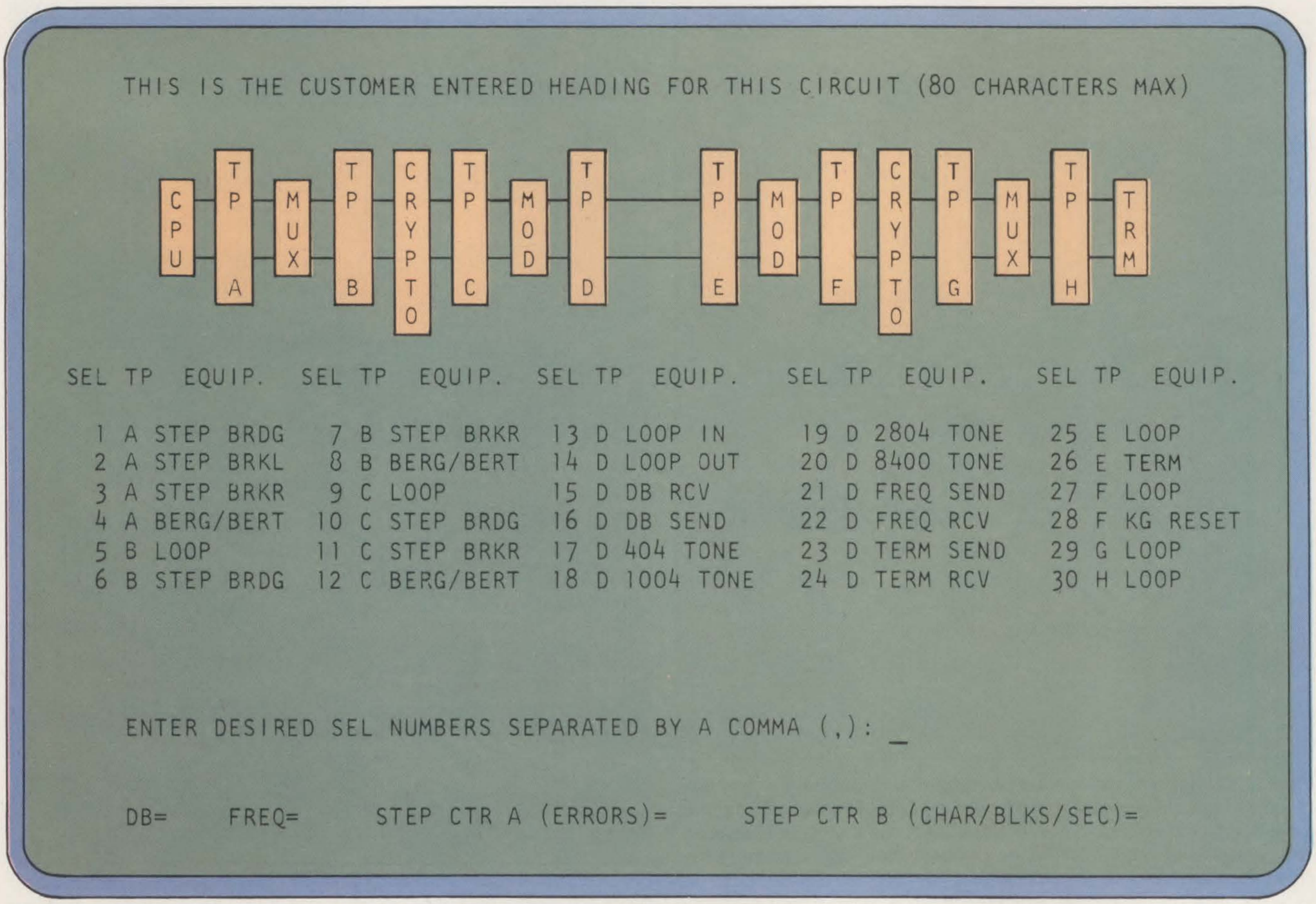

Fig. 3. Screen display for circuit test equipment selection *provides an operator with both a circuit map and an indication of the tests available.*

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CIRCLE NO. 81 ON INQUIRY CARD

During the diagnostic sequence, the computer is constantly logging events for future review, including why particular circuits fail more often than others, how much time it takes to restore a circuit and what types of problems occur.

that a central-site operator can perform loopbacks at the distant sites without the need for remote-site personnel. The central-site processor addresses a loopback device on the far side of a remote modem, and a test message is transmitted to that device. If the message is returned, the operator knows that the communication link is operating and the terminal is the failed unit. The minicomputer database can then test to determine the cause of the malfunction.

What the mini does

The minicomputer provides the central-site operator with the individual circuit information or port he must have to pinpoint the hardware problem. The system shows the operator the circuit being worked on as well as the tests available (Fig. 3).

Once the test is complete, the mini resets the communications system to its original state. This is important because sometimes a piece of manual test equipment such as a loopback can be inadvertently left on a line.

During the diagnostic sequence, the computer is constantly logging events for future review, including why particular circuits fail more often than others, how much time it takes to restore a circuit and what types of problems (modem, multiplexer or terminal) occur. With this information in the database, the system provides statistical reports on outages of various components for

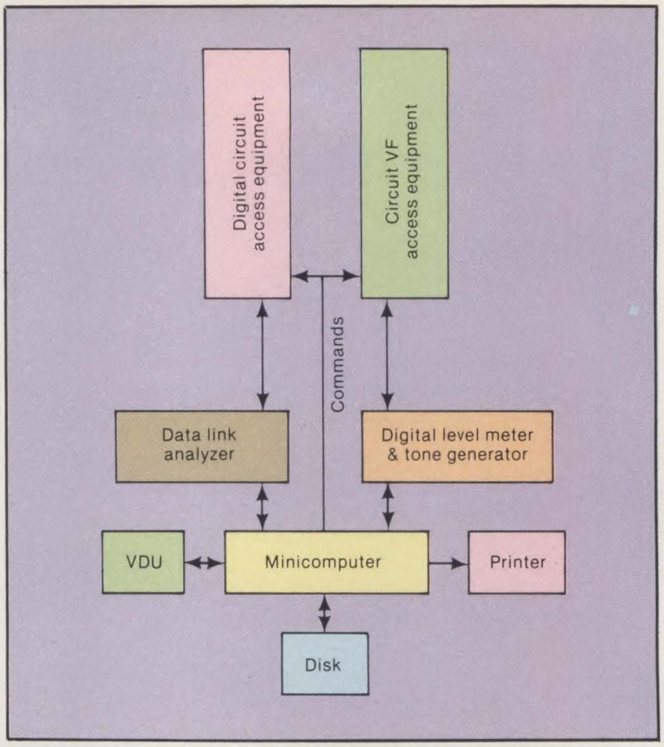

Fig. 5. Configuration of a tech-control system *at the central site. The minicomputer controls test equipment and interprets test results.*

planning purposes. A typical log entry detailing the announcement of a problem, its isolation and resolution is shown in Fig. 4.

A tech-control system

Dataproducts New England Inc.'s CENPAT systems are examples of tech-control devices. The components at the central site are configured generally as shown in Fig. 5. A CENPAT system typically consists of a minicomputer, a video-display terminal, a floppy diskette and a printer. The minicomputer is directly connected to a remotely controlled data-link analyzer

```
MASTER STATION LOG      FACILITY:  SITE #2      DATE:  13-JAN-81    PAGE 01
CIRCUIT ID   TIME INIT                       ACTION/EVENT

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

N/A          10:00 RJ      SHIFT CHANGE-R. JONES ON DUTY REPLACING JOE DOE
BERMUDA      10:11 SYST    MUX <IN ALARM>
WALL         10:12 SYST    MOD <IN ALARM>
BERMUDA      10:32 SYST    MUX <OUT OF ALARM>
WALL         10:32 RJ      AUTO-ISOLATION TEST INITIATED
WALL         10:32 SYST    AUTO-ISOLATION TEST - LOCAL MODEM TEST FAILED
WALL         10:40 RJ      CALLED MAINTENANCE - JOE BROWN
WALL         10:45 RJ      PROGRAMMED TEST 07 INITIATED
WALL         10:50 RJ      PROGRAMMED TEST 07 COMPLETED
WALL         11:10 SYST    MOD <OUT OF ALARM>

                                          TIME:  FROM 10:00 TO 11:10
```

Fig. 4. Master station logs entries *for a sequence of operations required to identify the two alarm conditions noted at 10:11 and 10:12*

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- Erase to end of page
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CIRCLE NO. 82 ON INQUIRY CARD

Each automated testing procedure is designed so that a central-site operator can perform loopbacks at the distant sites without the need for remote-site personnel.

(the DNE STEP 21) and a digital-level meter. The minicomputer is also connected to access equipment so that, under operator or stored-program control, the minicomputer can determine which circuit to access and which tests to run. The minicomputer controls the test equipment and compares the results of each test with stored values in its memory. The system then logs the test results at both the printer and VDT for the operator's review and action. ■

Peter Frigon is product manager, Dataproducts New England, Inc., Wallingford, Conn.

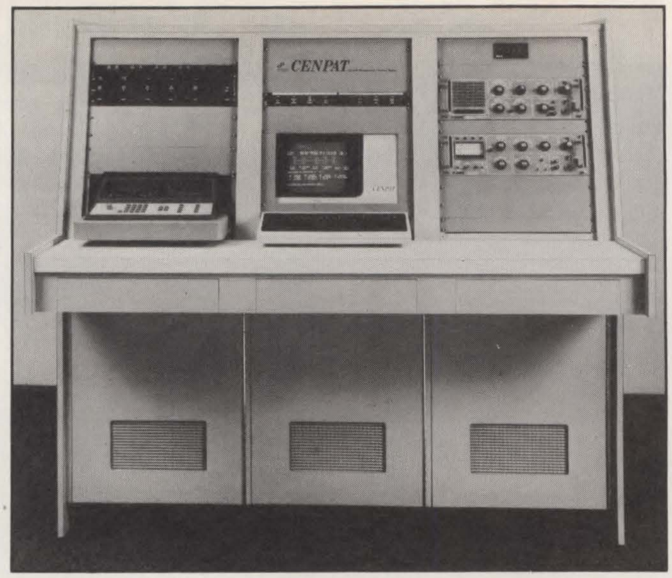

Fig. 6. The CENPAT 700 automated network management and control system from Dataproducts New England *performs fault isolation, restoration and record keeping in complex data networks. The modularly designed system allows central site control, unattended automatic circuit scanning and remote-site polling.*

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JOHN S. MARSHALL, Hewlett-Packard Co.

One system incorporates all hardware and software elements of design/development with a common database

The µp-based product-development industry has been content to test for proper system integration with separate and unrelated instruments, each dedicated to a specific measurement. The result of this practice has frequently been the underuse of narrowly focused expensive capital equipment and the inefficient use of manpower resulting from poor information transfer among design groups and from one project stage to the next.

A new design philosophy implemented through Hewlett-Packard Co.'s HP 64000 logic-development system integrates all hardware and software elements of the design and development phases into one system. Further, it links the phases through a common database and operating system, providing total integrated support for the entire design and development cycle. System context can be switched between real-time transparent analysis and software development for immediate software corrections or program enhancements. More importantly, changes are made at the source-code level rather than as object-code patches that can corrupt the documentation. Base price of a typical system is approximately $32,000.

Factors affecting software/hardware integration

Numerous simultaneous events are creating a dynamic—even unstable—situation in the electronics industry. The trend toward increasing circuit density has continued unabated, which means more functions are available on a chip at lower cost. The result has been a change in the economics of computer-system architecture—processing and memory have become commodities. Rather than a central computer surrounded by peripherals, the trend is toward distributing processing throughout the system. Communication with peripherals and I/O functions is now handled by special processors, and the peripheral devices themselves often contain processors.

The processors are also becoming much more complex and advancing too quickly for industry to absorb the changes. One group of products that has emerged as a result of the new VLSI technologies are 16-bit processors. Introduced in 1979 and 1980, they are only now attracting the high interest level that has surrounded 8-bit devices. In multiprocessor distributed-system architecture, the 16-bit processors can create formidable problems for system integrators.

Software is the largest of these problems. Integrator-supplied custom software is often required to interface the many elements of a complex system. Much software is written in high-level languages to increase the efficiency of design engineers and provide program portability. But high-level languages often produce inefficient code in respect to both execution time and code space. This is a problem when interactions between devices are time dependent. As a result,

The trend toward increasing circuit density has continued unabated, which means more functions are available on a chip at lower cost.

considerable time and effort are often dedicated to software optimization.

A casual approach to software design is no longer possible. The code must be modular, well structured and thoroughly tested and documented.

An effective testing program can greatly reduce the number of software bugs and, therefore, the cost. It may cost 10 times as much to fix a bug in the integration phase as in the software-design phase. Software modules can be tested using a procedure much the same as that used for hardware modules: subjecting the unit to various stimuli and observing the response. Stimuli can include variables and constants to which the module may be exposed or hardware stimuli such as glitches, marginal signal levels or timing conditions of control signals. Glitches are a concern when system response to asynchronous signals is possible. Timing margins are a source of trouble in handshake sequences between devices. An error in sequence can be the result of a faulty component or a programming error. Improper signal levels can result from excessive fan-out, a bad component, circuit loading or incompatibility between system components supplied by different vendors.

It is estimated that maintenance accounts for as much as 70 percent of the total cost of software over the life of a product. A software-maintenance plan must include provisions not only for finding and fixing bugs but also for enhancing systems and expanding capability. These tasks are especially difficult if documentation is not well maintained or not easily accessible. A subsequent design team must know the full impact of any code changes it proposes.

Examining the new system

The HP 64000 system completes a program begun in 1979, with the introduction of the 64000 logic-development system, which provided software-development tools and emulators, but only for popular 8-bit processors. Emulation for 16-bit μps was announced in 1981. The new HP 64000 includes a transportable development station (Fig. 1), a powerful software state-

Fig. 1. A transportable system, *the HP 64110A development station (bottom left) has a hinged keyboard (top left) that can be set in any position or closed to serve as a cover; provision for installation of an 8085 emulator (top right) for software development; and a 60-channel configuration (bottom right) that can be expanded to 120 channels (or a timing analyzer subsystem can be added for interactive measurement).*

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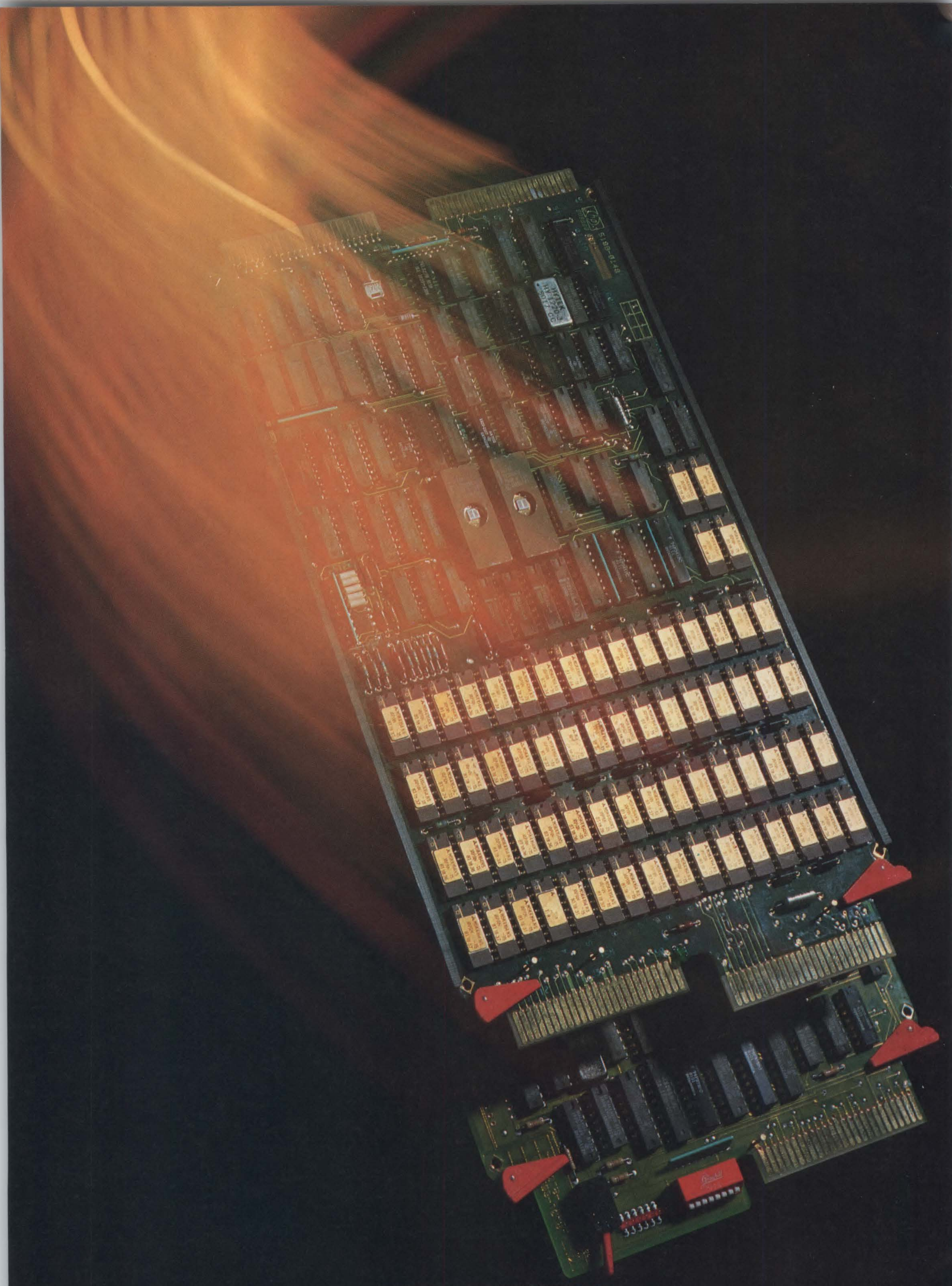

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It is estimated that maintenance accounts for as much as 70 percent of the total cost of software over the life of a product.

analysis subsystem expandable from 20 to 120 channels and an asynchronous timing analyzer subsystem with sampling speed as high as 400 MHz. The combined hardware and software facilities provide an environment for implementing a new measurement concept: interactive emulation and external logic analysis. Measurement configurations can include combinations of emulation and software analysis, hardware analysis or both. Prices for an H-P development station, including a dual floppy-disk unit for local mass storage, begin at $13,000. Prices for software-analysis subsystems start at $9000, and a hardware timing analyzer subsystem starts at $10,250. Two development stations host the software-development tools, emulators and analysis subsystems. Each station uses the same host processor and internal architecture (Fig. 2), and each has dual floppy-disk local mass storage. The larger station has 10 card slots for hardware options; the smaller station has five.

Both stations provide a software-development environment with an editor, file manager, assemblers, compilers and linker. Run controls and software execution in the target system are provided through emulation. The stations can also be configured as a powerful software or hardware analyzer or as a combination that can include emulation. When operated from local mass storage, a station brings software development and logic-analysis tools to the designer.

As many as six development stations can be connected in a cluster and share a compatible central hard disk and a printer (Fig. 3). This configuration offers higher performance and allows a design team to work together and share a database.

A third operating mode allows users to take advantage of powerful mainframes or minicomputers already in place. The development station becomes a terminal to the host computer where the software-development and program-management tools reside. Software programs are down-loaded into the development station for execution in the target system through an emulator. Automatic measurements are performed and data are collected over HP-IB and RS232C ports.

This approach to instrumentation enables a development station to be configured to address the problems at any phase of the development cycle or to be reconfigured and optimized to address new problems that arise as the project progresses. The system can also be adapted to the design philosophy of the group rather than forcing the group to adapt its objectives and operating procedures to the instrumentation.

Analyzing software in the HP 64000

A powerful logic analyzer optimized to address software and system-integration problems has been implemented as a subsystem for the HP 64000. Extensive symbolic tracing provides a user interface and

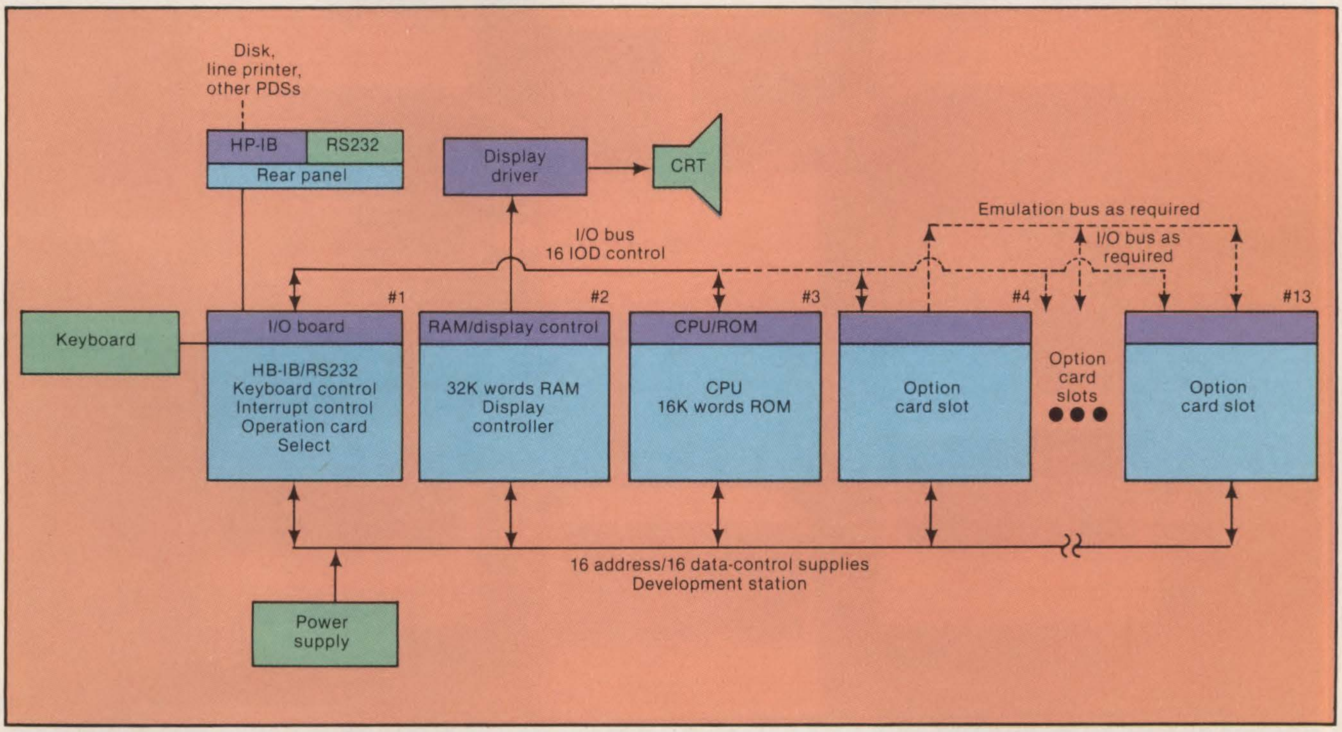


Fig.2. HP 64000 development system *has a 16-bit host processor and memory and a card cage for hardware options. Applications software resides on local mass storage or on a hard disk.*

Integrator-supplied custom software is often required to interface the many elements of a complex system.

measurement output that relate to software engineers. Input channels are identified individually or as groups with user-assigned labels. Likewise, a symbol map can be generated where symbols are assigned to values or ranges that correspond to variables, code modules and procedures as they appear in the source-code documentation. Also, because the analyzer is interactive with other subsystems, the linker symbol table created during software development can be accessed. Trace specifications are entered in terms of the input labels and the symbols from symbol maps and tables (Fig. 4). Pascal sources are also related to the analyzer measurements through program symbols and line numbers. As an added convenience, an expanded listing compiler option produces an output that includes both the Pascal source and the equivalent target processor mnemonics, which makes it easy to correlate the logic analyzer display to the source listing.

Analyzing performance

Program, procedure and variable tracing are microtracing capabilities that are extremely useful for isolating and identifying a problem. However, the narrow field of view that micro tracing provides can be difficult to position if the problem is not well under-

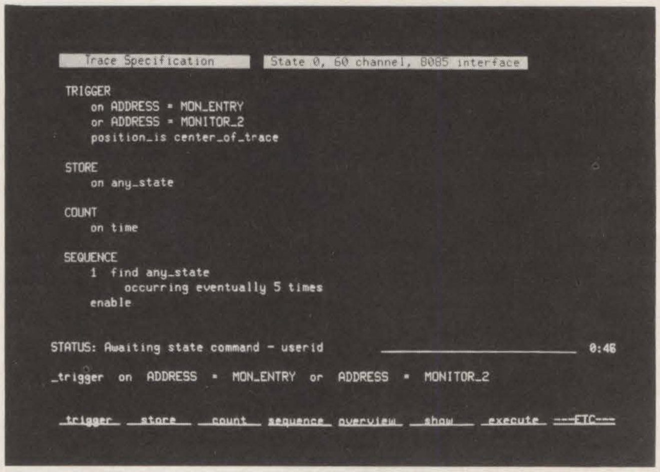


Fig. 4. Software-analyzer trace specifications *are entered symbolically in terms of the source-code documentation.*

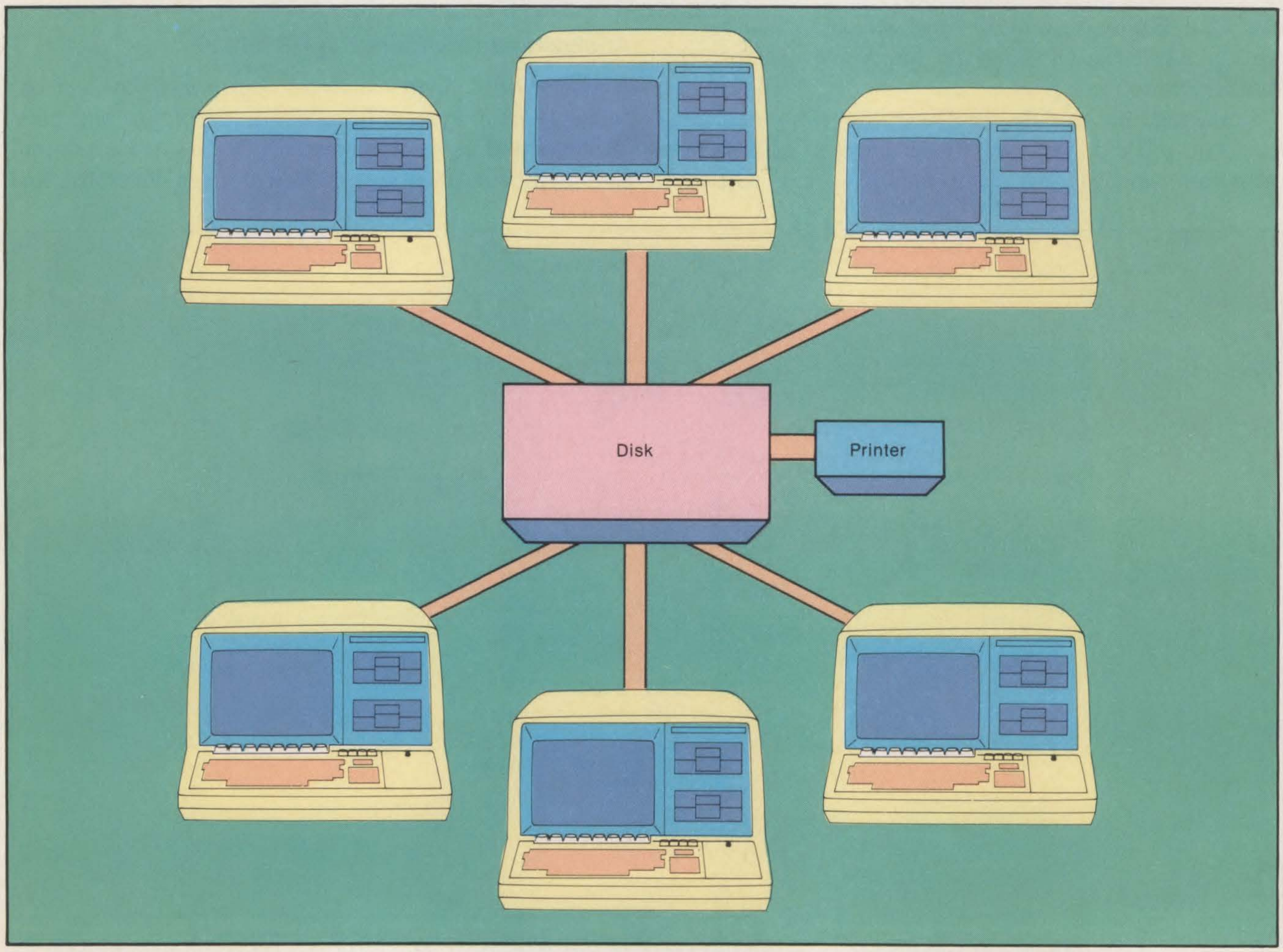
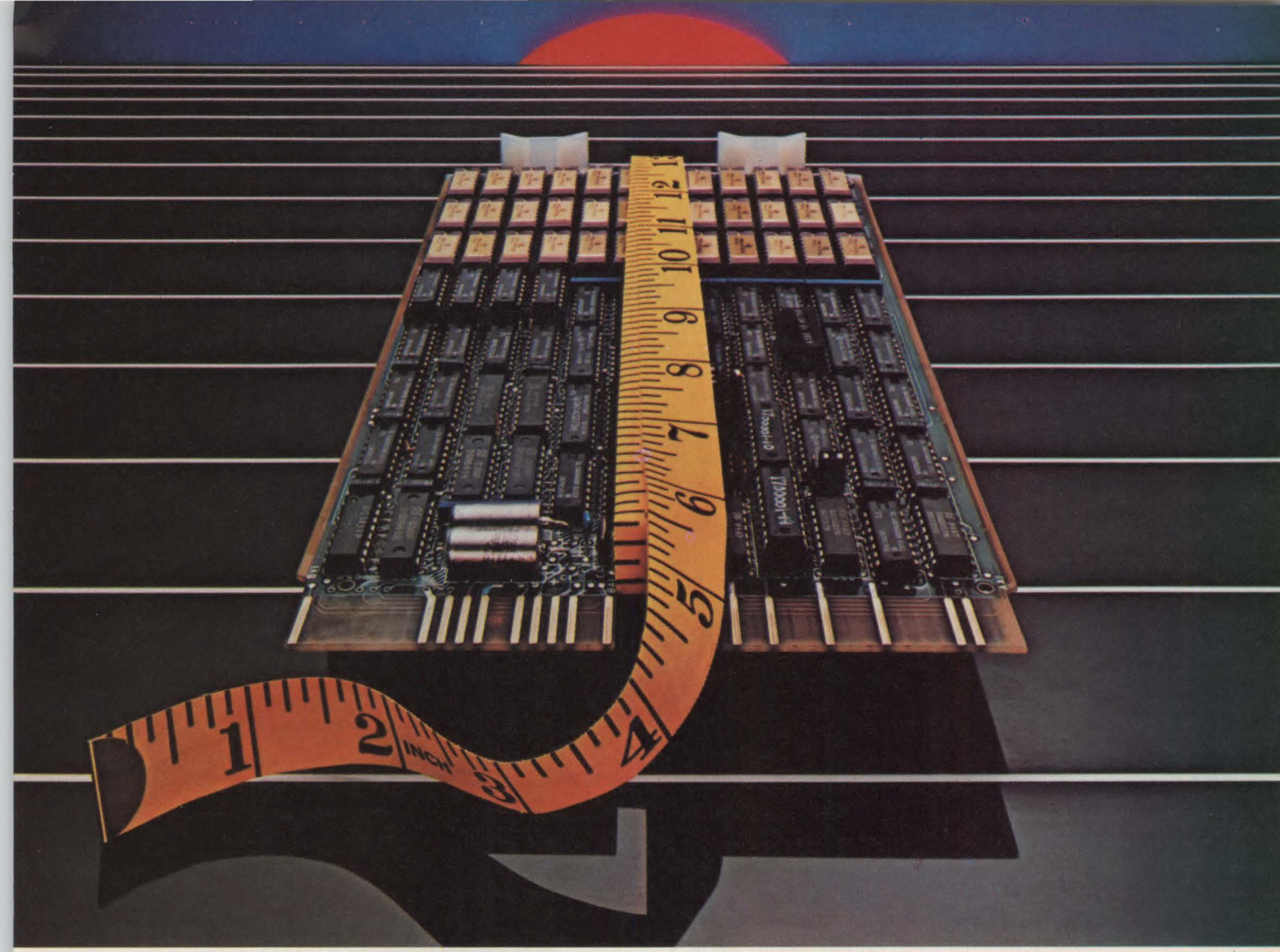


Fig. 3. Development stations can share high-performance peripherals, *allowing a design team to share a database.*



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[1]Parity optional [2]EDAC standard

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Hardware analysis in the HP 64000 is implemented as an asynchronous timing analyzer subsystem.

stood, and it limits information about overall system performance. The software-analysis subsystem includes an independent overview pattern-recognition circuit and memory that operate in parallel with the micro-tracing circuit. In the overview mode, values and ranges that correspond to variables, procedures and memory segments are identified as events and are stored in a table. These events are plotted as a histogram of events versus occurrence (Fig. 5).

If one overview event appears suspect, two alternatives are possible: a single event can be selected and a histogram of the time interval or occurrence-count distribution of that event can be displayed. If, for example, the events represent program procedures or code modules, the relative execution times of these modules are clearly displayed. This can be a powerful tool for optimizing time-dependent procedures that control peripheral devices. Benchmarks can easily be performed non-intrusively and in real time between a driver written in a high-level language and one written in assembly language. The other alternative is to use an overview event to trigger the micro trace for a more detailed analysis of the procedure.

Analyzing hardware

Hardware analysis in the HP 64000 is implemented as an asynchronous timing analyzer subsystem. A basic sampling rate of 200 MHz on eight or 16 channels is sufficient for most functional and some parametric measurement. In the fast sample mode, a 400-MHz internal clock rate is available on half the channels for high-resolution timing analysis. In the traditional sense, timing analyzers offer very limited measurement. Even the fastest timing analyzers provide timing resolution equivalent to an oscilloscope of only moderate bandwidth capability. Vertical resolution is 2 bits, which produces a sharp display but conveys little of the true signal activity. Two additional measurement modes in the HP 64000 timing analyzer provide the equivalent of additional vertical resolution. Glitch mode detects glitches as narrow as 3 nsec., stores the occurrences in a separate memory and displays them unambiguously. The occurrence of a glitch can be specified as a condition for triggering the timing analyzer.

Marginal signal levels are detected and displayed using the new dual-threshold mode. For example, two variable thresholds can be set at the minimum high and maximum low of the logic family in use within the system under test. Signal levels that fall between the thresholds are displayed as mid-level traces, which makes them easy to identify (Fig. 6). A mid-level signal condition can also be used as a condition for triggering and, combined with time-interval triggering, can be used to identify marginal rise times.

Combining measurements

An HP 64000 development station can be configured as a powerful real-time software analyzer or a high-resolution hardware timing analyzer. Multiprocessor system integration problems, however, may require multiple analyzers, which can be configured in a single station. Two software analyzers, for example, can be applied across an I/O port to monitor the peripheral processor and the controlling processor within the peripheral device. Entry into the procedure DATRAN by the peripheral processor can be used as an overview event for software analyzer A and as an arming function for software analyzer B. Analyzer A in the overview mode is set to trigger if procedure DATRAN executes for less than 20 msec.—an indication of incomplete data

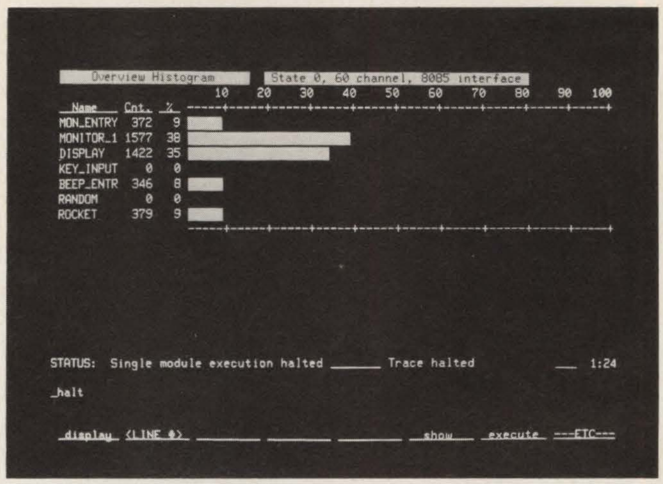

Fig. 5. Overview mode histogram *displays the relative performance of several procedures within a program.*

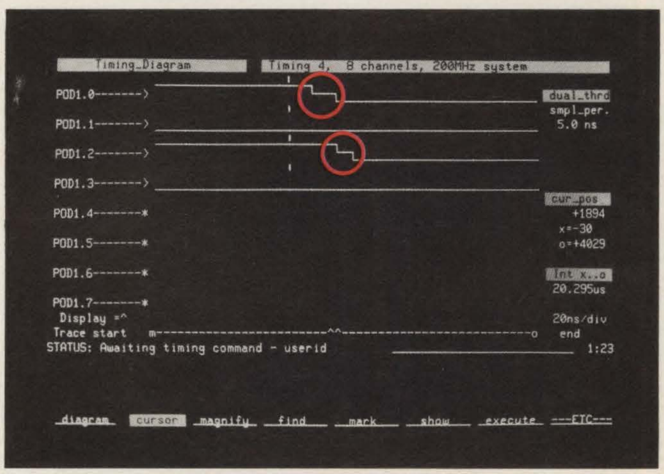

Fig. 6. Mid-level traces, *identifiable as marginal signals, are shown in this dual-threshold-mode timing diagram.*

An HP 64000 development station can be configured as a powerful real-time software analyzer or a hardware timing analyzer.

transfer. This same overview event could also trigger analyzer B, which would produce a trace list of the response of the control processor within the peripheral device, which may indicate why data transfer was incomplete.

In a similar manner, an interactive combination of hardware and software analysis could be applied to evaluate an interface between the CPU and a peripheral device supplied by a different vendor. The timing analyzer operating in the dual threshold mode is set to trigger if the signal G01 is detected in the mid-level condition for longer than 10 nsec. Recognition of the event also triggers the software analyzer. This reveals that a marginal signal level on a control line causes the CPU to jump into forbidden memory space. The problem is traced to improper loading on the output of G01 signal.

Combining software and hardware analysis with emulation produces a powerful stimulus-response interactive measurement system (Fig. 7) that can be applied to the integration problems of multiprocessor systems. The emulator provides extensive controls over the target system. Test programs can be loaded into RAM and executed, the program counter-initialized and registers can be interrogated. For example, execution can be initiated at a procedure that reads data from a mass-storage device. A timing analyzer subsystem triggered by a control word provides verification that handshake sequence and timing margins are correct. Should a problem be observed, the context is switched to the editor. Source code is then modified, the program is reloaded, and the measurement is performed again. ■

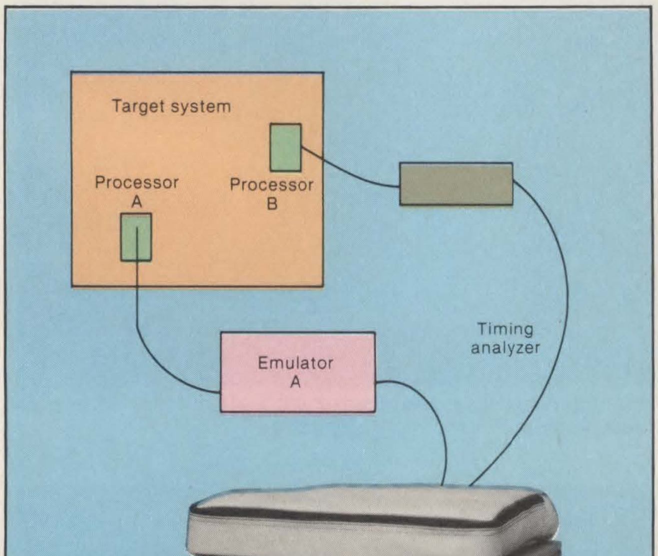

Fig. 7. Interactive measurement system. *Processor A is under control of the emulator. Simultaneously, the handshake signals at processor B are monitored with a timing analyzer subsystem.*

John S. Marshall is product manager, logic systems operations, for Hewlett-Packard Co., Colorado Springs, Colo.

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Array processors enhance minicomputer performance

JONATHAN COHLER, CSP, Inc.

Today's peripheral number crunchers are bringing batch mainframe computing power to scientific minis

Array processors are specialized minicomputers that perform iterative arithmetic very rapidly. When used as peripheral units attached to host minicomputers to perform signal-processing, image-processing, seismic-analysis, speech-recognizition and structural-analysis applications, they can provide mainframe performance for minicomputer prices. Adding a peripheral floating-point AP to a minicomputer system enhances system performance by a factor of 20 to 1000 for a much smaller increment in system cost. The MAP-200 32-bit AP from CSP, Inc., Billerica, Mass., for example, sells for $40,000 in single-unit quantities and performs a 100 × 100 matrix multiply in less than 6 sec. The same operation requires 220 sec. on a standard Digital Equipment Corp. PDP-11/34 system. Assuming a typical PDP-11/34 system sells for $80,000, then for a 50-percent increase in system cost, the speed of matrix multiplication can be enhanced by a factor of 370. Other standard FORTRAN-callable functions show similar improvements (Table 1).

The high performance and low cost of APs are a direct result of highly specialized parallel architectures. In contrast with minicomputers that operate serially, APs do many things simultaneously. Memory references, floating-point arithmetic and address calculations occur in parallel, and some APs also overlap I/O with calculation. CSPI and Floating Point Systems, Inc., Beaverton, Ore., manufacture the most popular lines of APs on the market. While both firms' products provide impressive performance gains for popular minis, their APs use radically different architectures: synchronous and asynchronous. A look at the two architectures will show how APs work, what programming and system integration problems they create and why they serve some applications better than others.

The synchronous architecture

The basic synchronous AP (Fig. 1) consists of a set of independent parallel processors controlled by a single high-speed processor. Every 167 nsec., a multifield microcode instruction is decoded, and several simultaneous operations—including floating-point arithmetic, address calculation, memory references and data transfers—are started.

Minicomputer/minicomputer-array processor performance comparison

Function	Execution time (msec.): PDP-11/34 plus CSPI array processor	Execution time (msec.): PDP-11/34 only	Performance improvement ratio
1024 point complex FFT	4.9	4900	1000:1
100 × 100 matrix multiply	265	220,000	830:1
1000 point vector multiply	0.6	130	217:1
1000 point vector divide	1.6	150	94:1
1000 point vector float	0.5	25	50:1

Table 1. A peripheral array processor can "turbocharge" most popular minicomputers. *Adding a $40,000, 32-bit array processor to an $88,000 PDP-11/34 can vastly improve the PDP-11/34's calculating performance and make it a viable mainframe alternative for many scientific applications.*

In contrast with minicomputers that operate serially, APs do many things simultaneously.

Floating-point arithmetic is carried out by a two-stage pipelined adder and a three-stage pipelined multiplier. In this context, pipelined means that once the first stage of an operation is complete, another of the same operation can be started. Thus, if the addition of A and B starts on cycle 1, followed by the addition of C and D on cycle 2, and then E and F on cycle 3, the result A + B is available on cycle 3. The total time through the adder pipeline (the add time) is 333 nsec., but if the pipeline is kept constantly full, an add is completed every 167 nsec. The peak adder throughput rate in this case is 6 million adds per sec. (6 MHz). Similarly, the floating-point multiplier is a three-stage pipeline with 500-nsec. total pipe time and peak multiply rate of 6 MHz.

If both pipelines are kept constantly full, this synchronous architecture achieves 12 million floating-point operations per sec. (MFLOPS), but it is often impossible to keep the pipelines full. Calculating matrix inverses, for example, requires three memory accesses per multiply. Because only one memory access is possible per 167-nsec. cycle, three cycles are required for memory accesses alone. In this case, the unit drops to the equivalent of 500 nsec. per add and 667 nsec. per multiply.

The synchronous processor has a pipeline-like, interleaved memory that can be accessed every cycle, but each access takes two or more cycles to complete. The memory consists of two 333-nsec. memory banks, one containing even address locations, the other containing odd address locations. Because the memory banks are separate, an access to one bank can overlap half of a 333-nsec. memory cycle of the other bank. If the memory is accessed on each clock cycle in an even-odd sequence of addresses, data are available every 167 nsec. However, if only even addresses or only odd addresses are accessed, data are available every 333 nsec. Some rate between these two rates is achieved if memory is addressed randomly.

Because the processors in a synchronous system operate on a single clock, memory accesses and data usage must be explicitly synchronized in every program. Consider a program that accesses memory on every clock cycle:

Cycle	Datum Referenced	Datum Available
1	X(1)	—
2	X(2)	—
3	X(3)	X(1)
4	X(4)	X(2)
5	X(5)	X(3)
6	—	X(4)
7	—	X(5)
8	—	—

Note that datum X(1) is available only on cycle 3, and X(2) is available only on cycle 4, etc. The program must use a datum as soon as it's available or transfer it to the data bus, where it can subsequently be placed in a register. If the program was changed and X(4) was needed on cycle 5, then its access would have to be pushed back to cycle 3, which would force X(3)'s access back to cycle 2 and so on. Explicit program synchronization is necessary even with a synchronous AP.

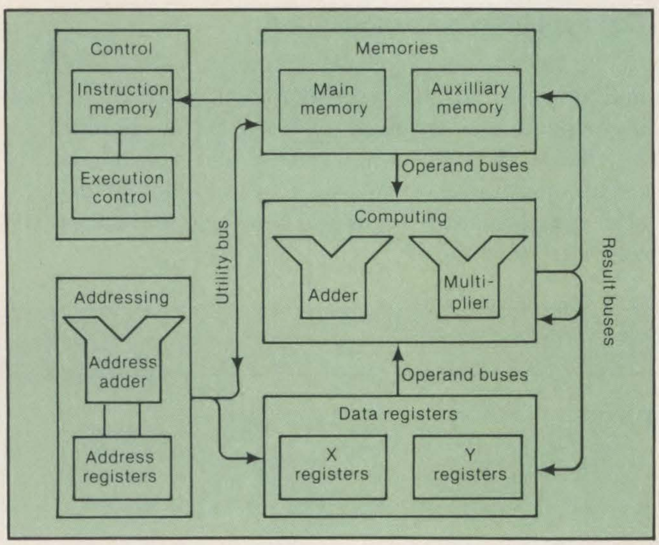

Fig. 1. A synchronous array processor *consists of a set of independent parallel processors controlled by a single control processor. The processors in the Floating Point Systems' array processor (above) combine as many as 10 minor operations into one machine instruction. At 6 million instructions per sec., this array processor performs as many as 60 million operations per sec., including 12 million floating-point operations per sec. The synchronous array processor incorporates hardware pipelining to operate several stages of computation simultaneously.*

The asynchronous architecture

The basic asynchronous AP consists of a controlling CPU, an arithmetic processor, a host-interface module and three independent, multiport RAMs (Fig. 2). Each processor in an asynchronous AP runs on its own clock and serves a specific function.

An integral 170- nsec., 16-bit CPU controls all of the asynchronous AP's subprocessors and memory via an internal, interrupt-driven, real-time operating system. The CPU fields interrupts from the other processors and dispatches tasks when processors and data are available. In real-time applications requiring response to external events, this integral CPU off-loads the AP's host and reacts much more rapidly than the host could. In many instances, the integral CPU enables the AP to handle continuous throughput without any host support. In typical configurations, the dedicated host interface module performs all data and command transfers between host and AP.

The three independent memory buses allow true parallel I/O and processing. All processors have access to all three memory buses, each of which can support any combination of 500-, 300- and 170-nsec. memories. The ability to choose a mixture of fast (expensive) and slow (less expensive) memory allows users to configure cost-effective systems for diverse applications.

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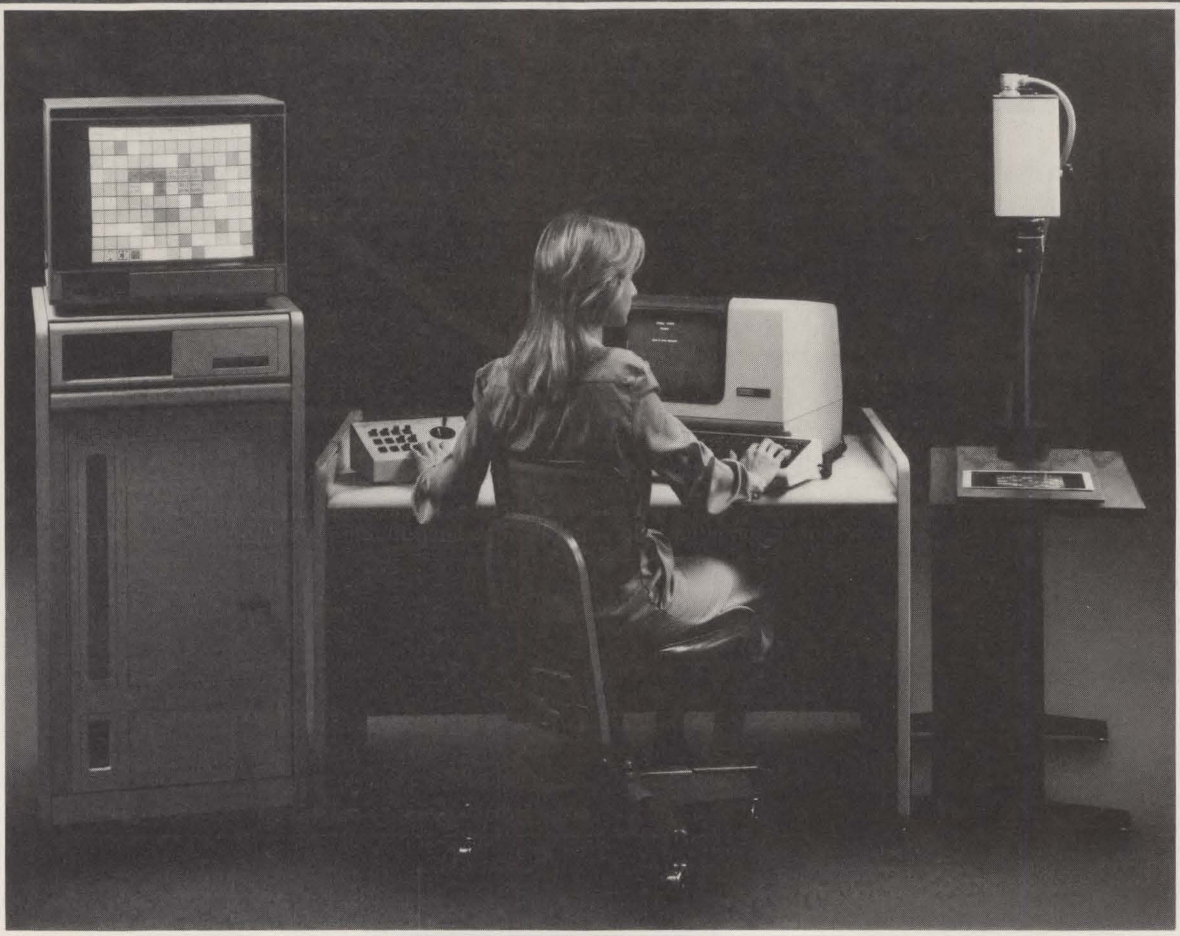

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CIRCLE NO. 91 ON INQUIRY CARD

Because the processors in a synchronous system operate on a single clock, memory accesses and data usage must be explicitly synchronized in every program.

AP function throughput is often limited by data and command transfer rates between the host computer and the AP. Making the AP's memory a part of the host's memory eliminates host/AP I/O. This concept, called shared memory (Fig. 3), has been implemented by CSPI in cooperation with Gould Corp.'s S.E.L. Computer Systems Division. Gould's VPS-3300 and VPS-6400 vector-processing systems consist of an S.E.L. 32/77 supermini coupled with a 32- or 64-bit AP, respectively, via a common memory interface.

The arithmetic processor (Fig. 4) consists of three independent asynchronous processors, one for address computation (the APS), one for arithmetic calculation (the APU) and one to manage memory transfers (the MTC). Sequencing of addresses and data is controlled by four queues—input and output data queues in the APU and input and output address queues in the APS. The MTC monitors the status of the four queues and executes memory reads and writes in parallel with address calculations and arithmetic. If the APU tries to extract a datum from an empty input queue, it automatically waits until one enters the queue. Similarly, the APU waits if an output is attempted to a full output queue. This data-driven queue structure provides nearly all necessary synchronization between the APU and APS.

The APU decodes 16-bit instructions in 100 nsec. It executes housekeeping commands and monitors data and processor availability. Floating-point add and multiply instructions are dispatched to a 250-nsec. adder and a 500-nsec. multiplier. Because the adder, multiplier and APU are all asynchronous, instruction decoding, addition and multiplication can occur simultaneously at a maximum rate of 6 MFLOPS (Fig. 5). An extension of this architecture (CSPI's MAP-300) incorporates a second multiplier, adder and full set of registers that run under the same APU controller as the first set. This AP can sustain a processing rate of 12 MFLOPS. To boost processing rates even higher than 12 MFLOPS, CSPI's new MAP-400 expands the basic asynchronous AP archi-

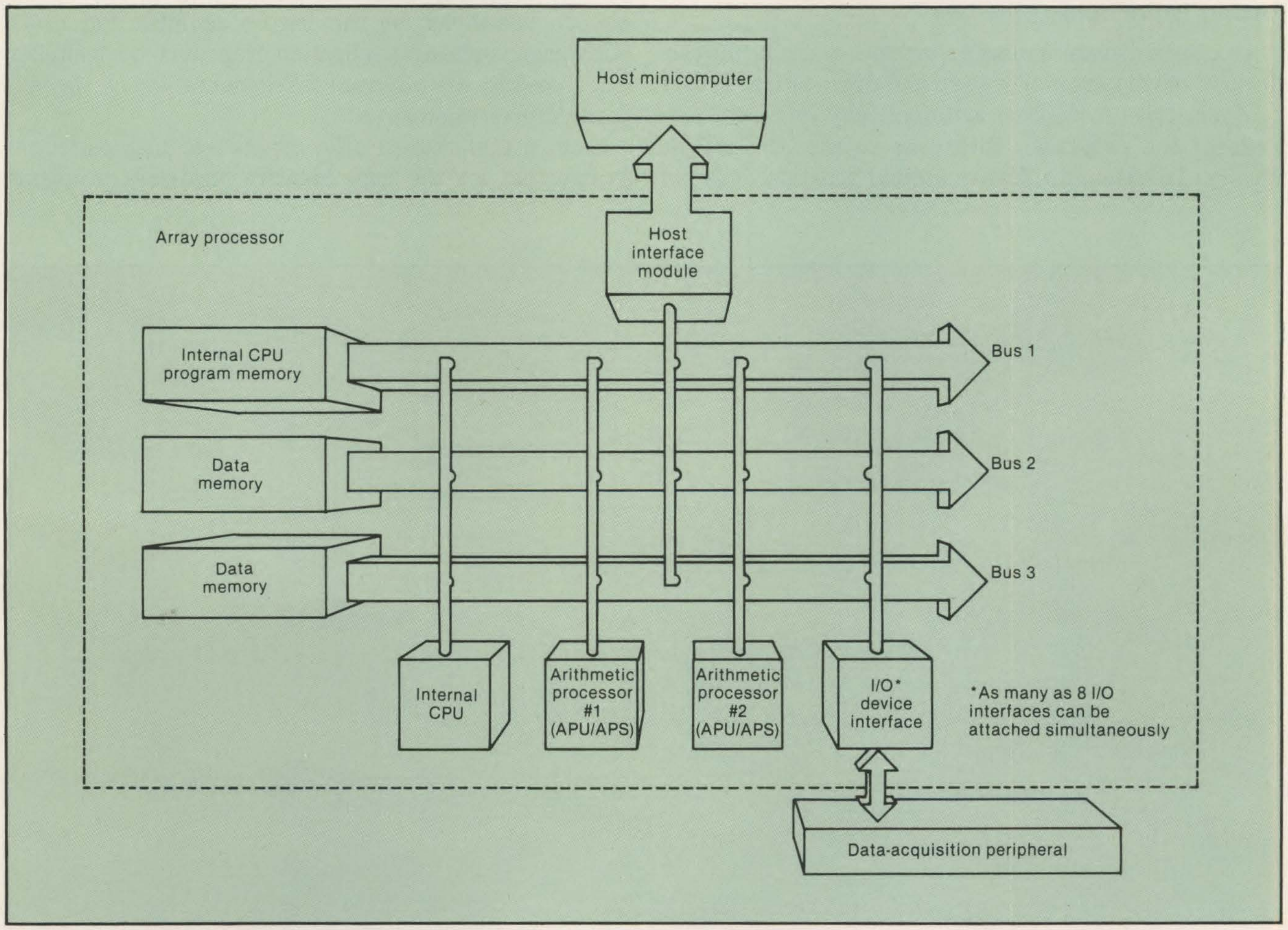

Fig. 2. CSPI's asynchronous, multiple-bus, multiprocessor array processor *contains an integral CPU, one (standard) or two (optional) arithmetic processors, a DMA host-interface module and as many as eight directly interfaced I/O devices. Programmable I/O devices interfaces can control disks, bulk memory, multi-channel A/D and D/A converters, magnetic-tape drives and direct digital-data streams. The array processor attaches to the host as does any other peripheral.*

AP function throughput is often limited by data and command transfer rates between the host computer and the AP.

tecture by adding a second complete arithmetic processor and allowing for yet another level of parallelism.

New minicomputer/asynchronous AP system configurations combine several independent APs that share a memory bus or are connected by a fast DMA interface. Because every asynchronous AP contains its own supervisory CPU and control software, multiple AP systems put little extra burden on the host.

Processing a continuous stream of data in real time poses a formidable problem for synchronous, single-bus APs, but is a natural for the multiple-bus, asynchronous architecture. Because synchronous APs use a single memory bus for processing and I/O, their peak performance falls as I/O activity increases (Fig. 6). Asynchronous multiple-bus APs can support full-speed I/O on one bus concurrently with full speed processing on another bus. Their data-driven queue structures also allow for fast concurrent I/O and processing on the same bus.

The software behind the box

AP user software generally includes a math function library, development software and diagnostics. A user typically tries to replace arithmetically intensive portions of the programs with calls to the AP function library. In cases in which a needed function does not exist, the development software is used to create it. Diagnostics allow a user to test the AP thoroughly if a malfunction is suspected.

Most vendors' math-function libraries contain hundreds of FORTRAN-callable functions ranging from the most basic vector multiply to the most complex banded equation algorithms. In addition to trigonometric, logarithmic and exponential vector/scalar functions, major vendors provide convolution, correlation, filtering and integration functions for seismic processing, speech analysis and other popular applications. Popular matrix math functions include multiply, invert, factorize and eigenvalue-eigenvector extraction. One of the most popular functions is the Fast Fourier Transform (FFT), a vector function used in all areas of signal processing and used often to measure AP performance.

Development software usually includes a cross assembler, simulator and sometimes a FORTRAN compiler for customers interested in writing specialized functions. The cross assembler assembles the AP's own assembly language. The simulator is an interactive program run on the host that simulates the execution of the AP and is used for off-line debugging of user-written programs. The compiler converts FORTRAN subroutines into AP assembly language programs that are subsequently assembled by the cross assembler. For users with large FORTRAN application programs, the compiler can expedite AP program implementation at the expense of execution speed.

Some manufacturers offer exhaustive diagnostic programs that let the user identify hardware problems

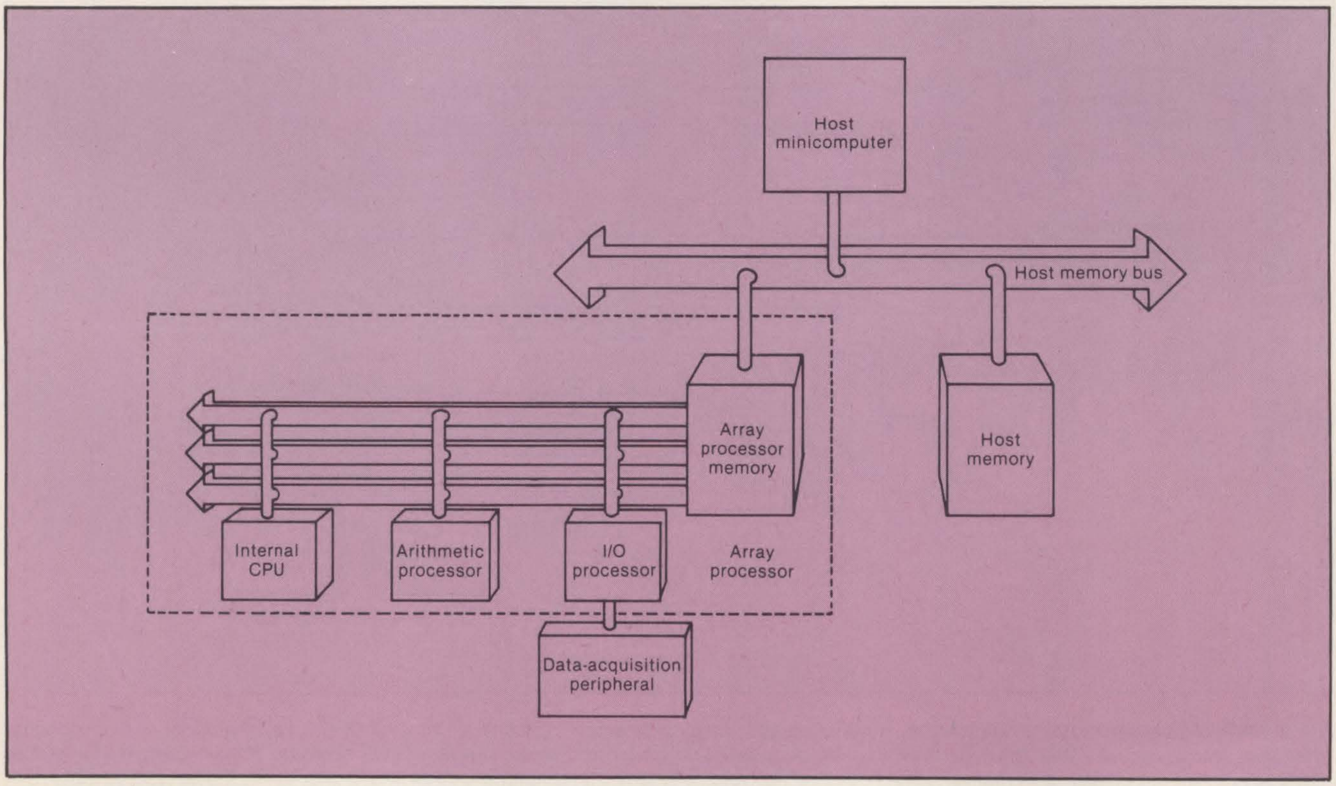

Fig. 3. A shared-memory minicomputer/array-processer system *makes the array-processor memory a part of the host's memory and boosts throughput by eliminating host-array processor data and command transfers.*

Do other diskette makers have this secret ingredient

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

$$= \sum_{j=1}^{K} \mathbf{X}_j^2 V''(\beta_j) + \sum_{\substack{i=1 \\ i \neq j}}^{K} \sum_{j=1}^{K} X_i X_j \mathbf{cov}''(\beta_i, \beta_j) + \sigma^2$$

that we don't have?

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CIRCLE NO. 92 ON INQUIRY CARD

Processing a continuous stream of data in real time poses a formidable problem for the synchronous, single-bus AP, but is a natural for the multiple-bus asynchronous architecture.

immediately. CSPI offers users the same diagnostics that are used at their factory for board-level testing. With a 5-min. run of these programs, a user can identify a defective board and swap it (overnight) for a factory- or depot-supplied replacement. AP software support is typical of small companies, but is getting more comprehensive. The large AP manufacturers provide extensive programming courses at both the assembly-language and FORTRAN levels, and offer application consulting for customers. Many manufacturers provide customized function-level and complete application-software packages.

What APs can and can't do

The specialized architectures that make APs super-efficient for number-crunching applications make them ill-suited for other problems. Business applications, for example, do not usually involve intensive arithmetic. Thus, keeping track of inventories, budgets and mailing lists is not a job for APs. Signal-processing, image-processing, speech-recognition, structural-analysis and other applications that require the dynamic range and accuracy of 32- and 64-bit floating-point arithmetic benefit from APs, as the following examples illustrate.

At Ford Motor Co. laboratories, minicomputer/AP systems analyze engine vibrations and find mechanical faults 10 times faster than previous mini-based testers. Load cells and other transducers connected to critical engine elements send signals directly to a CSPI AP via a real-time, 16-channel analog data-acquisition module. Fault detection and diagnostic information is processed and displayed in seconds. Ford has seen a dramatic improvement in the detection of low-incident engine faults and a reduction in the cost of high-integrity engine manufacturing.

Speech-recognition research programs at Bell Laboratories and at National Telegraph and Telephone in Japan also use APs. Speech-recognition systems digitize words into data matrixes (an average word can be represented by a 10-row × 100-column matrix) that are subsequently compared (in context) with word matrixes from a stored vocabulary. The systems must recognize human speech in real time, so APs perform the matrix math fast enough to keep up with the average speaker. In speech-recognition applications, minicomputer/AP systems have reduced day-long minicomputer runs to 30 min.

A recent study, using CSPI's 64-bit MAP-6400 to enhance various finite-element analysis programs, has demonstrated 10:1 overall improvements over the VAX-11/780 alone with optional floating-point accelerator. These programs are used to analyze the behavior of structures such as airplanes and bridges when they are subjected to prescribed external forces. From 70 to nearly 100 percent of computing time in these programs is spent manipulating "stiffness matrixes" that range in size from 500 × 500 to 50,000 × 50,000 points. When an engineer wants to know how a structure will react to various loads, he must solve a matrix equation involv-

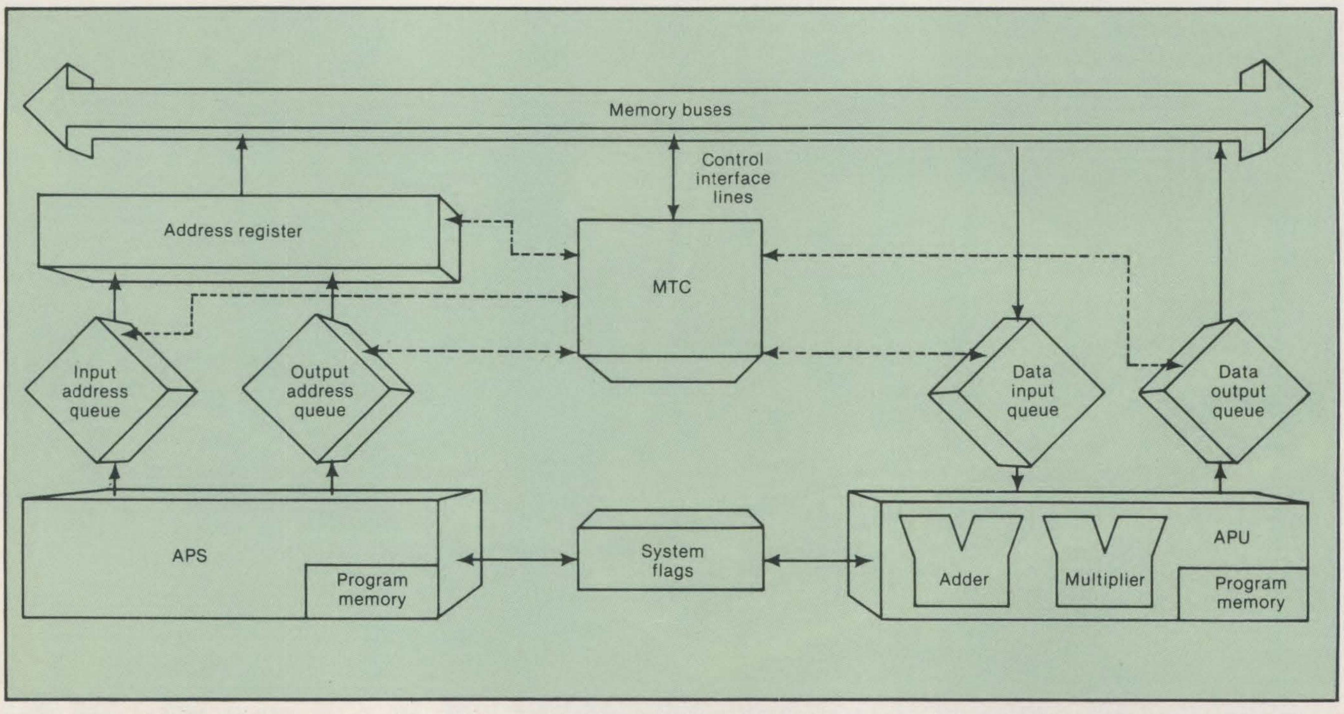


Fig. 4. The arithmetic processor in CSPI's array processsor contains three independent asynchronous processors: *the APU for arithmetic, the APS for address calculation and the MTC for monitoring the four queues and executing memory reads and writes. The data-driven queue structure provides nearly all of the necessary synchronization between the APU and APS.*

ing the stiffness matrix and the prescribed load vector. With only the matrix formulation and equation solution performed on a 64-bit array processor, as much as 90 percent of the computational time on a VAX 11/780 can be eliminated for moderate size problems (Fig. 7). The more calculation-intensive the problem, the greater the benefits an AP provides.

AP evaluation and selection

Both the internal AP architecture and the AP/minicomputer system architecture affect performance and efficiency. Several criteria are used to evaluate AP performance. The most common are MFLOPS, millions of instructions per sec. (MIPS), peak memory-access rate, standardized benchmark programs such as the Whetstone and application programs. Of these, the most appropriate measure is the application program.

MFLOPS alone can be a misleading specification. Using it to estimate vector add function-execution time on a 12-MFLOPS synchronous AP shows why. Evaluating the

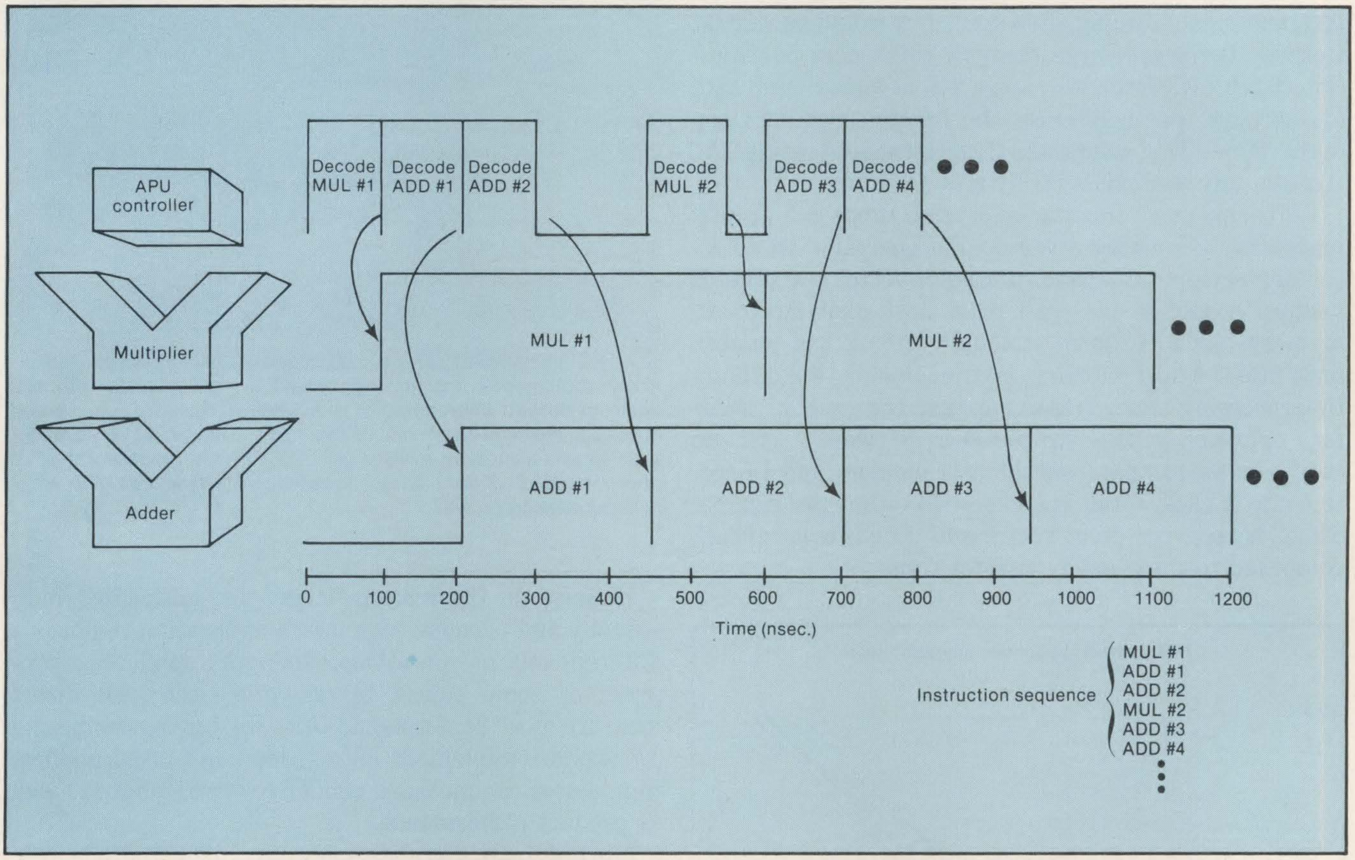


Fig. 5. Parallel operation of the APU controller, multiplier and adder in an asynchronous array processor. *Arrows indicate the APU controller dispatching multiply and add instructions to the independent, asynchronous multiplier and adder. Between times 100 and 1100, two multiplies are executed, and between times 200 and 1200, four adds are executed. This corresponds to a rate of 6 million floating point operations per sec.*

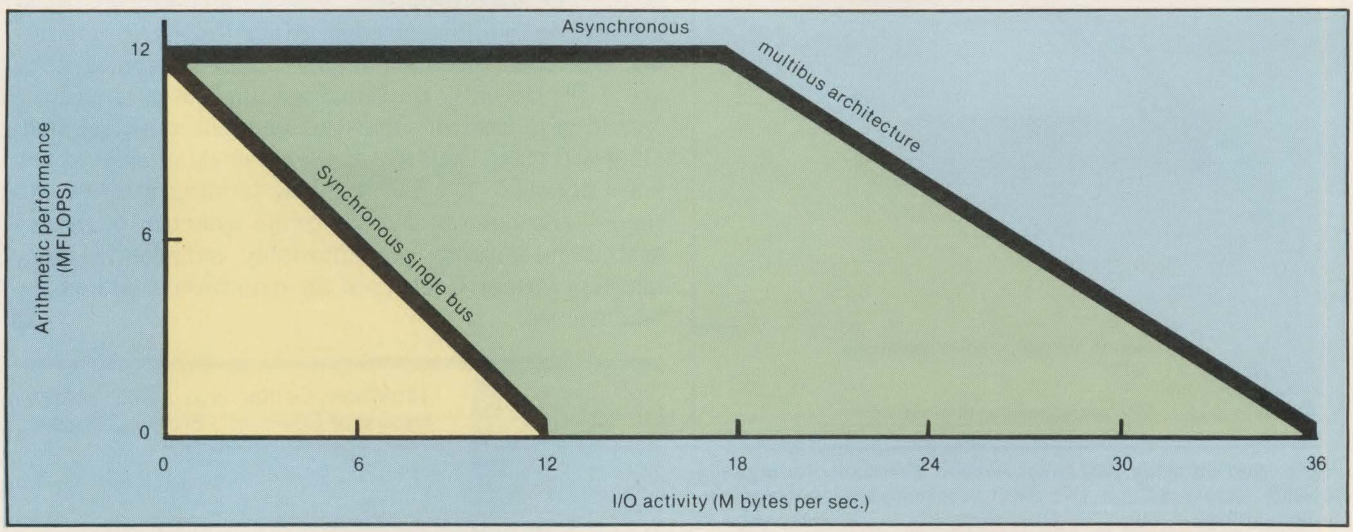
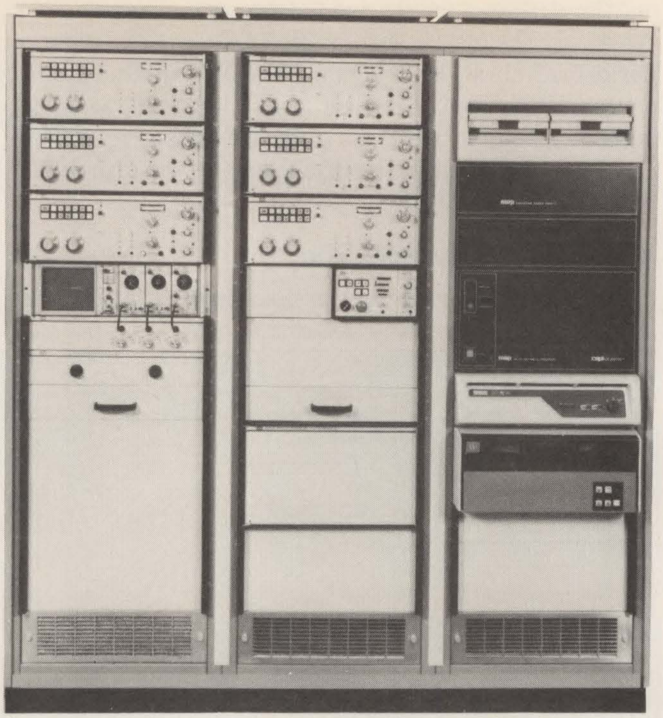


Fig. 6. Single-bus, synchronous array-processor arithmetic performance falls quickly as I/O activity increases. *Multiple-bus, asynchronous array processor can sustain full-speed processing on one bus concurrently with full-speed I/O on another bus.*

Most vendors' math-function libraries contain hundreds of FORTRAN-callable functions ranging from the most basic vector multiply to the most complex banded equation algorithms.

function (Y(i) = U (i) + V(i) where i = 1,2...,N) requires N floating-point additions. Simply dividing N by 12 MFLOPS to get a timing of 83 nsec. × N would be wrong. Because there are three memory references per addition (fetch U(i), fetch V(i), store Y(i) at a maximum rate of 167 nsec. per reference, the function requires 500 nsec. × N. The execution time estimated using the MFLOPS figure alone is off by a factor of 6.

By themselves, function-execution times can also be misleading. Consider a vector add operation on an AP that advertises a 0.5-μsec.-per-point vector add time. If vectors U and V are read from host memory to AP memory, added to form a result vector Y and written back into the host memory, I/O time dominates arithmetic-processing time. Assuming that the host/AP interface operates at 1M byte per sec., it takes 4 μsec. to read a 32-bit sample from the host memory and 4 μsec. to write it back, totaling 8 μsec. of I/O time per sample. The 0.5-μsec.-per-point vector add time is insignificant compared to the 8-μsec. transfer time.



Array processors are number-crunching peripherals that are used to boost minicomputer calculating speeds. *The "black boxes" in the right hand box of this PDP-11-based MTS vibration-analysis-and-simulation system are a CSPI array processor and its power supply. Modern array processors interface easily to most popular minicomputers.*

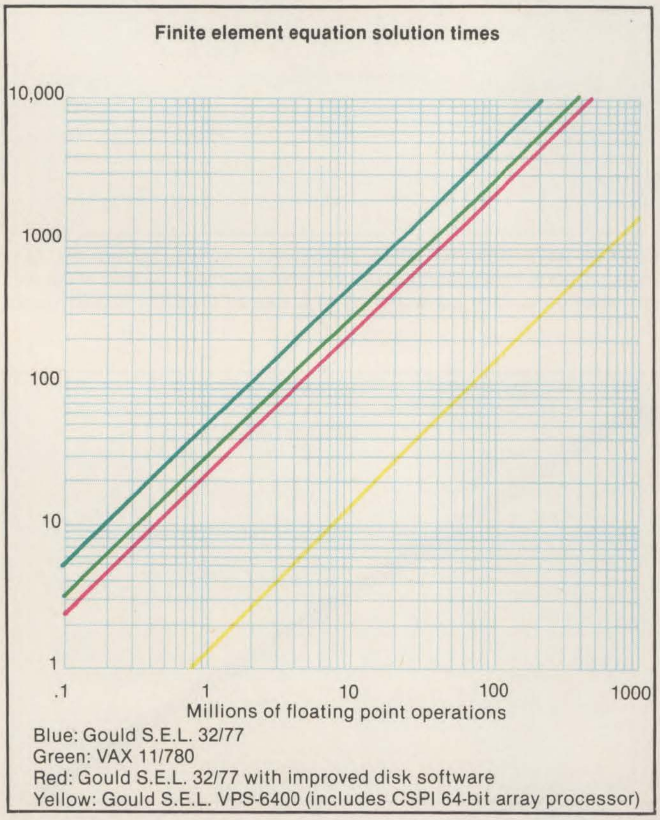
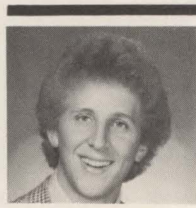


Fig. 7. Add-on array processors speed simultaneous equation solution. *Gould S.E.L.'s VPS-6400 minicomputer-array processor system (yellow) is roughly 17 times faster than a supermini alone for this application. Add-on array processors provide similar performance improvements for other number-crunching tasks.*

Because all the measurements are misleading individually and because each user's application requires a different mix of operations, timing an application program or some subset of one gives the best direct measure of AP performance. Also, by having competing AP vendors implement all or some part of an application, a user can measure vendor responsiveness as well as product performance.

Most of today's APs are sold to sophisticated scientific end users who have worked individually with vendors and together in users' groups to test minicomputer/AP systems against what were only recently considered mainframe-sized problems. Missile- and aircraft-tracking and navigation, electric utility load-flow monitoring, molecular modeling and medical X-ray tomography are a few recently implemented applications, and the spread of numerical simulation and mathematical modeling will make the AP's number-crunching ability even more desirable. By learning how to integrate APs into their minicomputer and supermini systems, OEMs and system integrators can affordably compete in many markets formerly reserved for mainframes and supermainframes. ■



Jonathan Cohler is a senior systems analyst at CSP, Inc., Billerica, Mass.

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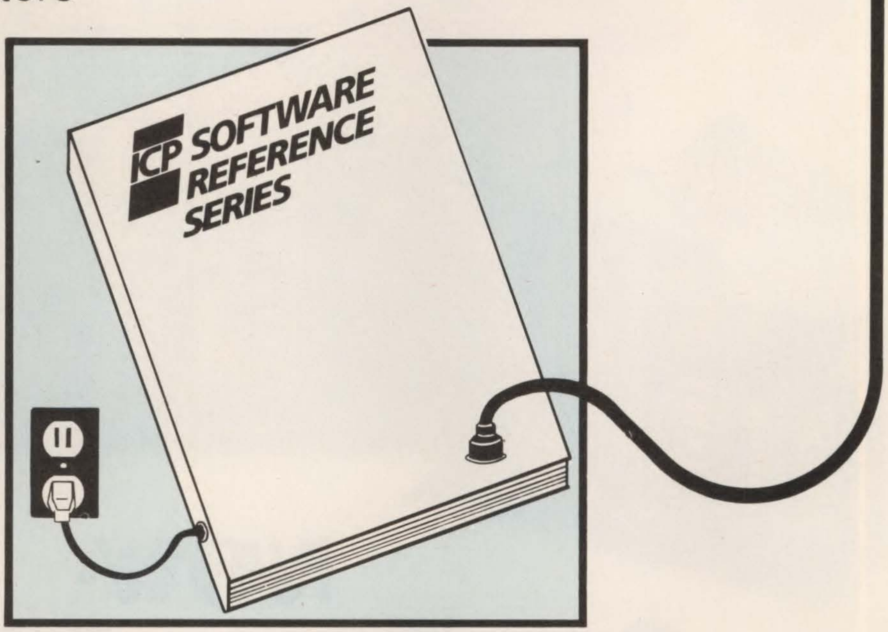

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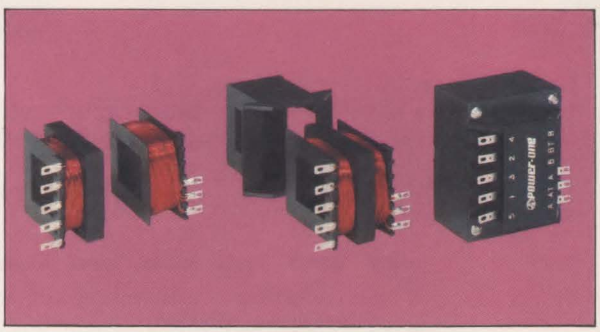

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Power-supply selection for system integrators

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Some straight advice on linear and switching supplies

A computer needs power to compute and must get that power from a power source a user can afford and on a schedule the user can tolerate. Most important, the power source must work with a system to provide the most cost-effective, reliable and efficient interface with the user's local power grid. How a user can satisfy these conflicting requirements in a way that makes sense for his product requires an understanding of power supply efficiency, size and economics.

Consider the power supply first

A power supply should be considered as a system element rather than as a minor add-on. A lamenting phrase heard over and over by every custom power-supply manufacturer is: "That odd-shaped corner of the enclosure is the only empty hunk of real estate left. Can you fit the power supply in there?" And the answer to that question is almost always: "Sure, how much do you want to spend?" This scenario is not an exaggeration, and points up the plight of many system integrators who, for various reasons, fail to consider their power source at the outset of their system design.

A power supply is a key piece of hardware that can determine to a great extent how well a system will perform, both technically and economically. Selecting the right one is just as important as selecting the right CPU or disk drive—a product's reliability depends on it.

A computer can talk to its power supply; it can also listen for problems. Most power supplies for computer systems have a margin control (usually two control lines—high or low margin), which allows the computer to run a self-check on its own logic circuits by raising or lowering the power-supply output voltages by a certain amount. ICs that have lower than normal noise margins can usually be located this way. This is not an expensive option. Some power supplies have this feature built-in, or, in the case of a custom design, the customer can request it in the beginning. Margining can be very expensive to add to a supply that was not designed for it.

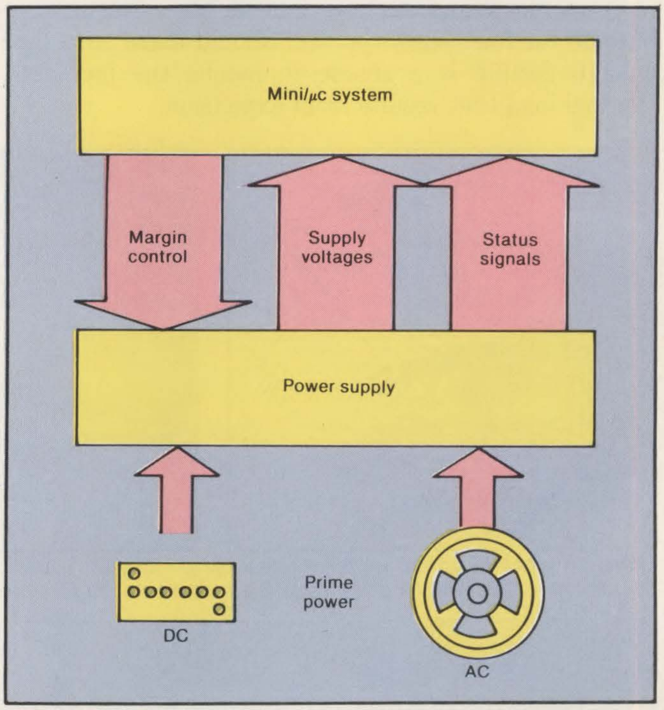


Fig. 1. Power supply/computer interface *shows how AC or DC prime power is converted to mini/μc system operating voltages while the margin control and status signals allow system/power supply communications.*

A computer listens to status signals that originate in the power supply and warn the system monitor electronics of an impending power-line failure, an out-of-tolerance output voltage, an over-temperature problem in the power supply or any other power-related problem that could affect your system's operation. The system must know what it wants to listen for, and then specify a power supply that speaks its language. A generalized system interface is shown in Fig. 1.

If the CPU or any of its peripherals require supply voltages to come up and go down in a particular sequence, this should also be specified in the beginning. Few standard (off-the-shelf) power supplies can be

A power supply is a key piece of hardware that can determine to a great extent how well a system will perform, both technically and economically.

made to sequence up or down without many expensive modifications, but sequencing can be added quite easily in a custom design.

Plan for system expansion

"Paralleling" power supplies to gain more current capacity is not easy, and should not normally be considered as a means of handling system expansion. It is usually less expensive to specify a power supply that handles a full up system from the start rather than having to change the supply, or to parallel supplies, as a system grows. This is particularly important when an end user might expand the system (such as by adding more memory) and discover that all the voltages have become too low. Also, the user should make sure that enough cooling is available to handle the increased thermal load that results from expansion.

Linear versus switching: which way to go

There are two basic kinds of power supplies. A linear, or "pass regulator," power supply (Fig. 2) has a continuous control scheme, excellent voltage regulation, low output ripple and spikes, high reliability and low price. However, they have several disadvantages, including large size and weight, inefficiency and poor holdup times.

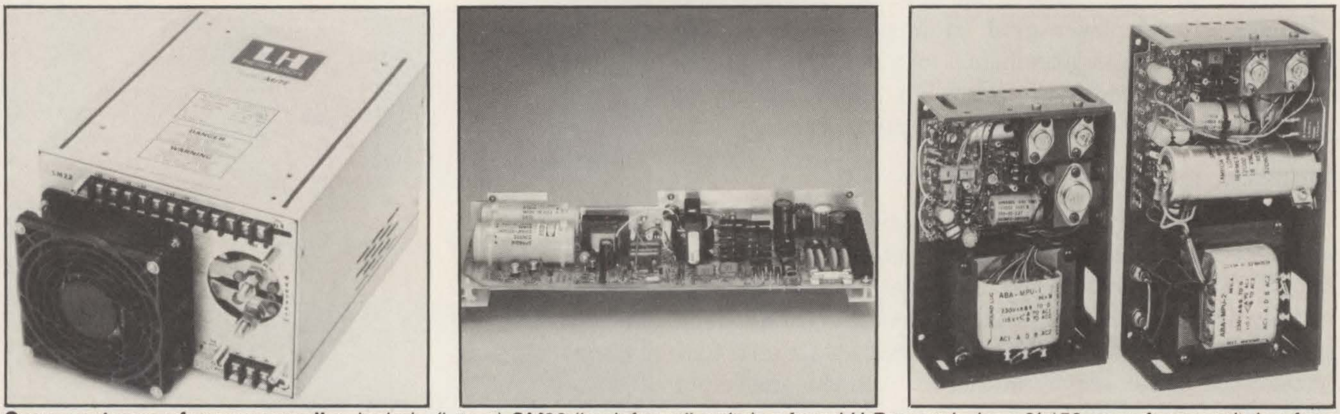
Switching power supplies (Fig. 3) offer the converse

POWER SUPPLY TRADE-OFFS

In this table, 3 is for the best and 1 is for the worst.

	Switcher	Linear
Size	3	1
Weight	3	1
Efficiency	3	1
Reliability	2	3
Cost	2	3
Ease of repair	1	2

Picking the best power supply is a game of trade-offs. *If you agree with the author's evaluations, and value each performance category equally, a switcher would be the appropriate power supply.*



Common types of power supplies *include (l. to r.) SM23 "mainframe" switcher from LH Research, Inc.; 0L150 open-frame switcher from Boschert, Inc.; and MPV-2 open-frame linear from Lambda Electronics, Inc.*

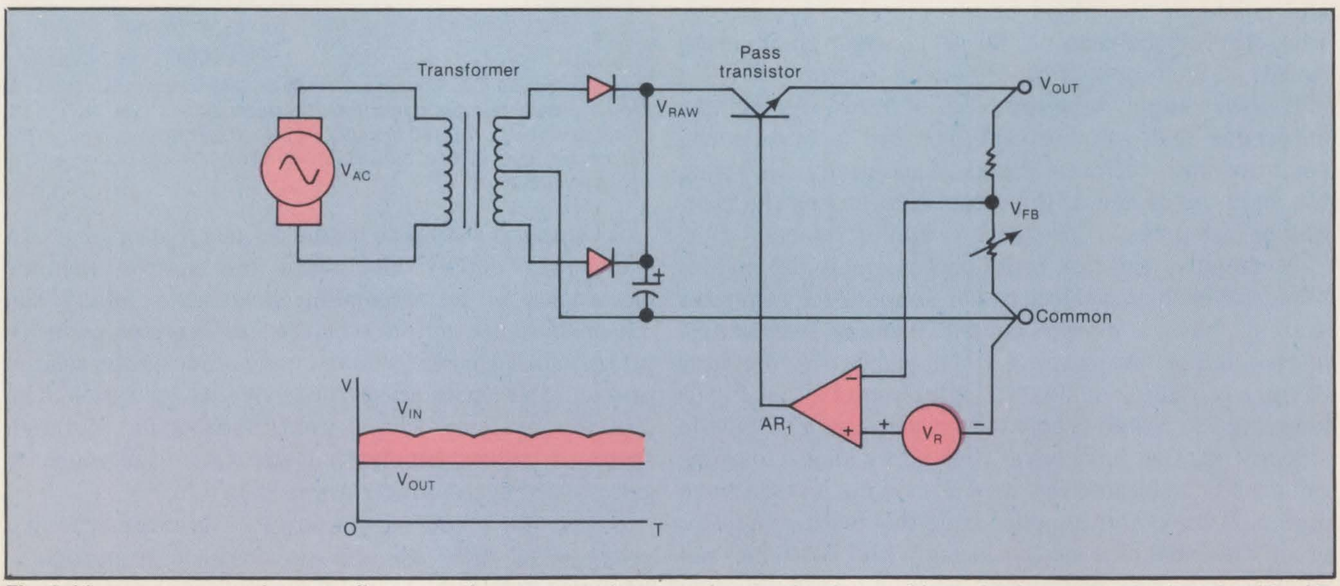
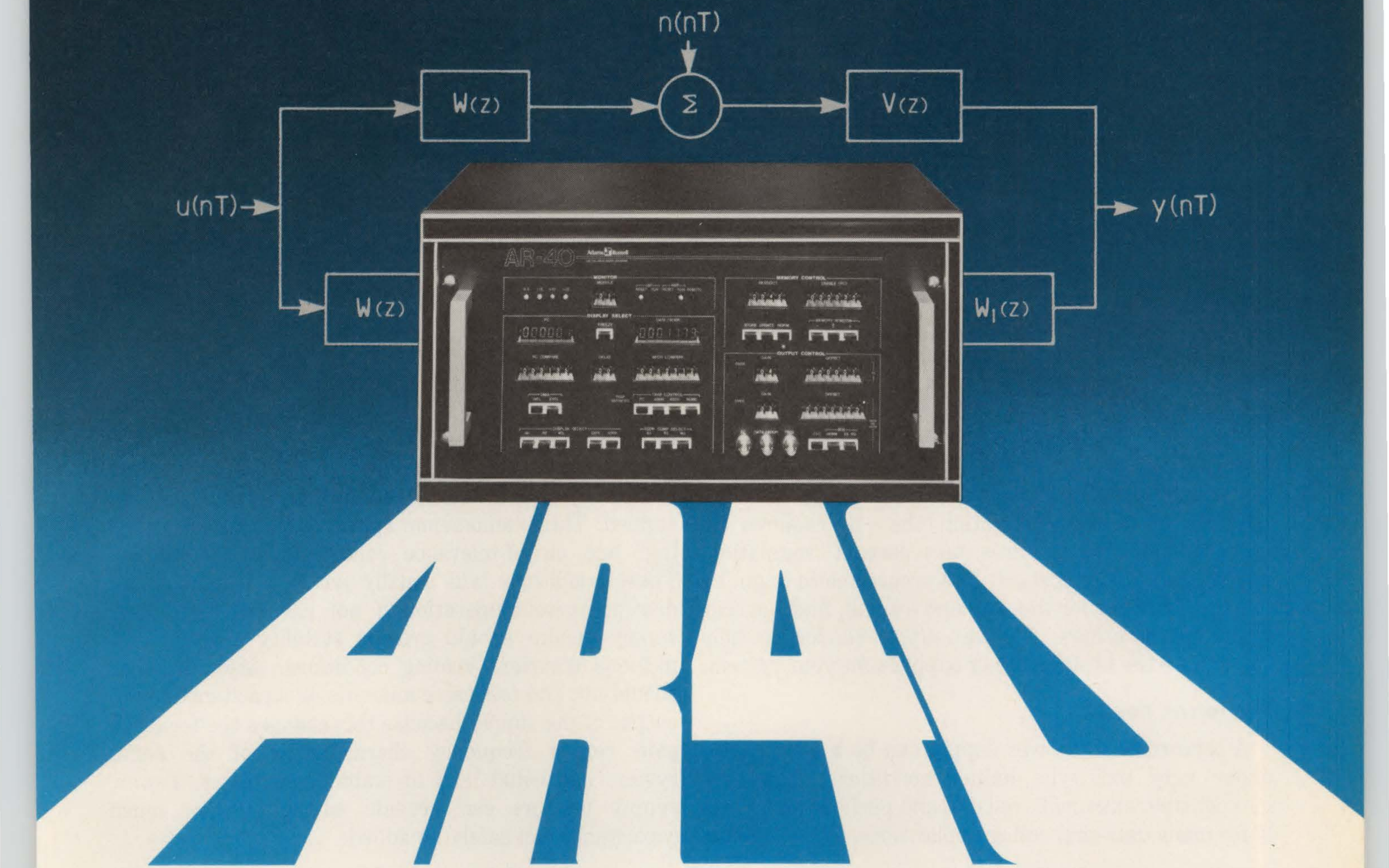


Fig. 2. Linear power supply uses a linear, continuous control system. *In operation, it resembles a simple servomechanism. Amplifier AR_1 assures that $V_{fb} = V_r$.*

Making the Complex Simple.



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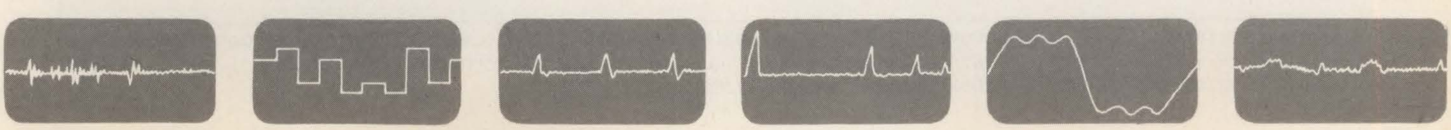

CIRCLE NO. 95 ON INQUIRY CARD

'Paralleling' power supplies to gain more current capacity is not easy, and should not normally be considered as a means of handling system expansion.

of the advantages and disadvantages of linear supplies with the exception of regulation. Both linear and switching supplies can achieve the same degree of regulation. Power-supply technology is rapidly closing the price and reliability gaps while maintaining size, weight, efficiency and holdup advantages. The future trend is toward switching supplies, but linears will maintain certain well-defined niches for many years to come. A system integrator interested in current and future price/performance ratios might choose one or both technologies when specifying a power source. For example, suppose a system requires +5V at 50A, −5V at 1A and ±15V at 0.5A. Further, suppose the +5V requires ±1 percent regulation, the −5V requires ±1 percent, the ±15V requires ±0.1 percent regulation, and efficiency is important. The proper choice might be to use a switcher for the +5V and a small, multi-output linear for the others. A power-supply vendor can help you choose the best supply or supplies for your system.

Are ferros dead?

A ferroresonant power supply can be a good choice under very narrowly defined conditions. They are inexpensive, extremely reliable and perform adequately for many data-processing applications. They combine several characteristics of linears and switchers; they are large, heavy, relatively inexpensive and efficient. Ferros do have one confounding disadvantage, though. They are extremely sensitive to power-line frequency. Therefore, a unit designed to operate at 60 Hz will not operate at 50 Hz. This is a concern if a product is intended to be sold overseas.

Battery backup is not difficult if a user plans ahead. If a user wants a system to work through brownouts, or at least save its data until usable line voltage returns, a power supply can operate with AC or DC as prime power—if a user has planned for it. Planning is the key to buying the right power source.

System considerations

Transient loads pose special problems. A power supply is essentially a servo system and, as such, can become unstable unless properly designed. Even if the supply is stable at constant load current, it can become marginally stable when rapidly changing loads are applied. This phenomenon appears as excessive "ringing" and out-of-tolerance conditions at the output. These conditions will usually not last long, but can disrupt system operation if not checked. A power-supply vendor should provide stability analysis that includes transient loading conditions. Also, the user should not add excessive amounts of capacitance to the output of the supply because this changes the feedback gain versus frequency characteristic of the servo system and could lead to stability problems. Power-supply vendors can provide advice on how much capacitance can safely be added.

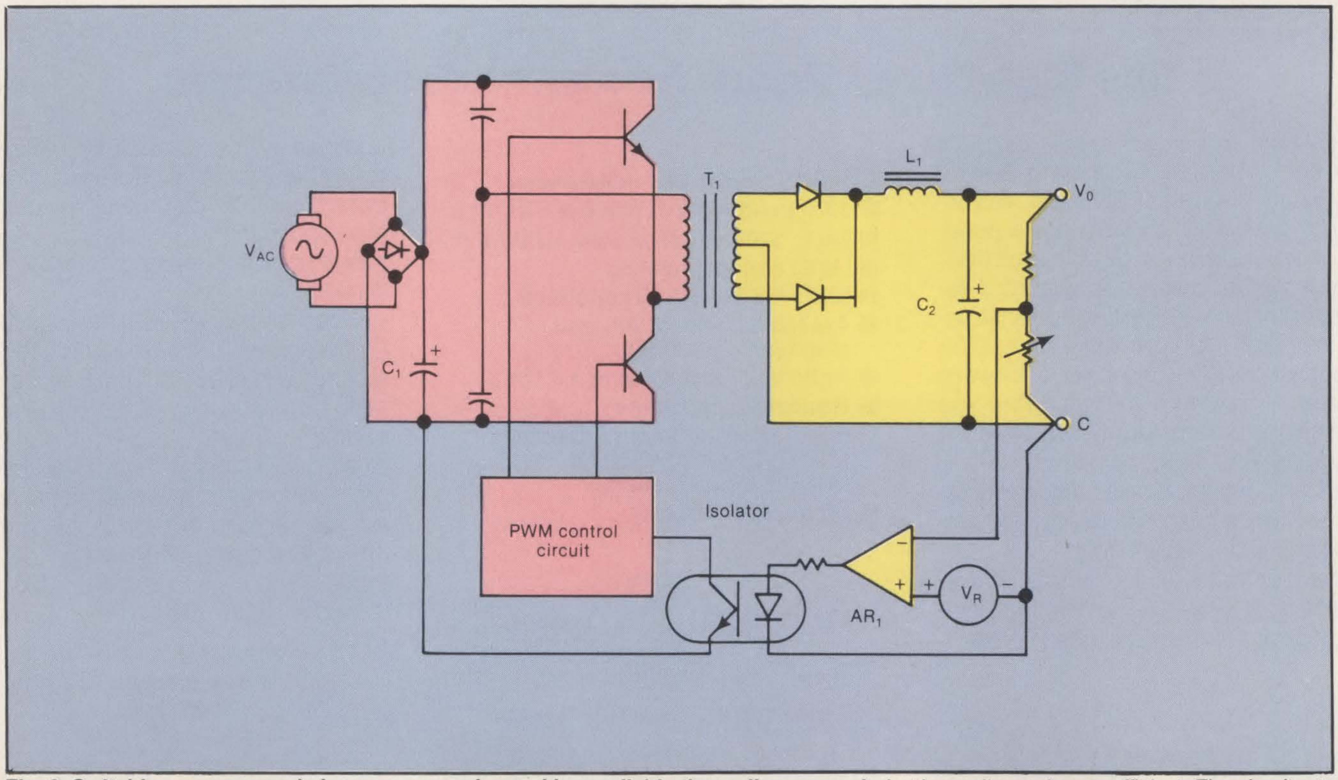

Fig. 3. Switching power supply is more expensive and less reliable than a linear supply *but is smaller and more efficient. The circuitry to the left of T_1 forms a high-frequency oscillator whose pulse-width is modulated by the PWM controller. To the right of T_1, L_1 and C_2 integrate these pulses to produce a smooth DC output voltage. Again, AR_1 is the servo amplifier.*

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A linear, or 'pass regulator,' power supply has a continuous control scheme, excellent voltage regulation, low output ripple and spikes, high reliability and low price.

If a user wants his computer to work without skipping a beat, battery backup is needed. Most minis can ignore blackouts and continue working for hours on batteries of modest size and cost.

The next best level of power-failure protection is holdup protection. Power supplies capable of useful holdup times can notify the computer that a power loss has occurred, and they continue to supply output power long enough for the system to organize its affairs and die gracefully. That way, a system goes down but can be resurrected with memory intact once power returns. Holdup (of sufficient duration to be useful) is the special province of the switcher because holdup energy is stored in the power supply's input capacitor and follows the equation:

$$E = \tfrac{1}{2}CV^2 \text{ (Joules)}$$

Energy increases with capacitance and with the square of the voltage. Computing the C necessary to store 10 Joules if V is 300V (switcher) yields quite a different result from that produced if V is 8V (linear). A linear power supply would require an enormous, expensive storage capacitor to match the holdup time of a switcher.

On-card regulation can be cost-effective by saving power-supply dollars. A user should consider placing small IC regulators at certain points in a system where voltage tolerances are important, or where an opposite polarity voltage is required. For instance, if only one card in a system requires ±15V and the rest require only +5V, it may be cost effective to make ±15V from the +5V already available. This can be done inexpensively with any switching regulator ICs available.

Remote sensing can improve logic noise tolerances. Consider the following scenario: A user has a long distribution bus for a +5V logic power. He measures the end of the bus next to the power supply and reads 5V. He then measures the far end of the bus and reads 4.2V. This is caused by IR drop, which means that the effective noise tolerance of the logic ICs at the far end of the bus is greatly reduced. This can be solved using remote sensing (Fig. 4). A power supply's servo amplifier regulates the supply's output at whatever point the user chooses to connect input leads. If the amplifier's "sense" leads are connected to the midpoint of the power bus rather than the power supply's output terminals, the bus voltages will now read between about 5.4V at the near end to 4.6V at the far end. All ICs now have sufficient noise tolerance.

Economics: the make-or-buy decision

If a user finds a good power-supply vendor, he should stick with him because the user will save much more in the long run than he would realize by hopping from one vendor to another. This is especially true in the customer power-supply business in which an engineer who designs a supply must know almost as much about

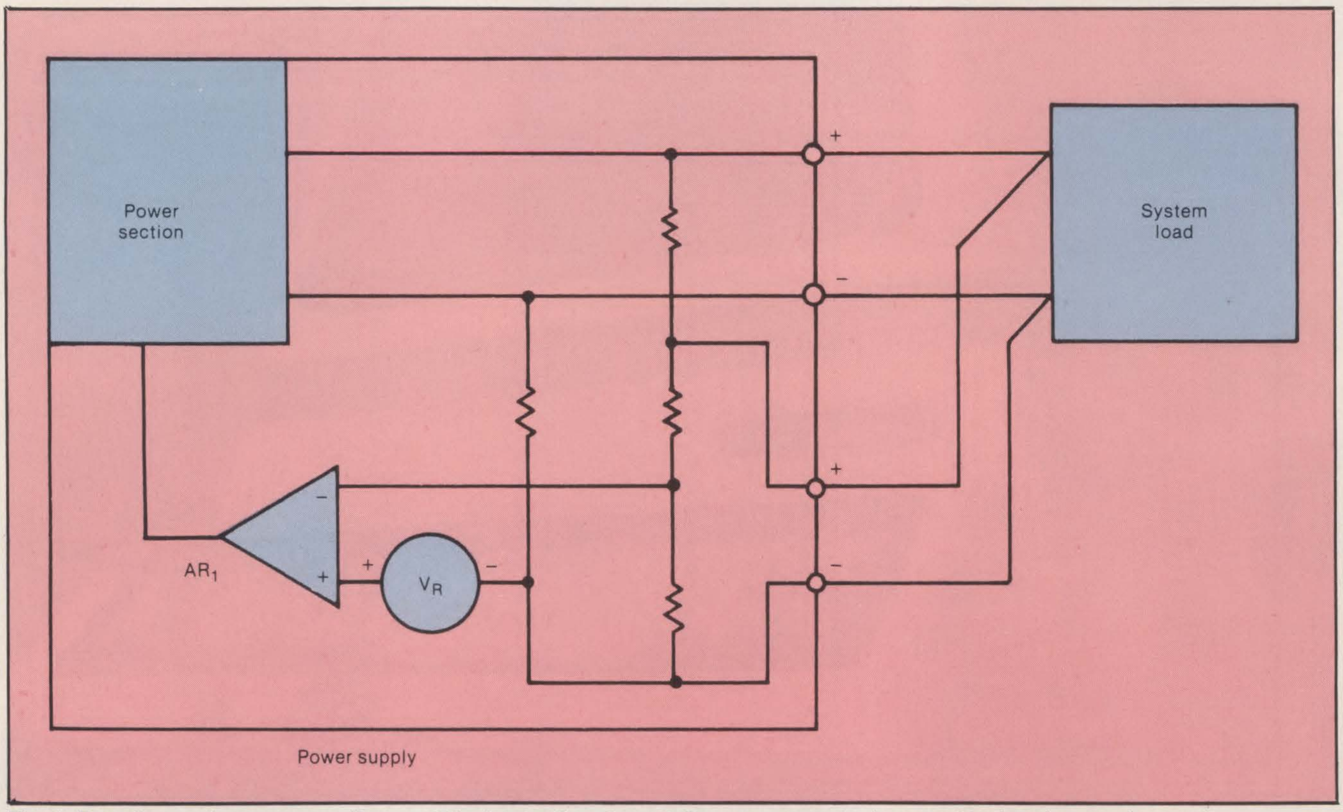
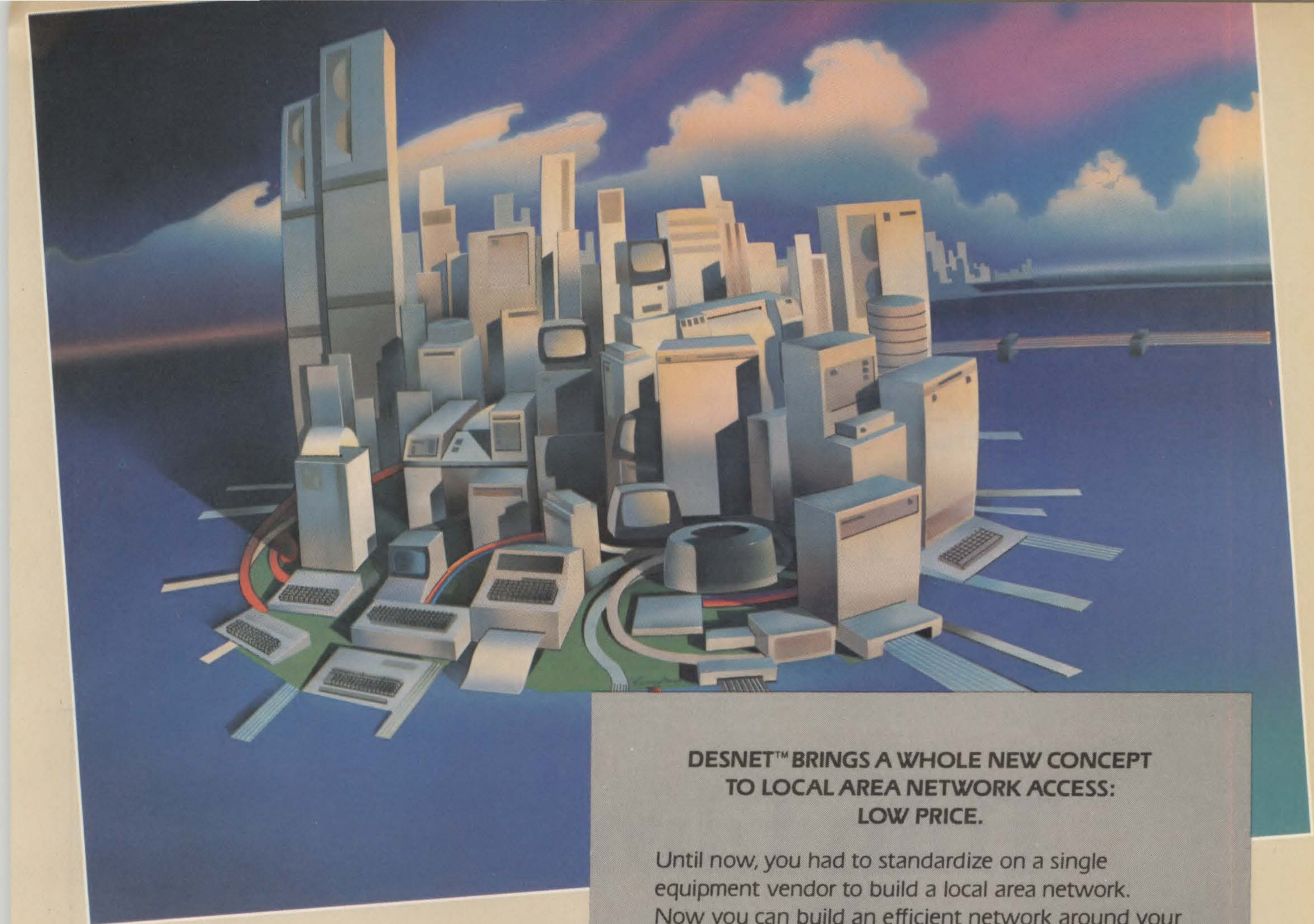


Fig. 4. Remote sensing senses voltages at the load rather than at the power supply. *Improved logic noise margins result.*



A power supply's servo amplifier regulates the supply's output at whatever point the user chooses to connect its input leads.

a customer's system as a customer does. It's expensive to repeat that learning process with each new power supply.

A user thinking about making his own power supplies should consider the total economic impact. First, does he want to be in the power-supply business, and does he want to commit the necessary economic resources to be in that business? Power-supply engineers and technicians are expensive and difficult to find. Second, does the schedule control achieved by making his own power supplies counterbalance all the other economic factors? Engineering is not a profit center; it produces no revenue, but is a cost.

A user should not buy a customized power supply if a standard one will do. Company Y, which makes an off-the-shelf power supply that fits a customer's needs, has already recovered design costs from many other customers. Also, market forces keep Company Y's sale price very near the competition's price. But suppose someone buys Company Y's entire stock of a customer's power supply. Now the customer must wait for more to be built. In the meantime, the customer has fixed expenses and no revenue (he can't ship his system without a power supply).

Buying a custom power supply is a third choice. It has many advantages, but is more expensive up front and should be analyzed carefully. A custom house computes the sale price of a power supply based on material, overhead, expected profit, quantity ordered and delivery schedule. Costs of buying custom power supplies are recurring and nonrecurring. The recurring cost is inherent in every unit purchased because it represents the labor and material input. The nonrecurring cost attaches to the entire program and represents the custom house's design and development costs. On a per-unit basis, nonrecurring costs decrease as the number of units manufactured increases. So custom designs favor large production runs. On the down side, the customer is stuck with one source ■

POWER SUPPLY EFFICIENCY CALCULATION

The efficiency of a power supply is the ratio of output power to input power, where both are expressed in watts (P). What results is a dimensionless number that can be expressed as a decimal fraction or a percentage. The lower-case Greek letter eta (η) is customarily used to represent this ratio.

$\eta = P_{out}/P_{in}$

$\eta\ (\%) = (P_{out}/P_{in}) \times 100$

For example:

$P_{out} = 75W$, $P_{in} = 100W$

$\eta = 0.75$ or 75%

This number helps estimate power use and costs and tells, among other things, how much power supply-related heat a system must deal with.

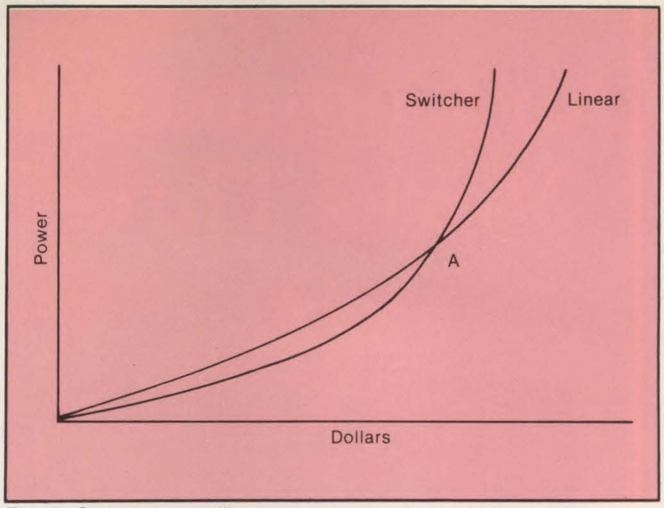


Fig. 5. Switcher and linear power supply costs vary with power output. *Until point A, a linear supply is probably less expensive than a switcher. After point A, higher material costs and labor content make linears less attractive. Point A is usually found around 1000W to 3000W. These curves assume a least-cost application of each technology.*

Phillip Thibodeau is chief engineer for electronic products at Babcock Electro-Mechanical, a subsidiary of Electro-Module, Inc., Anaheim, Calif.

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POWER PROTECTION

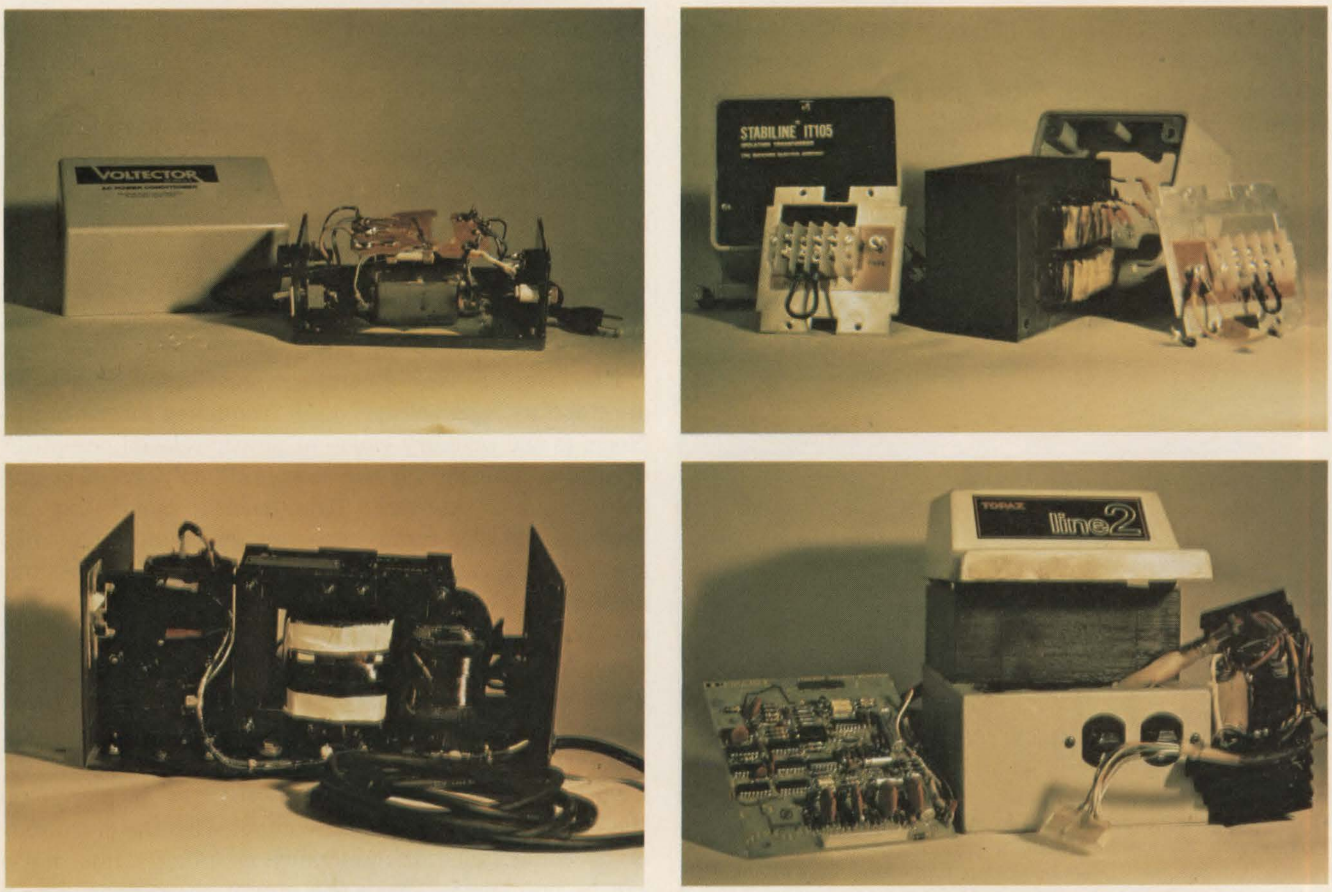
Evaluating power-protection equipment

WILLIAM LUCARZ, Sola Electric

Published specifications aren't always enough

The tremendous increase in minicomputer and μc operating speeds has been accompanied by a proportionate increase in sensitivity to power-line disruptions. A vast array of portable power-protection equipment has been developed to guard these advanced electronics systems from power-line irregularities.

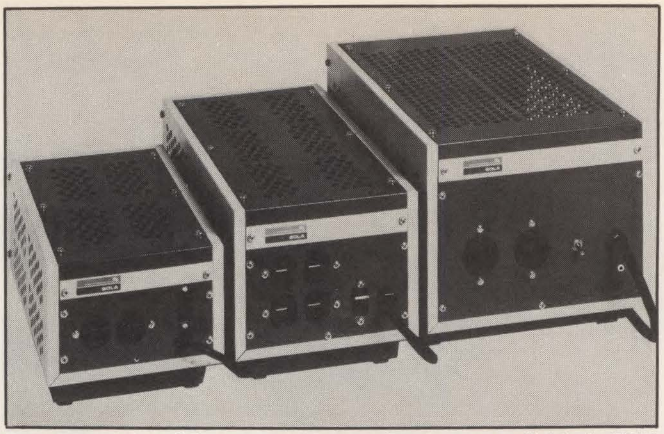
Choosing from this broad assortment of line-conditioning equipment is hampered, not helped, by performance-specification methods. The problem is not that manufacturers' specifications are inaccurate, but that their different standards and test procedures generate different results. The lack of uniform perfor-



Modern power conditioners are very compact. *Clockwise from top left, these units from Pilgrim, Superior Electric, Topaz and Frequency Technology provide multifunction power conditioning and are each smaller than a breadbox.*

Noise is the primary cause of power-related computer errors, accounting for 65 percent of line disturbances.

mance standards means that specs are often incompatible from one brand to another, and meaningful comparisons between equipment are difficult or impossible. Nevertheless, significant differences exist between various types of power-protection equipment, and the cost of minicomputer and μc downtime and replacement parts makes power protection more important than ever. By understanding the most common power problems and the specifications that measure how well conditioners solve them, minicomputer users and system integrators can learn how to protect their systems best.



Sola Electric's minicomputer/μc regulators are available in 70W to 7500W versions. *Prices vary from $150 to $2268, but all models provide multifunction ferroresonant power regulation.*

Common power-line problems

Most power problems affecting a computer are problems of fluctuating voltage. Voltage variations are basically classed by source, severity and duration. Common voltage variations include:

Blackouts—total power outage. Most outages are corrected in less than 6 sec. However, even a split-second outage is enough to affect computer performance drastically. Blackouts can cause a complete loss of computer memory and severely stress hardware components, especially if power is permitted to surge back automatically. Fortunately, blackouts account for only about 5 percent of the power problems experienced in most regions of the U.S..

Brownouts—5- to 15-percent voltage reductions lasting from a few hours to a few days. A brownout often is a corrective step that utility companies take when power demand exceeds generating capacity. Rather than completely cutting power supplied to one area of its grid, the utility reduces voltage to all customers on an equal basis. Because most electronic equipment is designed with only a ±10-percent tolerance to voltage variations, even a moderate brownout brings voltage levels dangerously close to system tolerance limits, so that other power problems will have even greater effect.

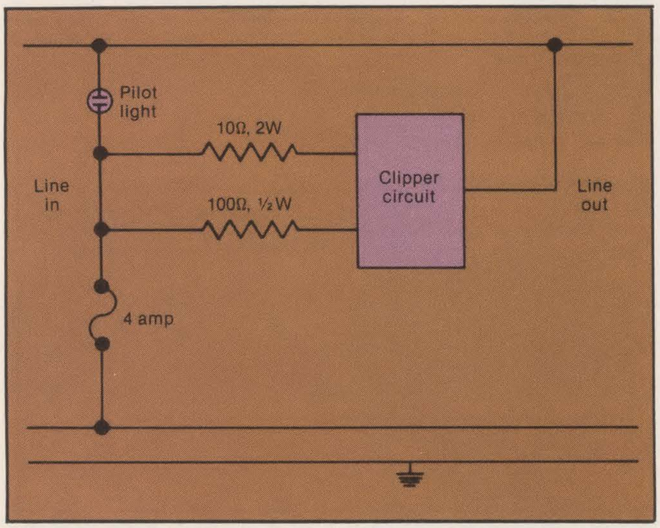


Fig. 1. Surge suppressor from R&K Enterprises is a simple and inexpensive device *that uses a clipper circuit to limit voltage transients or surges. It offers no voltage regulation, noise attenuation, short-circuit protection or isolation between input and output. Alone, it cannot reliably protect μp circuits. Source: Sola Electric.*

Voltage transients—high-speed voltage spikes and faults and longer surges and dips. These occur routinely on a power line when electrical equipment is turned on or off and account for 20 percent of all power-line disturbances. The magnitude and duration of voltage transients depend on the type and size of equipment the line serves. Any motor-driven device, from electric hair dryers to industrial cranes, causes a brief voltage fault on startup and a corresponding surge in voltage on shutdown. High-voltage devices such as medical X-ray machines have a similar effect on the line. Utility network switching, capacitor discharge and lightning are other common sources of line transients. Transient spikes can cause voltage to exceed normal levels by 10 times or more. Lightning powerful enough to burn electronic hardware can place spikes on the line.

Electrical noise—a complex phenomenon, best understood as high-voltage, high-frequency interference. Noise is the primary cause of power-related computer errors, accounting for the remaining 65 percent of line disturbances. At radio frequencies, noise can be broadcast just as radio waves are. Computer housings are normally shielded to block this inteference, but unshielded power cables can act like receiving antennas, passing this radio frequency interference (RFI) into the system. Typical RFI sources include radar, microwave equipment, broadcast transmitters, induction heating, medical equipment, lightning and solar flares.

Another type of noise occurs at lower frequencies. Electromagnetic interference (EMI) can be placed on the line by sources in direct contact with the conductor or by capacitance or inductance coupling. Thus, noise can be transferred from one circuit to another simply because the two conductors are close to each other. EMI

Power-line irregularities cause problems in digital electronics because they create false electrical pulses that look like data or instructions.

is caused by the operation of mechanical switches and relays and by basic electronic switches such as SCRs and Triacs. In addition to absorbing noise from external sources, a computer generates noise internally during operation.

Two kinds of electrical noise include common-mode noise, which is measured as a voltage potential between one line and ground, and transverse-mode noise, which appears as a potential between one line and the other line. Both types must be attenuated because either can regenerate the other within a system.

Effects of power-line variations

Power-line irregularities cause problems in digital electronics because they create false electrical pulses that look like data or instructions. Responding to such false operating signals, components can turn on and off when they shouldn't, timing circuitry can be affected, and programs can execute improperly. Data transmissions between processors and peripherals are especially vulnerable to voltage variations on the power line.

Power problems can alter a computer's memory contents in addition to affecting component operation. Volatile memories that require "refreshing" are particularly susceptible. If a transient voltage alters the timing of a system's refresh cycle or causes even one refresh pulse to be missed, an entire memory block can be erased.

Different kinds of computer equipment display different degrees of sensitivity to power-line problems. Semiconductor memories and processors are vulnerable to high-speed voltage transients. Magnetic disk drives, on the other hand, are most susceptible to longer term surges and sags. Disk drives are also particularly sensitive to changes in line frequency. Thus, line conditions that offer protection only from certain kinds of power disruptions are not suited for use with data-processing systems.

As the operating speeds of minicomputers and μcs increase, their tolerance to voltage variations gets correspondingly smaller. As hardware speed increases, more program operations are compressed into a given amount of time, and more circuit functions become vulnerable to power glitches of a given duration. A 20-msec. drop in voltage that would probably go unnoticed in an older and slower computer could very easily cause processing malfunctions in a modern, high-speed system.

Power-protection alternatives

Power-protection devices offer a wide range of performance benefits in a narrow range of prices (Table 1). To make an intelligent selection from this group, a

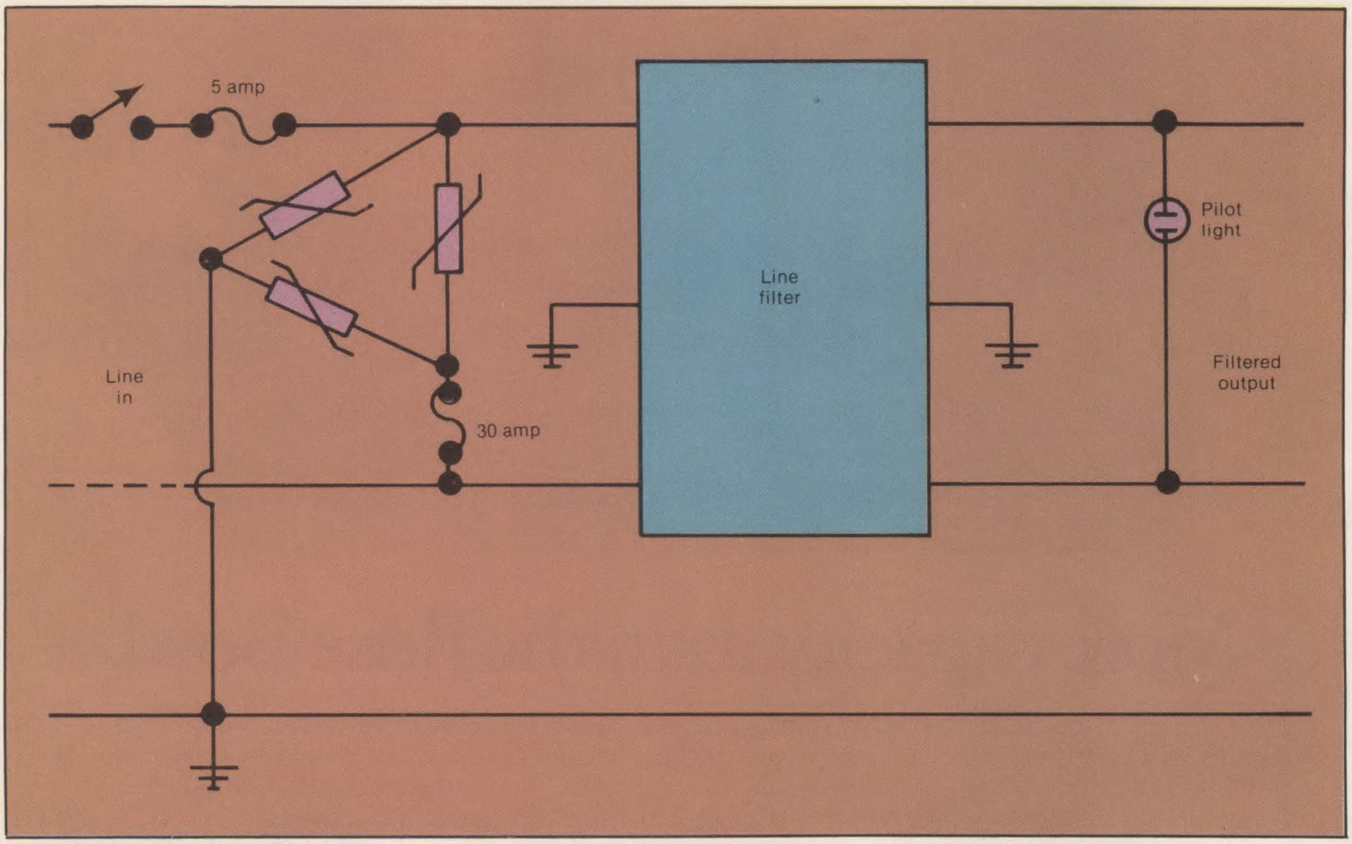
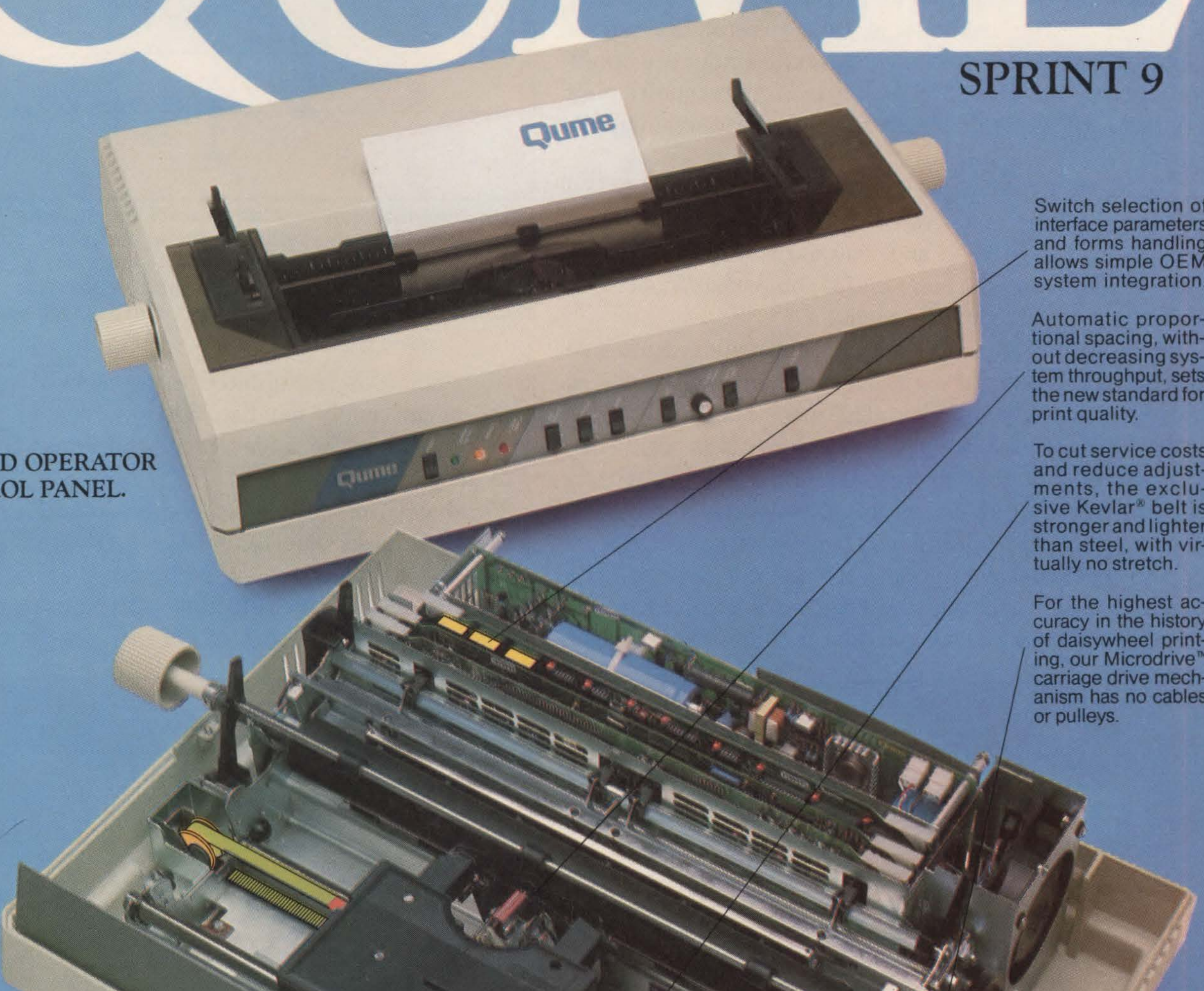


Fig. 2. Passive filter from Pilgrim Electric Co. offers good noise attenuation for frequencies higher than 10 KHz. *Low noise rejection in the low-frequency range and the absence of voltage regulation, surge suppression and isolation limit its computer-related power-protection applications. Source: Sola Electric.*

QUME

SPRINT 9



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Line conditioners that offer protection only from certain kinds of power disruptions are not suited for use with data-processing systems.

user must match the tolerances of his electronic equipment to the features of a power-protection device.

If total protection from all power problems including blackouts is required, some type of standby power source is necessary. Because blackouts amount to only 5 percent of all power problems, a line-conditioning device is sufficient for most computer-protection applications.

The major types of line-conditioning described in the following paragraphs were tested under controlled laboratory conditions, and standard test procedures were followed so that meaningful comparisons between equipment types could be made.

Surge suppressors are simple, relatively inexpensive devices designed to clip overvoltage transients or surges in the incoming line. The block diagram (Fig. 1) of R&K Enterprises Surge Sentry shows that the device is essentially a fuse-protected clipper circuit with a pilot light to indicate operation. A surge suppressor does not furnish a significant degree of power protection to µp-based equipment. It does not offer voltage regulation and isolation between input and output. It does not attenuate noise and does not offer short-circuit protection. It is also limited in the size of a transient spike it can safely handle. When subjected to a 500V peak-to-peak spike under test conditions, this device was destroyed.

Passive filters are also simple devices. A passive filter suppresses or attenuates electrical noise. Fig. 2 shows the main elements of a Pilgrim Electric Voltector Series 5 filter. A rejection filter provides noise attenuation over a band of frequencies to which the

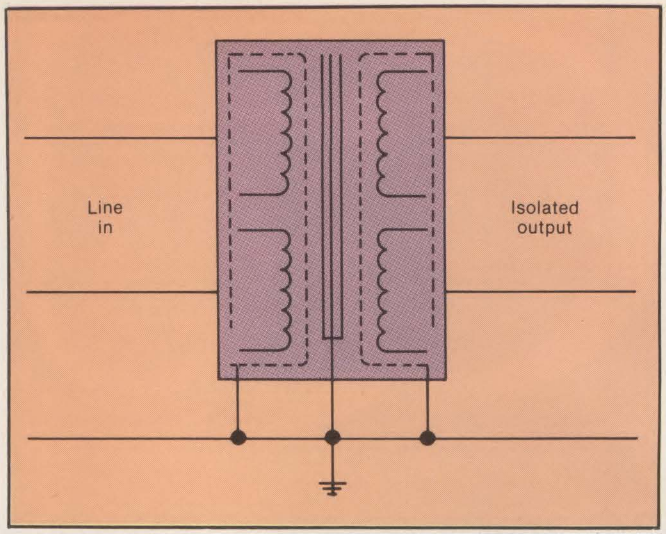

Fig. 3. Ultra-isolation transformer from The Superior Electric Co. suppresses common-mode electrical noise *by grounding its transformer core and by shielding the transformer's primary and secondary windings. The ultra-isolation does little to combat transverse-mode (inter-line) noise and does not regulate voltage.*

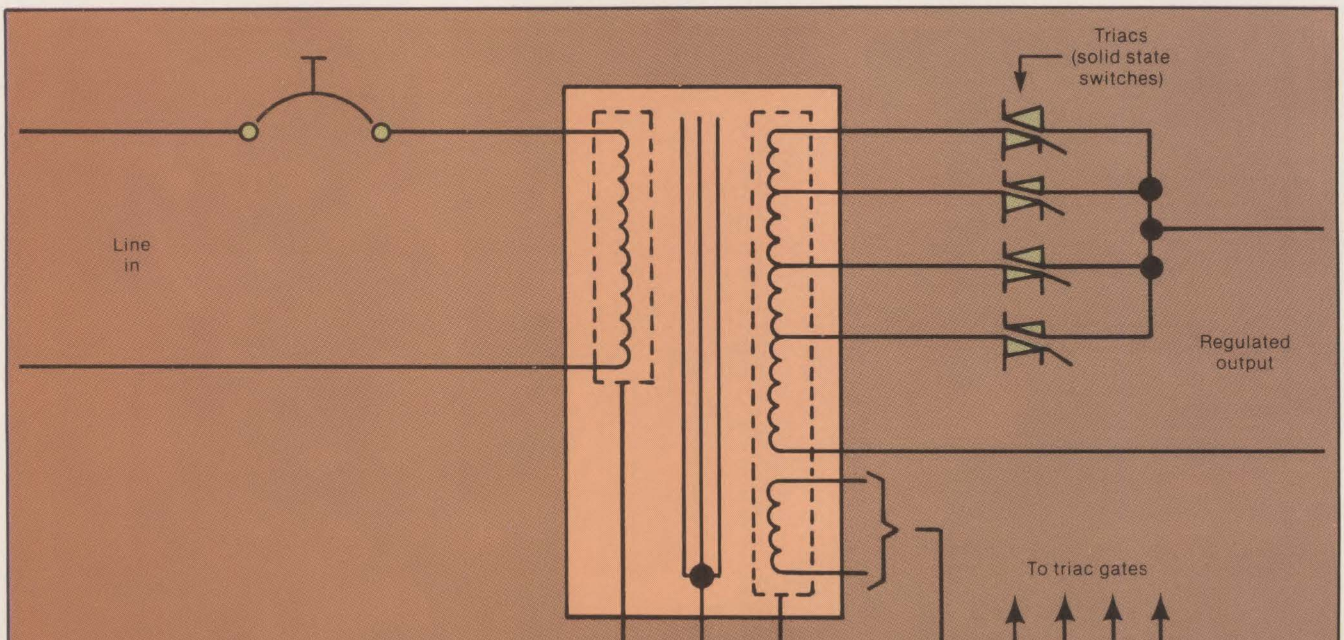

Fig. 4. Electronic tap changer from Topaz is a "comprehensive" line conditioner *combining voltage regulation and noise attenuation. An isolation transformer suppresses noise, while a Triac series taps the transformer's secondary to compensate for input voltage fluctuations. Voltage is regulated incrementally as taps are switched.*


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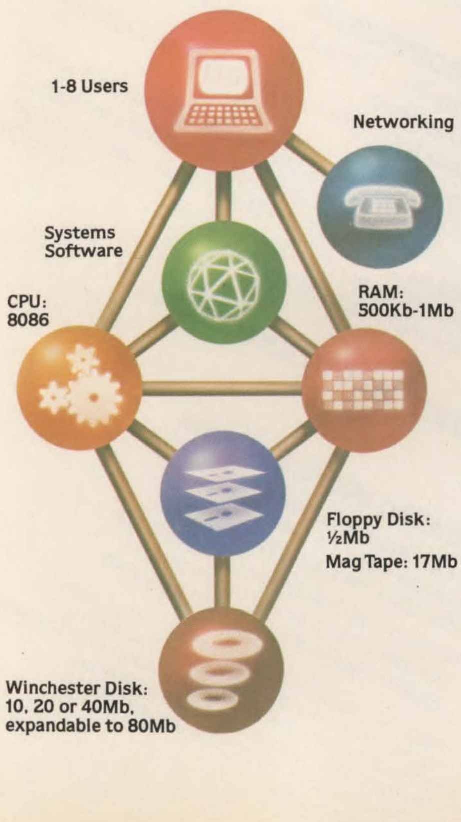

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Noise frequency, the size of the load, the design of the detection instrument and even the length of the output power cord can alter attenuation properties.

filter is tuned, while a varistor network provides general transient suppression.

When tested, this device displayed relatively good high-frequency noise attenuation of 30 dB for frequency higher than 10 KHz. However, it provided virtually no noise rejection in the low-frequency range—only 1 dB at 120 Hz. This is significant because low-frequency noise generally causes more problems for electronic circuitry than high-frequency interference. This is because the lower the noise frequency, the wider its pulse width, and the more energy it carries.

A passive filter does not offer regulation isolation or protection against high-voltage spiking that could destroy varistors or filter. For this reason, a passive filter is not normally used alone for critical applications.

The **ultra-isolation transformer,** although sometimes recommended for electronic-noise suppression, does not solve μp power problems. Its primary function is to eliminate line-to-ground leakage. As the illustration (Fig. 3) of a Superior Electric Stabiline IT-105 shows, the ultra-isolation transformer achieves common-mode attenuation (126 dB) by grounding the iron core and incorporating grounded shielding around the transformer's primary and secondary windings. It is an effective design, with less than 1-percent distortion at its output. However, tests indicate that the device provides only 19-dB transverse-mode noise suppression. It cannot regulate voltage or clip transients, and it is not short-circuit protected.

Comprehensive line conditioning

The comprehensive line conditioner is designed to guard minicomputer and μc electronics. Rather than performing only one or two functions, these units regulate voltage and attenuate both types of noise over a broad band of frequencies. They protect the load from every line problem except total failure.

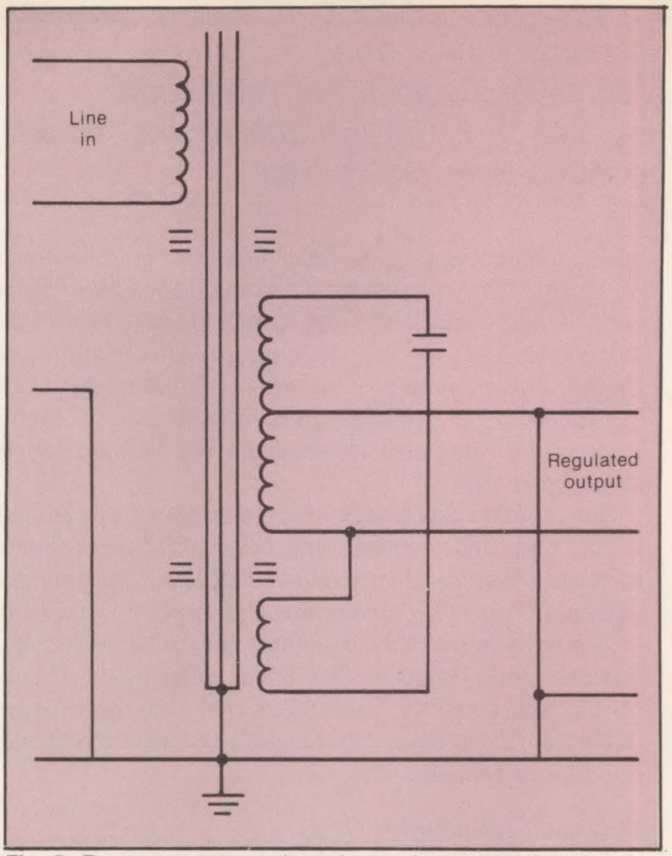

Fig. 5. Ferroresonant regulator is another comprehensive line conditioner. *It adds capacitive and compensating windings to the isolation transformer to compensate continuously for incoming voltage fluctuations, steplessly raising and lowering output voltage.*

The two most common types of comprehensive line-conditioning devices are the **electronic tap changer** and the **ferroresonant constant-voltage transformer.** Fig. 4 shows a block schematic of a Topaz Line 2 electronic tap changer. Sensing fluctuations in input voltage, the unit's logic turns solid-state switches on and off, selecting taps on the transformer's secondary to compensate for the fluctuations. The unit regulates voltage in steps, raising and lowering output voltage in increments as taps are switched. Fig. 5 illustrates the

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Surge suppressor	120V, 1 amp	$40
	480V, 100 amp	$1290
Passive filter	115V, 1 amp	$8.50
	115V, 10 amp	$50.15
Ultra-isolation transformer	500 VA	$254
	5K VA	$533
Electronic tap changer	500 VA	$410
	3K VA	$1380
Ferroresonant constant voltage transformer	70 VA	$150
	3K VA	
	7.5K VA	$2268.25

Table 1. Power conditioner prices fit minicomputer/μc budgets and vary with wattage. *Single-function conditioners are the least expensive but are inappropriate for data processing. Multifunction tap changing and ferroresonant conditioners are more expensive but provide protection from the power problems that cause most mini or μc failures.*

A passive filter does not offer regulation, isolation or protection against high-voltage spiking that could destroy varistors or filter.

basic components of a Sola Electric ferroresonant regulator. The regulator is a transformer-like device with added capacitive and compensating windings, along with filtering components for noise attentuation. Unlike a tap changer, a ferro regulator responds continuously to voltage fluctuations at its input, steplessly raising and lowering output voltage nearly instantaneously.

One primary advantage of the electronic tap changer is its high (95-percent) operating efficiency. Ferro regulator designs are not quite as efficient, ranging, for example, from 78 percent for a General Electric Co. model to 86 percent for Stabiline unit to 90 percent for the Sola unit. Balancing the lower efficiencies of ferro regulators, however, is the fact that they have fewer parts than electronics tap changers and are correspondingly more reliable.

Voltage regulation

Although both the electronic tap changer and ferroresonant transformer furnish line regulation, their performance varies considerably. The Topaz tap changer, for example, cites regulation capability at a nominal 120V AC of ±8.5V (±7 percent) for input fluctuations from 90V to 140V AC. When the unit was tested at full load (8.3A lamp load), output voltage was maintained within the published regulation band except at the low end. For a 90V AC input, output was 107.9V rms, or just slightly worse than −10 percent deviation from 120V AC nominal. This is marginally acceptable, though, for electronic systems to meet International Business Machines Corp. standard +8 to 10-percent voltage tolerances.

Table 2 lists regulation characteristics for several available ferro designs. The differences between types are not great, and performances are significantly better than electronic-tap-changer averages.

Differences in regulation capability occur because ferro designs must compromise between line regulation and noise attenuation. A standard off-the-shelf ferroresonant constant-voltage transformer routinely displays line regulation of ±0.5 percent. As noise rejection filtering is added, however, line regulation deteriorates. Voltage regulation must always be balanced against noise rejection when evaluating a ferro line conditioner.

Unlike the electronic tap changer, the ferro regulator inherently provides brownout protection. In the case of the Sola ferro regulator, the unit boosts output voltage to acceptable levels even when input voltage drops lower than −15 percent. The unit's output voltage drops to the NEMA minimum of −10 percent only after the input falls to 65 percent of nominal (75V AC).

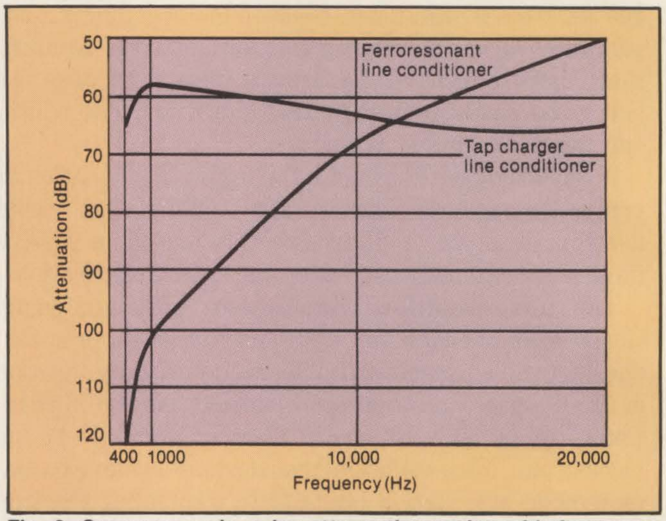

Fig. 6. Common-mode noise attenuation varies with frequency for tap changer and ferroresonant line conditioners. *The ferroresonant conditioner performs better in the dangerous low-frequency, high-energy noise ranges. The tap changer provides better high-frequency common-mode attenuation.*

Line-distortion protection also distinguishes ferroresonant regulators from electronic tap changers. The constant voltage transformer generally holds output distortion to less than 5 percent. In the tap changer, however, Triac switching noise can add substantial distortion to the output.

An important difference between ferro transformers and tap changers is the speed of their responses to voltage transients. Tap changers can adjust output voltage only once per control cycle. After comparing input voltage to its reference voltage, the unit fires a

FERRORESONANT LINE CONDITIONERS COMPARED

Model	Regulation	Output distortion (at full load)
Sola Electric's Minicomputer Regulator	±3%	2.0%
Superior Electric's Stabiline	±1.9%	1.3%
General Electric's Line Conditioner	±1.9%	3.4%
Frequency Technology's Isoreg	±0.5%	3.4%

Table 2. Design trade-offs are made between voltage regulation and noise rejection, *but major specs are similar for most ferroresonant conditioners. Major specs should be supplemented by response time, multi-frequency noise attenuation and load-size data.*

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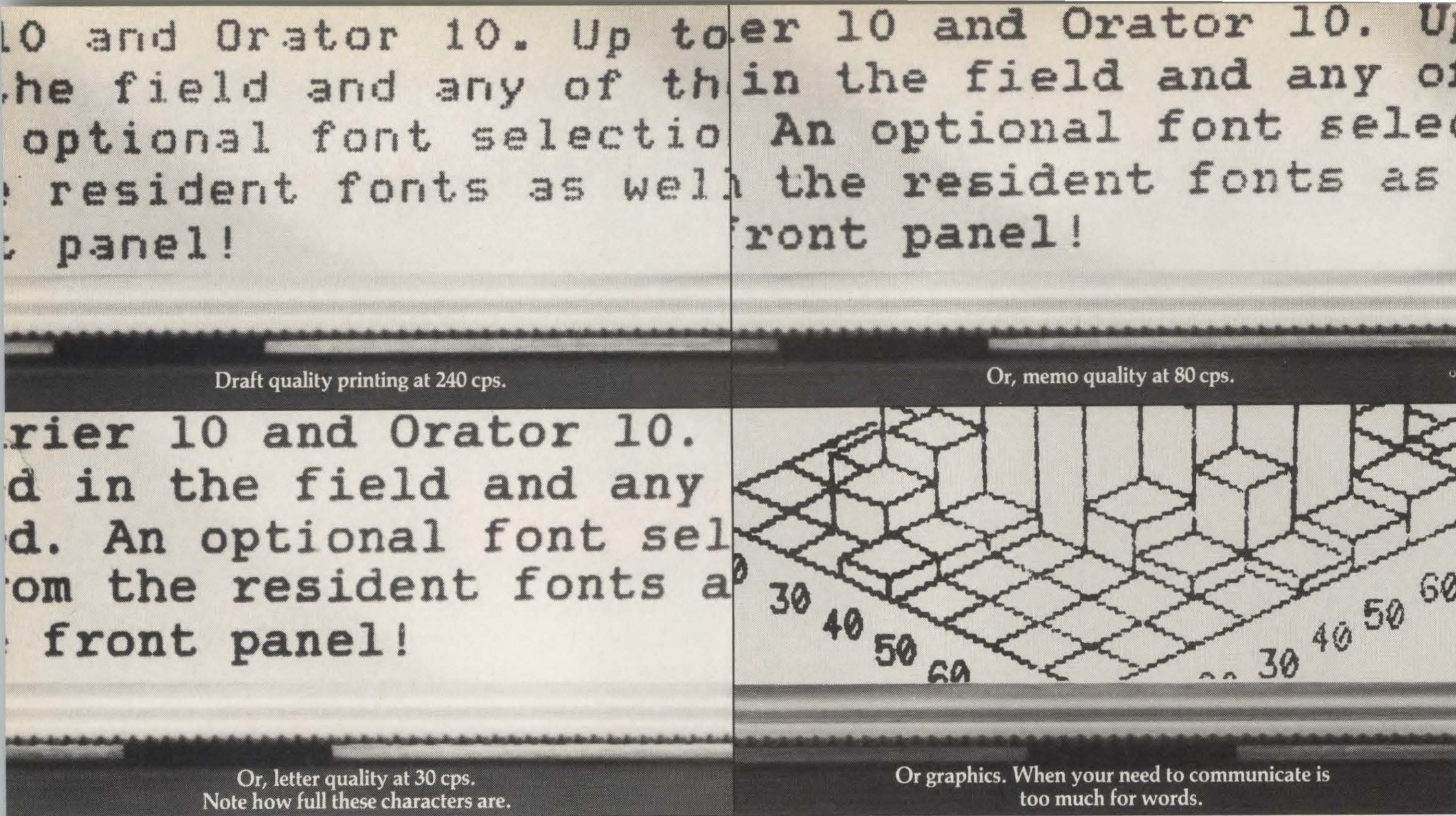

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When transverse-mode attenuation of transverse-mode source noise was measured, the ferro regulator outperformed the tap changer throughout the entire range of frequencies tested.

Triac, if necessary, to change taps on the transformer secondary. If a transient appears on the line immediately following an adjustment, the unit cannot correct for it until its next cycle.

Response time is important because transient spikes can boost voltage to 10 times normal levels. Unless these high-voltage pulses are immediately clipped, they can cause serious damage.

Manufacturers measure transient response differently. Some provide figures indicating how long a regulator takes to start voltage correction, others measure how long before the output voltage returns within the unit's specified range. Buyers should compare figures.

A simple simulation can illustrate the importance of response time. A 5-mfd capacitor is discharged across the input line to simulate a transient spike of 1500V. The Sola ferro regulator attenuates this spike at its output to 100V. The tap changer, however, cannot respond quickly enough to clip this spike and, as a result, its 200V, 2-mfd filter capacitor catches fire and is destroyed.

Noise attenuation

Noise attenuation is one of the most difficult and controversial specs to determine. Attenuation is measured in decibels, each 10-dB increment signifying a tenfold increase in attenuation. Thus, 10-dB attenuation means that the amount of noise reaching the detection instrument is 10 percent of the original source energy; 20 dB = 1 percent of source; 40 dB = 0.01 percent of source; 80 dB means that all but one millionth of a percent of source energy has been attenuated. A figure of 120 dB represents about the limit of attenuation technology.

Simply comparing standard noise-attenuation figures between line-conditioning devices can be misleading. Many variables can affect noise-attenuation characteristics. Noise frequency is most important, but the size of the load, the design of the detection instrument and even the length of the output power cord can alter attenuation properties.

As an example, attenuation of common-mode noise at a frequency of 1 KHz was compared between the Topaz Electronics Division electronic tap changer and the Sola ferro regulator—first, with 6-in. output cords attached, and then without output cords.

The results were:

Attenuation with 6-in. output cord: Topaz tap changer is 83 dB; Sola ferroresonant regulator is 74.4 dB.

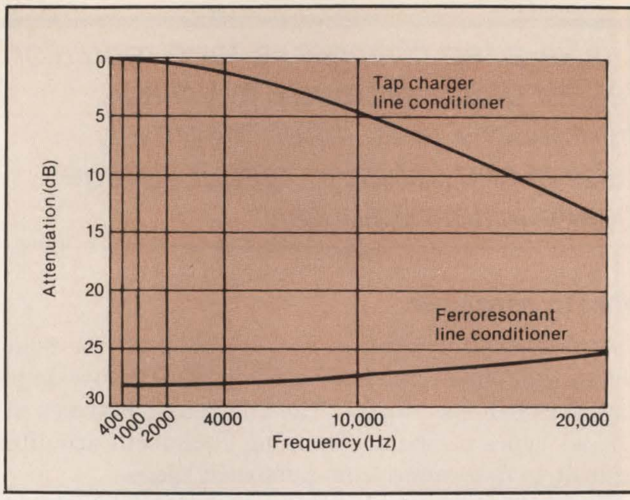

Fig. 7. Transverse-mode noise attenuation also varies with frequency. *Ferroresonant line conditioners provide better transverse-mode noise attenuation for all relevant frequencies.*

Attenuation without 6-in. output cord: Topaz tap changer is 115.5 dB; Sola ferroresonant regulator is 82.5 dB.

Attenuation was improved when the output cord was not used. Thus, laboratory test conditions exemplified by eliminating output cords can generate excellent test results, but these results may have little relation to field performance.

The variety of factors affecting attenuation has influenced manufacturers to supply peak attenuation figures rather than broadband attenuation specs. A user must determine average noise-rejection performance. For example, a unit may furnish specified peak attenuation at a very high frequency, while at lower, more damaging frequencies, attenuation may drop off significantly.

Fig. 6 reflects the importance of noise frequency on attenuation. The graph plots transverse-mode attenuation of common-mode source noise at various frequencies for the Topaz and Sola units, using 6-in. output cords on both models. The ferro transformer's noise rejection is superior at frequencies as high as about 10 KHz. Beyond this point, the tap changer offers better attenuation. However, when transverse-mode attenuation of transverse-mode source noise was meausred, the ferro regulator outperformed the tap changer throughout the range of frequencies tested (Fig. 7).

Such comparisons show that attenuation is an extremely complex function—one that a single specification such as peak dB does very little to describe.

A final important characteristic of ferro line conditioners is thermal rise. A ferroresonant unit runs significantly hotter than a conventional transformer—as much as 100 percent hotter in some cases. This is because during each cycle, the ferro's core goes into partial saturation. This core saturation contributes to the ferro's improved regulation capabilities, and the resultant higher thermal rise is normal. With proper ventilation, ferro regulator thermal rise poses no problem for computer applications.

Unlike a tap changer, a ferro regulator responds continuously to voltage fluctuations at its input, steplessly raising and lowering output voltage nearly instantaneously.

What to remember

An informed evaluation and selection of line-conditioning equipment must be based on more than a simple comparison of spec sheets. The differences between the various types of line-conditioning equipment are often difficult to determine from published specs.

A potential power conditioner buyer should ask:

- Is voltage regulation continuous or in increments?
- Do regulation figures apply to units operating at no load, full load or half load?
- Does the unit provide brownout protection in addition to voltage regulation?
- What is the unit's transient response time, and how is it measured?
- Is noise attenuation a peak value or a broadband average?
- What are the unit's noise-attenuation characteristics at low frequencies?
- Are any unusual procedures followed when measuring noise attenuation (with or without output cord, in or out of standard housing, etc.)?

Armed with answers to these questions, a minicomputer/μc user should be able to match proper conditioning equipment to his special power requirements. ■

William Lucarz is manager of technical services at Sola Electric, a unit of General Signal, Elk Grove Village, Ill.

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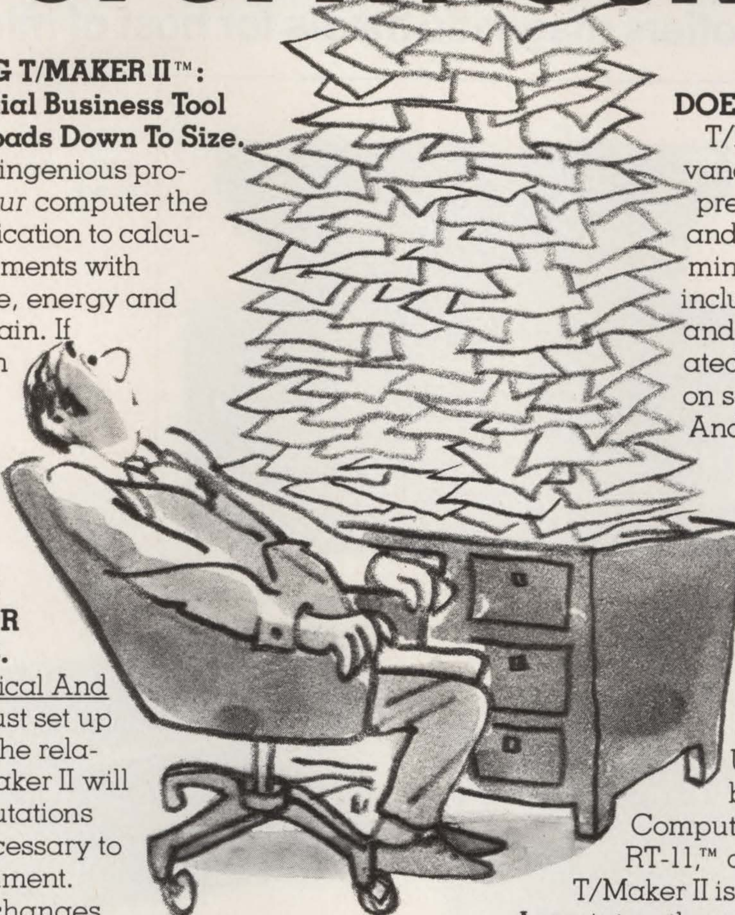

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Designing local-area networks

PEGGY M. KARP and IVAN D. SOCHER, Amdax Corp.

Only when issues of configuration, medium, access and control are resolved can a practical LAN be constructed

A local-area network (LAN) allows even the smallest computer or intelligent terminal to access large databases, fast line printers and long-distance communications networks, including satellites. But designing an LAN that satisfies user demands is not a simple process. It requires choosing a configuration, a medium, access and link-control methods and deciding where to position the interface and which industry standards to observe.

Manager/user perspectives

From the perspective of a data-communications manager, a network must be cost effective, support a variety of applications, be reliable and allow flexible growth. If a system or component fails, the time and skill to diagnose and fix the problem must be minimal.

Restricting the maximum distance of the network does not present a problem in an organization with fewer than 100 devices or in a laboratory environment. However, it can be a severe limitation in a large organization in a high-rise building, on a campus or spread throughout many buildings in a city.

Up-to-date communication networks must accommo-

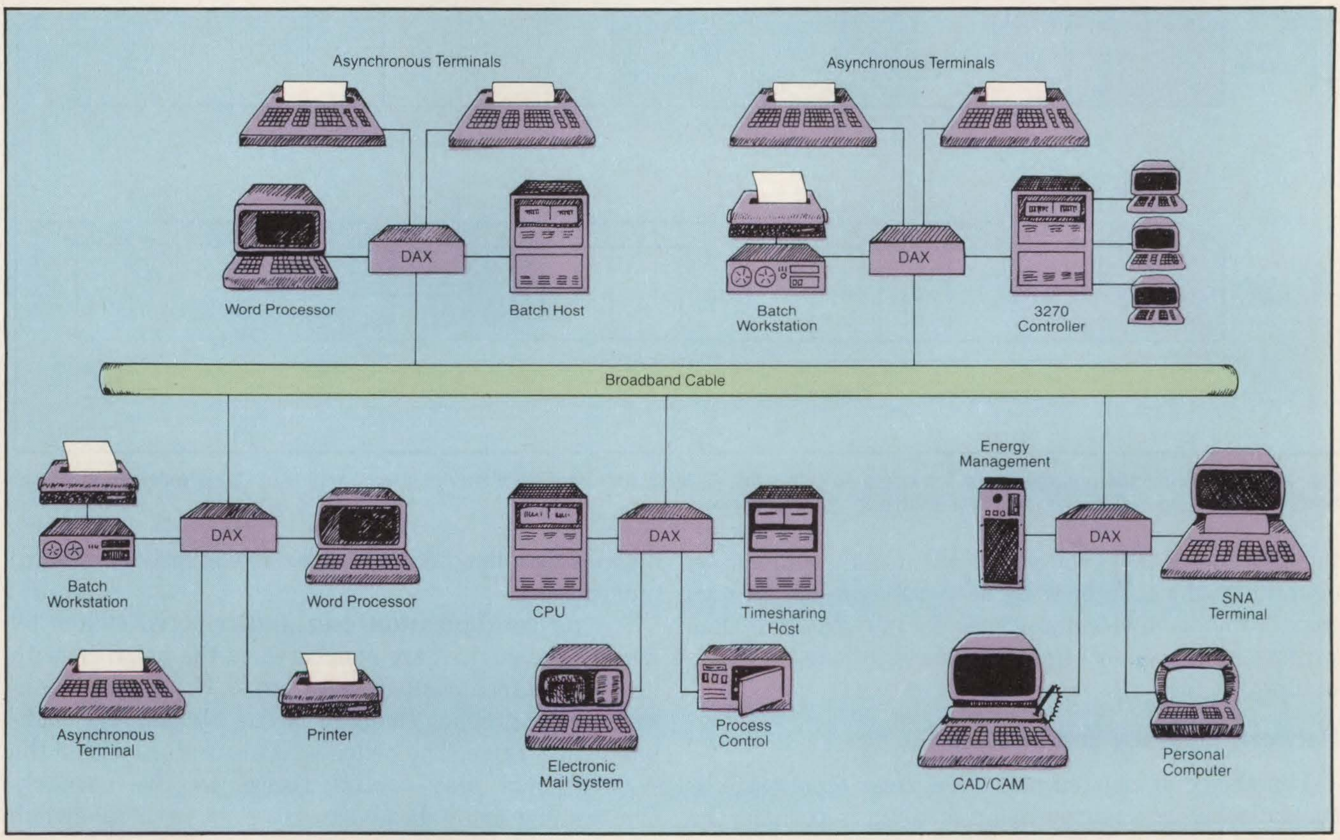

Fig. 1. A local-area communications network must support all the standard data protocols *and interconnect a wide variety of user devices.*

From the perspective of a data-communications manager, a network must be cost effective, support a variety of applications, be reliable and allow flexible growth.

date voice and moving-image video transmission. In addition to telephone and data applications, most organizations have audio-communication applications such as paging, background music and emergency telephone lines. Moving-image video applications include closed-circuit TV for security surveillance and training. Video conferencing is used to eliminate crosstown travel. The variety of communications systems is broad. The objective of an "automated factory" or "office of the future" should be to develop a single, unified utility system by combining and integrating all known forms of electronic communication.

From an end user's perspective, the network must be completely transparent. It must also support all the current applications without software changes, at comparable or faster speeds, consistent or improved response time and minimal changes in human operating procedures. Most users also want easy access to various local and remote resources on demand. The equipment and communications protocols used in the data-processing facilities of most companies are usually supplied by several vendors. To be truly user transparent, the LAN must provide device interfaces for all standard data protocols; it cannot limit support to one vendor's equipment (Fig. 1).

Network topology and medium

The choice of twisted-pair wire, fiber-optic cable or coaxial-cable as a transmission medium is perhaps the most important issue because the cost of labor involved in the installation and maintenance of the medium is the overriding expense. Network topology and medium are inherently related. Major network topologies are the star, ring and bus configurations.

The **star configuration,** with a central switch, is used in PABXs and data concentrators. User devices access the switch or a remote peripheral unit using point-to-point links, which are typically twisted-pair wire. The emergence of ring and bus LANs has spurred the development of data capabilities for voice PABXs. Thus, prospective LAN users should consider whether they can simply use the data-switching features on their existing PABX systems.

There are, however, disadvantages to the central-switch approach. Redundancy in a central switch is expensive, and, if the switch fails, all communication is lost. Twisted-pair wire is susceptible to electrical interference and limited in bandwidth and distance from the switch. And, until wideband PABX technology that is entirely digital between termination points becomes available, twisted-pair networks will be limited to low data-rate support. Neither the data switch nor the PABX can support video applications.

More important in a large user community are the operating costs of adding new devices and new services, and of troubleshooting and maintenance. Building ducts and conduits are often jammed, and no one is confident about where the wires go or what they connect. Adding a new device or service or even diagnosing a line failure, can be an expensive logistical nightmare.

A **ring configuration** uses a distributed switch by which user devices are connected to the network with limited-distance point-to-point links. The network consists of a circular chain of nodes, linked via high-bandwidth cable. The nodes act as repeaters within the network and also control access to the network. Overcoming many disadvantages of the central-switch approach, ring networks offer an attractive alternative for LANs, especially for very high-bandwidth communi-

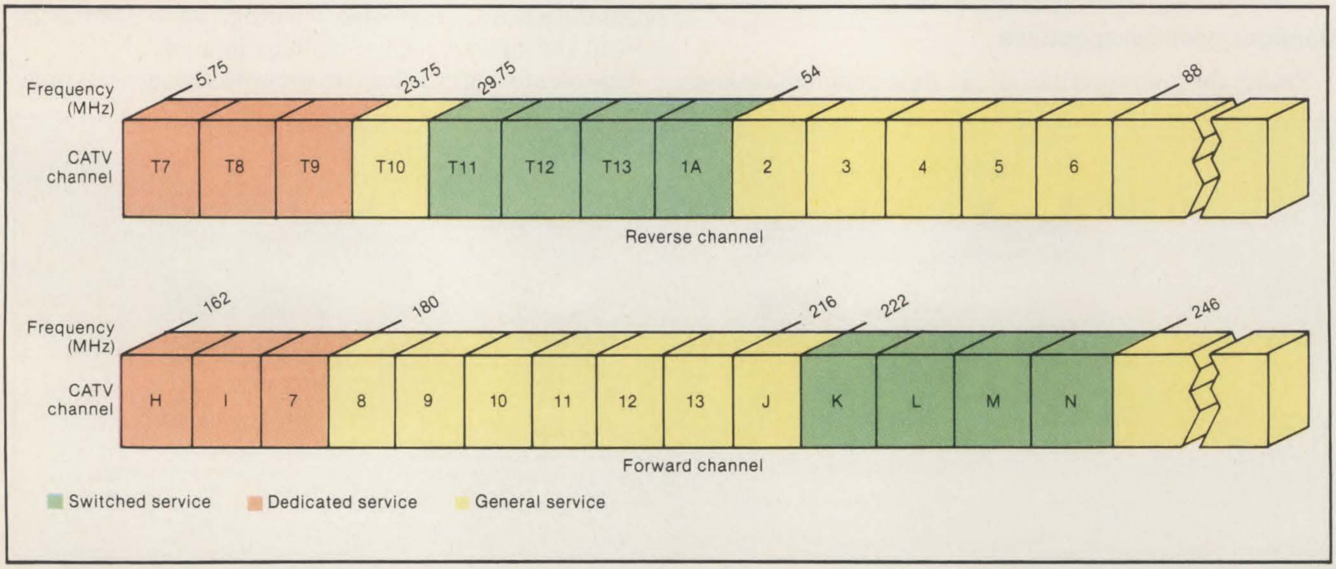

Fig. 2. CableNet frequency spectrum. *Switched service uses 48 MHz, and dedicated service uses 36 MHz of CableNet's 166-MHz total bandwidth, leaving half the bandwidth available for general service.*

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Redundancy in a central switch is expensive, and, if the switch fails, all communication is lost.

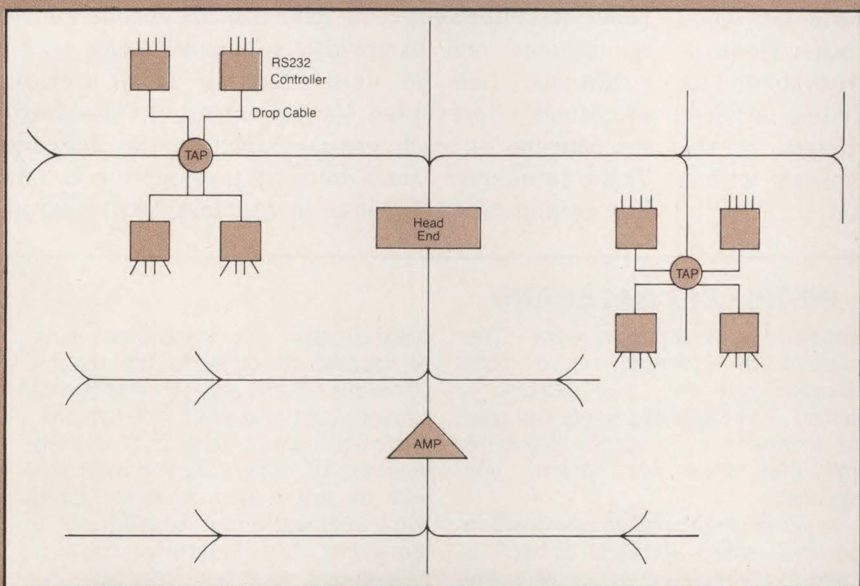
cation between devices.

At least three tough engineering problems are involved in the design of a distributed-control ring network: reliability of the repeater string, distributed initialization and recovery and closed-loop clock coordination. Solutions to these problems are being tested in laboratories, and more commerical LANs based on ring topology are expected soon.

A **bus configuration** provides a distributed switch with user interfaces similar to a ring configuration: user devices are connected to the network nodes or stations using limited-distance point-to-point links. Bus and ring topologies differ in that, in a bus configuration, the stations tap into a single high-bandwidth communication channel, which can be coaxial or fiber-optic cable. The advantages of fiber optics include low loss over long distances, high bandwidth, immunity from electrical interference and conformity with fire codes. However, use of fiber optics in distributed LANs remains limited because connectors are expensive and difficult to attach. Although fiber optics may be used more and more as point-to-point links, it will probably take many years before it becomes a viable transmission medium in a distributed environment.

Coaxial cable seems to be the most attractive medium for LANs. It is manufactured in large quantities and at low cost, and its bandwidth is sufficient for both baseband and broadband modulation.

The baseband approach places the signal on the cable



A broadband cable system *is easily configured to cover an area by simply branching the cable where necessary.*

INSTALLING BROADBAND

Broadband uses coaxial, usually standard CATV, cable and radio-frequency (RF) transmission. It is suitable for much longer transmission distances than baseband—as much as 80 Km. Broadband supports a data rate of 100M to 140M bps, full duplex. Because frequency division multiplexing (FDM) is used, multiple services can be supported on different bands of the channel.

Broadband is a directional-transmission system based on a single rooted-tree physical topology. Each user device broadcasts transmission in one direction (called the reverse channel) to the head end. The head end translates the transmission and re-broadcasts downstream (the forward channel) to all attached user devices. Some broadband local-area networks, such as DCC, Mitrenet and Wangnet, use a dual-trunk twin cable in which one cable is used for transmitting, and the other is used for receiving. Other networks, such as Amdax's and Sytek's, use a mid-split, two-way, single cable that is the CATV standard, the IEEE 802 standard and the EIA standard.

The IEEE 802 standard specifies that the broadband interface must support one or more of the following data rates: 1M, 5M, 10M and 20M bps, and must interface to standard CATV-like networks in which multiple channels can be used simultaneously for data, video and audio transmission. The interface must also support both carrier-sense multiple access with collision detection (CSMA/CD) and token media-access methods. The functions of CSMA/CD and the generation of a "signal-quality" signal (token) are performed at the head end of the cable rather than in the media-access unit.

A broadband local-area network consists of a coaxial cable, a head-end translator, taps and connectors, amplifiers, splitters, modems and controllers. The coupling to the ½-in. trunk cable is made with a connector and a passive tap. The tap can be for one, two, four or eight ports. Each port supports a ¼-in. drop cable connected to a modem at the controller.

The basic components of a broadband cable system are the coaxial cable, connectors, taps, tap terminators, drop cable, splitters, modems and amplifiers. The coaxial cable used for the trunk of a broadband network is a standard low-loss solid-aluminum sheath coaxial, 0.412-in. or 0.5-in., 75-ohm cable. The cable can be extended using connectors and by dropping branches from the trunk. The trunk connector accepts the coaxial trunk at one end and provides a hollow male thread for connection to the tap.

The broadband tap is a passive directional coupler that provides a mechanical interface between the trunk coaxial and the drop cable. It couples a predetermined fraction of the RF trunk power to the modem. Multi-port taps provide more than one drop cable in a location. A 75-ohm resistor in a connector is required to terminate the end of the trunk cable and any unused tap ports. The recommended coaxial for the drop cable from the tap to the controller is RG-6. The maximum length between the tap and the modem is 50m.

Coaxial cable is manufactured in large quantities and at low cost, and its bandwidth is sufficient for both baseband and broadband modulation.

and time-divides the network according to predetermined access methods. By contrast, broadband modulation is frequency divided. RF modems impress carrier frequencies on the broadband cable so that modems can transmit along the cable concurrently at different frequencies (see "Installing broadband," p.223).

Cost-per-port attachment to a baseband LAN is lower than that of broadband when fewer than 100 devices are attached. But with more than 100 devices, broadband LAN cost per port is lower.

Since 1973, Amdax Corp. has marketed an RF modem that permits digital data transmission over community antenna TV broadband cable systems. Audio and video applications operate simultaneously on other frequencies of the same cable. In 1980, Amdax reevaluated its media technology alternatives for expanding services within the LAN environment and, based on the preceding considerations, decided to continue with a broadband coaxial-cable bus configuration.

Accessing the media

Once a network medium and topology have been selected, the next design issue is choosing between contention and noncontention media-access methodologies.

Noncontention methods consist of assigning time slots or frequencies where a bandwidth is pre-allocated and reserved. Where the bandwidth is dynamically allocated to users on a demand basis, a media-access method that resolves contention for the bandwidth is required. The best known are statistical multiplexing for long-haul networks, carrier-sense multiple access with collision detection (CSMA/CD) for bus networks, token passing for ring networks and time-division multiple access (TDMA) with reservations for satellite links.

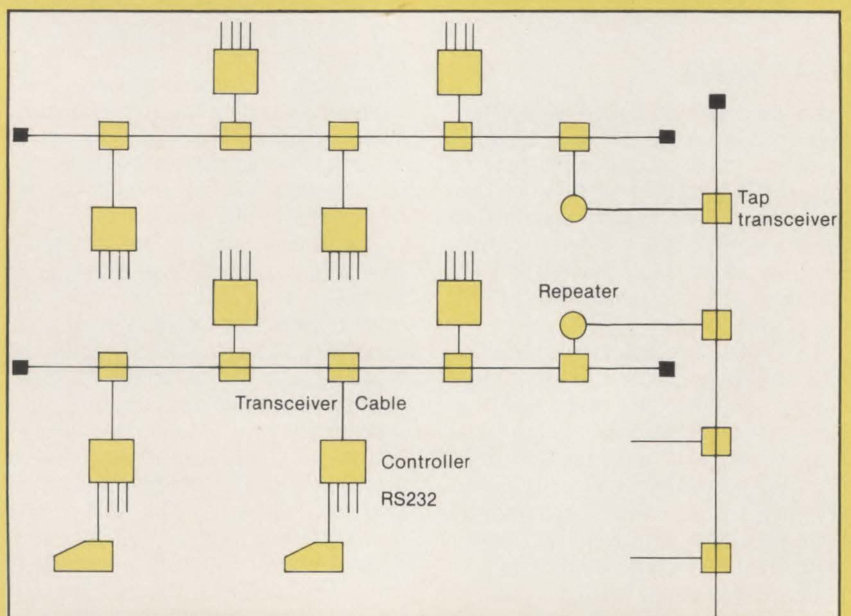
Multiplexing on a long-haul packet-switched network is achieved by queuing the packets at each node in the network until the outgoing channel is free. The nodes and interconnecting links provide enough memory (buffers) and bandwidth to handle peak traffic conditions. Loss of data resulting from overload conditions is prevented by implementing flow-control mechanisms on each virtual circuit in the network. These techniques cannot be readily adapted to an LAN bus configuration because in the long-haul environ-

INSTALLING BASEBAND

As defined by IEEE 802, a baseband LAN with a bus topology consists of a coaxial cable (50 ohms), repeaters, taps, transceivers, terminators, transceiver cable and controllers.

The coaxial cable is installed in segments that can be connected with repeaters to give greater geographical coverage. The repeater can be anywhere on the cable and takes the position of a tap/transceiver. The number of repeaters in a path between any two user devices is limited. The cable segments can also be extended by a single fiber-optic link that does not support any devices.

A tap (a simple plastic clamp with a pin that makes electrical contact) is used to connect a transceiver to the coaxial cable. The transceiver must be located as close to the tap as possible. Because of reflections caused by transceiver connections, each tap must be spaced at precise intervals of cable, starting with the end of the cable segment. Each cable-segment end is capped with a terminator. The transceiver cable is twisted-pair wire and connects the controller to the transceiver.



A typical baseband configuration *is characterized by its rigid network structure.*

User devices connect to the controller using standard RS232 interfaces. Alternatively, some products include the controller functions within the user device.

IEEE 802 specifies the following restrictions for baseband networks:

Maximum length of main cable segment must be 500m.,

Inter-tap cable spacing must be 2.5m.,

Space between tap and transceiver must be 3 cm.,

Maximum length of transceiver cable must 50m.,

Maximum length of fiber-optic link must be 1000m.,

Maximum number of repeaters in path must be two.

IEEE 802 specifies that baseband networks operate at three speeds: 1M, 5M and 10M bps, and restricts the distance between two stations to 2.5 KM.

COMMUNICATION STANDARDS

While data networks provide access to diverse computer resources, communication between different vendors' equipment is often still impossible. This is because of the proliferation of specialized higher level protocols employed by the vendors, as well as a lack of modularity in communication systems design. The International Standards Organization (ISO), in collaboration with CCITT, is attempting to alleviate some of the problems by defining the Open Systems Interconnection (OSI) reference model.

Network architectures have universally accepted the concept of layering, that is, creating levels of protocol that act independently of other levels. Examples of layered network architecture include vendor networks such as International Business Machines Corp.'s SNA, Digital Equipment Corp.'s DECnet and international standards for network interfaces such as CCITT recommendation X.25 for packet-switched networks.

ISO defines a formal structure for layered architecture by specifying a "reference model" for data-communication protocol design. ISO partitioned the logical functions performed in communication between two user applications into seven layers:

I. **Physical layer**—transparently transmits a bit stream over a circuit built in some physical-communications medium.

II. **Link layer**—performs error detection and correction.

III. **Network layer**—selects route and performs switching to deliver data transparently.

IV. **Transport layer**—establishes a data path from one end point to another, independent of the many networks and physical and link layers operating in tandem between.

V. **Session layer**—connects user applications.

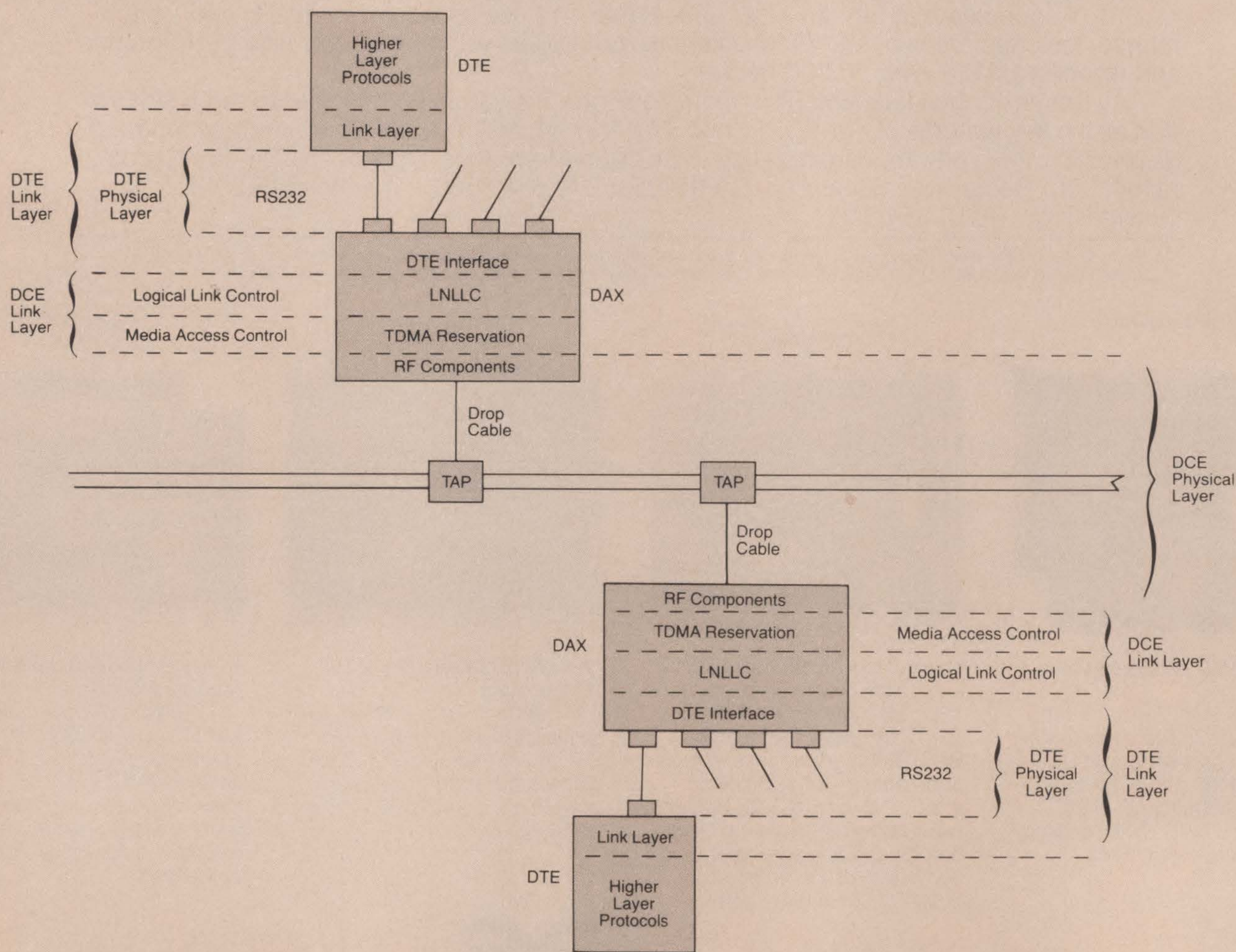
VI. **Presentation layer**—converts data from a sending unit into a format recognizable by a receiving unit.

VII. **Application layer**—provides system services that manage the transfer of data between application processes and user services process data.

This structure is only a model, and while it defines the necessary logical functions for each layer, it should not be considered a design for implementation. With specific functions for each layer and inter-layer, higher layers can depend on lower layers to perform well-defined services. The intended result is that more efficient peer protocols can be defined. For example, two end-point session layers can "talk to one another."

Common carriers have traditionally been responsible for defining layers one through three, while vendors have defined their own versions of layers four through seven.

In the context of LANS, the IEEE 802 standard specifies the physical layer and link layer.



The open systems interconnect reference model *as it is implemented by the CableNet data-exchange unit.*

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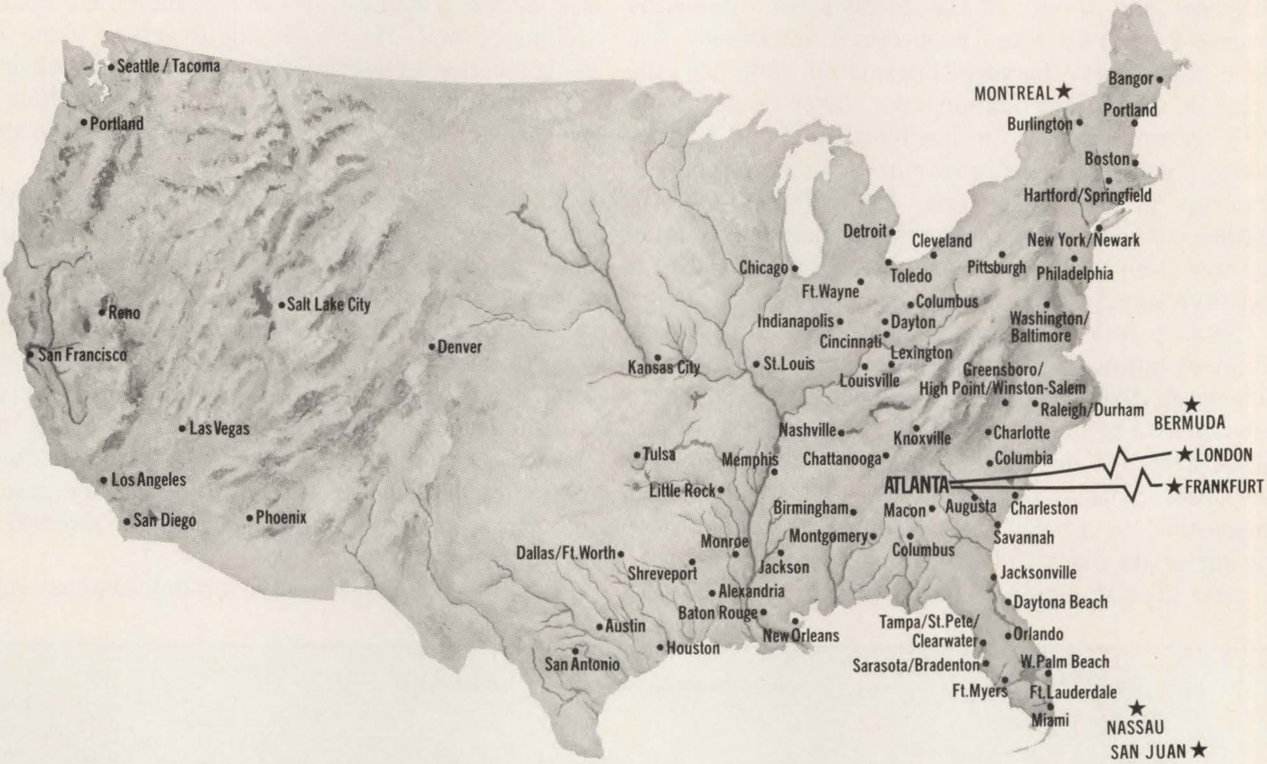

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DELTA AIR CARGO. READY ALL·AROUND

Providing a separate network interface allows a customer to use his existing equipment on the network and to buy from a variety of vendors.

ment, multiplexing control for each link is concentrated in the end-point nodes. In an LAN bus configuration, multiplexing control for a single transmission channel is distributed throughout all nodes.

CSMA/CD was developed by Xerox Corp. for Ethernet and is one of the media-access standards proposed by IEEE 802. The protocol implements two basic rules that manage information flow on the network. First, any station must defer transmission until transmission on the medium has ended (carrier sense). Second, when two or more stations attempt to transmit at the same time, the collision-detection feature curtails transmission and requires each station to retry later at different times. Retransmission delays can vary significantly, depending on network loading.

CSMA/CD is a good access method for traffic with frequent bursts. Because access control is distributed among all the nodes on the network, a centralized arbitrator is not required. However, loading variances make CSMA/CD unsuitable for applications requiring responses within predetermined times, and it is impossible to predict the loading at which these variances are likely to become unacceptable.

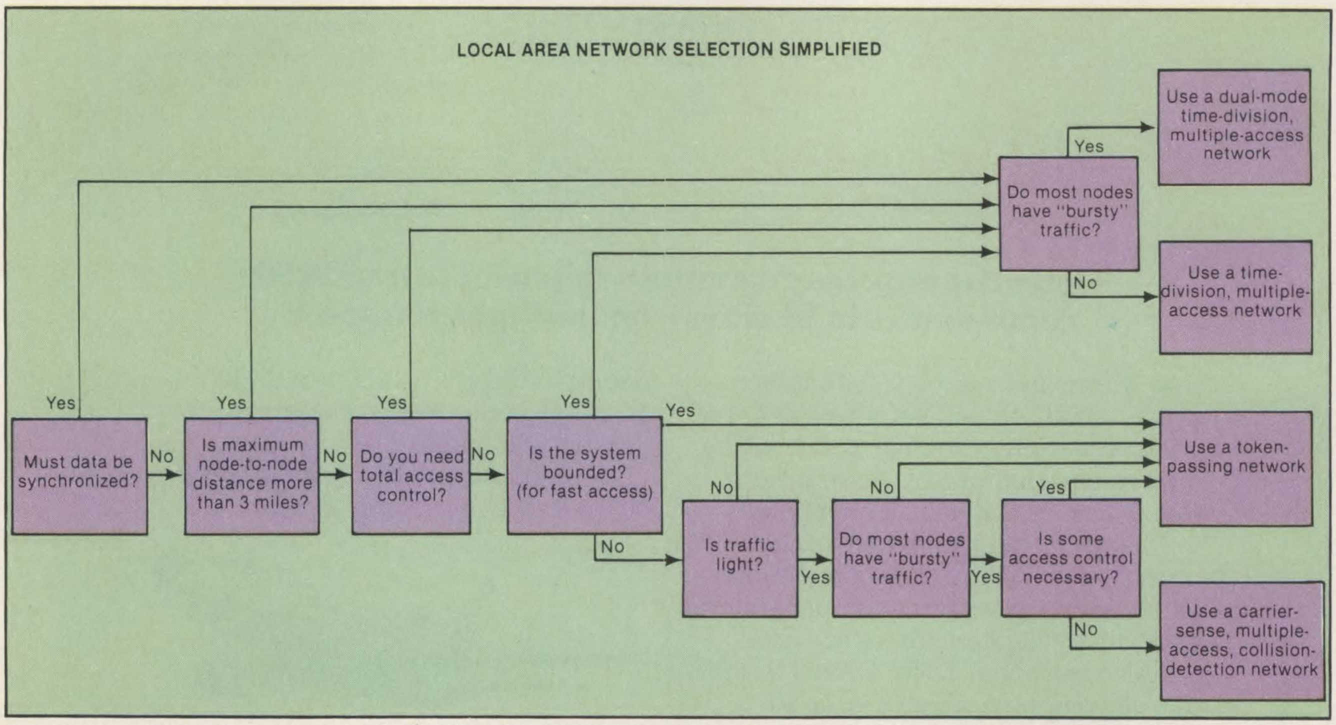
CSMA/CD also places a constraint on packet size. To ensure that all cable nodes receive a frame and detect collisions by sensing all simultaneous transmissions, transmission time for the shortest packet must be at least as long as the round-trip propagation delay on the cable. The trade-off is between restricting the maximum distance of the network or introducing fill-character overhead in the packet structure.

Token passing is the method usually used in ring networks. A token is circulated from node to node, and the one that holds the token controls the medium for a defined period. This method governs both sustained traffic and traffic with frequent bursts.

Token passing does not impose restrictions on packet size, although slight overhead is incurred if a node has nothing to send. The biggest disadvantage of the token method is that initialization, error recovery and control of the ring are performed by one or several adminstrative nodes. Thus, two types of nodes must be developed.

IEEE 802 has defined a token-passing access method for a broadcast bus that does not base the ordering of the ring on the physical connectivity of the nodes. A "logical" ring is defined when each node must maintain the identity of its predecessor and successor. In steady-state operation, when no nodes want to enter or leave the logical ring, the method has the same advantages and disadvantages as the ring token method. An additional disadvantage is that, because of the logical ordering of the ring, the latency time of a token pass may be longer than in the physical ring configuration.

In a **satellite** system, the up-link channel carries



A local-area network "selection tree" reminds potential buyers and system designers of important network considerations. *A user must first consider whether his application requires synchronous or asynchronous transmission and how far apart the nodes of his network will be. Then he must decide whether total security and assured quick access for every device are primary considerations. The amount and nature of traffic then guide the user into one of the four generic LAN types. Knowing what type of network is best, the user should contact vendors directly.*

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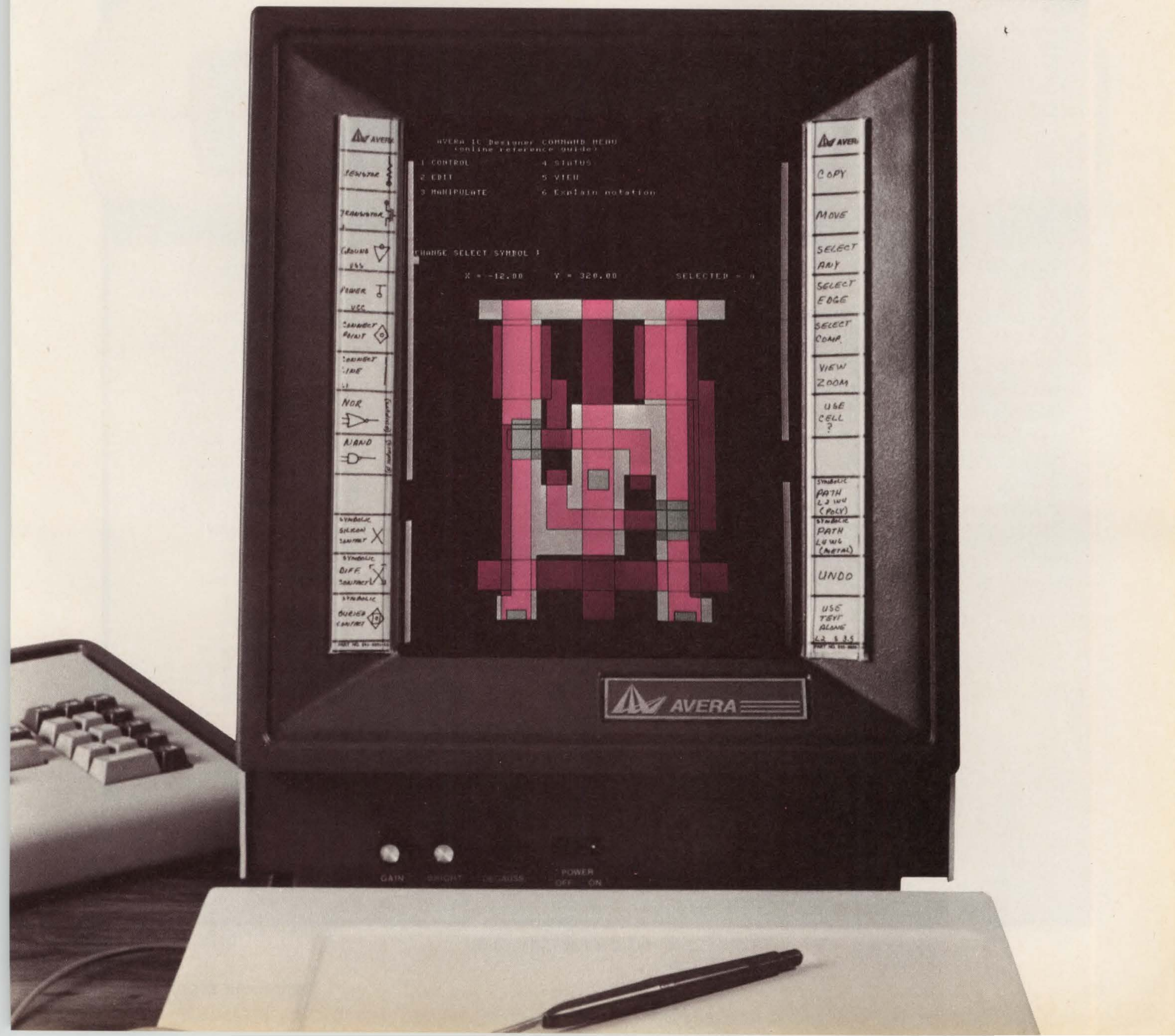

On point-to-point and multi-drop links, various link-layer protocols are used to detect line errors and, in some cases, detect/correct transmission errors and provide flow-control mechanisms.

transmissions from many transmitters (ground stations) to one receiver (satellite); the down-link channel reverses this. Various access methods have been used for packet switching in a satellite environment. One of the most efficient is TDMA with reservations, which divides the up-link channel into fixed size slots and organizes the slots into frames. The duration of a frame must be longer than the round-trip propagation delay.

The slots in a frame are either free or reserved. Free slots can be used for single packet transmissions or to request reserved slots for stream-type traffic or multi-packet messages. Various techniques are used for detecting collisions in three-slot transmissions, and reserving slots.

The satellite uses TMDA to broadcast on the down-link channel. Ordering is not given to slots on the down-link channel because each ground station receives every packet and identifies its packet by the destination address (the same method used by nodes on a broadcast bus). The satellite can optimize the use of the down-link channel by filtering collisions and by not transmitting empty slots.

After examining the pros and cons of the various contention-based media-access methods, Amdax chose to use a variation of TDMA with reservations for CableNet switched service. The head-end translator (CableNet Executive) of a broadband cable is analogous to the satellite, and the nodes (CableNet DAX) are the ground stations. The reverse channel is the up-link channel, and the forward channel is the down-link channel (Fig. 2).

The major difference between the satellite environment and the LAN is that, while ground stations are always a fixed, known distance from a satellite's orbit, CableNet nodes are located at unknown distances from the head end. To overcome this problem, Amdax developed a technique called "ranging," in which the Executive polls each DAX at start-up time so that each DAX can calculate the distance to the head end. The Executive then compensates so that all nodes appear to be the same distance. Fixed packet sizes of 512 bits are used, where 72 bits are overhead containing information exchanges between the DAX and the Executive. Packets are guaranteed to reach the Executive within 16 time slots (8192 bit times), permitting the network to span a 25-mile radius from the Executive. Each DAX monitors the traffic on each virtual circuit and automatically changes from using free slots (with the possibility of collision) to reserved slots for sustained traffic.

The disadvantage of the TDMA-with-reservation scheme is that it requires coordination between the Executive and the DAXs. Because the Executive is relatively inexpensive, a "hot" standby Executive provides cost-effective backup.

Link control

On point-to-point and multi-drop links, various link-layer protocols are used to detect line errors (asynchronous and datagram-based protocols) and, in some cases, detect/correct transmission errors and provide flow-control mechanisms (bisynchronous, SDLC and HDLC). In an LAN bus environment, many logical links between devices are established on a single transmission channel. Link-layer protocols must be modified to adapt their use to the LAN.

IEEE 802 has defined the local network logical link control (LNLLC) protocol, based on the International Standards Organization's high-level data-link-control balanced link-access procedure (HDLC LAPB) (see "Communication standards," p.226). LNLLC differs from HDLC in that each frame must contain a source address as well as the destination address. LNLLC provides two types of operation: a datagram-oriented service in which frames can be sent anytime and a service in which a logical link is established between communicating stations and frames are sequenced and acknowledged.

Amdax supports a version of LNLLC that is a "snapshot" of the proposed standard. Logical links are established for every call, and the datagram operation is used only for broadcast messages.

Positioning the interface

Vendors position user interfaces to LANs in one of two locations. The hardware and software implementation of the media-access and logical link-control mechanisms can be inside the device or in the network node with standard interfaces to the device.

Implementing hardware and software inside the device is less expensive because it uses a single housing and power supply. The disadvantage is that an end user is locked into one vendor's equipment. Providing a separate network interface allows a customer to use his existing equipment on the network and to buy from a variety of vendors.

Amdax provides a network utility and does not manufacture or market end-user data-terminal equipment. Therefore, the design choice was simple, and the issues were those of what protocols to support.

For the CableNet dedicated service, the DAX units are basically RF modems. The user interface protocol consists of only the physical layer. User devices connect to the DAX using standard EIA RS232C. All higher layer protocols are those supported by the data-terminating equipment (DTE) and are completely transparent to the DAX and the network.

For the CableNet switched service, the DAX units contain an RF modem, the implementation of TDMA-with-reservation media access and LNLLC, network control and administrative functions and DTE interface software. Each DAX port is determined by a set

The choice of twisted-pair wire, fiber-optic cable or coaxial cable as a transmission medium is perhaps the most important issue because the cost and labor involved in the installation and maintenance of the medium is the overriding expense.

parameter (and can be modified) by a customer network administrator or by a user. The DAX performs packet assembly/disassembly (PAD) functions and supports a subset of CCITT recommendation X.3 parameters. A user command language that supports the functions defined by CCITT recommendation X.28 is used to communicate between the DAX and the user.

Implementing standards

Standards serve as a frame of reference in design choices. Based on the stability and acceptance of a standard, and on a product's effect on performance, each vendor must decide when to use standards.

Because cable and components are commercially available, reliable and inexpensive, Amdax adheres to EIA and the proposed IEE 802 physical-layer standards for broadband coaxial-cable systems. Based on the limitations of CSMA/CD and the incompleteness of the token-access method for broadcast media, Amdax does not conform to IEEE 802 for media-access control. Rather, the TDMA reservation access method employed in the CableNet switched service is an adaptation of a widely used method in satellite communications. Amdax supports a version of the proposed IEEE 802 LNLLC standard for logical link control.

The implementation of these network-interface standards does not affect higher layer protocols, which are the responsibility of user data-terminating equipment vendors. ■

Ivan D. Socher is president and chief executive officer of Amdax Corp., Bohemia, N.Y. **Peggy M. Karp** is vice president of market development at Amdax, and is a member of the CCITT, ISO, ANSI, IFIP and IEEE standards committees.

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NCR Systems replace V-8500M and MP processors

NCR Corp. has introduced a seven-member family of computers *priced from $59,370 to $341,000 to replace the firm's V-8500M and MP processors.*

NCR Corp., Dayton, Ohio, has introduced a line of computer systems to replace the company's V-8500M and MP processors. The company claims the new systems, named the V-8500 Group II, offer as much as a 66-percent price/performance improvement over the systems they replace, and that programs, files and most peripheral equipment used with the current V-8400 and V-8500 can be easily transported to Group II configurations.

There are seven members of the Group II family, all running under NCR's Virtual Resource Executive operating system. The seven models are: the V-8535 II, V-8545 II, V-8555 II, V-8565 II, V-8575 II, V-8585 II and V-8595 II.

The entry-level model V-8535 II offers 75 percent the performance of the company's previous entry-level system, the V-8555M, at about 56 percent of the previous system's price. In a 1M-byte configuration, the V-8535 II sells for $59,370 and has a monthly rental cost of $2491 under a three-year agreement.

The V-8545 II has 1M byte to 2M bytes of memory. The 1M-byte configuration sells for $63,240, and monthly rental fee is $2648 under a three-year plan. The V-8555 II has memory sizes ranging from 1M byte to 4M bytes. The 1M-byte configuration is priced at $82,000 or a monthly rental fee of $3481 under a three-year agreement. The V-8555 II, the smallest of the new systems, has multiprocessor capability, allowing two processors to be attached in a configuration providing 1.7 times the throughput of a single system.

The V-8565 II, offers from 2M to 6M bytes of memory, a 56-nsec. CPU and a virtual assist unit for improved performance. The model is priced, with 2M bytes of storage, at $139,000, and a three-year monthly rental plan is $5876 per month.

The three high-end Group II systems are dyadic systems with dual CPUs. Each processor has a 56-nsec. cycle time, and all can be upgraded to multiprocessor configurations.

The V-8575 II has 2M to 6M bytes of four-way interleaved memory and sells for $178,250. The V-8585 II has 2M to 6M bytes and includes a virtual assist unit. Purchase price with 2M bytes of storage is $248,000. The V-8595 II has memory sizes from 4M to 8M bytes, and the 4M-byte version sells for $341,000.

Production of the new systems has begun, with deliveries starting in the second quarter. **NCR Corp.,** Main & K Sts., Dayton, Ohio 45479.
Circle No 300

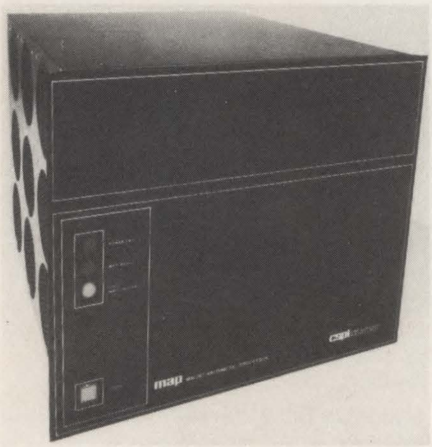
Sanlab announces data-acquisition system

The Analogger 1 data-acquisition system includes an analog measurement system and an Apple II Plus computer. The system allows data logging with a printer, a tape cassette, a disk or combinations. It provides 48K bytes of RAM to develop averaging, alarms, temperature gradients and other process-control functions. The system also includes the vendor's Level 1 software on disk and an analog scanner interface written in machine language and memory-mapped. The system, including a clock/calendar, a parallel interface, a card cage for I/O modules and software, sells for $3995. **Sanlab, Inc.,** 7969 Engineer Rd., San Diego, Calif. 92111. **Circle No 301**

Systems

CSPI announces array processor

The MAP-400 array processor for real-time signal processing provides arithmetic processing at 24 million floating-point operations per sec. The system executes 1024-point complex FFTs on a continuous basis at the rate of 2.7 msec. per FFT. Arithmetic is performed in a 32-bit floating-point format. The system also contains an internal CPU; multiple independent memory buses that accommodate 170-, 300- and 500-nsec. memory speeds; and peripheral I/O interfaces for digital



devices, A/D, D/A and remote storage devices. Twin arithmetic-processing units operate in parallel without cross-interference. Prices start at $54,900 for a configuration that includes a 16-slot chassis with self-contained power supply, 128K bytes of program memory and an operational software package with an extensive array-function library. **CSP Inc.,** 40 Linnell Circle, Billerica, Mass. 01821.

Circle No 302

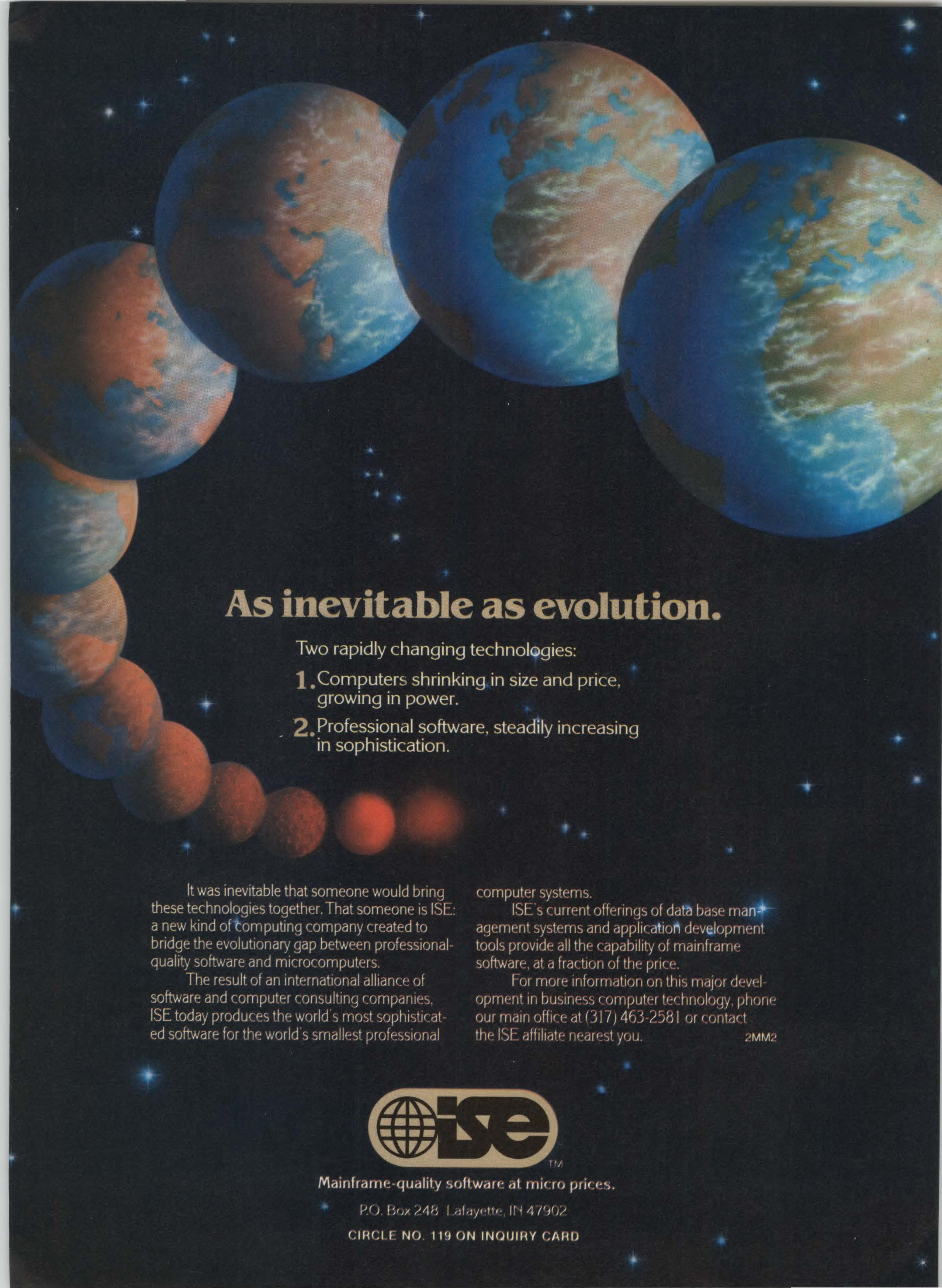
Wang unveils 32-bit mini

The VS 90 32-bit minicomputer contains a 32-bit CPU with 1M byte of main memory, one work station/printer IOP that provides as many as 16 ports; one disk IOP that controls as many as four disk drives, a tape IOP that controls as many as four tape drives, a three-port telecommunications IOP; an archiving work station as an operator console, a standard VS operating system and a compiler. The system can be configured with as much as 4M bytes of main memory and 2.3G bytes of on-line disk storage, a bus adapter, eight IOPs, 48 serial devices, two disk IOPs and a tape or telecommunications IOP. The basic 1024K-byte system sells for $73,000. Monthly maintenance is $450. Memory upgrades in 1M-byte increments are priced at $16,000 per megabyte. **Wang Laboratories, Inc.,** One Industrial Ave., Lowell, Mass. 01851. **Circle No 303**

Micro Business announces desk-top system

The Micron 400 series desk-top computer system uses local-network/distributed-processing architecture to permit as many as three intelligent work stations to operate independently and simultaneously, using the data on a shared 12M-byte Winchester fixed disk. The system provides each terminal with its own

CPU and RAM linked through the Intel Multibus. Software consists of four basic accounting modules, with five optional modules available. Each module operates independently or can be integrated. A basic configuration includes a Z80B μp with 64K RAM, an intelligent disk controller, a dual-sided, double-density, 5¼-in. floppy disk with as much as 1M byte of unformatted storage, one 12M-byte Winchester-disk drive, a video display with 25-line × 80-character screen,


As inevitable as evolution.
Two rapidly changing technologies:
1. Computers shrinking in size and price, growing in power.
2. Professional software, steadily increasing in sophistication.
It was inevitable that someone would bring these technologies together. That someone is ISE: a new kind of computing company created to bridge the evolutionary gap between professional-quality software and microcomputers.
The result of an international alliance of software and computer consulting companies, ISE today produces the world's most sophisticated software for the world's smallest professional computer systems.
ISE's current offerings of data base management systems and application development tools provide all the capability of mainframe software, at a fraction of the price.
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CIRCLE NO. 119 ON INQUIRY CARD

Attention,
Multibus™ users…

Only the CD100M now supports CP/M and CP/M86 in the perfect desktop package.

Hear this,
LSI-11 users…

Only the CD100L emulates a VT103, an RL02 and an RX02 in a single desktop package.

And both now include a 10 megabyte Winchester!

CD100M — THE TOTAL OEM SOLUTION

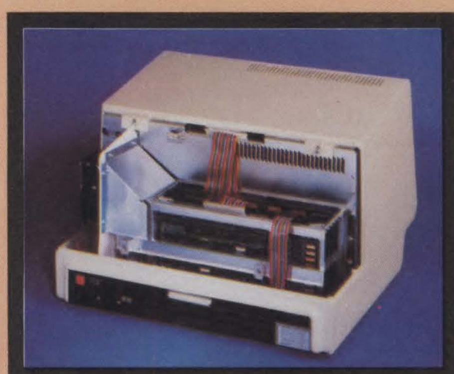
To give your Multibus microcomputer system increased file storage, the Callan™ CD100M Integrated Work Station now includes a high performance 10 Mbyte 5¼-inch micro Winchester disk drive complete with full DMA and fully automatic and transparent burst error correction. A one Mbyte unformatted floppy provides file entry and back-up. With its integral 6 slot Multibus compatible card cage, intelligent video terminal, and Winchester/Floppy disk system, the CD100M is the *only* single desktop package available to OEM and volume end-users who wish to configure a modular microcomputer system using any Multibus compatible card set. It's the perfect solution, significantly reducing product costs and development time.

CP/M AND CP/M86 CONFIGURATIONS

If you prefer the popular CP/M operating system, Callan can provide the CD100M with either 8-bit or 16-bit micros. A Z80 with 64K RAM and CP/M, or an 8086 with 128K RAM with error correction and CP/M86 are both available as the complete solution for CP/M compatible software. And both systems include 10 Mbyte Winchester performance.

If you're using Multibus cards in your system you must see the Callan™ CD100M Integrated Work Station.

CP/M and CP/M86 are trademarks of Digital Research. Multibus and 8086 are trademarks of Intel Corp. Z80 is trademark of Zilog.



Built-in card cage holds 6 Multibus or 7 quad/14 dual height LSI-11 cards.

CD100L — COMPLETE DEC COMPATIBILITY

For the OEM or end-user configuring an LSI-11 system, only the Callan™ CD100L Integrated Work Station can emulate a 10 Mbyte RL02 Winchester disk, a 0.5 Mbyte RX02 floppy, and a VT103 Terminal in a *single* desktop unit. Software presently running on RT-11, RSX-11 or other LSI-11 operating systems can now run on the CD100L, reducing hardware costs by as much as 30%. For users who prefer a more complete solution, the CD100L can also be ordered complete with LSI-11/2 or LSI-11/23 and RT-11.

MORE FOR LESS

No other solution compares for performance, features and price. The VT100/VT52 compatible terminal offers 6 video attributes, true split screen with separate scrolling regions standard. The LSI-11 Q-bus compatible card cage provides 7 quad or 14 dual height slots to house even the largest configurations. A Winchester controller is available to directly emulate the 10 Mbyte RL02. RX02 emulation is available either in a 1 Mbyte dual floppy configuration or as 0.5 Mbyte back-up for the Winchester.

If you're tired of multiple package or multiple vendor solutions, you must see the CD100L.

DEC, LSI-11, VT103, RL02, RX02, RT-11, RSX-11, VT100/VT52, LSI-11/2, LSI-11/23 are trademarks of Digital Equipment Corp.

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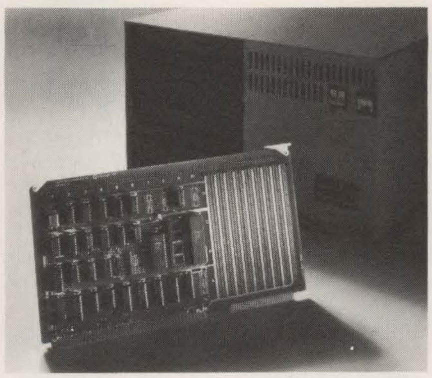
DATA SYSTEMS
2637 Townsgate Road
Westlake Village, CA 91361
Telephone: (805) 497-6837

CIRCLE NO. 120 ON INQUIRY CARD

detached keyboard with 96 ASCII characters, a 10-key numeric pad and an accounting software package, including accounts receivable, accounts payable, general ledger and payroll. It sells for $14,500. **Micro Business Applications,** San Diego, Calif. **Circle No 304**

DMS announces 16-bit system

The DSC-86, an enhancement to the vendor's DSC-4 Multibus, Z80-based system, provides 16-bit processing. The system allows execution of CP/M-compatible 8-bit software and 16-bit CP/M-86 software. The DSC-86 features Intel's 8086 μp or an optional 8087. The Multibus interface includes a 20-bit, 1M-byte address and eight vectored interrupts. Memory mapping hardware in the DSC-4 makes 0.5M bytes of memory available, which can be



directly addressed by the DSC-86. The DSC-86 is priced at $995 in single-unit quantities, and the DSC-4 is priced at $6995 in single-unit quantities, with dealer discounts available. **Digital Microsystems, Inc.,** 1840 Embarcadero, Oakland, Calif. 94606. **Circle No 305**

MTI announces CP/M display for Mod III

The Mod III series of computer systems has been enhanced with business CP/M, a 1920-character, 80-character × 24-line CRT display and a Winchester-disk system. CPM application software includes Wordstar, Datastar and Mailmerge. Hardware required to run business CP/M includes a CP/M adapter and an 80-column video board. The CP/M version 2.2 software runs on any 48K-byte Mod III 140, 240 or 280 system using CP/M 80. The Winchester system features 48K bytes of RAM, a 2-MHz Z80 CPU, a 5M-byte Winchester disk, a 700K-byte floppy-disk drive, a printer interface and a cassette interface. An RS232 interface and a 4-MHz speed enhancement are optional. Hardware and software to run CP/M sell for $849, including documentation and CP/M manual. The Winchester system sells for $5399. Micro Systems DOS sells for $299. **Microcomputer Technology, Inc.,** 3304 W. MacArthur Blvd., Santa Ana, Calif. 92704. **Circle No 306**

Videodisk includes laser disk player

The DiscMaster 5000 computer-controlled, laser video-disk system incorporates an Atari 400 Computer, a Pioneer VP-1000 laser disk player and an interface with a built-in Z80 μp. Also included is 16K of memory, a floppy-disk drive, Atari BASIC, cabling, connectors and user documentation. Price is $3000. **New Media Graphics Corp.,** 139 Main St., Cambridge, Mass. 02142. **Circle No 307**

Mitsubishi introduces small-business computer

The 8018 II small-business computer includes BASIC software, a large-character green phosphor CRT display, a Selectric-style keyboard and 10-key numerical pad and two,

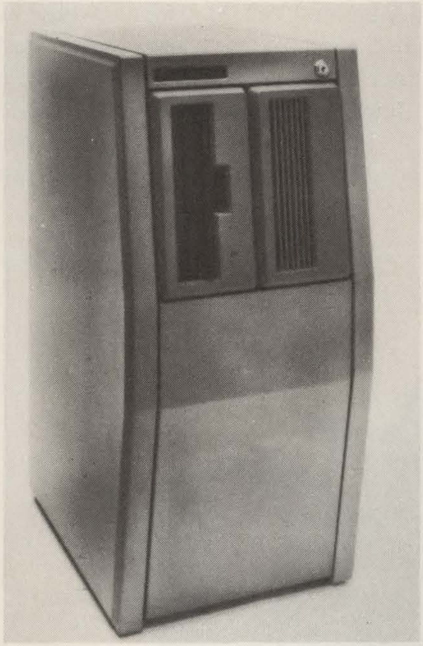
double-sided, double-density, 8-in. floppy-disk drives. Additional CRTs and add-on drives are optional. **Mitsubishi Electronics America, Inc., Computer Division,** 2200 W. Artesia Blvd., Compton, Calif. 90220. **Circle No 310**

System is contained on single board

The single-board Super/Net S-100 computer system consists of 64K of bank-select dynamic RAM, a Z80A CPU, a 2716 2K monitor EPROM, a 5¼- and 8-in. floppy-disk controller, two serial and two parallel interface ports and a Z80A counter/timer circuit for real-time interrupts. The device supports DMA and operates under CP/M and MP/M. Price is $1125. **Advanced Micro Digital Corp.,** 7201 Garden Grove Blvd., Suite #E, Garden Grove, Calif. 92641. **Circle No 311**

Micromation introduces multi-user μc system

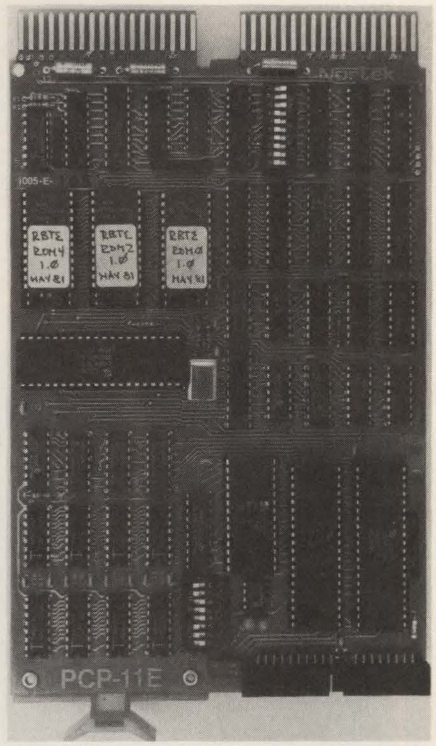
The Mariner series of 8-bit μcs allocates a satellite processor card with a Z80A and 64K bytes of RAM to each user. The satellites are linked via an S-100 bus to mass-storage devices and other peripherals. A master processor oversees system operation and arbitrates bus usage. The system handles as many as eight on-line users. It can be configured with one or two single- or double-sided floppy-disk drives for a capacity of as much as 2M bytes and an 8-in. Winchester-disk drive with 21M-byte capacity. Backup for the hard disk is provided by a ¼-in.



streaming-tape drive. The system supports RS232 display terminals and printers with serial and Centronics interfaces. Single-user system prices start at $4500. An eight-user system with a hard disk, a single-sided floppy and tape backup sells for $26,850. **Micromation, Inc.,** 1620 Montgomery St., San Francisco, Calif. 94111. **Circle No 312**

Nortek announces Z80-based system

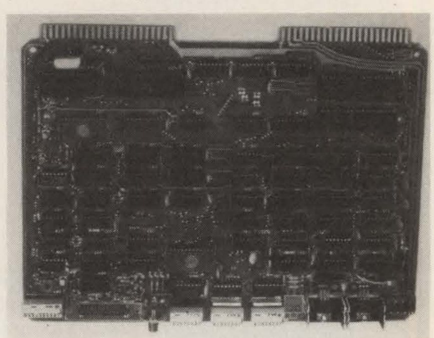
The PCP-11E DEC LSI-11-compatible computer includes a 4-MHz Z80 μc, 16K bytes of RAM, as much as 24K bytes of EPROM, an RS232 channel with asynch and synch operating modes and modem control, an auxiliary asynch serial channel, an 8-bit parallel port, four counter/timer circuits and a 16-bit programmed I/O interface to the host Q-bus processor, with interrupt-driven handshaking. The system also includes the SPICE EPROM-resident operating system. The system sells for $950 in single-unit quantities and $665 IN 100-unit quantities. An applications-development package, which includes a PCP-11E with ROM-resident SPICE



extension set, an RT-11-based macro cross assembler, a relocating linker, diagnostics, monitor listings, model applications and interfacing software, full technical documentation and user's group membership, sells for $1950. **Nortek, Inc.,** 2432 N.W. Johnson St., Portland, Ore. 97210. **Circle No 313**

6502-based μc supports video formats

The Micro Plus μc features video and communications support, a keyboard interface, RAM, EPROM and I/O capabilities. A 6845-based



video controller supports programmable screen formats of as many as

132 columns × 30 lines, user-defined character sets, cursor control, reverse video, blanking and special effects. The device includes a 6522-based ASCII keyboard controller, a 6551-based communications controller to support RS232C and 20-mA current-loop service, programmable baud rates as high as 19.2K bps and a choice of software monitors, including MicroMon 2, in EPROM. The unit is priced at $375 with a 3K RAM and $425 including RS232C communications. **The Computerist, Inc.,** 34 Chelmsford St., Chelmsford, Mass. 01824.

Circle No 308

RCA announces 8-bit CMOS μp

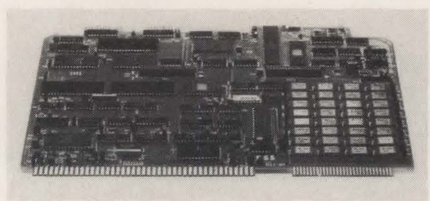
The 8-bit CDP1802A CMOS μp offers a clock frequency of 3.2 MHz at 5V and 6.4 MHz at 10V, over a −40°C to +85°C temperature range. The device operates from 4V to 10.5V and has an internal Schmitt trigger buffer on the CLEAR input.

The device is pin-for-pin compatible with and functionally equivalent to the CDP1802 CMOS μp. In a plastic package, the device is priced at $3.98 in 1000-unit quantities. **RCA Solid State Division,** Rt. 202, Box 3200, Somerville, N.J. 08876.

Circle No 309

Single-board device has 4-MHz Z80

The DSZ-80 single-board μc incorporates a 4-MHz Z80, an 80 × 25 CRT controller, a Centronics printer



interface, a keyboard interface and an asynchronous/synchronous RS232 communications channel. Additional I/O expansion via two SBX-compatible connectors enable a floppy-disk controller to be attached. The device's memory array consists of 64K bytes of dynamic RAM and 2K bytes of 2716 or 4K bytes of 2732 bootstrap PROM. A 2K-byte global memory for inter-processor communication in a distributed multiprocessor system ar-

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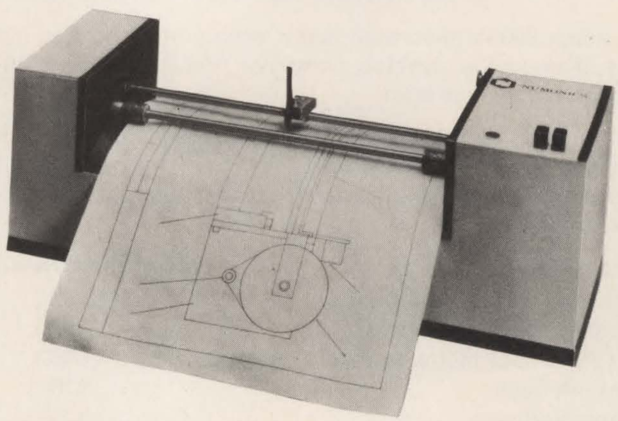

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chitecture is also available. The DSZ-80 is compatible with MP/M+ and CP/M+ 2.2. It sells for $1295 in 100-unit quantities. **Dynamic Structured Systems,** 8 Murray Dr., Westbury, N.Y. 11590.

Circle No 314

Genisco introduces OEM graphics system

The G-6150 color/monochromatic graphics system for OEMs incorporates the vendor's G-6000 advanced display computer, a graphics processor, refresh memory and a post-processor. The 16-bit, PLA-oriented, bit-slice processor has internal instruction execution times as low as 160 nsec. It includes 16K bytes of PROM, 112K bytes of RAM, a 60-Hz, non-interlaced 768 × 512 × 4 bit-mapped refresh memory, 16 colors or monochrome shades from a palette of 64, selectable raster DMA from the host to the refresh and an animation-assist mode, in which the graphic is erased during the read refresh cycle. Options include resolutions to 1535 × 1024 × 4, additional overlay memory planes, expanded refresh memory, interfaces for major minicomputers and an RS232C interface. The system sells for less than $13,000, and a dual-channel version sells for less than $17,000 in OEM quantities. **Genisco Computers Corp.,** 3545 Cadillac Ave., Costa Mesa, Calif. 92626.

Circle No 315

Selanar announces graphics for CIT-101 terminal

The SG101 and SG201 graphics boards for the vendor's CIT-101 alphanumeric terminal provide 1225- × 240-dot resolution. The SG101 is compatible with Tektronix 4010 software, DISSPLA and TELAGRAPH. The SG201 also features 4010 compatibility as well as 4014 compatibility. A CIT-101 with the SG201 emulates Tektronix 4010 and 4014 terminals with an addressable plot area of 4096 × 4096 dots. Plot modes consist of normal, point plot and incremental plot, and vector-variation modes include solid, dotted, dot-dashed, short-dash and long-dash lines. The SG201 also features page-break capability, enabling an operator to sequence through graphics images. Both boards feature native mode graphics, which include a μp-based vector generator. Each model is priced around $1500. **Selanar Corp.,** 437-A Aldo Ave., Santa Clara, Calif. 95050. **Circle No 316**

IC performs multiplication, division

The SN54/74S508 digital IC performs multiplication, division and accumulation as an intelligent co-processor for an 8-bit μp. The device performs 28 multiplication instructions and 13 division instructions. Basic multiplication instructions are performed in less than 0.8 μsec., and basic division instructions are performed in less than 2.2 μsec. Multiply options include positive and negative multiply, positive and negative accumulation, multiplication by a constant and single- and double-length addition with multiplication. Divide options allow single- or double-length division by a single-length number, division of a previously generated result, division by a constant, continued division of a remainder or quotient and repetitive multiplication followed by division. Dividends are 16 bits. Housed in a 24-pin, 0.6-in.-wide DIP, commercial and military versions of the SN54/74S508 sell for $64 and $96, respectively, in quantities of 100. **Monolithic Memories, Inc.,** 1165 E. Arques Ave., Sunnyvale, Calif. 94086.

Circle No 317

CDC announces business, educational μc

The model 110 μc functions as a business or educational unit or as an on-line work station to access the vendor's time-sharing services or the Plato computer-based education system. The 110 also enables the use of Cybernet, Call 370 and Plato services. BASIC and Pascal are also available. A basic 110 without applications sells for $4995 and includes a CPU with 64K bytes of memory, an 8-in. disk subsystem, which contains 1.2M bytes of RAM, and an operating system. Business and education applications sell for $625 to $4000. **Control Data Corp.,** Box 0, Minneapolis, Minn. 55440.

Circle No 318

The 10½ Commandments.

Revelations don't come easy. But they do come fast. And the computer industry is no exception.

That's why the first reaction to our Cynthia D100 Series 10½" disk drives was almost universally... "Holy Moses!"

But, when you think about it, every industry standard began as a new standard. From 14" to 5¼". The 10½" is no different.

Actually, the 10½ Commandments are really a compendium of critical considerations, specifically: when you need the power and performance of a 14" drive in a package ⅓ the volume, specify Cynthia; when you need a more efficient use of surface storage space than an 8" drive, specify Cynthia; when you need an optimal-sized drive for high performance, highly reliable stand-alone systems, specify Cynthia. Amen.

What it all comes down to is the fact that Cynthia D100 Series 10½" disk drives are proving to be the optimum answer in a myriad of minicomputer and distributed processing applications. In fact... we've already shipped over 12,000 units to satisfied customers in the United States and throughout the world. It's this unique combination of proven product experience, together with the technological achievements of our parent company, Cii Honeywell Bull, that have made us the recognized leader in 10½" technology.

Sure, our Cynthia D100 Series disk drives may not be what you've previously considered "industry standard." But when you consider the inherent advantages of the 10 ½" format, together with technological advances like our patented embedded servo design, you may find that this new standard may be an infinitely better standard. It's easy to find out. Just call us at (415) 856-8181. Or drop us a line.

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les Clayes-sous-Bois, France.

CIRCLE NO. 128 ON INQUIRY CARD

SGM announces real-time software

RCS-7, a real-time, data-acquisition-and-control product, runs on DEC PDP-11 series, VAX series, Modcomp Classic series and other real-time computers. RCS-7 uses Aydin Controls color graphics CRT display generators and accommodates customer-specified data-acquisition units. Other features include on-line interactive display and database creation using fill-in-the-blanks CRT questionnaires. RCS-7 requires no programming knowledge. Price is $35,000. **SGM, Inc.,** 8830 Interchange Dr., Houston, Texas 77054. **Circle No 354**

Operating system is compatible with CP/M

The Z80-based TurboDOS operating system, claimed to be compatible with and faster than CP/M 2.2, provides single-user and networking configurations, supports hard disks totaling as much as 16 bytes and files as high as 134M bytes without partitioning. Features include automatic file and record interlocks, print spooling, support of as many as 16 printers, multiple commands per line and nesting of command files. TurboDOS is also available for the TRS-80 model II, Xerox 820, Televideo TS-800, Digilog 1000 and 1500, IMS International 5000 and 8000 series and S-100 systems. **Software 2000 Inc.,** 1127 Hetrick Ave., Arroyo Grande, Calif. 93420. **Circle No 355**

MAG announces sort/select utility

The Magsort sort/select/merge utility runs on μcs under the CP/M and MP/M operating systems. Magsort can be run in stand-alone mode or called directly from user programs written in CBASIC, CB80, Microsoft BASIC (interpreter or compiler), FORTRAN-80, Pascal MT+ and PL/I-80, sorting on as many as 10 keys. A self-relocating bootstrap routine writes the calling user program to disk and then loads Magsort into memory. This makes the entire memory available for sorting. When the sort is complete, Magsort reloads the user program into memory and returns control to it, also returning a completion code. In stand-alone mode, the program prompts a user for all necessary information. **Micro Applications Group,** 20201 Sherman Way, Suite 205, Canoga Park, Calif. 91306. **Circle No 356**

Infosoft announces OS for TRS-80 model II

The MultI/OS and I/OS operating systems provide Radio Shack TRS-80 model II computers with CP/M compatibility. MultI/OS supports as many as three users with as much as 196K bytes of memory in the system. As much as 40M bytes of disk can be added on as many as 15 drives, with 63,000 files allowed. Features include autostart capability; the ability to disable user-abort sequences; symbolic-debugger, text-editor, directory-status, disk-copy and file-transfer utilities; disk and memory diagnostics; printout formatting facility; and five user-programmable function keys. MultI/OS allows as many as 16 tasks simultaneously, multiple printers with automatic spooling and 48K bytes per user. **InfoSoft Systems Inc.,** 25 Sylvan Rd., S. Westport, Conn. 06880. **Circle No 357**

First Systems announces cross-development tools

First versions of the cross-development software Tool Set, available on DEC VAX and IBM 370 computers, produce object code for Intel 8086 and 8088 μps. Programming can be done in Pascal, ANSI-77 FORTRAN or assembly language. The Tool Set also includes a linker, a locator, a symbolic debugger and host/target communication programs. The FS optimizing Pascal compiler supports the 8087 floating-point processor. The FS symbolic debugger controls program execution through host-system terminals, using Pascal-style syntax and expressions to examine and set variables, interrupt programs and insert conditional logic at break points. Various license agreements, are available, with fees depending on the host system. **First Systems Corp.,** 865 Manhattan Beach Blvd., Manhattan Beach, Calif. 90266. **Circle No 358**

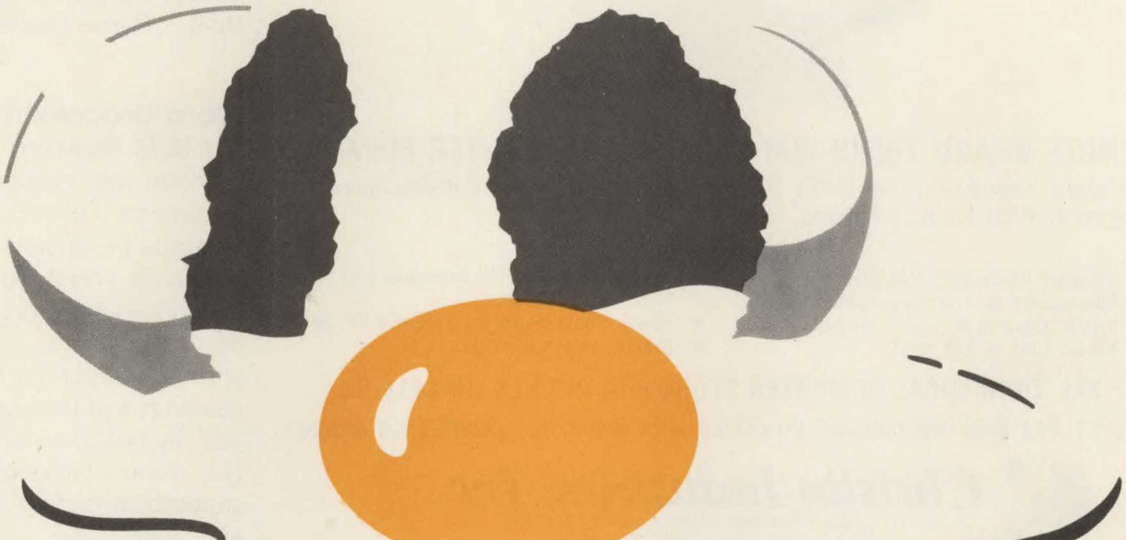
Texprint offers printer graphics upgrade

Decplot, a plug-in electronic module, installs in 5 min., providing dot-addressable plotting over the entire page of the DEC LA120 printer. Decplot software, conforming to DEC graphic protocol standards, employs three simple commands and none of the ASCII control characters for plotting. Existing programs can be modified for graphics without rewriting systems software. Decplot is also compatible with ISSCO's Disspla and Tell-A-Graf and many computer time-sharing services. A Decplot LA120 can accommodate standard DEC terminal options. Decplot plug-in modules sell for $595 in single-unit quantities. **Texprint, Inc.,** 8 Blanchard Rd., Burlington, Mass. 01803. **Circle No 359**

Data Access unveils development system

The DataFlex application development system, running under the CP/M operating system, provides the on-line functions necessary for development of multi-user, multi-file, on-line business applications. The system contains a relational DBMS, an on-line, interactive multi-file data-entry/retrieval module, a report generator and utilities used to "configure" applications. The report generator can produce multi-file reports and process file updates

Compared to Cynthia, most Cartridge Disk Drives are strictly for the Birds.

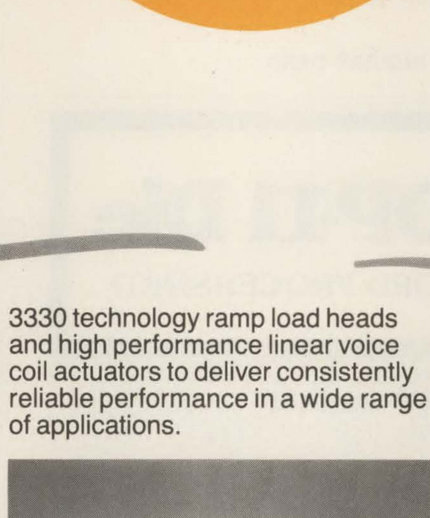


Funny, isn't it? While some people are crowing about the fact that they're just now delivering compact fixed/removable hard disk drives, we've been shipping them for years. Over 12,000 of them, to be exact.

On top of that, we can offer you a choice.

Need 10MBytes of formatted capacity on a removable disk in a compact, high performance package? Our D120's your answer. Want 10MBytes of fixed disk storage with an additional 10MBytes of removable disk-to-disk backup? Voila... D140. Both are powerful, 10½″ rigid disk drives, incorporating the latest disk drive technology in a compact, proven package.

Whichever Cynthia cartridge drive you choose, you'll be receiving a reliable, field-proven design, with over 6,000 hours MTBF. You'll also be receiving Cynthia's patented embedded servo track positioning system which ensures consistently accurate head positioning, with no head alignment required. Cynthia D120 and D140 drives also incorporate proven 3330 technology ramp load heads and high performance linear voice coil actuators to deliver consistently reliable performance in a wide range of applications.



Need more?

Cynthia D120 and D140 disk drives have it. Like SASI*-compatible controllers that provide simple, low-cost integration to your host bus. And all DC power for international flexibility. Plus you get a proven track record in cartridge disk drives that only our parent company, Cii Honeywell Bull, can provide.

So why take a flier on just any fixed/removable disk drive? Check out the Cynthia D120 and D140's today. Call us for an evaluation unit. Or write for free product information. We'll send it to you. By air, of course.

Cynthia Peripheral Corporation... we're setting new standards in disk drive technology.

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CIRCLE NO. 131 ON INQUIRY CARD

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TWX: 910-373-2088

Europe:
Cii Honeywell Bull
Cynthia OEM Division
Phone: (3) 055.55.58
Les Clayes-sous-Bois, France

Software

simultaneously. As many as 50 files can be supported, with four ISAM indexes per file. Record protection is provided at the field level. **Data Access Corp.,** 4221 Ponce De Leon Blvd., Coral Gables, Fla. 33146.
Circle No 360

Word processing offered for IBM System 38

ZWORD/38, running on the IBM System 38, allows for the insertion of words or phrases into lines with automatic wraparound to the next line. Previously prepared text can be inserted into new documents without retyping. Page numbers, headings and footings can automatically be placed on all or any pages of the final document. ZWORD/38 supports a variety of letter-quality and high-speed line printers. A full-screen text editor allows access to any section of the document, by line number or by scrolling. Data can be entered from the computer database directly into documents, without converting the files to a special format. **AccuSoft, Inc.,** 126 Alto St., San Rafael, Calif. 94901.
Circle No 361

Program provides file handling

CMAR, a keyed file-access method for the Commodore line of small-business computers, is written in 6502 machine language. The package performs read, write, change and delete functions and supports as many as five opened keys concurrently. Because the file system is dynamic, file reorganization is not required as in ISAM and binary tree configuration. CMAR requires less than 10K bytes of memory and can be expanded to any operational file size, limited only by disk-storage capacity. Files can consist of 2000 to 20,000 keys, depending on key size. CMAR is priced at $99. **Cimarron Corp.,** 666 Baker St., Suite 319, Costa Mesa, Calif. 92626.
Circle No 362

Software

Phase One announces C compiler for OASIS

OASIS C is claimed to support all features of Bell Laboratories' UNIX Version Seven C except floats, doubles, longs, multidimension arrays, fields, structure initializers or type definitions and type casts. Producing Z80 assembler code, OASIS C includes an optimizer that shrinks the compiled code 30 percent to 50 percent. Recursive by design, OASIS C allows a routine to call itself repetitively. Pointers are used in place of arrays. Logical and bit assignment operators are provided. The I/O library offers file, string, character, size and buffer-adaptation abilities. Separate and conditional compilation facilitates migration from one operating environment to another. Price is $250. **Phase One Systems,** 7700 Edgewater Dr., Suite 830, Oakland, Calif. 94621. **Circle No 363**

Text editor joins Mainsail stable

Mainedit provides full-screen text editing on a broad range of computer systems, from μcs to mainframes. The text editor, an adjunct to Mainsail, the vendor's high-level language, offers multiple windows, allowing the user to see two pieces of a document or two files at the same time, and multiple files, for text movement between files. Mainedit can be integrated into a larger system, such as an electronic-mail package. It can also be called as a procedure, returning the edited text to the calling program. **Xidak, Inc.,** 530 Oak Grove Ave., Suite 101, Menlo Park, Calif. 94025. **Circle No 364**

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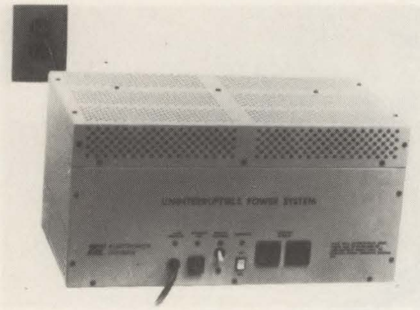
Components

UPS provides continuous power

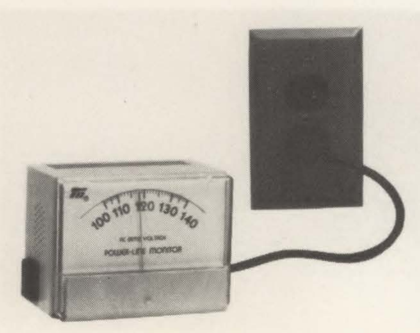
This uninterruptible power supply delivers 400W of power in an AC-format continuously recharged battery. In the event of a utility power outage, the batteries continue to provide output AC power for a minimum of 20 min. The UPS



prevents power dips and brownouts from affecting equipment or dropping data from computer memories. Automatic shutoff prevents battery damage in the event of an extended blackout beyond the capability of the UPS. Standard output voltage is 120V AC, single phase with ±3 percent regulation, 60 Hz ±0.1 percent and a sinewave with 3 percent maximum harmonic distortion. Standard operating temperature is 0 to +40°C (+32°F to +104°F). **TII Electronics Division,** 1375 Akron St., Copiague, N.Y. 11726. **Circle No 366**

Indicator monitors power-line voltage

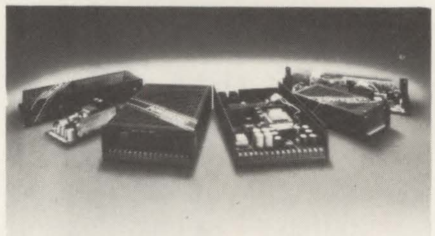
This power-line monitor plugs into a standard 120V outlet to indicate RMS AC voltage level. The monitor has a moving vane-type indicator, which tracks voltage



within ±2 percent of the RMS value for frequencies of 50 or 60 Hz. The monitor warns of spikes and dips and reveals bounces and fluctuations, indicating voltage from 100V to 140V. **TII Electronics Division,** 1375 Akron St., Copiague, N.Y. 11726. **Circle No 367**

Powertec introduces switching power supplies

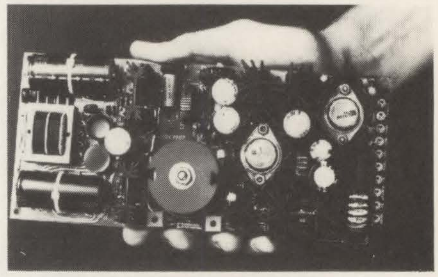
The series 19 ValueSwitcher switching power supplies for 50W to 300W applications offers a regulated main output and fully or semi-regulated auxiliary outputs. Other features include input filtering, logic inhibit, AC under voltage, inhibit and remote sense. Overvolt-



age protection is standard on the main output and optional on the others. Other options include a power-fail signal and cover, brownout below 85V or 170V AC and EMI protection. ValueSwitchers, which are field strappable and available in open-frame or enclosed models, sell for $101 to $410 in quantity. **Powertec, Inc.,** 20550 Nordoff St., Chatsworth, Calif. 91311. **Circle No 368**

Power General announces off-the-line switchers

The series 5110 power supplies are true off-the-line switchers with five output voltages on a PC board. Full rated output is provided over an ambient temperature range of 0°C to 40°C with a 2 percent derating to +71°C. Model 5110-1 provides outputs of 5V DC at 10A, −5V DC at 1A, +12V DC at 1A, −2V to −12V DC at 0.2A to 1A and 24V DC at 2.5A. Model 5110-2 is identical, except the +12V DC output is +15 V DCat 1A. The supply input offers pin-strappable voltage ranges of 85V to 130V AC or 170V to 250V AC at 47 to 470 Hz. Other specifications include ±0.1 line regulation, ±0.2 percent load regulation for the primary output, ±5 percent secondary outputs, transient response of 300



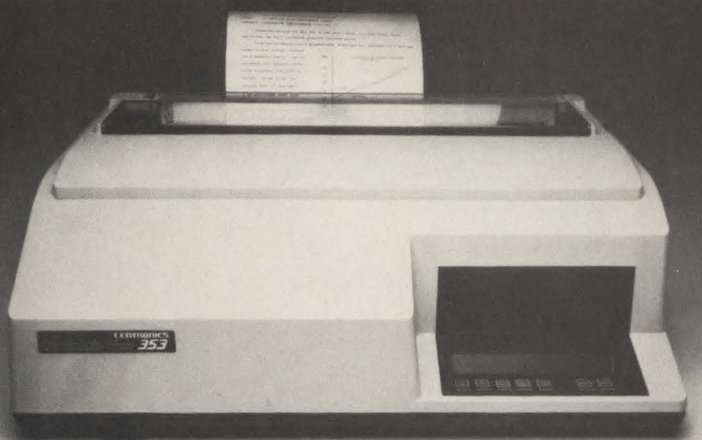
μsec. to 1 percent of the final value, 1200V AC input to output isolation, 16-msec. hold-up time, input surge current and 5 percent to 80 percent noncondensing relative humidity range. The devices sell for $179 each. **Power General,** 152 Will Dr., P.O. Box 189, Canton, Mass. 02026. **Circle No 369**

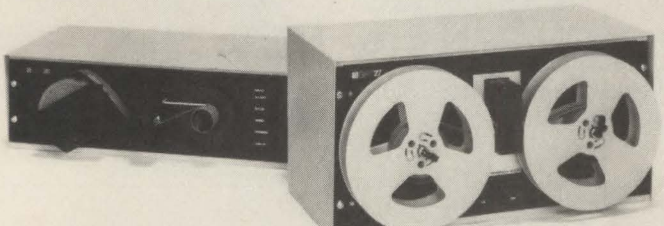
Analog switch uses bipolar, ion-implanted FETs

The SW-201 four-channel, normally closed, single-pole single-throw analog switch is pin-compatible with all 201 analog switches. The device employs bipolar and ion-implanted FETs. At −125°C, on leakage current is a maximum of 60 nA. Maximum on leakage current at 70°C is 30 nA. All digital channel select inputs operate from TTL and CMOS logic levels. The digital input logic current remains lower than 5 μV for digital inputs between 0V and 15V. Maximum turn-on and turn-off switching speeds are 50 and 400 nsec., respectively. Prices range from $2.50 to $12.90 in 100-unit quantities. **Precision Monolithics, Inc.,** 1500 Space Park Dr., Santa Clara, Calif. 95050. **Circle No 370**

Power center protects computer equipment

The MFJ-1108 power center fea-

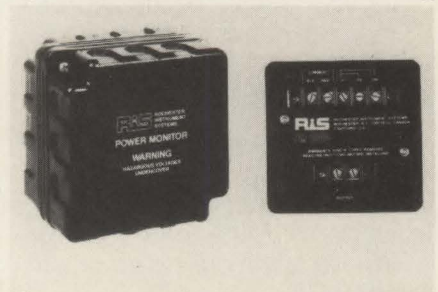




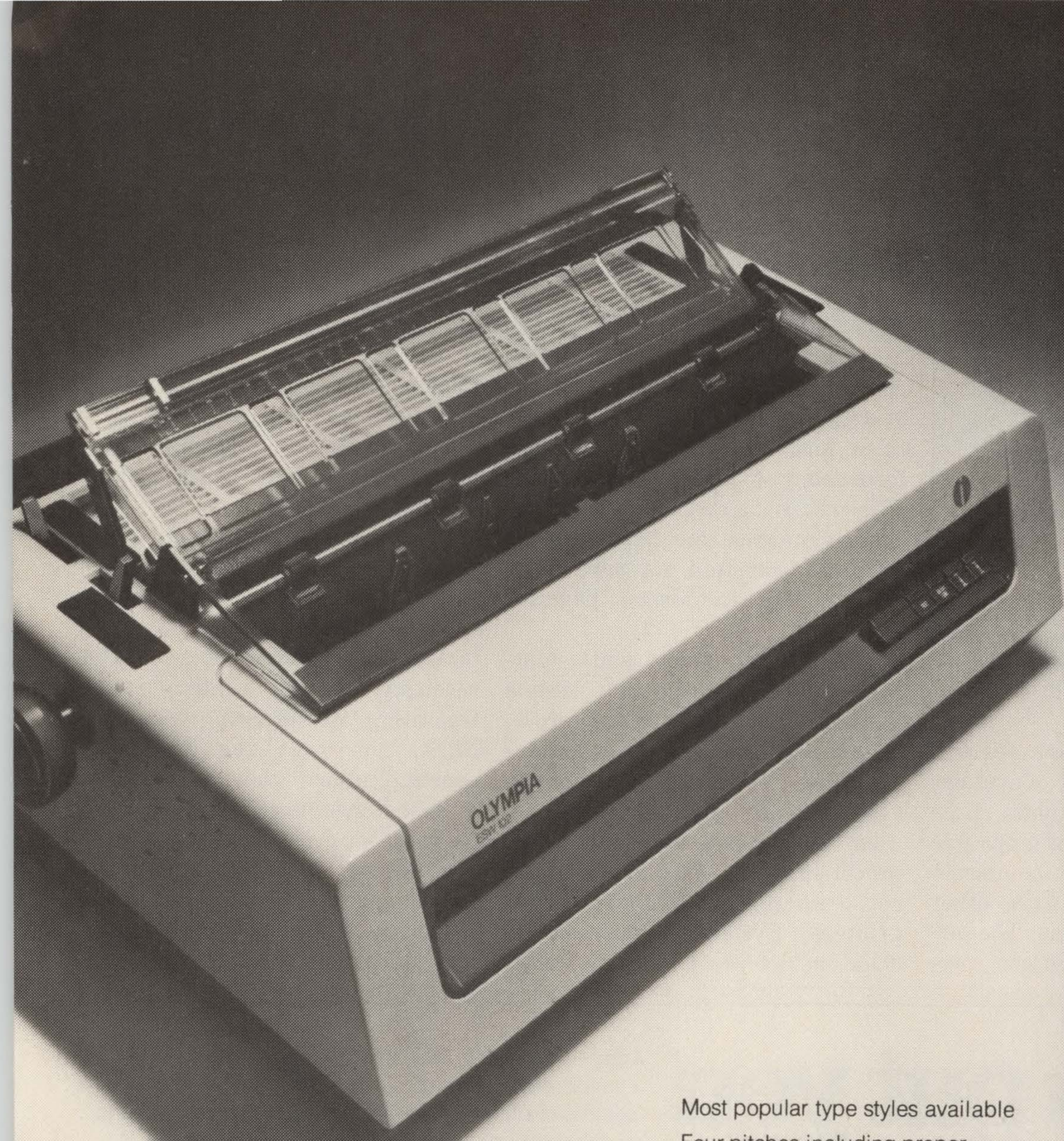
tures a sensitive protective relay; momentary power-line off-on transients cause this relay to latch out power before damaging disks and equipment. The device includes RFI pi filters that isolate each line of each pair of sockets from power-line noise, hash and other pairs of sockets. Varistors between each line and ground and between lines suppress voltage spikes. Other features include a heavy-gauge aluminum enclosure, a 6-ft., heavy-duty, three-wire power cord and industrial-grade grounded sockets. Three pairs of sockets are isolated, protected and controlled by a lighted on/off switch. The device sells for $99.95. **MFJ Enterprises, Inc.,** P.O. Box 494, Mississippi State, Miss. 39762. **Circle No 371**

Rochester Instruments offers power monitor

The series PM-1000 power monitors for monitoring a building, a zone, a department or a piece of electrical equipment can be used as primary sensors for energy-management systems, sub-metering



applications or load-shedding controls. The monitors measure line voltages, line currents and power factors and provide a pulse output proportional to kilowatt hours. Six kits are available: 120, 208/240 or 460/480 nominal AC voltage ranges; single-phase two-wire, single-phase three-wire, split-phase or three-phase three-wire applications; and 50A or 200A ranges. **Rochester Instrument Systems,** 255 N. Union St., Rochester, N.Y. 14605. **Circle No 372**



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CIRCLE NO. 142 ON INQUIRY CARD

A single-line LED display on the OCP/88 *indicates which systems are connected and in which direction data are flowing.*

Interface links incompatible processors

Transmitting between several machines simultaneously, a modular interface from G.O. Graphics, Lexington, Mass., permits incompatible word processors to communicate with each other or with other office-automation systems. The OCP series office-communications processor transfers the transmitting system's full error-correction routines, and the interface retains the formatting of any documents sent. If the receiving system doesn't have the same formatting capabilities as the sending system, software in the OCP simulates the format, page for page.

Available in four- and eight-channel versions, the OCP accepts PROM cartridges that contain protocol translations, code conversions and line disciplines for specific systems. G.O Graphics offers modules for more than 150 word processors, typesetters, data processors and intelligent copier/printers. Systems supported include models from Xerox Corp., Lanier Business Products, Inc., Wang Laboratories, Inc., CPT Corp., Honeywell Information Systems, Inc., and IBM Corp., among others.

Acting as a desk-top communications switchboard, the OCP enables users to establish full-duplex links so two systems can carry on a dialogue without requiring constant resetting of the control panel. Operating over existing telephone lines, the OCP regulates the communications flow among the attached systems in any way an operator desires. Once translation modules are inserted into the OCP, the operator punches keyboard buttons to set the required communications links.

"Without touching your program I can move it to and from Z80, LSI-11,™ 8086, 6502, 8080, 6809, 68000 and 9900-based computers."

JULIE ERWIN, Vice President, Marketing, SofTech Microsystems, Inc.

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CIRCLE NO. 144 ON INQUIRY CARD

Aside from linking various office systems, the OCP serves as an access port to remote systems via modems or other communications networks such as TWX, Telex or various local-area networks. With an add-in storage option, the OCP handles message store-and-forward functions.

The four-channel OCP/44 sells for $5995, and the eight-channel OCP/88 sells for $7495. Users who need to connect more than eight devices can link several OCP units. Software cartridges for each supported device sell for $500 each. The manufacturer also offers 90-day trial rentals of the OCP/44 and the OCP/88 at rental prices of $1500 and $1875, respectively. **G.O. Graphics, Inc.,** 179 Bedford St., Lexington, Mass. 02173. **Circle No 373**

IDS offers modem-line switch

The model 8504-12 multiple modem-line back-up switch switches 12 analog four-wire channels and allows four telephone lines to share a single modem for each channel, or four modems to share a single telephone line for each channel. Several modules can be chained to form a 4 × 4 modem-line crossbar switch to connect four modems and four telephone lines. The rack-mounted device measures 5¼ × 19 in. Price is $1735. **International Data Sciences, Inc.,** 7 Wellington Rd., Lincoln, R.I. 02865. **Circle No 374**

General Micro unveils quad ACIA/TTY module

The quad GMS6511 quad ACIA/TTY module is compatible with the Motorola EXORciser/Micromodule and Rockwell System 65/AIM 65 bus structures. The unit is available in 1-MHz and 2-MHz versions and offers data set/modem control functions and a wire-wrap section for custom-clock circuitry. The module includes base address and enable/disable switches plus overvoltage and reverse polarity protection. Each of the four channels can be operated at different interface standards and baud rates, and can control a TTY. Other features include control software for each channel; 15 programmable baud rates from 50 to 19.2K bps; and programmable word length, number of stop bits, parity generation and detection and interrupt control. Data set ready and data carrier detect are also available. Price is $343 in single-unit quantities. **General Micro Systems, Inc.,** 1320 Chaffey Court, Ontario, Calif., 91762. **Circle No 375**

THE ANN ARBOR AMBASSADOR™ 300

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	AAA 300	DEC*VT100*		AAA 300	DEC*VT100*
Display Lines	60	24	Send/Print Controls	12	0
Screen Size	15″	12″	Send/Print Modes	30	0
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The Ann Arbor Ambassador 300 supports most of your VT100* software *without* asking you to give up other features you'll like. Its selectable 60-line display lets you see more of your program or report. And you still get all the capability of the standard Ambassador. Things like editing, formatting, printer output and programmable function keys.

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CIRCLE NO. 146 ON INQUIRY CARD

Brochure describes memory tester

The model 6000A memory tester is featured in a brochure. The six-page, color brochure lists applications and options and information on user training and the company warranty. The device's architecture is illustrated in block diagram, and a line drawing with callouts and photographs shows how the elements combine to produce a memory tester. **Testmaster,** 3191-D Airport Loop, Costa Mesa, Calif. 92626. **Circle No 373**

Bulletin describes uninterruptible systems

A line of uninterruptible power systems is featured in a product bulletin. The two-page illustrated bulletin details the systems' function and operation in isolating loads from blackouts, brownouts, line transients and voltage fluctuations on the commercial AC line. The bulletin also describes the three-phase UPS—from 12.5 kW to 125 kW, 50 and 60 Hz. It provides a reference of input and output specifications, equipment ratings and customizing options. A flowchart illustrates power flow in a typical UPS-protected computer operation. **Lortec Power Systems, Inc.,** 5214 Mills Industrial Parkway, North Ridgeville, Ohio 44035. **Circle No 374**

Brochure describes telecommunication trends

Trends in hard-copy message transmission are described in a 12-page brochure. The color brochure contains a brief overview of message communications, how communication networks evolve, advantages and problems of networks and the evolution of electronic mail. It also details selection of telecommunications equipment, how the vendor's "Micronet" terminals are designed for various applications and how equipment can be upgraded to keep pace with demands and technology. The brochure also includes short case histories on three corporate communication networks. **Sidereal Corp.,** 9600 S.W. Barnes Rd., Portland, Ore. 97225. **Circle No 375**

Handbook features data-conversion technology

Circuit application for designers of A/D conversion systems is featured in a handbook. The 32-page book compiles practical formulas, test methods, definitions and application considerations. It also includes condensed specifications and selection criteria for a broad range of A/D and D/A converters, sample-and-hold circuits and ancillary devices (analog multiplexers, filters, isolation amplifiers, power supplies and modular subsystems) that are useful in precision circuits and systems. **Analogic Corp.,** Audubon Rd., Wakefield, Mass. 01880. **Circle No 376**

Display terminal described in literature

The concept APL8 series APL display terminals is described in a product bulletin. The literature covers specifications, standard functions, operating modes and options. **Human Designed Systems, Inc.,** 3700 Market St., Philadelphia, Pa. 19104. **Circle No 377**

Brochure outlines computer graphics

Graphics and color-graphics terminal enhancements are described in a brochure. The publication describes the vendor's history, products, and services. Products include terminal enhancements for the DEC VT-100, VT-103, VT-132, the Lear Siegler ADM 3A and ADM 5, the Texas Instruments OPTI 900 Model 940 and the Datamedia ColorScan. The brochure also lists warranty and repair information and manuals available from the manufacturer. **Digital Engineering, Inc.,** 630 Bercut Dr., Sacramento, Calif. 95814. **Circle No 378**

Design guide details fiber optics

Fiber-optic systems and guidelines for designing a communications link are described in a design guide. The 12-page booklet provides five steps of designing a fiber-optic communications system, including describing physical requirements, specifying operational requirements, computing signal power, performing bandwidth analysis and reviewing the design. The publication also includes charts, graphs, tables and diagrams. **Belden Corp.,**

LITERATURE THAT COSTS

Book details UNIX operating system

The structure, software and capabilities of the UNIX operating system are described in *A User Guide to the UNIX System* by Jean Yates and Rebecca Thomas. Written for novice computer users, the book describes how to log into the system, enter the shell, handle files, send mail and create directories. It introduces the utility programs that accompany UNIX and references the most frequently used command. The $15.99 book also provides consumer information about the software, related products, university facilities, user groups and newsletters. **Osborne/McGraw-Hill,** 630 Bancroft Way, Berkeley, Calif. 94710. **Circle No 379**

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Dennison's new Electrosensitive Paper comes with a whiter, less metallic matte finish. And because Dennison always has all standard printer and calculator sizes in stock, you get *this* Paper *fast.*

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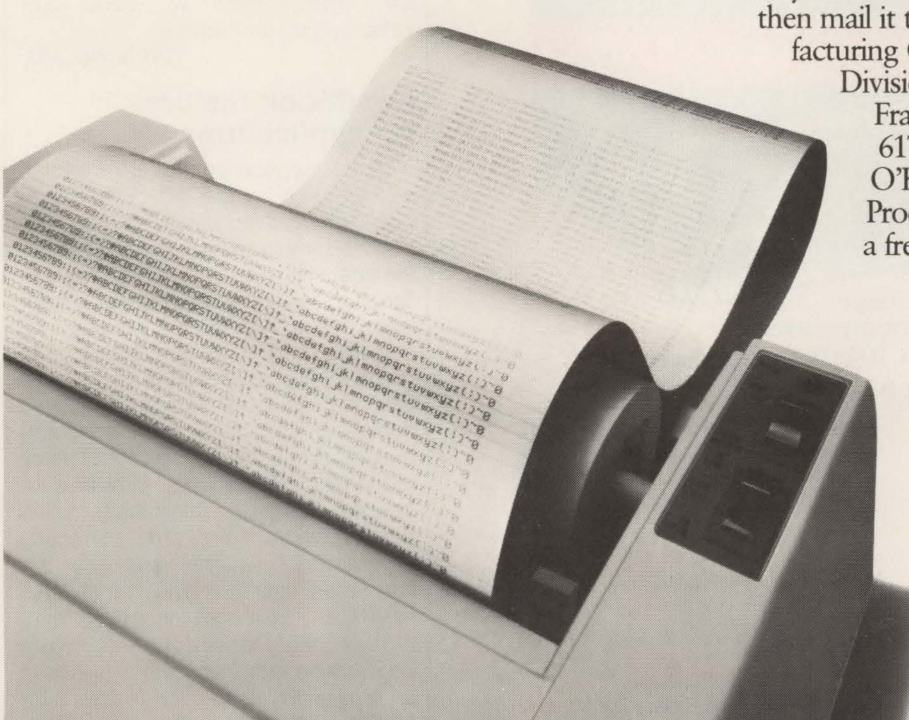


Dennison
Technical Papers

CIRCLE NO. 148 ON INQUIRY CARD

Literature

2000 S. Batavia Ave., Geneva, Ill. 60134. **Circle No 380**

Winchester-disk drive described in brochure

The Micro-Magnum 5/5, 5¼-in.

LITERATURE THAT COSTS

Book details integer BASIC

An introduction to BASIC, for people with no knowledge of programming, is presented in a book by George H. Blackwood and Brian D. Blackwood. Written for Apple II users, *Intimate Instructions in Integer BASIC* is applicable to any µc using BASIC. Each chapter provides definitions, the fundamentals of a programming technique and one or more self-testing lesson exercises in a lesson-type format. The book also covers programming and print rules; operators; truncation and integers; simulated reals; sorting; flowcharting; and graphics to loops, functions and variables. The 158-page book is priced at $7.95. **Howard W. Sams & Co., Inc.,** 4300 W. 62nd St., Indianapolis, Ind. 46268.
Circle No 381

Handbook features µp applications

Useful applications for µp systems are featured in the *Microprocessor Applications Handbook.* With contributions by electronics experts, under the direction of editor-in-chief David F. Stout, this 464-page handbook examines design concepts, schematics, software and hardware for a wide range of µp applications. The book gives details of methods for analyzing, designing, constructing and programming applications. It also covers voice recognition, telephone, lumber processing, IEEE-488 interfacing, video games, digital filters, error correction in memory systems, A/D and D/A interfaces, parallel and serial data interfaces, keyboard scanning techniques, state-description software preparation and using multiple µcs in a single system. Price is $35. **McGraw-Hill Book Co.,** 1221 Avenue of the Americas, New York, N.Y. 10020. **Circle No 382**

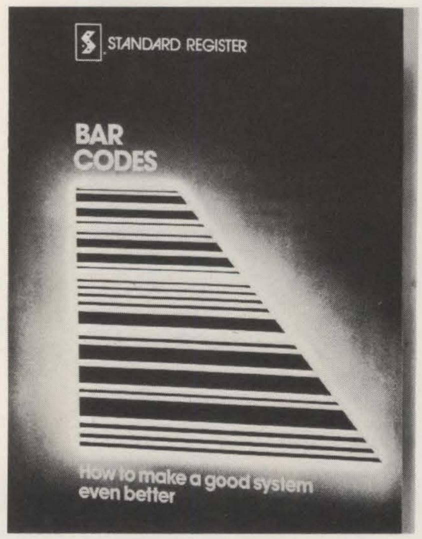
Winchester-disk drive is featured in a brochure. The four-page, color brochure details read/write heads, reliability factors, transportability and interchangeability and system integration. The publication covers head positioning, eliminating head-media contact, air filtration and data integrity, transportability and interchangeability of the removable disk cartridge. A block diagram shows interface connections between the Micro-Magnum 5/5 and a controller. **DMA Systems Corp.,** 325 Chapala St., Santa Barbara, Calif. 93101. **Circle No 383**

Software applications described in a catalog

Software products for the TRS-80, Apple II, Apple III and TI99/4 computers, are featured in a software-applications guide and catalog. The catalog features applications for business, education and personal use. The catalog also details discounts of as much as 30 percent off the retail prices of more than 25 software manufacturers and publishers. **Creative Discount Software,** 246 S. Robertson Blvd., Suite 2156, Beverly Hills, Calif. 90211. **Circle No 384**

Brochure describes bar codes

Designing and supplying bar-coded forms and configurations are described in a six-page, color brochure. The publication describes



press-applied codes (with or without mechanical check digits), LPS-applied codes (form or label with or without mechanical or electronic check digits) and VIS-applied bar codes (high-speed ink-jet system for very large bar codes for systems using remote beam readers). The booklet also provides a glossary illustrating bar-code variations and designs. **The Standard Register Co.,** P.O. Box 1167, Dayton, Ohio 45401. **Circle No 385**

The Pragma non-streamer... *non* is better

for Winchester memory back-up.

Pragma's non-streamer Direct Access Cartridge System™ is simply a better solution.

We made our system hold the tape still while a rotating scanner reads/writes data on tape in the same format as your disk drive. Ingenious!

Your Winchester thinks it's talking to another Winchester. But it's not. Ours is really a "Pragmatic tape that thinks disk™"...but with all the advantages of tape.

We use a ½-inch removeable tape cartridge—like an 8-track stereo—with an 80M byte formatted capacity that attaches directly to a port on your Winchester disk controller. No need for an additional controller, associated memory or software. No dedicated CPU time during dump/restore. All in a package the size of an 8-inch floppy.

With a 200KBS sustained transfer rate, our non-streamer is as fast as a Winchester...up to 10 times faster than a streamer! It's an incremental device that lets your user copy a sector, a track...even an entire disk. No need to copy hard errors just to keep the data stream intact. Thus, a less complex and time-consuming off-load. You can back-up 80M bytes of data with read/verify in only 10 to 11 minutes with a single command from the CPU. Just like disk-to-disk.

Our DAC 2080 is only $1700 in OEM quantities. Call or write us and ask for a price on our special evaluation package—a Pragma non-streamer. And find out why ***non*** is better.

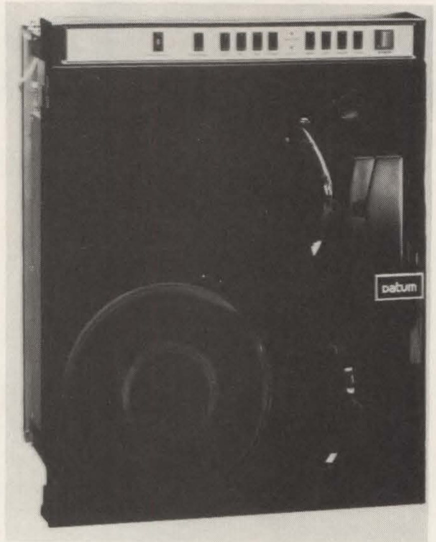
Pragma

Pragma Data Systems, Inc.
610 Palomar Avenue, Sunnyvale, CA 94086
(800) 538-1895
In California Call:
(408) 738-8215

CIRCLE NO. 152 ON INQUIRY CARD

Datum's Gemini offers dual capabilities

A two-year, $1-million R&D effort by Datum, Inc., Anaheim, Calif., has culminated in that company's first tape-drive offering this year: a 45-in.-per-sec., nine-track ½-in. start/stop device that converts on software command to a 125-ips streaming device for Winchester backup.



Designated the DMF-1000 "Gemini" for its twin-mode capabilities, the unit eliminates the need for separate tape transports to accomplish two disparate functions—loading and unloading from high-capacity disk drives as well as start/stop work associated with ½-in. hardware. The 45-ips transaction speed compares favorably to the 25-ips speeds characteristic of other drives. When operating at high speeds in the start/stop mode, Datum president Louis B. Horowitz says, the 25-ips streamers cannot reposition a tape quickly following write errors.

In the 125-ips streaming mode, Gemini monitors the data rate to match data-flow rates of Winchester or SMD disks. If a mismatch occurs, Gemini returns to its 45-ips speed to await software command or manual front-panel switching before resuming backup speed. A Fairchild F8-type µp drives the embedded formatter controlling the host drive. Three additional daisy-chained drives can also be supported.

The drive, which has 95 percent of its electronics on two PC boards, interfaces to Digital Equipment Corp., Data General Corp., Hewlett-Packard Co. and International Business Machines Corp. Series/1 minicomputer systems via a standard ½-in. start/stop interface. In the transaction mode, Gemini accommodates NRZI coding at 800 bits per in. and phase-encoded formats at 1600 bpi.

Horowitz says that ¼-in. cartridge drive manufacturers concentrate on low price/performance to meet the growing need for backup, but he believes the key factor in Winchester backup is high performance. "It is beyond reason to accept the premise that only low-cost, low-performance products can serve this market," he says.

The device sells for $4800 in single-unit quantities, including a controller. OEM discounts are available, and deliveries have begun.

—Nancy Love

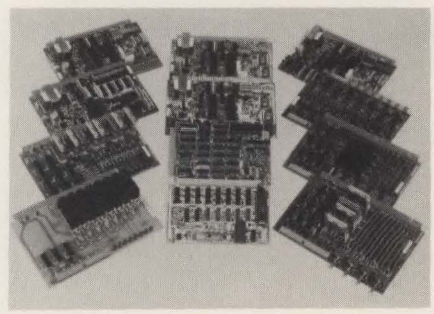
Datum Inc., 1363 S. State College Blvd., Anaheim, Calif. 92806.
Circle No 319

µC-based cards link as many as 256 stations

The Remdacs II family of µC-based preprogrammed modules from Intersil, Inc., links as many as 256 remote data-acquistion-and-control stations with a central computer over a single twisted-pair wire. The family includes three receiver/transmitter cards, four analog data-acquisition cards and six digital cards for input data and control of supply outputs. Each card plugs into a screw-terminal motherboard system. All cards have automatic power-failure and restart circuits.

The receiver/transmitter remote cards handle polling, message formatting, error checking and communications with remote stations. The general-purpose card communicates directly to the bidirectional port of the computer (or to a data bus via handshaking) via an RS232 interface. Two other plug-compatible cards are available for interfacing with STD-bus or Multibus-based systems.

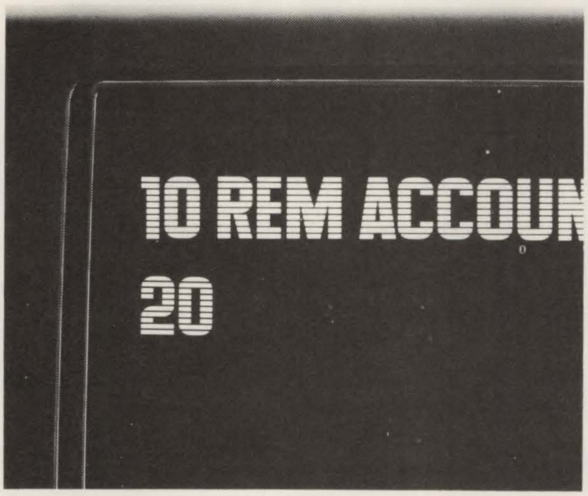
The four analog remote cards for data acquisition multiplex and digitize input signals with a 12-bit, dual-slope, integrating A/D converter. Digital data are stored in on-card memory, to be polled by the receiver/transmitter card.



Intersil's Remdacs II multi-card family *links as many as 256 remote stations with a host computer over a single twisted-pair wire.*

One analog card is dedicated for temperature monitoring, using 16-channel AD 590 integral circuit temperature sensors. Another accepts 16 4- to 20-mA channels. The other two are general-purpose input cards—one a 16-channel single-

BOY, IS THIS COSTING YOU.



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dBASE II is a complete applications development package.

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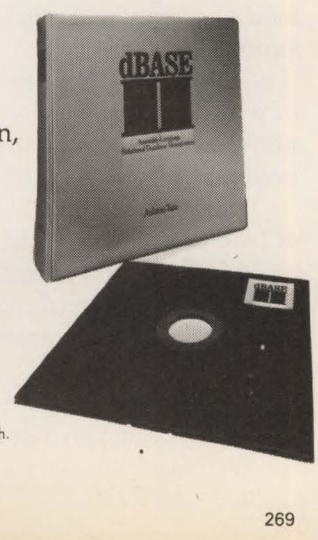
Then send dBASE II back and we'll return all of your money, no questions asked.

During that 30 days, you can find out exactly how much dBASE II can save you, and how much more it lets you do.

But it's only fair to warn you: business programmers don't go back to BASIC's.

Ashton-Tate, 9929 Jefferson, Los Angeles, CA 90230. (213) 204-5570.



Ashton-Tate

CIRCLE NO. 153 ON INQUIRY CARD

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The new Diablo 620 is constructed with a total of five modules for an MTTR of 15 minutes and an MTBF of 2500 power-on hours. It features a single PCB, an RS 232 serial interface, a buffer of 512 bytes, and complies with VDE 0730, 0804 and 0871, and FCC Classes A&B.

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CIRCLE NO. 154 ON INQUIRY CARD

ended card and the other an eight-channel differential card—that interface to many common transducers.

The Remdacs family also includes six digital remote cards. The 36-channel master digital I/O general-purpose card includes 16 latched digital inputs, 16 Darlington-type digital outputs and four extra ports for input or output. This card controls the other five digital cards, providing all error-checking and communications functions.

The remaining digital cards provide monitoring and control functions. An eight-channel high-voltage card monitors 20V to 230V AC in five stages and 5V DC in six stages. Two electromechanical cards are offered: an eight-channel relay card includes either normally open or normally closed single-pull, double-throw contacts, and a four-channel version has four relays and toggle switches to override the relays. In addition, two solid-state cards are available in four- or eight-channel versions that supply normally open single-pull, single-throw contacts, and on-card LEDs to indicate output channel conditions and switching transistor excitation.

Eight motherboards support the remote stations. Analog motherboards house one to four cards each, digital motherboards have two- to five-card positions, and all cards are the same size for ease of interchange.

The units are available now, and prices range from $429 to $669 in single-unit quantities. Installed wiring costs are estimated at $3 per ft. **Intersil, Inc.,** 10710 N. Tantau Ave., Cupertino, Calif. 95014.

Circle No 320

SSM announces board with eight RS232 ports

The IO8 S-100 board comprises eight asynchronous RS232 ports, each individually accessible and

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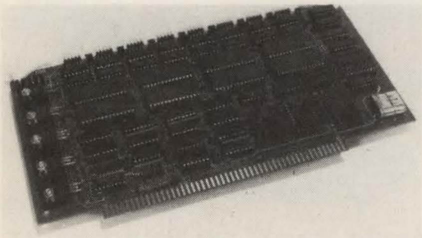
CIRCLE NO. 156 ON INQUIRY CARD

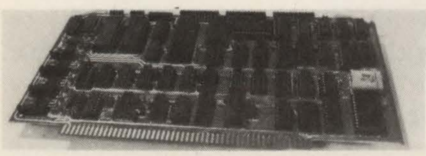
individually programmable. The device features individually programmable baud rates from 110 to 19.2K bps, send/receive LED indicators on each line and a time function, which provides master interrupt clocking (50 Hz/60 Hz) and



supports real-time or multi-user applications. The 108 also provides multiple interrupt modes, including priority, vectored, daisy chain and maskable. Terminal and modem cables are optional. The board sells for $550. **SSM Microcomputer Products Inc.**, 2190 Paragon Dr., San Jose, Calif. **Circle No 321**

SSM offers serial parallel I/O interface

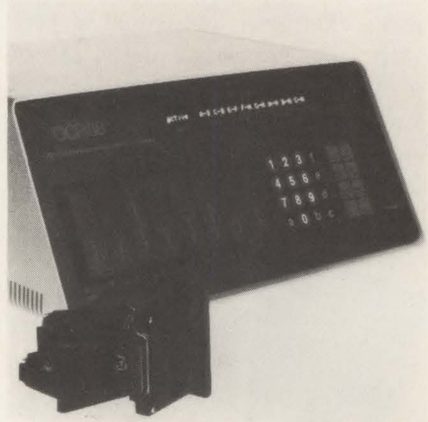
The 105 serial/parallel I/O board offers two asynchronous RS232 interfaces and header-selectable baud rates from 110 to 19.2K bps. It also offers three parallel ports, including a bidirectional, programmable port with 16 data lines, an



8-bit input interface for general-purpose data entry, an 8-bit output interface for Centronics compatibility and send/receive LED indicators on each line. The 105 provides multiple interrupt modes, including priority, vectored, daisy chain and maskable. It sells for $329. **SSM Microcomputer Products Inc.**, 2190 Paragon Dr., San Jose, Calif.
Circle No 322

G.O. Graphics unveils communications interface

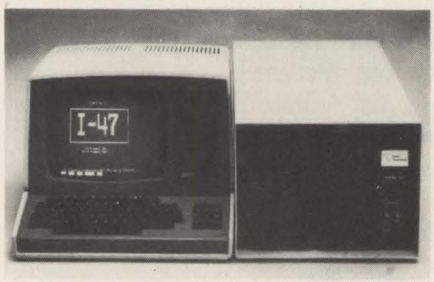
The OCP series office communications processor enables incompatible word-processing and other office-automation systems to communicate. The OCP automatically performs protocol translation, code conversion and determining transmission disciplines. It can also be used to access remote systems via modems as well as TWX, Telex, Ethernet and other communication networks. With optional storage, OCP handles message store-and-forward functions for electronic mail. Other features include the ability to handle as many as eight links, to transfer documents while maintain-



ing full format parity, to transfer error-correction routines and to link several systems to a single typesetter or to a main system in a home office. Two models are available. The OCP/44 handles four simultaneous transmissions, and the OCP/88 handles as many as eight. Prices are $5995 for the OCP/44 and $7495 for the OCP/88. Software cartridges are $500 each. **G.O. Graphics, Inc.,** 179 Bedford St., Lexington, Mass. 02173. **Circle No 323**

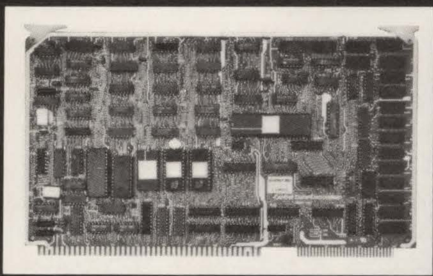
Data Compass offers floppy for Heath/Zenith

The I-47 8-in. floppy-disk system for use with Heath/Zenith computers consists of two intelligent 8-in., double-density, double-sided drives with a formatted capacity of 1.25M bytes per drive. The master/slave drives are built into a 13½-in.-wide cabinet with write/protect switches and indicators, power-on LED and

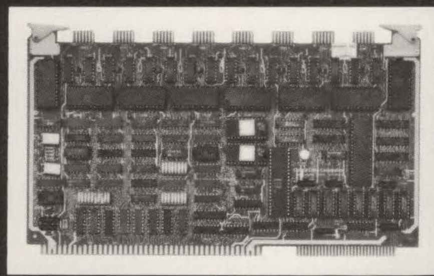


built-in power supply, fan, data cable and documentation. As many as three slave drives can be daisy-chained to the master for a total capacity of more than 5M

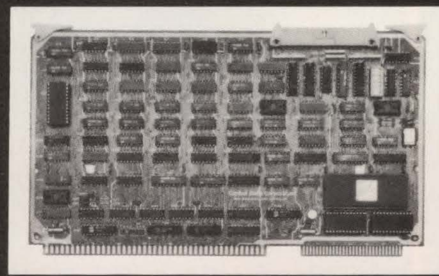
MORE NEW STARS FOR THE MULTIBUS* FROM CENTRAL DATA



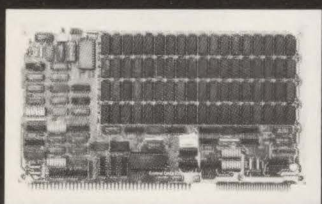
Z8000* Memory Management Processor Board features 4MHz Z8000 running with unique paged/segmented memory management. Includes interrupt controller, interval timers. Can also support PROMs and 9511 APU.
Multi-User operating system available. Standard Board
Monitor PROMs
9511 APU



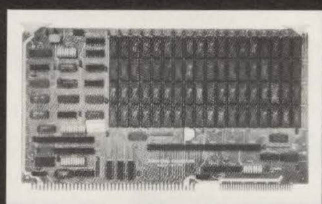
Intelligent Octal I/O Board provides 8: RS-232 ports controlled by on-board 2650 microprocessor. 16K of dual-port RAM allows data transfers with no bus overhead. Includes standard terminal driver program, can hold 4K custom driver program in PROM.



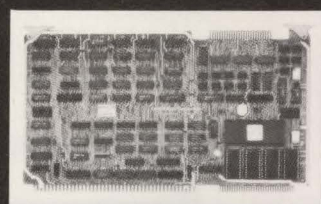
ANSI Winchester Controller fully conforms to the proposed ANSI standard for 8" winchester disk drives. Custom microprogramming available to interface with other disk drive interfaces. Controls up to eight drives.



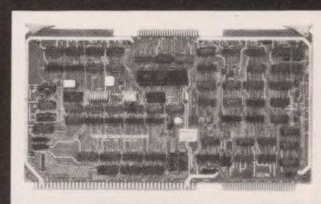
32K-128K Dynamic RAM Board features low power consumption, standard parity checking, and ultra-high reliability.
32K- 96K-
64K- 128K-



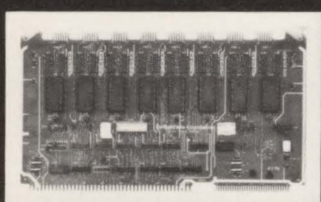
Static Ram Board adds either 16K or 32K of static memory to a Multibus system. 16K—
32K—



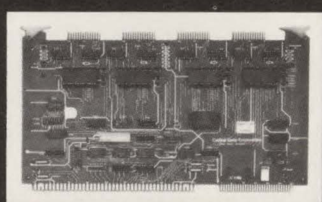
Cartridge Disk Controller Board provides DMA transfers to or from cartridge disk drives with capacities of 10 or 20 Mbytes.



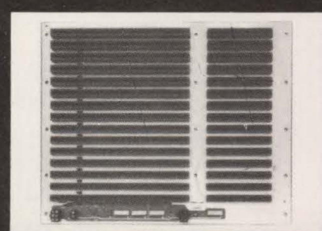
Double Density Floppy Disk Controller adds from one to four double density standard sized floppy disk drives, either single or double-sided.



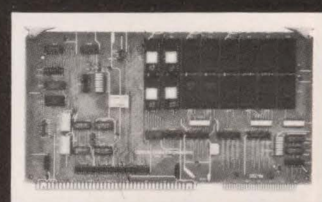
Octal Serial Interface Board allows up to eight EIA RS-232 interfaces.



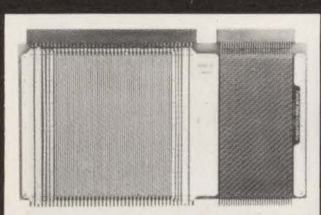
Quad Serial Interface Board hooks up to four EIA RS-232 interfaces to your system.



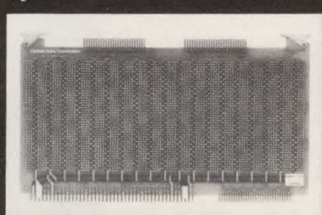
Mother Board can hold up to 15 Multibus cards with both P1 and P2 provided for each card position.



PROM Board allows the user to hook between 1K and 128K of PROM to a Multibus system.



Extender Board will raise a board being tested up to a height of 6.9 inches.



Prototyping Board will accommodate up to 95 16-pin sockets, allowing the user to wire wrap a prototype circuit.

Central Data Corporation

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*Multibus is a trademark of Intel Corporation
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Peripherals

bytes. A 6800 μp on the master drive handles control and formatting functions, and gives direct access to signal status. The system supports five single-density and eight dual-density disk formats and provides diskette-to-diskette copying. The I-47 is priced at $2795. A single-drive version is priced at $1995, with dealer discounts available. **Data Compass, Peripheral Products Division,** 2730 Regal Park Dr., Anaheim, Calif. 92806.

Circle No 324

Minifloppy stores as much as 408K

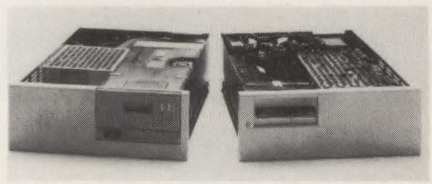
The MiniMate III minifloppy storage device for data-collection applications provides as much as 408K bytes of storage on a single-sided diskette. Operation is code-switchable 7-bit ASCII or 8-bit

binary. Binary operation provides for storing 8-bit program codes for μps and machine-tool applications, allowing punched paper-tape units to be replaced with 5¼-in. diskettes. The device also includes a file-management system and automatic and manual controls. Other features includes dual RS232 ports; dual baud rates and answerback message; X-on, X-off code response; power-up restart in case of AC power failure; automatic disk motor timeout; and a 12-month warranty. **Western Telematic Inc.,** 2435 S. Anne St., Santa Ana, Calif. 92704.

Circle No 325

Point 4 unveils peripheral subsystem

This peripheral subsystem integrates an 8-in. Winchester-disk and a disk backup device in a standard 19-in. rack with the vendor's Mark 3, Mark 5 and Mark 8 computers. The subsystem is available in two versions. One provides a Lark Winchester disk with 8M bytes of fixed and 8M bytes of removable data storage. The other version features an 8-in. BASF Winchester disk with a 20M-byte formatted capacity and an Archive ¼-in. (62.5-mm.) streaming-tape cartridge. The system includes cooling fans, power supplies, AC distribution and interconnection cabling.

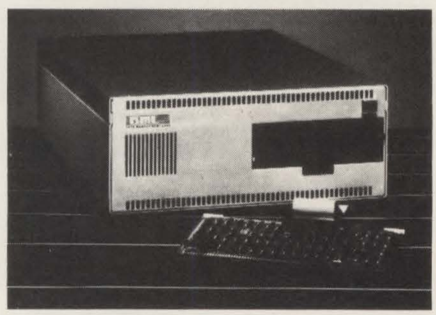


The subsystem with a Lark disk drive is priced at $6965, and the subsystem with a BASF Winchester and Archive streamer is priced at $7990. **Point 4 Data Corp.,** 2569 McCabe Way, Irvine, Calif. 92714.

Circle No 326

Subsystems include 10M-, 30M-byte Winchesters

The model 1010 ISIS-II-compatible Winchester mass-storage subsystem features an 8-in., 10M-byte Winchester and a double-density floppy. It also includes a disk controller and a Multibus interface.



Another version, model 4030 stores 30M bytes. Models 1010 and 4030 sell for $8995 and $9995, respectively. **Data Management Labs,** 2148 Bering Dr., San Jose, Calif. 95131.

Circle No 327

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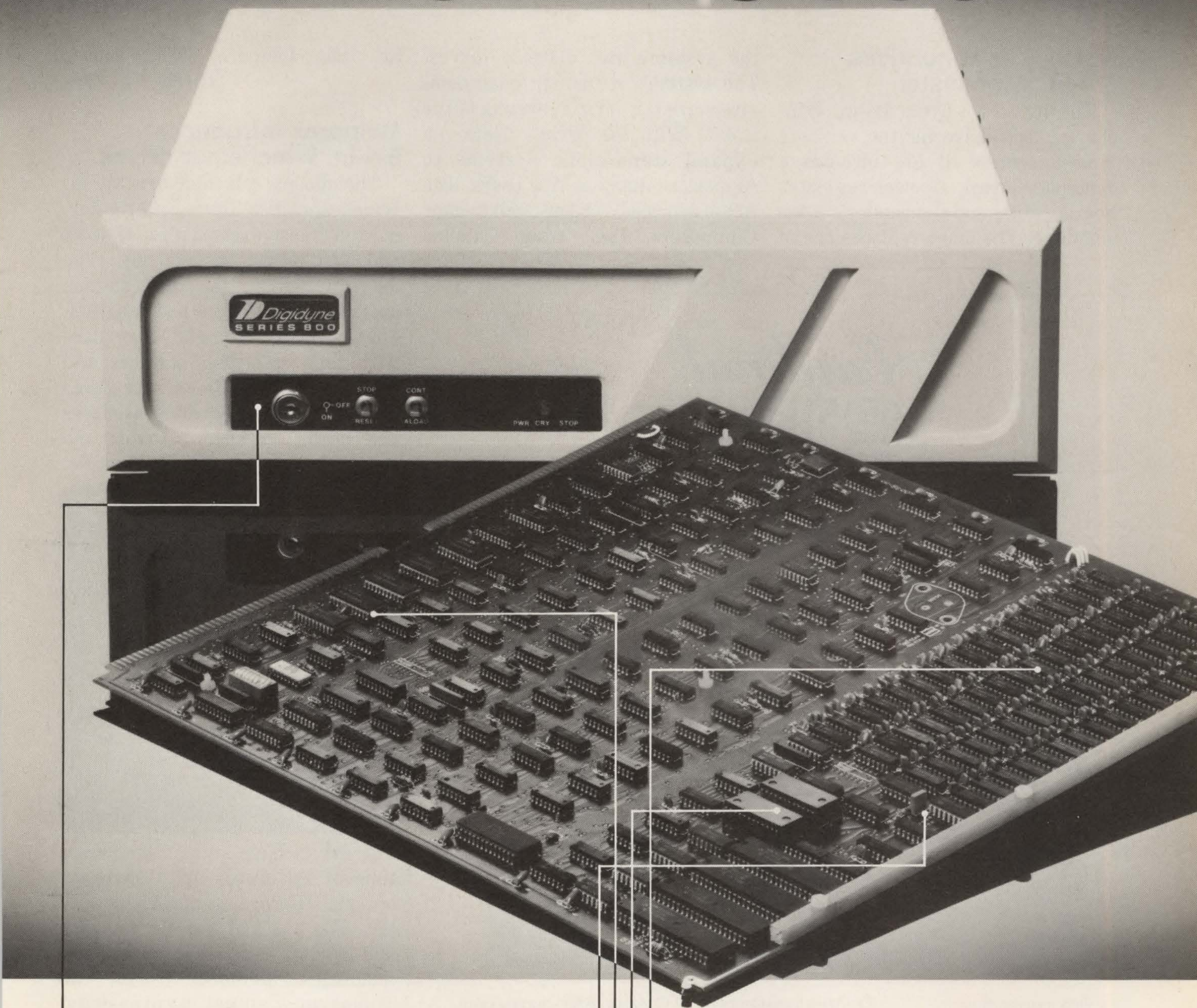

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CIRCLE NO. 161 ON INQUIRY CARD

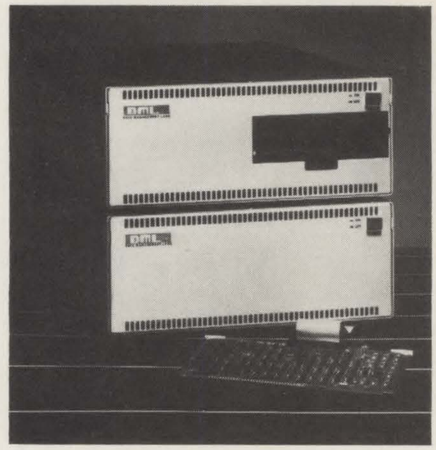
North Star announces 5¼-in. Winchester

The HDS-5 5M-byte, 5¼-in. Winchester-disk drive for the vendor's Horizon series of μcs includes a controller board, a power regulator board, cables and the vendor's HDOS software. The drive replaces one of the system's two diskette drives. The system's remaining quad diskette drive is used in operating of the HDS-5. With the drives, users can expand stand-alone systems to support as many as five users. The HDS-5 is priced at $2999. **North Star Computers, Inc.,** 14440 Catalina St., San Leandro, Calif. 94577.

Circle No 330

Memorex introduces 5¼-in. Winchester drives

The models 306 and 310 5¼-in. Winchester-disk drives, offer unformatted storage capacities of 6.7M and 10M bytes, respectively. The devices use a sealed head-disk assembly and two PC-board assemblies. The 306 contains two disks with four recording surfaces and read/write heads. The 310 has three disks with six recording surfaces and heads. A band actuator and stepper motor position the heads.



The drives have an average access time of 170 msec., with 95 msec. optional. Recording density is 8020 bpi. The 306 and 310 sell for $950 and $1250, respectively, in OEM quantities. **Memorex Corp.,** San Tomas at Central Expressway, Santa Clara, Calif. 95052.

Circle No 331

Winchester interfaces to Apple, IBM μcs

The MiniMega 5¼-in. hard-disk and floppy backup interfaces to Apple II and III, the IBM personal computer, the TRS-80 series, NEC computers, S-100 systems, LSI-11, Multibus and Motorola 6800 systems. Features include ECC, an on-board μp, 5M- or 10M-byte configurations and the ability to be integrated with a 5¼-in., 1M-byte

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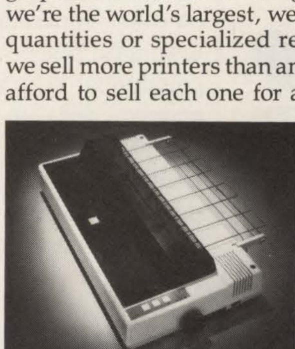

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CIRCLE NO. 162 ON INQUIRY CARD

floppy. The system also includes controller, a host adapter, operating software, power supply, cable, cabinet and operating instructions. **Santa Clara Systems, Inc.,** 560 Division St., Campbell, Calif. 95008. **Circle No 332**

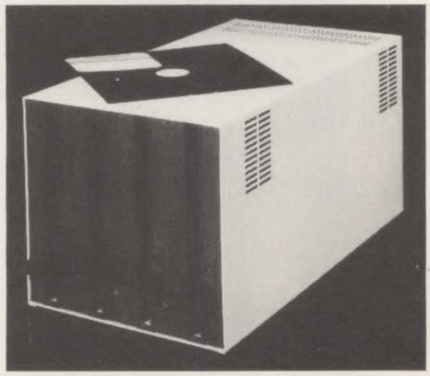
United Peripherals unveils 480M-byte disk subsystem

The UP-1698 disk-storage subsystem for Hewlett-Packard's HP 3000 and HP 1000 series minicomputers includes a CDC 9775 fixed-module drive with 480M bytes of on-line storage. The drive subsystem attaches directly to the HPIB and provides command-set compatibility and software transparency. Other features include a 25-msec. average access time, a 1.2M-byte-per-sec.

data-transfer rate, 50- or 60-Hz line power requirements, μp-controlled servo technology and a drive-analysis diagnostics panel. The UP-1698 controller features a 4K-byte data buffer with parity, 32-bit polynomial ECC, internal microdiagnostics and an eight-LED fault-analysis panel. Price is $34,500. **United Peripherals, a Microcomputer Systems Corp. Company,** 432 Lakeside Dr., Sunnyvale, Calif. 94086. **Circle No 333**

Four-drive subsystem stores 4.8M bytes

The CMS 16004 drive subsystem uses four Tandon Thinline DS/DD 8-in. drives. The subsystem includes power supply, cables and cabinets, and uses the Shugart-compatible interface for 8-in. CP/M disks. Price is $2995, with quantity



discounts available. **Columbia microSystems, Inc.,** 905 E. Broadway, Columbia, Mo. 65201. **Circle No 334**

Disk drives feature band/stepper mechanism

The single-head FDD 111-5 and double-head FDD 221-5 incorporate a proprietary band/stepper motor head positioning mechanism, provide 48- and 96-tpi track densities, respectively. The FDD 111-5 accommodates as much as 125K bytes of unformatted data on 40 tracks for single-density applications. Unformatted storage capacity is 250K bytes per side with double-density recording. For single-density applications, the FDD 221-5 accommodates as much as 500K bytes of unformatted data on 80 tracks. When double-density recording is used, unformatted storage capacity is 1M byte. As many as four units can be daisy-chained on a single bus for a total of as much as 4M bytes of on-line data storage. Other features include a 5-msec. track-to-track access time, an average access time of 80 msec. for 40 tracks with the FDD 111-5 and 146 msec. for 80 tracks with the FDD 221-5. Data is transferred at 125K bps with single density or 250K bps with double

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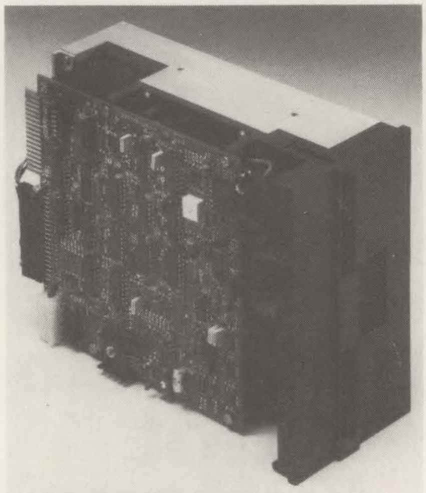
CIRCLE NO. 164 ON INQUIRY CARD

Peripherals



density. **Siemens Corp.,** 240 E. Palais Rd., Anaheim, Calif. 92805.

Circle No 335

Eder announces 8K-byte RAM

The STD Z80-compatible CB8K CMOS nonvolatile-RAM board enables the addition of 1K to 8K bytes and retains data for 14 days after power loss. Other features include DIP-selectable address to any 8K boundary over a 64K field, +5V and +12V operation with optional +5V-only operation and 2.5- and 4-MHz versions. Price is $235. **Eder Industries, Inc.,** 4864 S. Tenth St., Milwaukee, Wis. 53221.

Circle No 336

TI announces 16K static RAM

The TMS4016NL, an upgraded version of the TMS4016 16K static RAM, offers maximum access/minimum cycle times as fast as 120 nsec., maximum power dissipation of 385 mW, static operation and EPROM/ROM compatibility. Organized as 2K × 8, the TMS4016NL includes common I/O capability, three-state outputs for OR-tie capability and a chip-select control. All inputs and outputs are TTL compatible, and it has a noise immunity of 400 mV with standard TTL loads. The device is available in 120-, 150-, 200- and 250-nsec. maximum access

times and minimum read/write cycle times. Prices are $15.90, $13.85, $10.75 and $9.25, respectively, in 100-unit quantities. **Texas Instruments Inc.,** P.O. Box 202129, Dallas, Texas 75220.

Circle No 337

64K static CMOS RAM is M6800/6809 compatible

The 9638 64K-byte static CMOS RAM module for operation with the M6800/6809 μp is pin and outline compatible with the Motorola EXORciser and Micromodules. The 9638 provides 65.5K bytes of storage when fully populated to 64K bytes. Partially populated version provide 32K, 48K and 56K bytes of storage. The 9638 is configured as eight 8K blocks that can be independently placed in the memory map by on-board switches. The module also provides decoding for four additional address lines for memory-management systems. Typical access time is less than 200 nsec., and power required is 150 mA from a 5V supply. Single-quantity price for the 64K version is $1095, with quantity discounts available. **Creative Micro Systems,** 3822 Cerritos Ave., Los Alamitos, Calif. 90720.

Circle No 338

Dilog announces magnetic-tape controller

The model DQ330 μp-based, single-board ¼-in. 3M cartridge magnetic tape controller for backup use with DEC LSI-11, 11/2 and 11/23 computers provides an interface for one or two Kennedy 6450 ¼-in. DE300 type cartridge-tape drives with as much as 17M bytes each of

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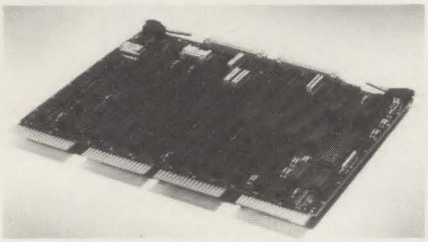
CIRCLE NO. 166 ON INQUIRY CARD

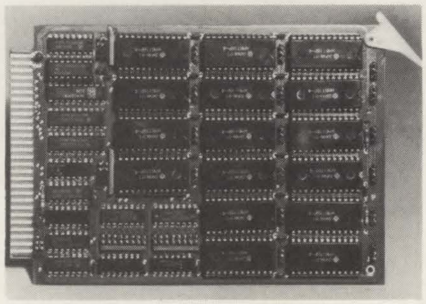
storage. The quad-sized controller requires a CPU card slot and ribbon cable for interconnection. It is compatible with DEC TM-11 and TS-03 software drivers in RT-11 and RSX-11 operating systems. The controller handles read-after-write serpentine head drives and includes



a diagnostic routine, automatic self-test and an integral LED. Other features include a FIFO buffer for DMA latency and memory addressing to 128K words, 30-ips read/write speed, 6400-bpi format densities and 192K-bps data-transfer rate. Price is $1436 in 50-unit quantities. **Distributed Logic Corp.,** 12800 Garden Grove Blvd., Garden Grove, Calif. 92643. **Circle No 339**

Jonos announces 32K RAM

The JL-32M 32K × 8 static RAM EPROM card is available in 0K, 8K, 16K or 32K configurations. Addressing is achieved on any 4K boundary



within a 64K block. The JL-32M is processor independent and uses 2716 EPROMs or 2K-byte-wide static RAMs with a resultant 250-nsec. access/cycle time. Addressing is available to as much as 1M byte for use with 8088 processor cards. A wait-state jumper is available for use with EPROMs in faster systems. Single-unit pricing for the JL-32M (32K) is $550, for the JL-16M (16K) is $350, JL-8M (8K) is $250 and the JL-0M is $150, with OEM and dealer discounts available. **Jonos Ltd.,** 920-C E. Orangethorpe, Anaheim, Calif. 92801. **Circle No 340**

ADAC offers CMOS RAM boards

The model 1816CMOS battery-backup CMOS RAM boards for the LSI-11 bus are half-quad size and each occupies a single slot in the backplane. Four models are available. The 1816CMOS-16S 16K-word unit has 168-hour retention, model 16L offers 16K words with 30-day retention, -8S has 8K words and

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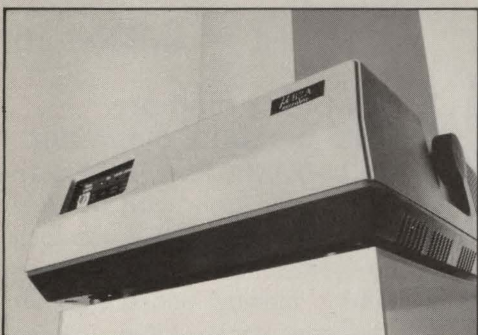

ML-82A: Prints 80 columns bidirectionally at 120 cps, has 9-pin head for true descenders. Short line seeking logic increases throughput by 80 percent.

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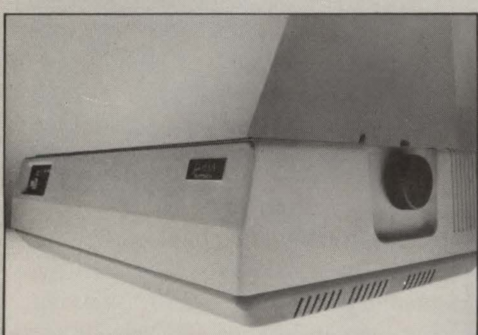


ML-83A: All the features of the 82A, including double-width and bold characters. The 136-column-wide carriage can handle paper up to 16 inches wide.

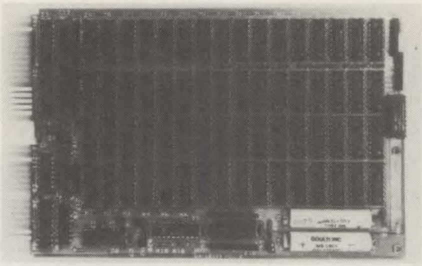
Making small printers for people who think big

Okidata is a subsidiary of Oki Electric Industry Company, Ltd.

CIRCLE NO. 169 ON INQUIRY CARD

Peripherals

standard retention; and -8L has 8K words with long retention. On-board 18-bit address decoding circuitry and write protect DIP switches, accessible while the memory board is in the backplane,

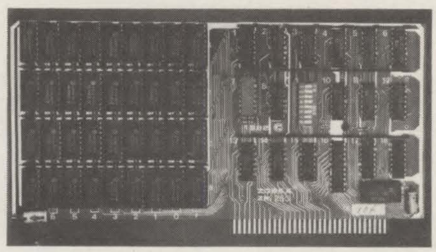


permit memory access to start at any 4K-word boundry and write protect of 4K-, 8K-, 12K- or 16K-word segments. The 1816CMOS-8S, -8L, -16S and -16L sell for $695, $795, $1095 and $1295, respectively, with quantity discounts available. **ADAC Corp.**, 70 Tower Office Park, Woburn, Mass. 01801.

Circle No 341

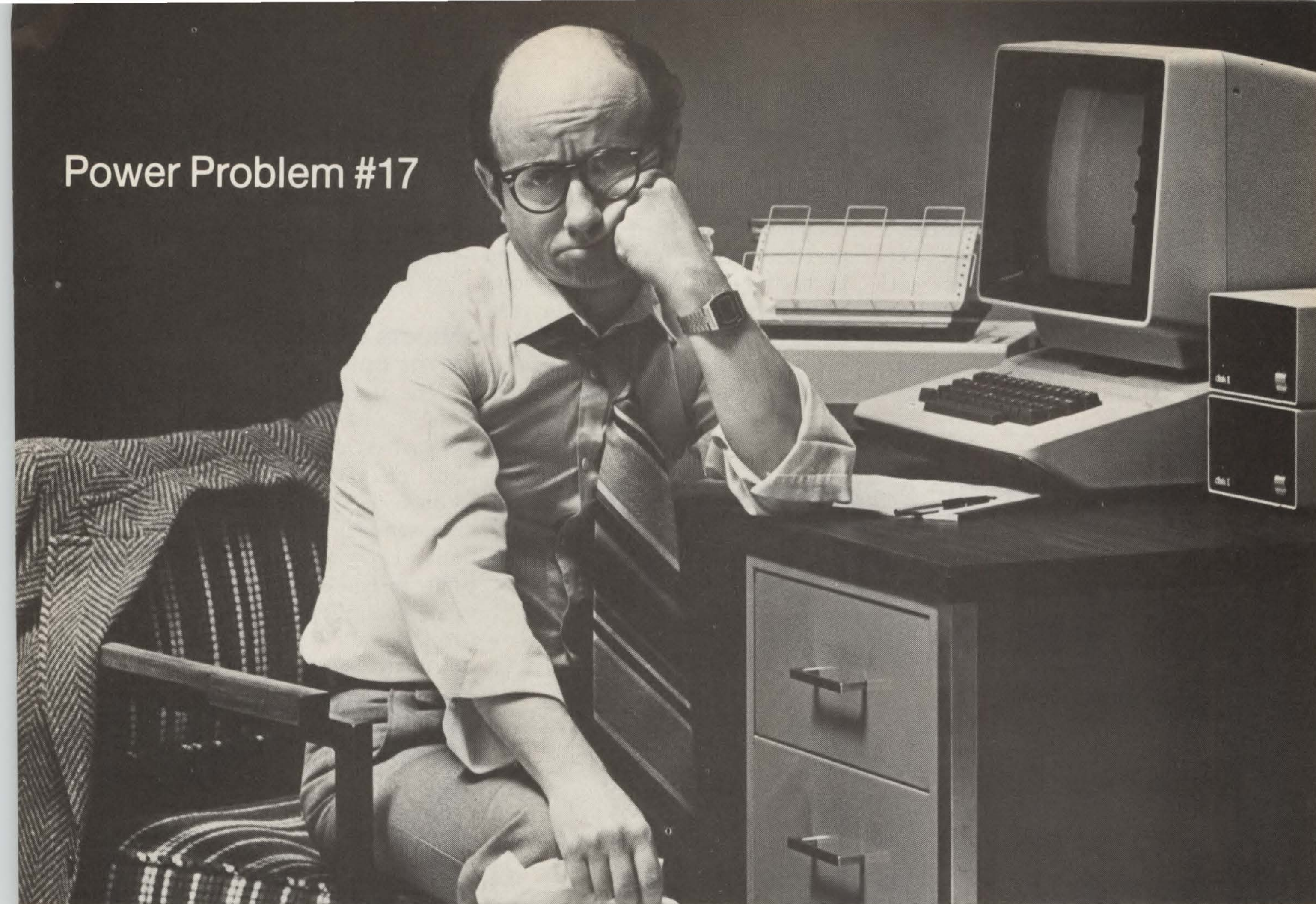
Zobex offers memory for IBM personal computer

This 256K-byte RAM board with parity is compatible with the IBM personal computer. The memory requires only one expansion slot and contains a memory-address decoding scheme implemented via an on-board configuration switch that allows each 64K-byte segment to be disabled or based at any 64K-byte



boundary from 0 to 1M byte. This allows the board to be used with the IBM CPU board-mounted 64K-byte memory or mixed with IBM 64K-byte expansion boards. Price is $549 in 100-unit quantities and $998 in single-unit quantities. **Zobex**, 7343-J Ronson Rd., San Diego, Calif. 92111.

Circle No 342



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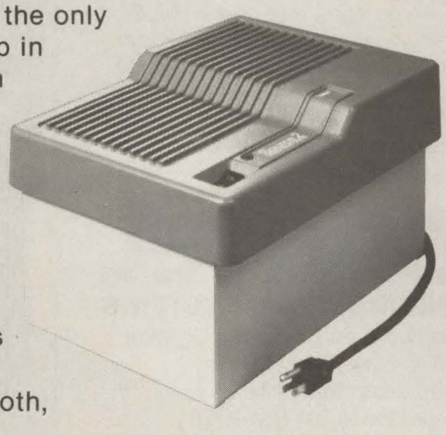

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CIRCLE NO. 170 ON INQUIRY CARD

Fujitsu introduces 32K-byte bubble cassette

This 32K-byte bubble-cassette system has a modular holder with built-in control card and peripheral circuits for attachment to test-and-measurement equipment and portable recorders. Average access time is 7.5 msec., and 32K bytes can be transferred in 3 sec. The 8-bit parallel interface can be connected to any type of μp, and the system memory can be expanded to 128K bytes by combining three FBM-U004 slave holders to a FBM-U404 master holder. **Fujitsu America, Inc., Component Division,** 918 Sherwood Dr., Lake Bluff, Ill. 60044.
Circle No 343

Micom unveils error controller

The model 596 error controller enables dumb terminals to operate error-free at speeds as high as 9600 bps on dial-up or leased lines. Functions include automatic retransmission on error, asynchronous-to-synchronous conversion, full- to half-duplex conversion and data compression. The device enables users to convert to half-duplex mode to access the dial network,

access Viewdata and Teletext to networks with asymmetrical data rates and automatically recover from phone-line errors. Price is $795. **Micom Systems, Inc.,** 20151 Nordhoff St., Chatsworth, Calif. 91311. **Circle No 344**

Transterm introduces portable terminal

The TransTerm 2 alphanumeric keyboard/display terminal for portable or remote communication environments consists of a single-line, 80-character LCD and a 58-key TTY-style membrane keyboard. The unit communicates in full duplex RS232 asynchronous ASCII, with 20-mA current-loop or RS422 optional. Eight baud rates (110 to 9600 bps) and character parity (even/odd/mark/space) at 7 data bits per character are switch selectable. The LCD supports the 96-character upper- and lower-case ASCII set in a 5 × 7 dot-matrix font with an underscore cursor. Memory holds 24 lines of displayed data. Three

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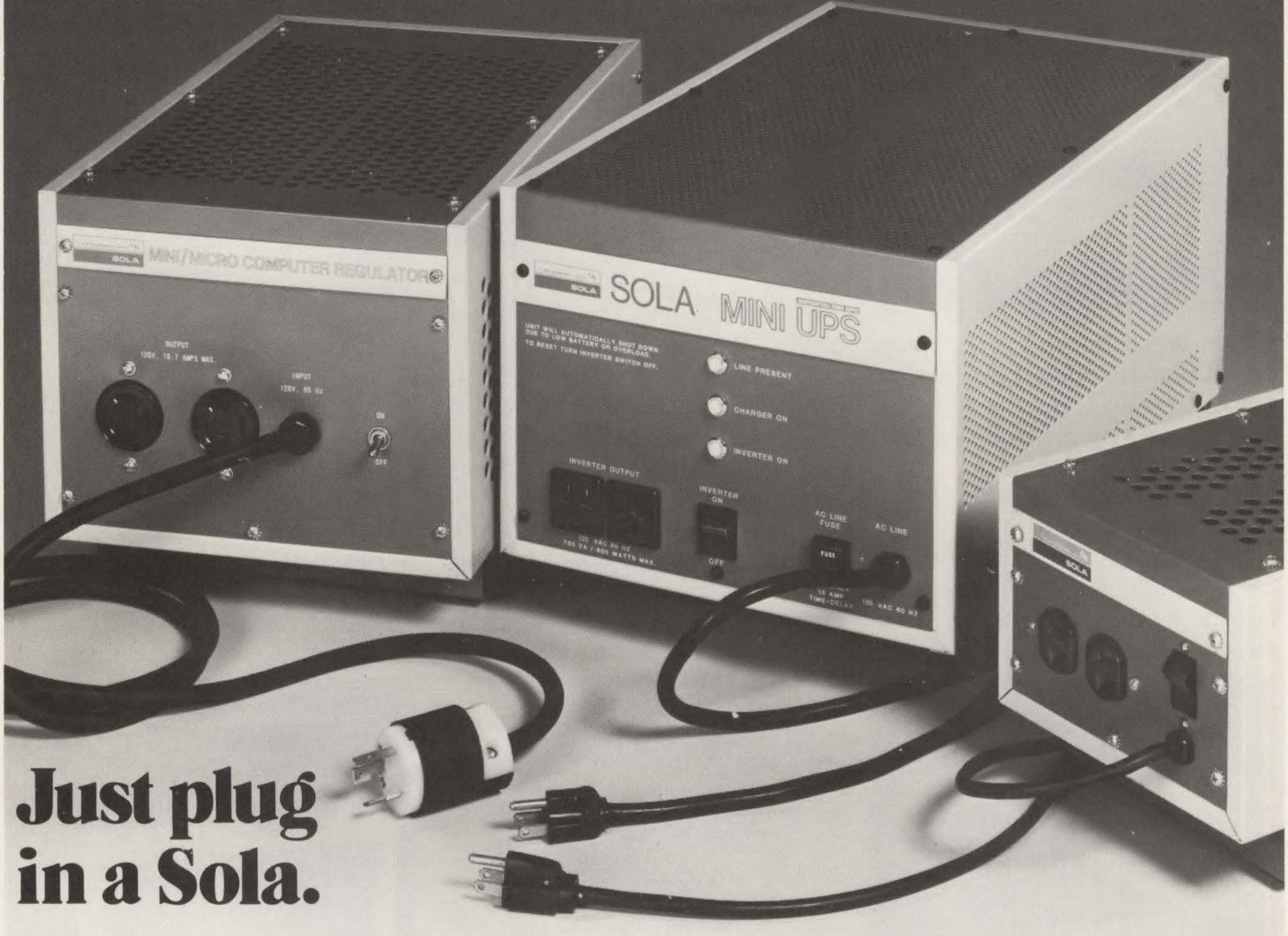

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	spikes and faults	dips and surges	line noise common-mode	line noise transverse mode	Brownout	Blackout
	momentary sharp voltage peaks or split-second power outages	short-term high or low voltages due to load start-up or shut-down	Unwanted voltages or frequencies due to bad grounding, switching, or radio-type interference — line-to-ground interference	line-to-line interference	Planned voltage reductions in response to high demand	Total loss of line power
Dedicated Line (with dedicated ground)	some, internal only	some, internal only	some, internal only	some, internal only	No	No
Ultra-Isolation Transformer	No	No	Yes	No	No	No
Sola Micro-Minicomputer Regulator	Yes	Yes	Yes	Yes	Yes	No
Sola Mini-UPS	Yes	Yes	Yes	Yes	Yes	Yes

Don't go through another day risking electronic malfunction due to unreliable power. Talk to your local Sola Electric representative or distributor. Or contact Sola Electric, 1717 Busse Road, Elk Grove Village, IL 60007. (312) 439-2800. We're the people who invented power protection 50 years ago.

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CIRCLE NO. 171 ON INQUIRY CARD

switch-selectable operating modes provide TTY compatibility, a block send mode or multidropped/polling operation. Options include expanded data memory of as much as 12K bytes, a 40-column alphanumeric

printer and battery-powered operation. **Computerwise, Inc.,** 4006 E. 137th Terrace, Grandview, Mo. 64030. **Circle No 345**

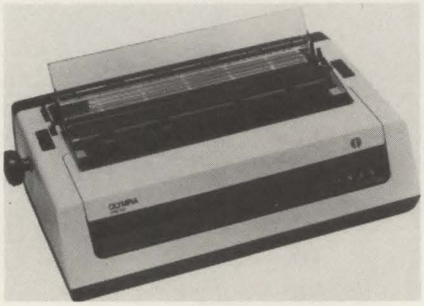
Cobar introduces terminal with 15-in. screen

The model 3132 video-display terminal, in 80- or 132-column format, features a non-glare 15-in. screen and is plug-compatible with

DEC's VT-100, VT-131 and VT-132. The terminal provides line and character insertion or deletion, a DEC-compatible printer port, a detachable keyboard and a 256-character receive buffer. The terminal also has 18 programmable function keys with storage of 99 characters, a screen-displayed set-up prompt legend, reverse video, blinking and underlining, batch transmission and RS232C communications with selectable baud rates from 50 to 19.K bps. Prices are $1595 in quantities of one to nine and $1195 in quantities of 100 or more. **Cobar, Inc.,** 1181 N. Fountain Way, Anaheim, Calif. 92708. **Circle No 346**

Olympia introduces letter-quality printers

The models ESW 102 letter-



quality printer for use with keyboard-oriented displays incorporates the vendor's Whisperdisc print wheel. Features include varying typestyles, proportional spacing, four pitches, bidirectional printing and print-wheel cassette insertion. The model ESW 103 incorporates the features of the 102 and can be used as an electronic typewriter or as a printer by

pressing a key. Single-unit price is $1590, and single-unit price of the 103 is $1990. **Olympia USA Inc.,** Box 22, Somerville, N.J. 08876. **Circle No 347**

Tektronix introduces dot-matrix impact printer

The model 4643 dot-matrix impact printer uses bidirectional logic technology to print 340 cps. With a 132-character line, the 4643 prints a minimum of 125 lpm. The print head consists of 14-wire matrix heads for a 7 × 7 dot matrix. Other features include front panel controls; front-, back- and bottom-loading ports for paper; replaceable matrix heads and ribbon cassettes; and RS232 compatibility. The printer is priced at $4200, with OEM discounts avail-

able. **Tektronix, Inc.,** P.O. Box 500, Beaverton, Ore. 97077. **Circle No 348**

Harris unveils 600-lpm band printer

The model 1656 band printer has a 12-channel electronic vertical forms unit with tape input, enabling six-part forms to be used, horizontal spacing of 10 cpi, vertical spacing of

6 to 8 lpi and a 132-character line. Other features include self-test and diagnostic display; paper-low and paper-jam indicators; and ASCII, EBCDIC, display code and Fieldata print bands in 64- or 96-character sets. Price is $22,000; extra print bands are priced at $295 each. Monthly lease prices are $456 for one year, $410 for two years and $378 for three years, and maintenance is $117 per month. **Harris Corp., Data Communications Di-**

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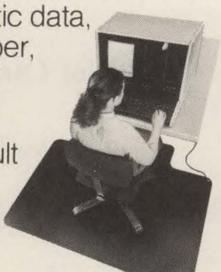

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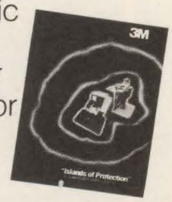

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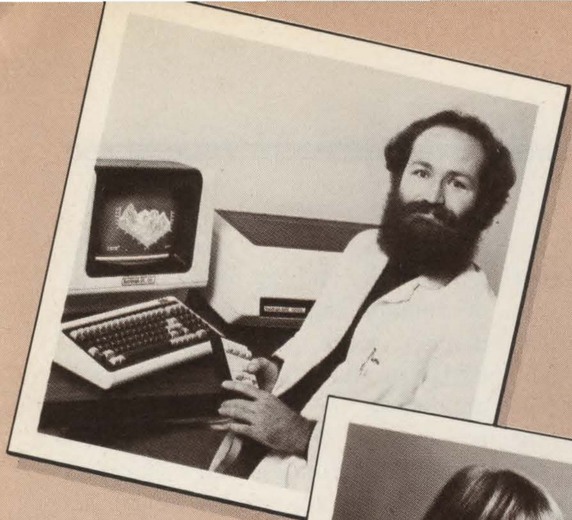

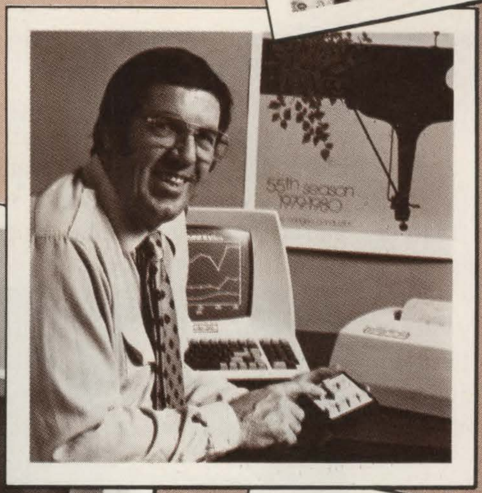


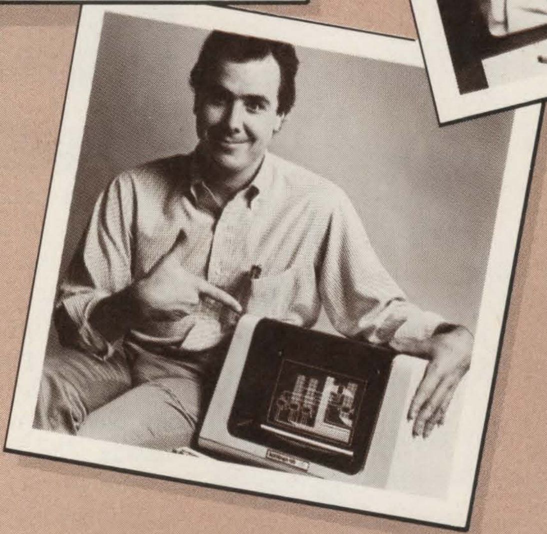

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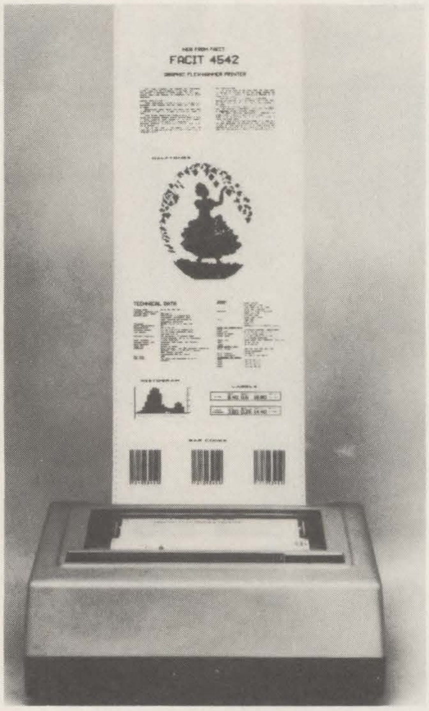
CIRCLE NO. 173 ON INQUIRY CARD

vision, 16001 Dallas Parkway, P.O. Box 400010, Dallas, Texas 75240.
Circle No 349

Facit introduces serial matrix printer

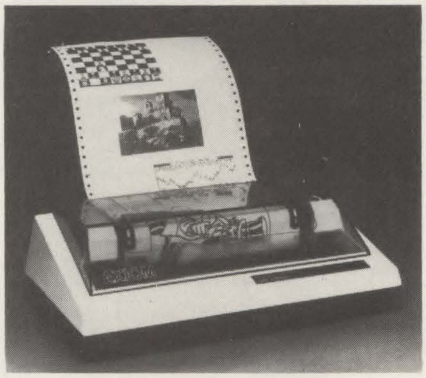
The 250-cps 4542 serial matrix printer has a Flexhammer print head that consists of nine metal hammers mounted directly on a magnet armature. The printer offers as many as 15 character sets and performs scanning and gray



scale. The print head provides automatic adjustment of copy control. Left and right margins and horizontal tab sets can be set by software commands. The printer uses a Z80 μp and can be supplied with a constant or proportional character spacing. Other features include the ability to print 6 or 8 lpi and a 766-byte standard data buffer that can be increased to an additional 3K bytes. **Facit, Inc.,** 66 Field Point Rd., Greenwich, Conn. 06830. **Circle No 350**

Dot-matrix printer has one hammer

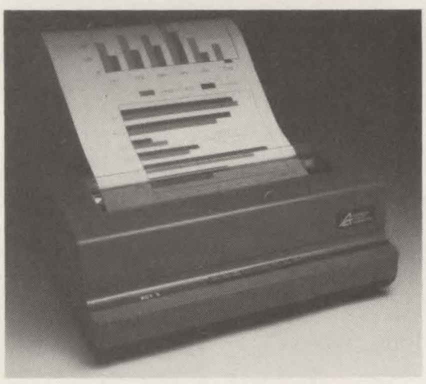
The model GP100 impact printer with one print hammer uses standard fanfold paper as wide as 9½ in. and allows dot graphics, alphanumeric characters and double-width characters to be mixed in a line. The GP100 uses a rotating platen with protruding lengthwise splines positioned behind the paper.



The character or graphics image is formed by multiple hammer strikes in rapid succession as the print head advances across the paper in front of the rotating platen. A gear train assures the positioning of the print hammer relative to the splines on the platen, providing a 5 × 7 dot matrix. The GP100 is priced at $389. **Axiom Corp.,** 1014 Griswold Ave., San Fernando, Calif. 91340.
Circle No 351

ACT announces ink-jet color copier

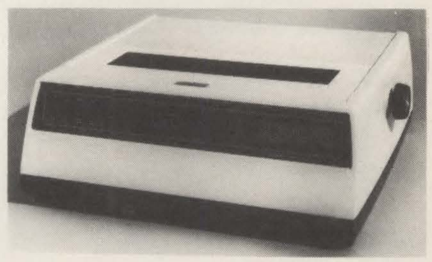
The ACT 1 ink-jet color copier uses cyan, magenta and yellow to produce an 8½- × 11-in. copy in 90



sec. in as many as 125 colors. The copier has an 85-dpi vertical resolution × as much as 140 dpi horizontally and can be used in local or remote control from the color display. Each disposable ink cartridge produces 1000 to 3000 copies, depending on the amount of ink coverage on the paper. The ACT 1 prints a maximum picture size of 12 in. wide × an infinite length on 14⅞-in.-wide perforated roll paper. Other features include a user-selectable option panel that provides the ability to copy from color displays of variable resolution and offers 12 aspect ratios, internal or bidirectional print mode, internal shading, an 8-bit parallel Centronics-/DataProducts interface, an RS 170, 343A video interface and an RS232C interface. Price is $9000. **Advanced Color Technology, Inc.,** 21 Alpha Rd., Chelmsford, Mass. 01824. **Circle No 352**

Telex introduces 150-cps printer

The model 287D tabletop bidirectional printer provides 150-cps print speed and attaches to the vendor's model 276 control unit or IBM's 3274/3276 cluster controller and 4331/4341 processors and 3601 finance communications controller. The printer produces characters on a 7 × 8 dot matrix. Printout is at 10



cpi with 6 or 8 lpi. Other features include ASCII-B or EBCDIC character sets, upper- and lower-case characters, underscoring, serial character string operations, a choice of five buffer sizes and a friction platen. Pin-feed and forms tractors are optional. The 287D is priced at $5150. **Telex Computer Products, Inc.,** 6422 E. 41st St., Tulsa, Okla. 74135. **Circle No 353**

Endpoints

Wet Ink Department: **Honeywell, Inc.,** Minneapolis, has picked up two contracts totaling more than $34 million. Varicomp International, Fairfield, N.J., has signed a three-year, OEM purchase/resale agreement of $24 million for 1000 DPS 6 minicomputers, which it will sell, along with Honeywell's line of 32-bit superminis and software, to smaller OEMs and end users. The Treasury Department has signed a $10-million contract for six Level 66/80 mainframes and two 66/20 systems to handle government payments in eight regional offices....**North Star Computers, Inc.,** San Leandro, Calif., has signed a three-year, $25-million contract with General Binding to provide General's Business Computer Division with Advantage and Horizon systems. The Northbrook, Ill., division will resell the systems under the names GBC System 9 and System 12....**Digi-Log Systems, Inc.,** Montgomeryville, Pa., has awarded an 18-month contract to Seagate Technology, Scotts Valley, Calif., for 5¼-in. Winchesters to be used in Digi-Log 1500, 1800 and 7130 desk-top μc systems....**Coburn Consultants, Inc.,** Torrance, Calif., has signed a $2.7-million distribution contract with Intertec Data Systems for the Columbia, S.C., company's SuperBrain minicomputer....**The Peripherals Division** of Woodland Hills, Calif.-based **Pertec Computer Corp.** has signed a two-year, $12-million OEM contract to supply Thomson-CSF, a large European computer-system and data-processing equipment manufacturer, with several disk- and tape-drive models for integration into Mitra and Solar computer systems....**M/A-COM DCC, Inc.,** Germantown, Md., has contracted with GTE Telenet, Vienna, Va., for data-concentration equipment, which GTE will integrate into its packet-switching network. M/A-COM subsidiary Linkabit in San Diego recently netted an $8-million contract from Satellite Business Systems to design, develop and produce two central reference stations to be used in the SBS satellite business computer system....**Altos Computer Systems,** San Jose, Calif., will receive more than $6 million worth of 17M-byte tape-cartridge drives from San Diego-based Data Electronics, Inc., and integrate them into Altos's ACS8000 series μcs.

Ground-Breakings: Dallas-based **E-Systems** has moved into a new 200,000-sq.-ft. northern Virginia facility, which will support the growth of its Melpar Division in Falls Church....Instrument and equipment manufacturer **Analogic Corp.,** Wakefield, Mass., broke ground in Peabody, Mass., for a 230,000-sq.-ft. facility....Disk drive manufacturer **Siemens Corp.,** Anaheim, Calif., will add 50,000 sq. ft. to its OEM Data Products Division in Tustin, which was acquired from Perkin-Elmer Corp. in 1978....**Otrona Corp.,** manufacturer of the Attache line of desk-top computers, will relocate to a larger 20,000-sq.-ft. facility in Boulder, Colo., to boost its manufacturing capacity....**Micro Business Software,** which has its main development/distribution/support office in Florida, has expanded with a new office in Chichester, N.H. Future plans include West Coast and European offices....**P.A. Industries subsidiary Z-C Circuits** has begun construction on a $4.5-million, 46,000-sq.-ft. plant in Amityville, N.Y....**Software International Corp.** has broken ground on its 7-acre site in Andover, Mass., for new corporate headquarters....Data-communications equipment manufacturer **Compre Comm, Inc.,** has completed its 22,000-sq.-ft. production facility/headquarters in Champaign, Ill....**Sage Distributing** has moved headquarters from Manhattan Beach to Culver City, Calif., tripling its operating space.

Siemen's OEM Data Products Division *has added 50,000 sq. ft. to its disk-drive manufacturing operations in Tustin, Calif.*

Money Talk: TRW division **TRW Datacom International,** Los Angeles, has exclusive rights to market Convergent Technologies' computer products in non-U.S. markets (except France) until 1989....**Modular Computer Systems,** Fort Lauderdale, Fla., is offering a disk subsystem based on 8-in. Winchesters to its 8-in. rigid-disk line. The models 4180 controller and the 13.5M-byte 4181 8-in. drive sell for a package price of $11,775, plus $6475 for each additional drive....**Iomega Corp.,** Ogden, Utah, has landed $8 million in capital investment financing, to be used to step up production of its Alpha-10 10M-byte, 8-in. disk-cartridge drive....**Memorex Corp.** is lowering prices 25 percent on its models 3672 and 3674 storage-control units. The Santa Clara, Calif.-based company is also raising prices 5 percent on its models 3650 and 3652 disk subsystems.

Randomly Speaking: A poster contest sponsored by AFIPS will pit electronics artists against traditional print-media graphic artists for a $500 first prize. Prizes will be awarded in conjunction with the 1982 Office Automation Conference in San Francisco, April 5-7. Contact Diane Shedron at **Hewlett-Packard Co.,** Cupertino, Calif., for more information.

—Nancy Love

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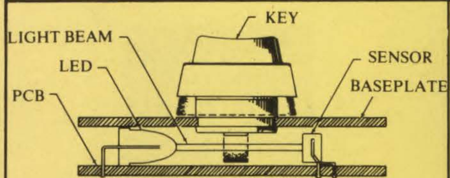

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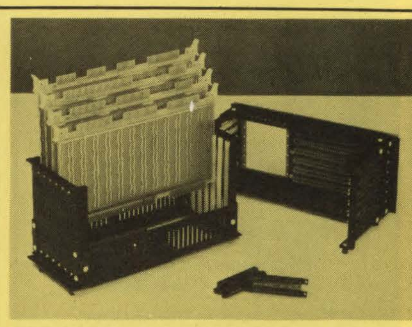

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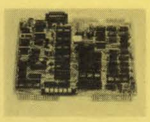

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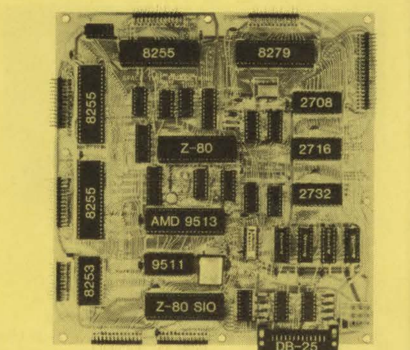

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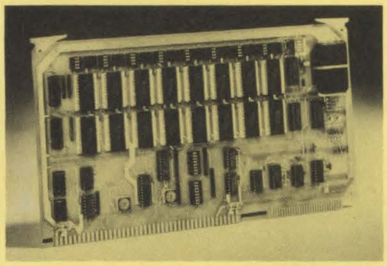

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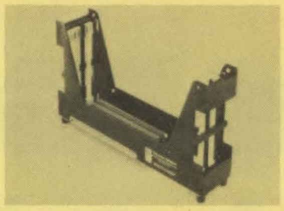

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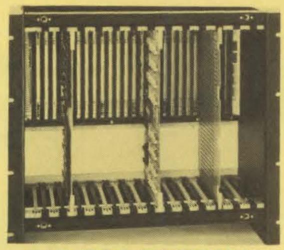

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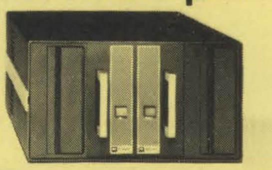

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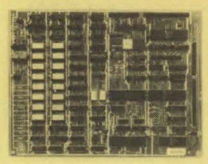

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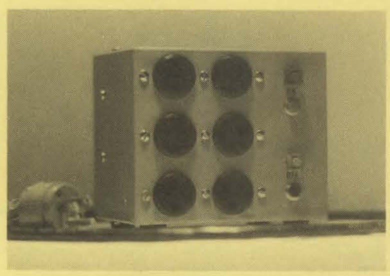

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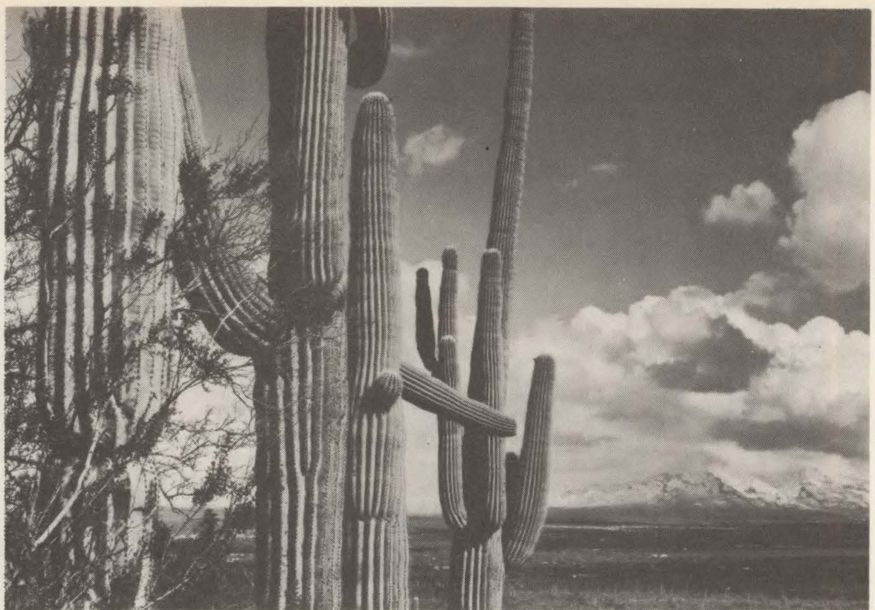

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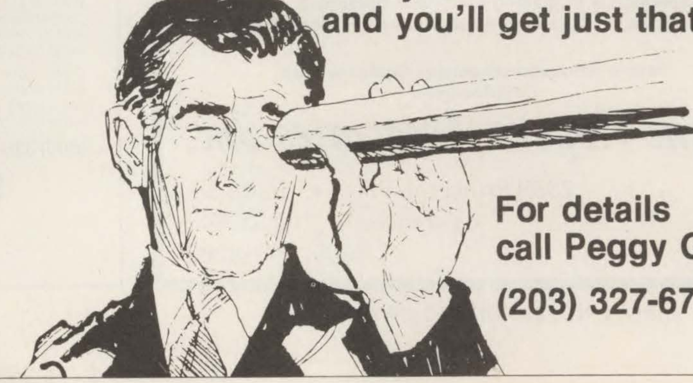

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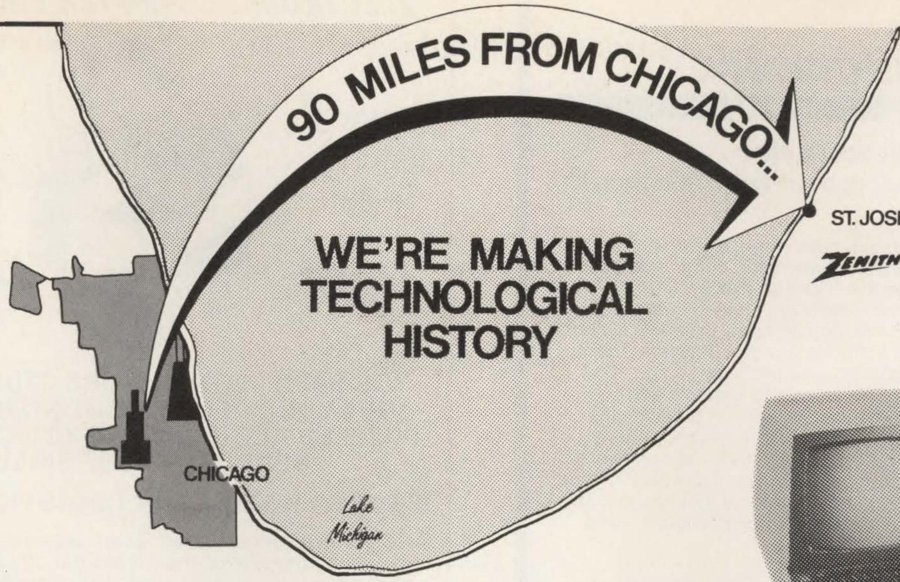
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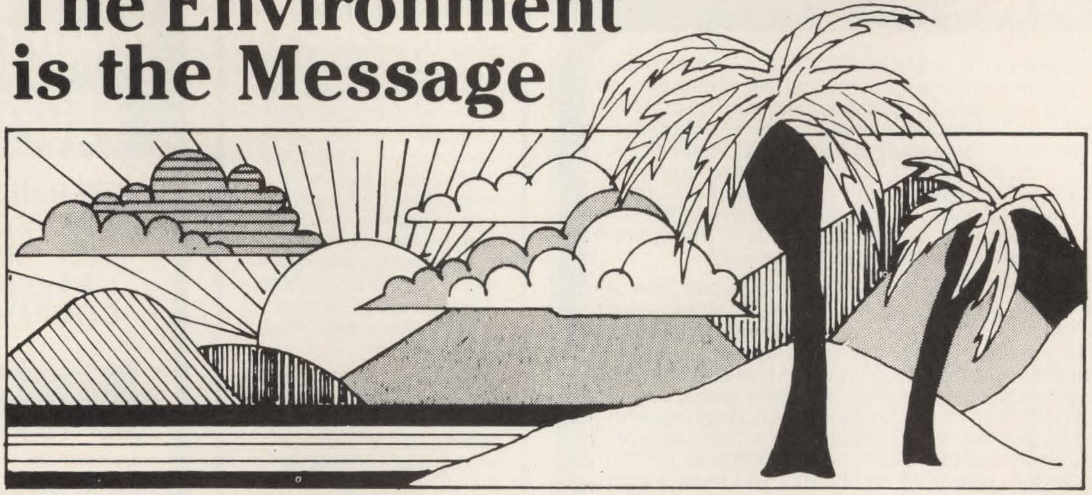

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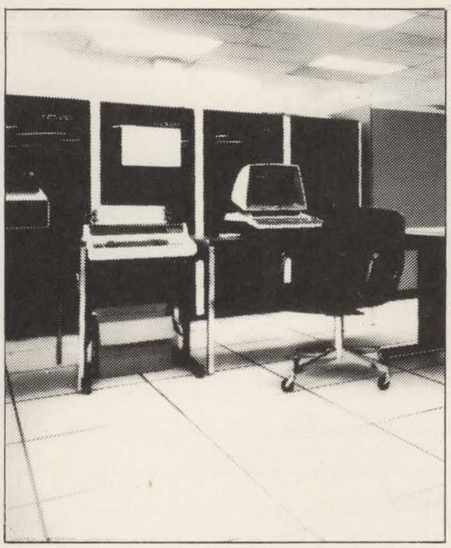

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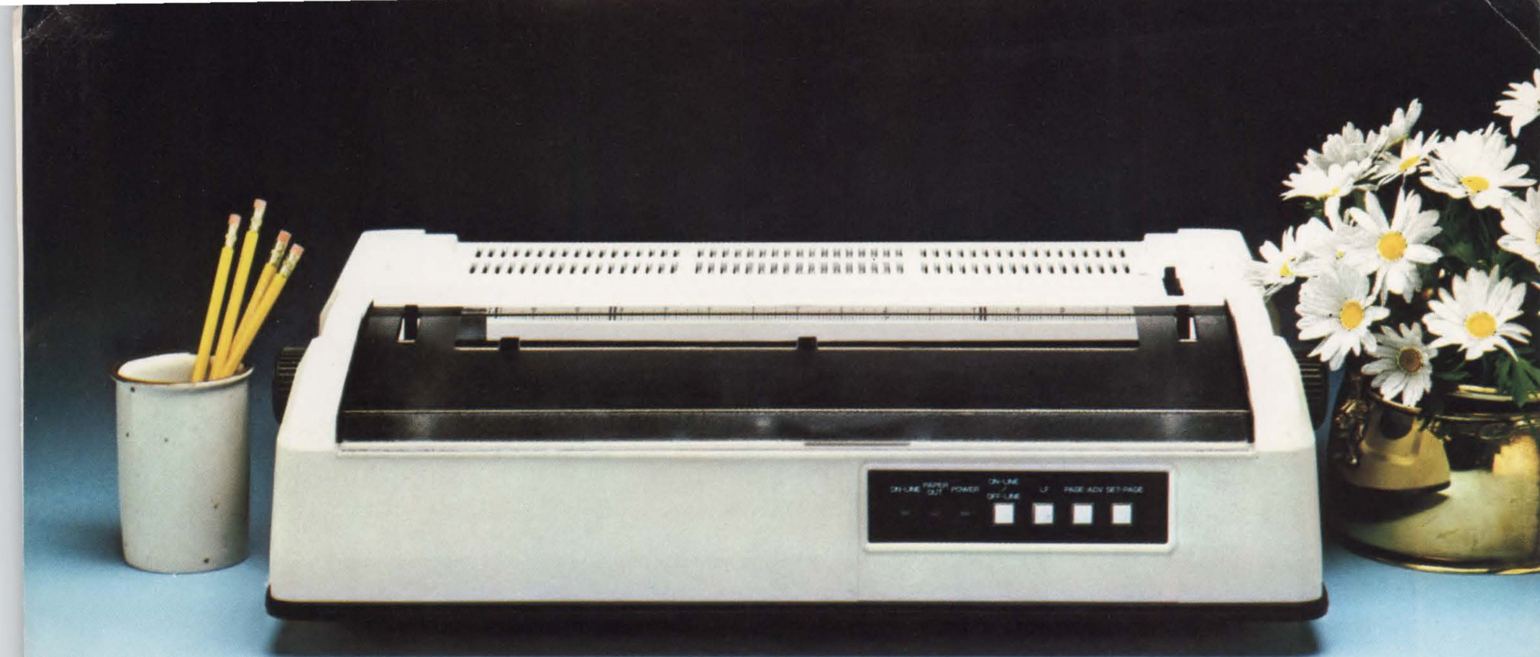

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