

Mini-Micro Systems

A CAHNERS PUBLICATION

JUNE 1983

Small-business system changes

Bar codes ease data entry

Europe eyes machine-vision market

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M B A: FOLDER-SAMPLE1: DEMOS1,  
DOCUNT-TROPIFRUIT,  
CONTEXT-MODEL >AB 135
```

	A	B	C	D	E	F
1 TropiFruit	Annual Sales (Millions)					
2 Product	'81	'82	'83	'84	'85	'86
3						
4 Pineapples	\$15	\$18	\$20	\$23	\$25	\$28
5 Limes	5	10	12	20	3	3
6 Bananas	25	22	20	16	1	1
7 Sugar Cane	40	41	42	43	4	4
8						
9 Total:	\$85	\$91	\$94	\$102	\$110	\$118

TropiFruit Sales



Spreadsheets grow in sophistication

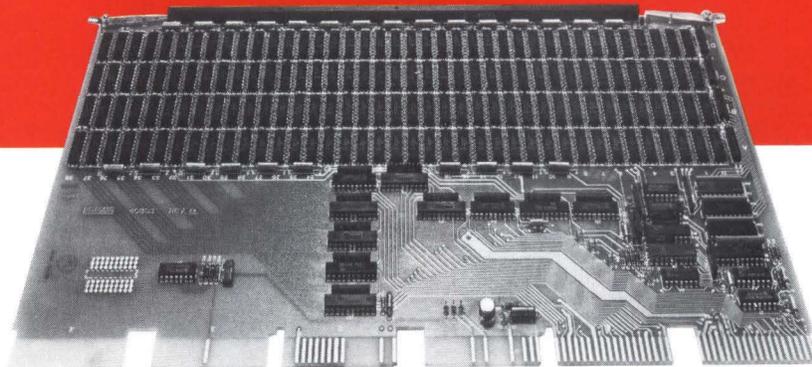
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LSI-11	DR-213	quad	1.0 MB
PDP [®] -11	DR-114S	hex	256 KB
PDP-11	DR-114SP	hex	256 KB
PDP-11	DR-214	hex	1.0 MB
PDP-11	DR-144	hex	256 KB
PDP-11	DR-244	hex	1.0 MB
VAX [®] -11/750	DR-175	hex	256 KB
PDP-11/70			
VAX-11/750	DR-275	hex	1.0 MB
VAX-11/730			
VAX-11/780	DR-178	extended hex	512 KB
VAX-11/780	DR-278	extended hex	2.0 MB
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Mini-Micro Systems

MINI-MICRO WORLD

News

Zilog Z800 may be too late to gain large share of design-ins (p. 23). . . Veteran business micro builders alter strategies to ensure survival (p. 24). . . OEM thin-film drive competition heats up despite high start-up costs (p. 28). . . Local dealers outraged at GSA's solicitation policies (p. 32). . . Diablo broadens product line with ink-jet, thermal printers (p. 35). . . Start-up's low overhead to set IBM PC subsystem price floor (p. 38)

Corporate and Financial

Convergent is poised to attack two new markets (p. 45). . . Shugart revenues increase, as image declines (p. 46). . . Guest Forum: Thermal transfer printing: beware of the bandwagon effect (p. 52). . . Corporate and financial briefs (p. 54)

International

British firm offers 432-based system, claims advantages over Intel's 432/670 (p. 59). . . CDC investment may lead to iAPX 286, 432-based products (p. 62)

Shows and Conferences

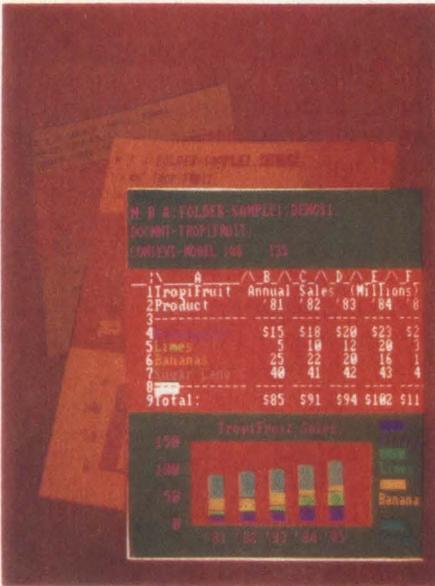
Microcomputers, communications products highlight Hanover fair (p. 71)

INTERPRETER

- 81 Europeans set the pace for several Ada developments
- 91 Personal computers' entry further clouds terminal market boundaries
- 103 Serial printer market warms to thermal transfer technology

SYSTEMS IN MANUFACTURING

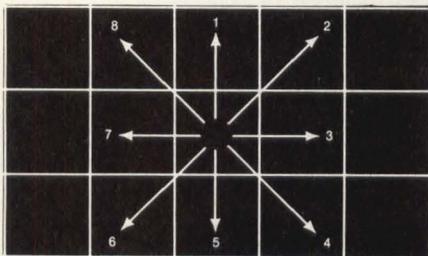
- 113 Data-collection devices play key role in automated factories
- 127 European firms eye U.S. vision-system market
- 135 Far sighted manufacturer computerizes data entry, analysis



p. 205... Spread-sheet packages gain popularity. Art direction by Vicki Blake, photography by Tom Norton.



p. 32 Local dealers seek bids



p. 127 The eyes have it

FEATURES

145 Feature Highlights

151 Product profile: small business systems . . . multi-user, micro-based systems take over.

197 Large disks: greater capacities, greater choice . . . products are reaching gigabyte capacities.

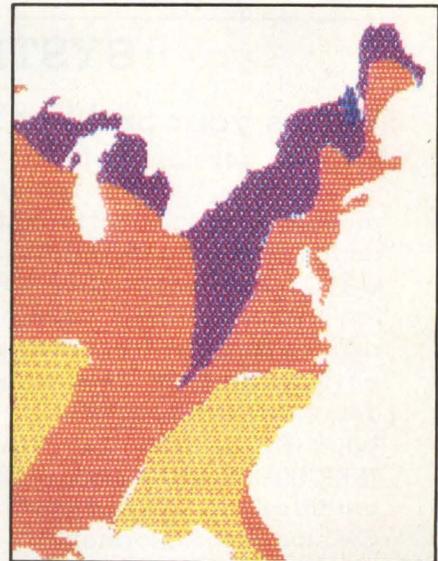
205 New spread-sheet packages do more than model . . . integrated second-generation packages are here.

217 Color non-impact printers hit the market . . . color graphics gains popularity for ink-jet, thermal printers.

227 Processor matches text at high speeds . . . specialized query processors reach 2 million characters per sec.

239 Bar-code and voice recognition ease data-entry problems . . . wands and microphones are giving keyboards some competition.

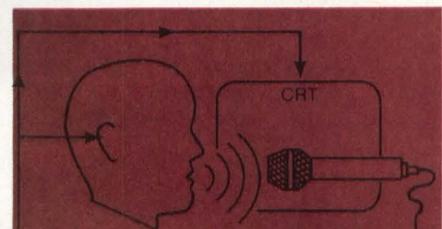
249 Coaxial-cable multiplexers solve a big LAN problem . . . IBM-compatible multiplexers cut costs.



p. 217 Color impacts printers



p. 227 TAP is speedy



p. 239 Data entry made easy

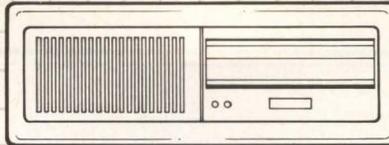
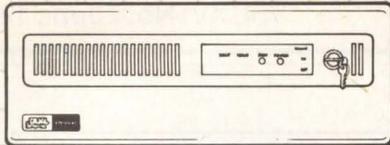
DEPARTMENTS

- | | |
|--------------------------|----------------------------|
| 4 Editorial Staff | 254 Calendar |
| 7 Breakpoints | 259 New Products |
| 17 Publisher's Letter | 293 Mini-Micro Marketplace |
| 18 Letters to the Editor | 299 Career Opportunities |
| 54 Box Score | 304 Index to Advertisers |

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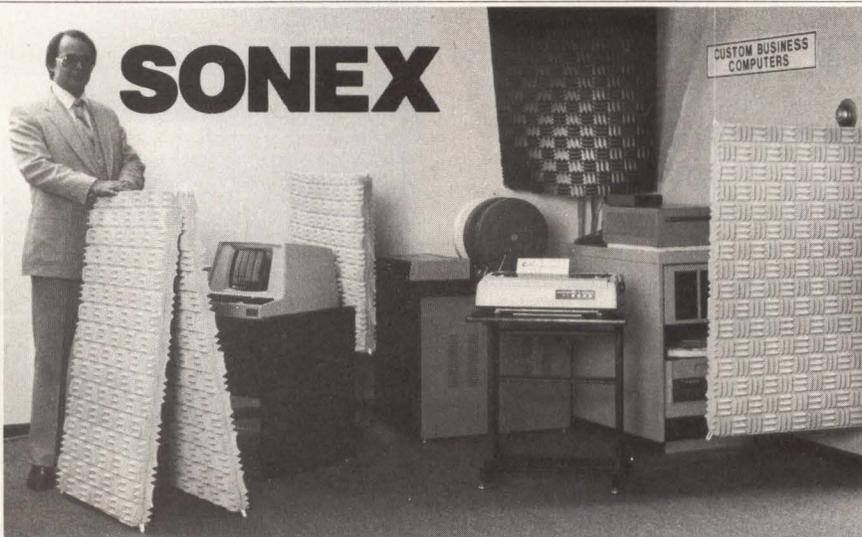
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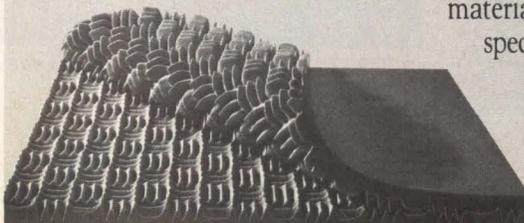
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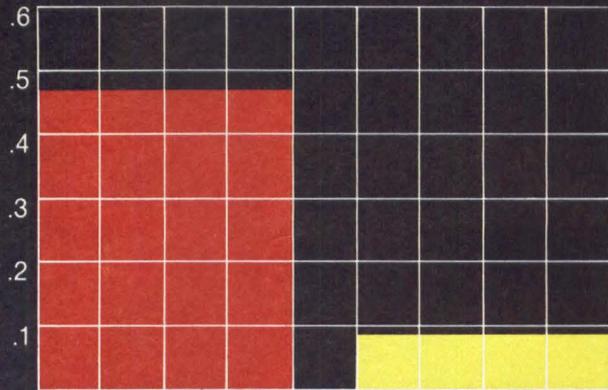
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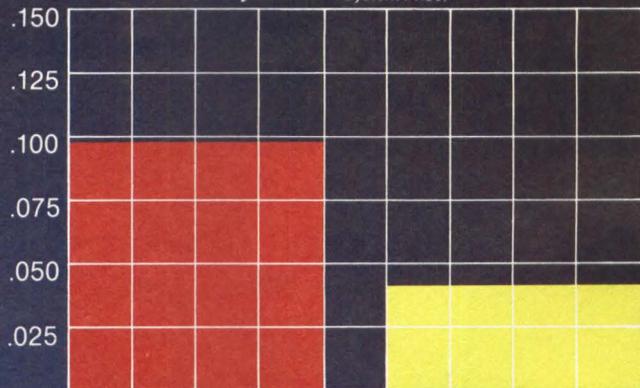
MIPS/SQ. FT.*



CONCEPT 32/6780

VAX 11/782

MIPS/\$10,000* (Equivalent System Price)



CONCEPT 32/6780

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* All chart data from published competitive information.

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Breakpoints

XEROX COMPUTER SERVICES PLANS STOREFRONT SYSTEMS HOUSES

Xerox Computer Services plans to open a prototype Xerox Business Systems Center next month in Los Angeles. The 3500-sq.-ft. facility will function as a systems house for small businesses and will offer education, training and support as well as sales of hardware and vertical software packages. The operation will initially concentrate on XCS's traditional strengths in manufacturing and wholesale distribution businesses, but vertical markets may eventually include construction and medicine. The hardware and operating systems to be used are not yet selected. Xerox officials say they want to offer a less-than-\$20,000 multi-user system. Sources close to the company say Dynabyte Business Computers and Altos Computer Systems have been competing to supply a 16-bit system that would run the OASIS operating system and Track Line Computer Corp.'s package. At press time, however, Xerox had not signed a contract and is evaluating other hardware and operating systems. The company is considering Xerox's 820-II, which had been upgraded with a Z80A/8086 dual-processor architecture.

DEC'S UK SUBSIDIARY IS THE TARGET OF A \$15-MILLION DAMAGES CLAIM

The British subsidiary of Digital Equipment Corp. is the subject of a \$15-million damages claim filed by Darkcrest Ltd. Darkcrest is a small London vendor of systems based on DEC processors, but incorporating memory and other peripherals from a variety of other manufacturers. Darkcrest chairman Nick Brackenbury explains the claim is his company's response to the forced entry and searching of its offices last August by DEC officials. Those officials were seeking documents that could support a software copyright-infringement case against Darkcrest. Before the raid, DEC obtained from the High Court in London what is referred to as an Anton Piller Order, which authorizes a company to search for documentary evidence. Brackenbury says the search followed an unsuccessful application by his firm to obtain OEM status from DEC. Darkcrest had won an order last spring from the British government's department of health and social security for a PDP-11/44-based hospital record system. Brackenbury says the order was the first of as many as 200 similar systems expected to be placed by the DHSS. Brackenbury stresses the first customer obtained the necessary systems software—DEC's standard MUMPS operating system—from an unnamed but authorized DEC OEM, and not illegally from Darkcrest. His main justification for the \$15-million action is that the well-publicized DEC raid has cast doubt on his company's integrity. He notes Darkcrest lost the second DHSS order to DEC, although it has secured the five orders placed since then, having convinced the DHSS of its innocence. A few weeks ago, DEC succeeded in obtaining an order in the high court restraining Darkcrest from copyright infringement and "passing itself off as a DEC OEM able to trade in DEC software." DEC says the full trial will not be held until next year and refuses to cite an example of copyright infringement by Darkcrest.

SHUGART MAY BE MERGED WITH CENTURY AS PRIVATE SPIN-OFF

Shugart Corp.—which changed its name from Shugart Associates in honor of its 10th anniversary in April—may be declaring its independence in time for July 4th. After a round of rumors that had Xerox Corp. selling Shugart to a long list of potential buyers ranging from General Electric Co. and AT&T to the Pillsbury Baking Co., most recent speculation has the company being made a separate public company—merged with fellow Xerox high-end disk manufacturer Century Data Systems. Giving credence to the rumors is the recent appointment of William T. Bayer as president of Shugart. Bayer is Xerox executive vice president and head of its Information Products Group, which also includes Century Data Systems, Shugart, Diablo Systems Inc. and Kurzweil Computer Products. Bayer will succeed Jim Campbell, whose retirement will become official June 30. Bayer will retain his duties with the Information Products Group while leading Shugart. If Shugart becomes an independent company, Xerox would continue to be its majority stockholder.

Breakpoints

VERTEX, CII HONEYWELL BULL IN DISK DRIVE MANUFACTURING ACCORD

Vertex Peripherals Corp., which experienced production delays on its V-100 series of high-capacity Winchester drives, has received a major boost from French giant Cii Honeywell Bull, France's largest peripheral manufacturer and distributor. Cii Honeywell Bull has entered a long-term cooperative agreement that gives it the right to market Vertex's current and future products not only in Europe, but also in the U.S. through its Cynthia Peripheral Corp. marketing subsidiary. In turn, Vertex will have the right to manufacture and market Cii Honeywell Bull products such as the recently introduced 13M-byte fixed/13M-byte removable, 5¼-in. cartridge drive being marketed by Cynthia. Vertex was the last manufacturing start-up for 5¼-in. drives last year to begin shipments because of engineering problems. Cii Honeywell Bull has a similar agreement with Seagate Technology to sell Seagate's low-end 5¼-in. drives exclusively in Europe.

START-UP WORKS ON INTEGRATED SOFTWARE WRITTEN IN C

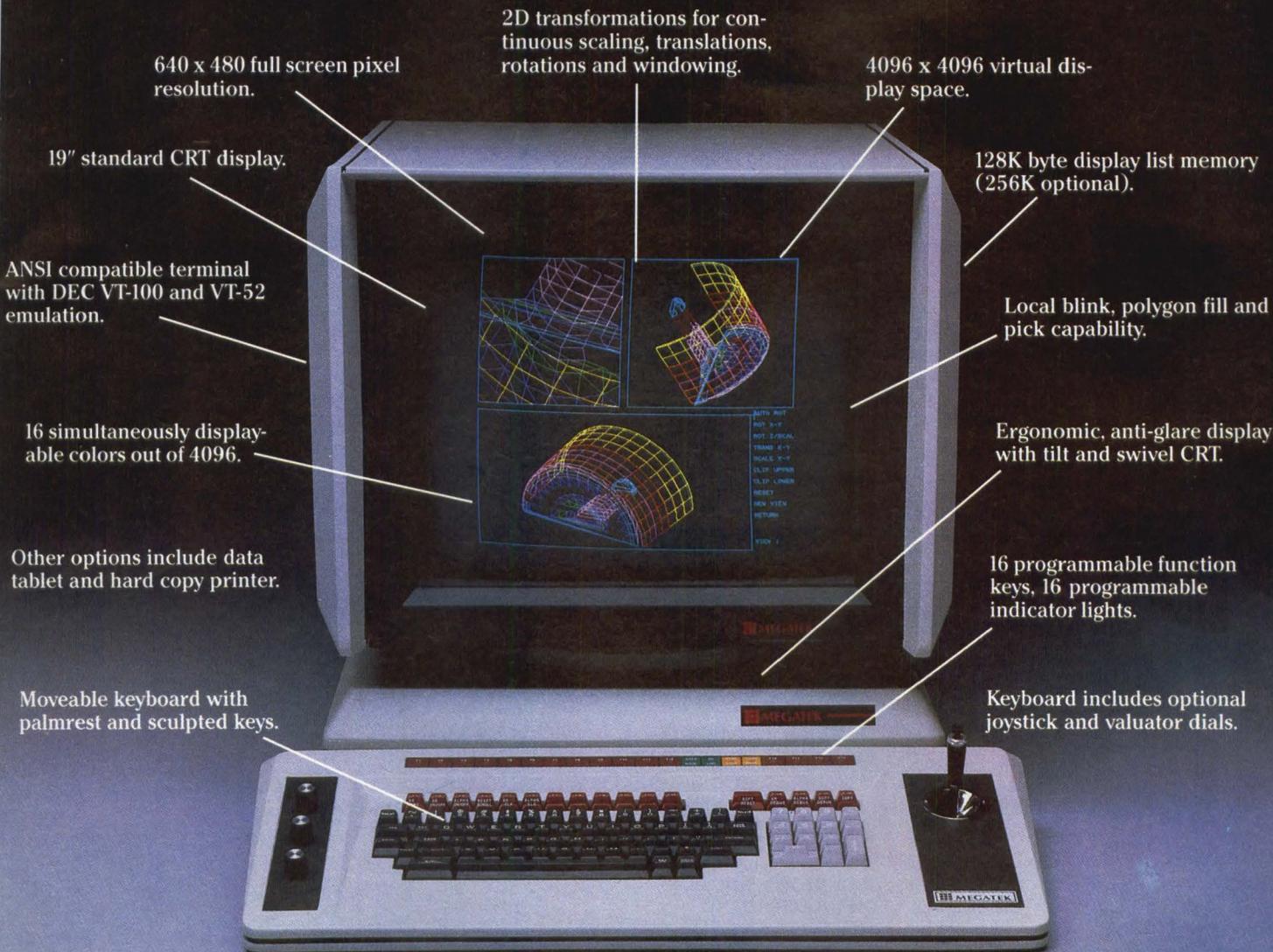
A Southboro, Mass., software start-up founded by four Data General Corp. alumni recently announced its formation, and plans to have its first integrated software package ready in 12 to 18 months. Applix Inc. will put its \$2 million in venture funding to develop what it calls the next generation of integrated office-automation software for OEMs. The modular software will include spread-sheet, word-processing, graphics, communications, calendar-management and project-management functions that will be strongly integrated and tied to the systems. The software will be developed in C. Initial target users are OEMs and large end users with UNIX-based computers, but the product will be tailored for other environments as well. Applix president Jit Saxena was formerly laboratory director for DG's Information Systems division's software-development efforts. Other founders are John Butler, also an alumnus of ISD, and Robert O'Donoghue and Paul Dale, both formerly involved in DG's CEO office-automation system program.

IOMEGA PLANS 5¼-IN. CARTRIDGE DRIVE, GETS SECOND SOURCE

Iomega Corp. may have missed the market window for its innovative 8-in., 10M-byte cartridge drive because of production problems and a failure to obtain a second source. But plans for its 5¼-in. product are geared toward producing better results. The company has named SCI Systems, a broad-based electronics manufacturer in Huntsville, Ala., as a second source for the 5¼-in., 5M-byte cartridge, along with the rest of its product line. Iomega recently named Gabriel P. Fusco, a 26-year veteran of IBM Corp.'s Information Systems Group, as its new president and chief executive officer. Despite market reports to the contrary, Iomega believes a demand still exists for an 8-in., 10M-byte product. The company began shipments of its 8-in. product this year, well behind schedule, and now expects to ramp up production for the 5¼-in. drive this summer.

SGS OFFERS CP/M DEVELOPMENT SYSTEM WITH REAL-TIME TRACE AND C COMPILER

The Systems Division of SGS Semiconductor Corp., which recently opened American headquarters in Phoenix, Ariz., is releasing a development system for CP/M software that incorporates logic analyzer functions. The UX8-22 is a desk-top computer that includes optional Z80 in-circuit emulation with real-time trace at processor speeds as high as 6 MHz. Trace information can be accessed in binary hex, disassembled Z80 code or graphic waveform format. In graphic waveform format, a user can display a traced sequence on the system CRT in a sophisticated analyzer format without attaching oscilloscopes or logic analyzers. In addition, the SGS CP/M C compiler is available on the UX8-22, including an optimizer that increases the execution speed of compiled code by as much as 20 percent. Also new from SGS for its multi-user UX16 16-user computer is a UNIX package called Telex Plus that handles simultaneous reception, transmission and preparation of Telex messages from any of seven system users on one leased Telex line.



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*Thaumaturgy (thō'ma tūr jē), n., the performance of miracles.



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Breakpoints

ZILOG TARGETS DG CUSTOMERS WITH SOFTWARE TO RECOMPILE COBOL VERSIONS

Zilog Inc. is hoping to lure Data General Corp. systems houses and commercial OEMs to the S-8000 supermicrocomputer with a package from Solvation Inc., Westboro, Mass. The Solvation package, developed to meet internal requirements as the company put together its custom microcomputer packages, is designed to "transliterate" DG ICOS COBOL packages so they will run as Ryan-McFarland Corp.'s RM COBOL packages on the UNIX-based S-8000. To make the move tempting, Zilog will offer the transliteration free to OEMs that can bring their ICOS tapes to Zilog field offices for recompilation. Solvation also plans to offer other in-house tools, such as RM COBOL development aids, to other software houses.

PICK-LIKE PACKAGE RUNS ON IBM PC-DOS, MS-DOS

Cosmos Inc., a Morton, Wash. software house, may be the first on the market with a version of the Pick operating system for the IBM PC and the swarm of IBM look-alikes. If the operation system is shipped this month, Cosmos will get the jump on both Pick Computer Works and Computer Distributors Inc., an IBM Series/1 distributor getting Pick under PC-/MS-DOS for shipment by year-end. The Cosmos product, called Revelation, is expected to run about 50 percent of Pick applications written for systems such as Microdata Corp.'s Reality, Ultimate systems or Applied Digital Data Systems' Mentor. ADDS reportedly is interested in getting the package onto parent NCR Corp.'s DecisionMate to give its Pick-based Mentor a low-priced little brother. Computer Distributors, whose package runs under PC-/MS-DOS as well, is hoping to beat Cosmos by pricing its package lower than Cosmos's \$950 for end users. If Computer Distributors can get Pick to make the right deal on royalties, Computer Distributors' version will be priced at less than \$500 and possibly as low as \$200.

PRIAM, OTHERS MAKE PUBLIC OFFERINGS TO BOOST RESOURCES

Priam Corp., which cited a shortage of manufacturing capacity as the reason for withdrawing its high-capacity, 5¼-in. drive last winter, apparently will overcome its resource constraints after a public offering that is expected to net the company at least \$50 million. The money will help pay for a new 140,000-sq.-ft. manufacturing facility to produce the born-again Priam 502 drive as well as the rest of the company's 8- and 14-in. product line. The new 5¼-in. family will include four drives ranging in capacity to 111M bytes.

TECHFILES: A quick look at industry developments

Terminal files: At NCC last month, **Lear Siegler Inc.** planned to buck the trend toward offshore production by introducing a new terminal assembled in its Anaheim, Calif., facilities. The terminal, retailing for \$695, is compatible with ADM-3A and ADM-5 protocols. It features a 12-in. tilt-and-swivel display, nonvolatile soft setup, a 7 × 11 character cell matrix and four function keys that can be dynamically labeled on the bottom line of the display by host-resident software....At the NCGA computer graphics show this month in Chicago, look for Santa Clara, Calif., start-up **Verticom Corp.** to introduce what it's claiming is the first color graphics terminal in production that is compatible with the North American Presentation Level Protocol System proposed ANSI standard. NAPLPS is a compact communication protocol for the efficient transmission of graphics information over phone lines. Of the candidate protocols to implement commercial videotex services, NAPLPS offers the most capability and the highest resolution. Some observers predict the increasing importance of graphics will cause NAPLPS to replace ASCII as a standard in the market for general-purpose video displays. The Verticom terminal is based on two Z80 processors and offers 640 × 480 resolution at 30 Hz, interlaced, a tilt-and-swivel display and a low-profile keyboard....Carrollton, Texas, start-up **Quazon Corp.**, which recently inked a contract with Travelhost Inc. to supply as

Breakpoints

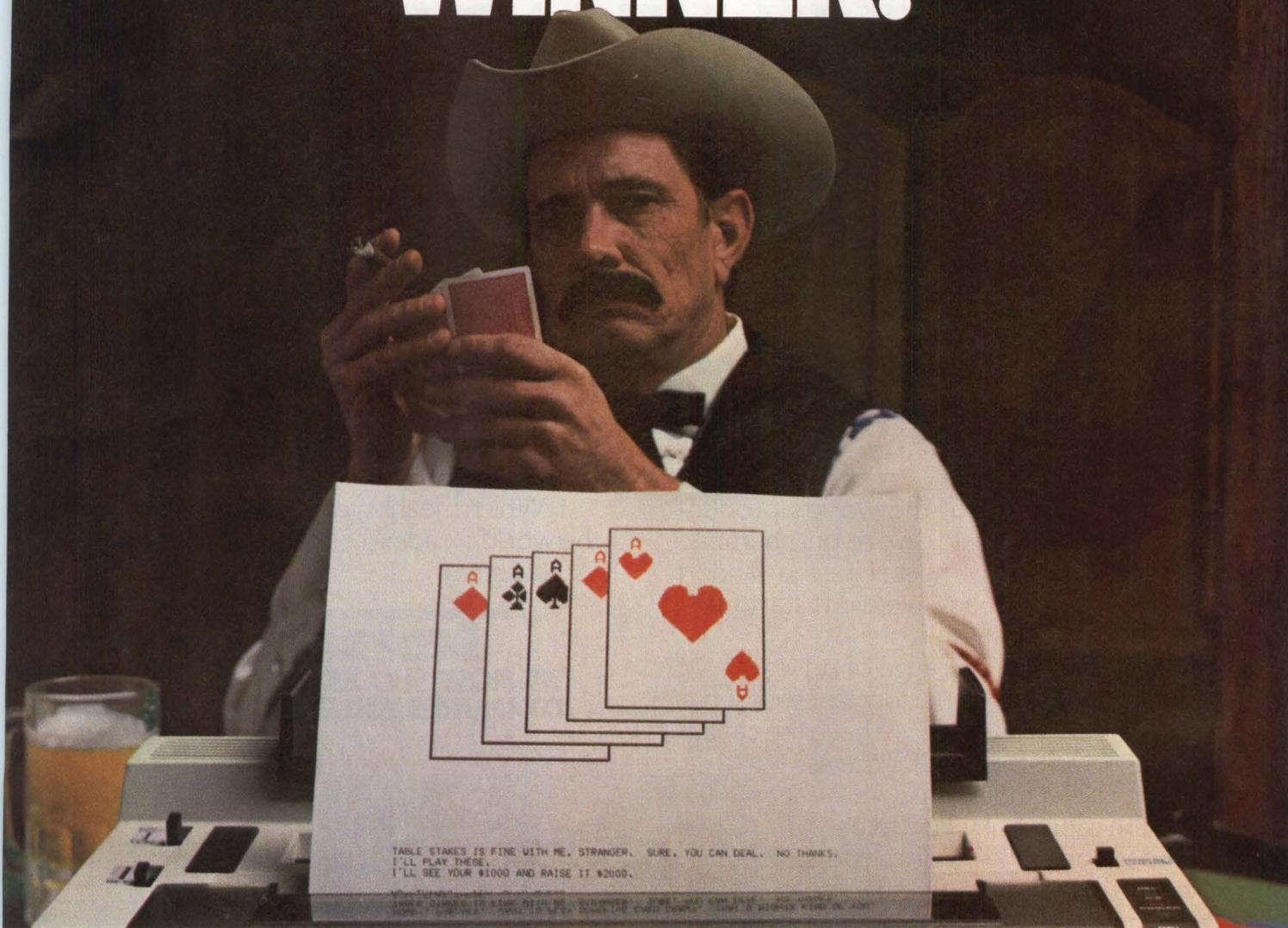
many as 500,000 videotex terminals for use in hotel and motel rooms, plans to introduce this month at CES a version of its product for sales through OEMs and a variety of distribution channels. Dubbed the Quick-Link 300, it is an alphanumeric terminal with an integral 300-baud modem that uses 10 touch-sensitive membrane function keys to automate dialing into and logging onto four remote databases. A display is connected to a television. Suggested retail price is less than \$200. Upcoming Quazon offerings will include an NAPLPS terminal that incorporates a 1200-baud modem and a BASIC interpreter.

Random Disk Files: In addition to the reborn Priam 502, three other manufacturers of high-end 8- and 14-in. Winchesters were scheduled to introduce high-capacity 5¼-in. products at NCC last month. **Fujitsu America Inc.**, which doubled 8-in. drive capacity to 168M bytes, introduced a 5¼-in. drive nearing the 84M-byte capacity of its best-selling 8-in. product. **Memorex Corp.** introduced its first 5¼-in. product that is similar to the withdrawn Priam 502 because it also is 2 in. longer than the standard form factor. **Control Data Corp.**, which had little luck with its 5¼-in. Wren drive last year, has a new high-capacity, 70M-byte 5¼-in. drive....Although **Tandon Corp.**'s new low-cost tape drive has not yet entered production, it is heightening concern that Tandon, which brought cutthroat pricing to the market for low-end disk drives, will erode tape drive prices as well. In anticipation of the Tandon drive, Cipher Data Products Corp. introduced its 10M-byte FloppyTape drive last fall for \$300 each in large OEM quantities. **After the announcement that the \$750 Tandon drive will store 50M bytes, Cipher has increased the capacity of its FloppyTape to 32M bytes at no price increase.** It won't be long, Cipher executives say, before FloppyTape capacity will be increased to 50M bytes or more.

Printer Files: Mannesmann Tally Corp., which recently entered the low-end plotter market, is said to be expanding its high-end printer line as well. The Kent, Wash., company will add a 900-lpm printer to its 300- and 600-lpm dot-matrix line printers. The company recently reduced the price on its 300-lpm T-3000 printer from \$5940 to \$4995.... **Axiom Corp.** has begun shipping production quantities of its newest electrosensitive printer, the model EX1620. Printing near-letter-quality characters at 240 cps, the printer features a "quick print" mode as fast as 960 cps in which two rows of characters are printed in a single pass. Single-unit price is \$795. OEM quantity discounts are available....Following the delayed introduction of the **Alphacom 42** 40-column thermal printer in April, the company last month announced the availability of an OEM version of the printer, designated the 1842. Printing 2 lines per sec., or 80 cps, the 1842 has a single-unit price of \$199.95 each including plug-in parallel, RS232 serial or IEEE-488 interface modules. Alphacom will develop unique interfacing modules for OEMs and expects to introduce Teletext and videotex interfaces by the third quarter of this year. The company recently completed a second round of venture financing and is said to have signed a multi-year, \$54-million OEM printer deal with Timex. It is expected to demonstrate an 80-column thermal printer for the retail market at the CES show this month, with an OEM version to follow shortly.

Micro Files: Microbol, the combination operating system and business programming language that runs on Advanced Electronics Design Inc.'s Freeport multi-user microcomputer, **may be ported to the IBM PC XT, enabling the XT to support multiple users.** Richard Call, president of **MICROBOL Inc.**, Longwood, Fla., plans to tailor the system to IBM's long-rumored forthcoming MC68000-based machine. MICROBOL officials claim exceptional speed for Microbol, although it is non-compiled....**Franklin Computer Corp.**, Cherry Hill, N.J., is reportedly trying to break out of the Apple mold by producing an IBM-compatible portable by early 1984. The system may also support Apple DOS and CP/M, as does the firm's ACE 1200 computer.

A SURE WINNER.



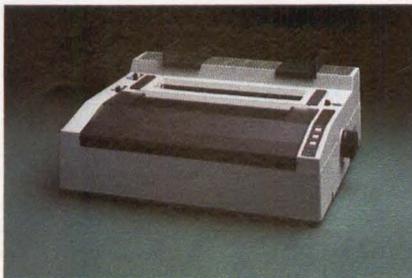
The new C. Itoh 8600 Serial Matrix Printer is clearly a hands down winner. For unlike others that offer graphics only as a high-priced option (if at all), the 8600 comes with built-in graphics at no extra cost. Graphics with even better resolution than many graphics plotters offer.

The 8600 also includes variable speed printing, with three task-specific speeds:

- 180 cps for Data Processing/Rough Draft
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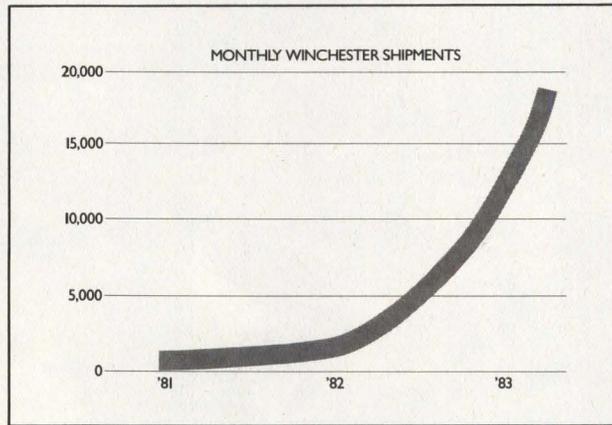
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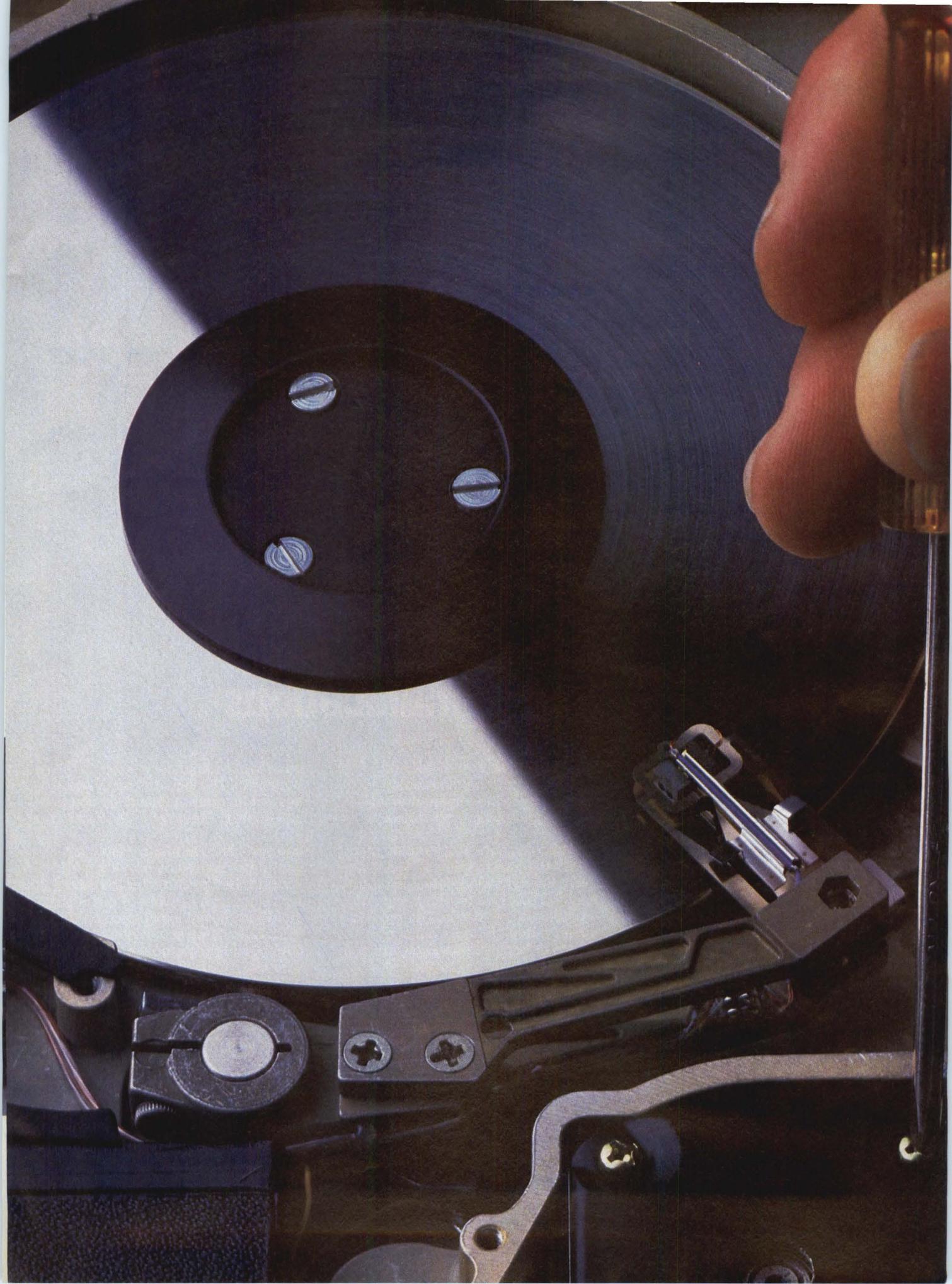
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Publisher's Letter

Expanding "New Products"

This letter introduces some important changes to an already-important section of *Mini-Micro Systems*—New Products. *Mini-Micro* covers new products in all its regular departments and in its *Peripherals Digest* issues, but the New Products section covers more than any other. In 1982, the New Product section covered 623 items, 52 of them in 500-word featurettes and the remainder in new product briefs.

Editorial surveys and compilations of reader response cards indicate that the section was very well-read, but we often found ourselves covering fewer products than we would have liked. We receive many more new product announcements than we can or care to publish, but the number of introductions of significant new products over the past few months has forced us to forego some products we'd have liked to tell you about.

Towards that end, we've changed the type size in the New Products section so that we can get more products on each page. We've also added more pages to the section and plan to devote at least 10 pages to New Products each month. As a result, we should be covering about twice as many new products per month as we did last year.

Quality should increase with quantity. Our New Products editor, Steve Frann, who joined us last August, has been writing and editing all our recent new product featurettes and has reorganized the section into Systems, Disk/Tape, Printers, Terminals, CAD/CAM, Datacomm, Software, Literature and Subassemblies subsections.

These changes will give you more information and spare us some phone calls. Turn to page 259, and tell us what you think.



S. Henry Sacks
Vice President/Publisher

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CIRCLE NO. 15 ON INQUIRY CARD

Letters

Ada and the micro

To the editor:

Please let me add some information to Keith Jones' very informative International column.

The statement that TeleSoft produces an Ada interpreter for the MC68000 is far short of reality, I'm afraid. TeleSoft makes a production compiler for the MC68000, using '83 ANSI syntax, running in the UNIX environment and producing MC68000 native code. The compiler includes TeleSoft's programming support environment to provide complete development capability, and an embedded systems support package is available to load code into ROM.

TeleSoft also produces '83 syntax compilers running on VAX/VMS and VAX/UNIX environments. Other TeleSoft Ada compilers, which use a proprietary operating system interface to the host system, run on IBM 370, IBM PC, 8086/8 and HP 9836 systems. Work is in progress to upgrade several of these to host operating systems.

TeleSoft also provides a series of computer-aided Ada education products, including workshops, seminars, case studies and TeleQuizzes.

Peter Dine

President and Chief Executive Officer

TeleSoft

San Diego, Calif.

NEXT MONTH IN MMS

July's spotlight is computer graphics and MMS will feature two focus articles. One will cover a wall size graphics projection system, designed for mass viewing of CRT-generated color images. A second article highlights a computer terminal for measuring 3D objects.



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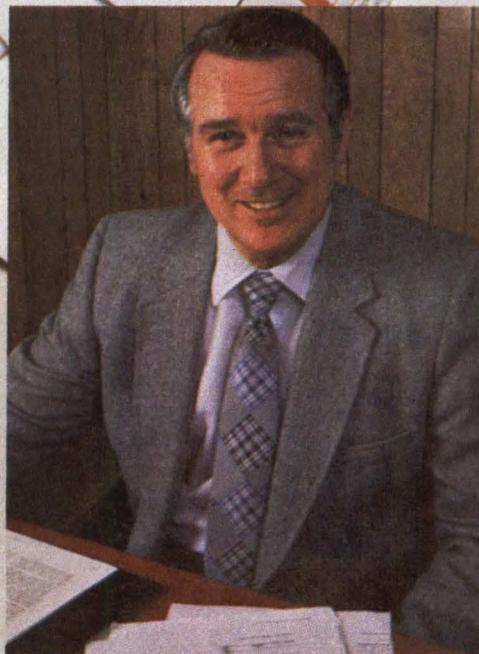
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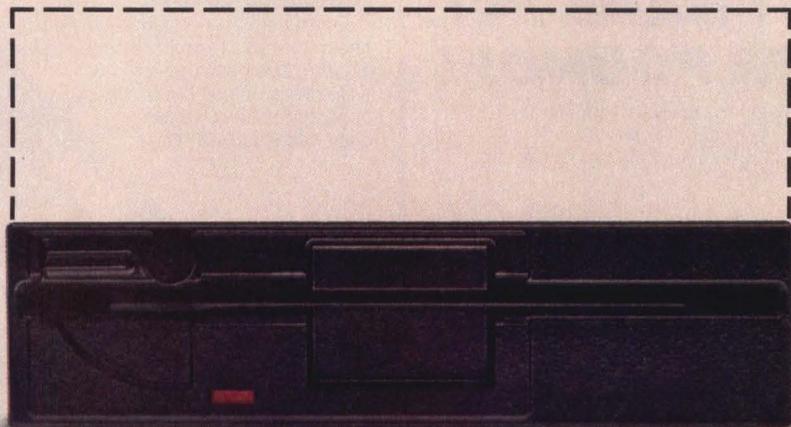
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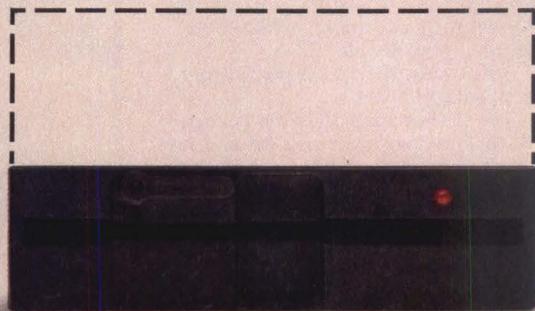
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SA810



SA455



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Even if it's only half as much.

For more information, contact Shugart Corporation, 475 Oakmead Parkway, Sunnyvale, CA 94086, 408/733-0100 (Hamilton/Avnet, authorized distributor).

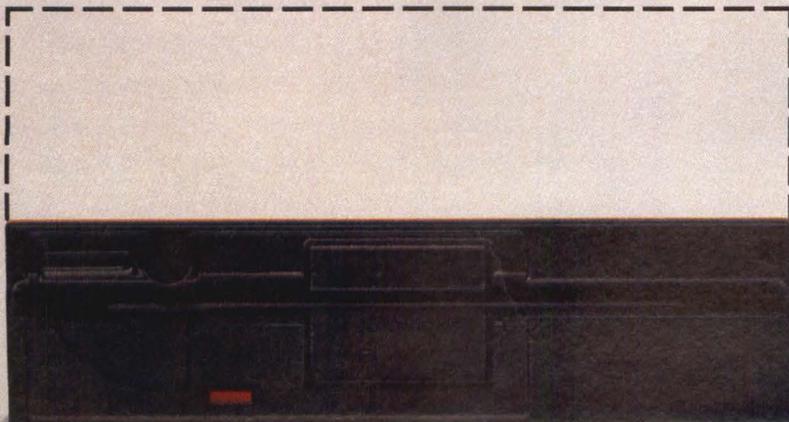
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Right from the start.

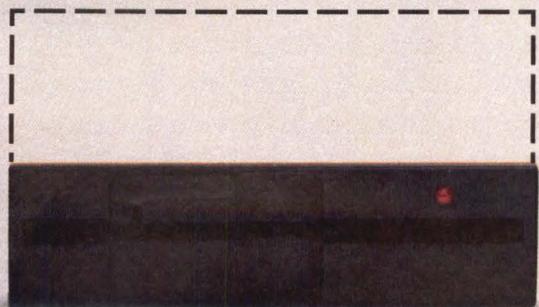
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SA860

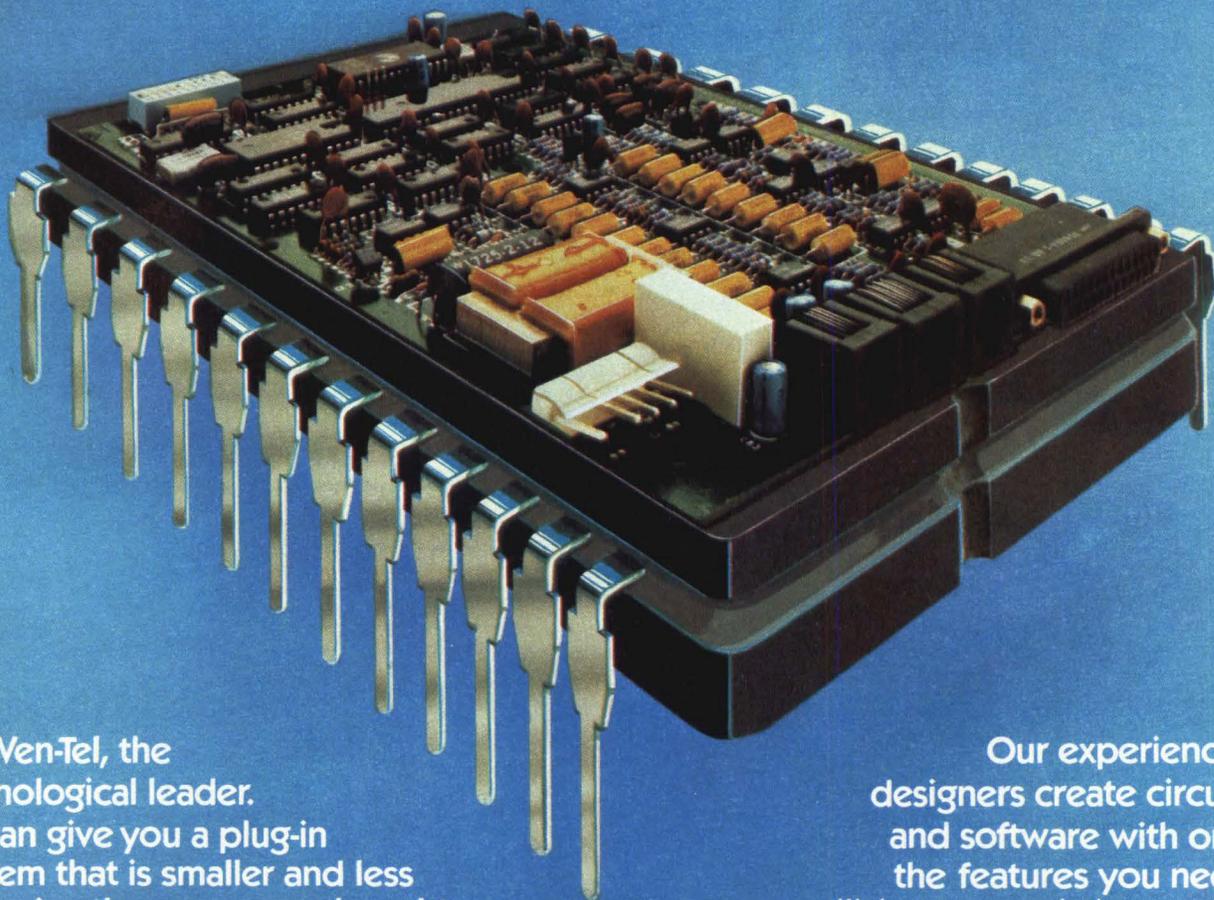


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Mini-Micro World

NEWS

Zilog Z800 may be too late to gain large share of design-ins

Zilog Inc.'s four-member Z800 family of 16-bit microprocessors is winning much praise from most industry observers, who see it as a solid part and attractive Z80 upgrade. But they say it may have arrived too late to impact Zilog's also-ran position for 16-bit system design-ins. The company's initial 16-bit entry—the Z800—introduced in 1979, generally is perceived as less capable and more difficult to program than its competitors. Thus, it failed to leverage the huge installed base of Z80 microprocessors held by the Santa Clara, Calif. manufacturer. Zilog claims the Z800

performs as many as 5 million instructions per sec., with a clock rate as fast as 25 MHz, and is completely binary-code compatible (see "A look at Zilog's Z800 family," below).

Had Zilog been able to deliver the Z800 family when then-company president Manny Fernandez first leaked word of it at the National Computer Conference in 1981, Zilog would be in a strong position. Assembly-language programs under CP/M were then virtually unchallenged in the software market, and the attraction of running them unchanged at three to five

times the Z80's speed on the 8-/16-bit Z800 would have kept a number of Z80 customers from leaving the Zilog fold. Customers may have been intrigued by performance increases made possible by the family's new instructions, 16M-byte maximum addressing range and 8- or 16-bit bus compatibility.

But Jim Ready, vice president of marketing for Hunter and Ready, Palo Alto, Calif., says Zilog could not have built the Z800 when they designed the Z8000. That is because the new chips feature a 2- μ m. geometry, much finer than Zilog has

A LOOK AT ZILOG'S Z800 FAMILY

Zilog Inc.'s Z800 family consists of four processors. The Z8108 and Z8208 interface to an 8-bit bus, work with Z80 support chips and are targeted, say Zilog officials, at applications in which Z80 hardware and software must be preserved. For new designs, the company claims, the 16-bit Z8116 and Z8216, which interface to the 16-bit ZBUS, are preferable because of increased bus bandwidth and their compatibility with the more powerful Z8000 family of

peripheral chips.

While even the 10-MHz version is fast enough to outrun memory and peripherals, as is the 25-MHz version Zilog hopes to sample in 1985, the Z800 architecture includes a 256-byte on-board cache that can be pre-loaded with upcoming instructions and data to increase throughput. For code containing many short loops or accesses to the same locations, an algorithm that retains most recently referenced memory fetches in the

cache can be chosen during system initialization. The rest of the Z800's three to five times throughput advantage in Z80 mode over the Z80 is obtained by pipelining, says Zilog. Running in full Z800 mode can double performance again.

Jim Ready, vice president of marketing for Hunter and Ready, which sells the VRTX real-time operating system in silicon, says the two 64-pin versions of the Z800, the Z8208 and Z8216, "should give Intel Corp.'s iAPX 186 chip a real run for its money" in embedded applications. In such use, the smaller boards and lower design and hardware costs made possible by reduced chip count are critical.

All Z800 family members include an on-board memory management unit, clock oscillator and refresh address generator. The two 64-pin parts also incorporate four DMA channels, four 16-bit counter/timers and a full-duplex asynchronous serial channel that can send and receive at speeds as high as 2M bits per sec. at a 10-MHz CPU clock rate.

Z800 PROCESSOR FAMILY

	Peripherals	40-pin package	64-pin package	8-bit	16-bit
Z8108		•		•	
Z8208	•		•	•	
Z8116		•			•
Z8216	•		•		•

The Zilog Z800 family of four chips features complete Z80 binary-code compatibility at triple the throughput. The Z8108 and Z8208 interface to an 8-bit bus, work with Z80 support chips and are targeted to Z80 upgrades. The Z8116 and Z8216 interface to the 16-bit ZBUS and Z8000 family of peripheral chips. The Z8216 and Z8208 64-pin packages support on-chip DMA, counter timers and a full-duplex, asynchronous serial channel.

Mini-Micro World

NEWS

used in any previous chip. "Yet it was worth waiting; we're very interested in the Z800," says Ready, who believes the Z800 family's architecture and Z80 software base make it an attractive processor.

Unfortunately for Zilog, the 8-/16-bit microcomputer designs that remain to be won are dwindling. By the time large quantities of the Z800 family are shipped in early 1985, 32-bit microcomputer designs will be in full swing. Most observers expect the Z800's primary function to be as a mid-life kicker for Z80-based computers, and because of its clock speed—as high as 25-MHz—and integration of several chips on a piece of silicon, it can function in some controller applications.

But the Z80 upgrade market alone has huge potential. Ken McKenzie, semiconductor industry analyst at Dataquest Inc., Cupertino, Calif., estimates monthly shipments of

Z80s from all sources at nearly 1 million a month in 1982, up more than 40 percent from 1981. He expects that trend to continue for at least several years, which will help the Z800. "That means there's a huge number of machines and a huge software base begging for an upgrade," he says, "and the Z800s are damn fine chips."

Ready says that smaller, less expensive and faster CP/M-based personal computers will be possible because of the Z800 and reduced chip counts. But Skip Bushee, executive vice president of market research firm InfoCorp, Cupertino, Calif., questions whether that potential will sell a significant number of processors. Although he agrees that the chip's compatibility with binary Z80 code is a plus, he says most companies for which CP/M software is a major factor have committed to dual-processor designs. But compatibility with Z80

software will be less critical by the time Zilog ships the Z800s in volume, he says, because the software base for competing 16-bit chips from Intel Corp. will be larger and more attractive than the older 8-bit CP/M programs. "So the Z800 becomes just another 16-bit processor with a lack of 16-bit software," Bushee says. "Who's going to design them in?"

Vector Graphic Inc. is one company that will do design-ins, says a spokeswoman for the Thousand Oaks, Calif., manufacturer of small-business systems. Vector Graphic expects to use the Z8108 to enhance the performance of its Z80-based computers. Zilog says the Z8108 can be retrofitted onto a CPU board such as Vector Graphic's via a daughterboard—containing only a Z8108, a crystal and an octal latch—that simply plugs into the Z80 socket. Andy Reichert, Vector Graphics head of engineering,

Veteran business micro builders alter strategies to ensure survival

With an estimated total of 200 domestic suppliers of microcomputers for small-business and office markets, names like Cado Systems Corp., Durango Systems, Pertec Computer Corp. and Vector Graphic Inc. have lost their prominence. These pioneering companies along with a handful of others helped develop the market in the mid-1970s. Now, they are under considerable pressure from a swarm of 16-bit microcomputers that are invading the market. To compete, veteran companies are reshaping their product and distribution strategies in a variety of ways, such as offering higher end multi-user systems, expanding distribution channels, altering software strate-

gies and exploiting vertical markets.

According to Infocorp analyst Skip Bushee, such veterans may yet have the chance to become major suppliers. "The multiterminal small-business microcomputer market is a highly fragmented one. Nobody's a clear-cut leader, so there are opportunities for all of them to succeed still," Bushee observes. While the small-business multi-user microcomputer segment is growing slowly at 15 to 25 percent a year compared to the dynamic 30 to 60 percent annually for stand-alone personal computers, Bushee feels that, "The growth rate in that segment will actually accelerate in coming years."

Like the minicomputer vendors that turned to larger supermini systems to avoid price wars with microcomputers, several established microcomputer vendors are turning to higher end systems to preserve their profits. They are putting their resources into larger, networked products and, in some cases, are preparing to address the major accounts markets.

Prominent among this group are Cado with its new Tiger series (see "Cado uses multiple-microprocessor architecture to support 64 users," p. 27), Pertec and Vector Graphic. Pertec began deliveries of its new Motorola MC68000-based systems last summer and plans to expand the line upward with systems that

warns that the upgrade process is not that simple. "It makes more sense to design a new board from scratch," he says.

David Stevenson, chief architect of the Z800 family, argues that board redesign is well worth the effort because Z800 chips will be used for more than simply to run Z80 software faster. He expects people to take advantage of the new chips' extensions of Z80 capabilities. "The software designer has a number of new addressing modes that enable him to, among other things, manipulate dynamic arrays and pass parameters on a stack," says Stevenson. In addition, extensions to the Z80 instruction set include calls to the forthcoming Z8070 floating-point co-processor, full 16-bit arithmetic including hardware multiply, divide and compare, semaphores for multiprocessing and access to separate user and system stacks. Also included is

a validation of the undocumented, but much-used Z80 op code that allows high- and low-order byte addressability in the IX and IY registers (effectively adding four 8-bit registers).

For the software author who wants to write a program using the Z800 extensions without losing Z80 compatibility, both standard and enhanced code can be put on the same diskette, says Stevenson. More important in a market that demands increased programming space without address-translation overhead, Zilog claims, is the Z800's on-board memory-management unit. The MMU provides virtual-memory capability including the ability to recover from page faults. The 64-pin Z8116 and Z8216, moreover, provide a directly addressable memory space of 16M bytes, compared to Z80's 64K bytes.

Stevenson notes that, even in Z80 mode, all Z800s support separate

64K-byte work spaces for program, data, the operating system and the operating-system scratchpad. This, combined with a separate system mode, allows for running one operating system in the user space while another runs underneath it in the system space.

Despite the Z800's advantages, Mike Skelton, director of marketing for Altos Computer Systems, which uses Z80s in most of its more than 30,000 installed multi-user systems, does not think the Z800 will have much of an impact. "We won't devote our development resources to building Z800 products," he says, explaining that his company's latest systems are based on Intel's 8086 and Motorola's MC68000. "We're looking ahead, and except for support, we've left the Z80 behind."

Price of the Z800 in quantities of 10,000 will be approximately \$30, more than 10 times that of the Z80.

—Kevin Strehlo



Durango's two new systems are housed in the same packaging. List price for an eight-user 1000 with an Intel 80286 processor, an on-board 80186 I/O controller, a 40M-byte Winchester disk drive, 512K bytes of main memory, XENIX and the terminals is \$21,470. The printer is optional. The single-user 500 runs MS/DOS and has only the 80186 processor, but it can be field upgraded to the 1000.

will match the Cado 64-terminal limit. "We will have a modular family based on the MC68000 that

will enable a user to grow from an under-\$6000 workstation to a multi-processor system supporting 64 workstations," says Soron Litman, Pertec vice president of marketing programs. New members of the family were scheduled to appear

around the National Computer Conference.

Fred Snow, ex-president of Vector Graphic, says, "There is no question that we are moving up in the market. When the value you can get for \$2000 is increasing every month, a full-service supplier like us has to move up to compete." Although Vector recently introduced an aggressively priced version of the Vector 4 that has a 10M-byte disk and a list price of \$5995, Snow describes the move as a short-term attempt to "sustain a position against the competition." Long-term strategy, he says, revolves around products such as the Linc local-area network and advanced communications options that will appeal to larger corporate customers as well as small customers who need distributed, multi-user systems.

Durango is also extending the

Mini-Micro World

NEWS

sizes of its systems, adding a 16-bit family that will support as many as 12 users in its initial release (see "Durango adds Intel 186/286-based systems," below).

Another tactic has been the expansion of distribution. Vector and Cado are for the first time beginning to generate significant OEM orders. Cado president William Patton says his firm has a \$20-million contract with a European firm he declines to identify. Vector recently signed a major contract with Federal Express and has several others pending.

At Rexon Business Systems Corp., recently appointed president Gerald W. Fleming is counting

heavily on OEM sales to accelerate revenue growth. The company now uses dealers exclusively, but, Fleming says, "Four years out, you'll see dealers dropping to 20 percent of our sales. Vertical OEMs such as system houses configuring turnkey systems will account for 35 percent, and hardware OEMs will make up the rest." He says the dealer sales volume will not decrease in that period. "What this company has failed to do has nothing to do with our products and everything to do with distribution," he maintains, blaming the dealer-only strategy for keeping annual sales below \$10 million last year, the company's fourth. Fleming says the company is

ahead of this year's plan to hit \$13 million in sales. Part of that is due to a \$2-million OEM order about which Rexon is not permitted to divulge details, he says.

Durango is also eyeing the OEM market for the first time. Its new systems feature a generic package similar to the IBM PC's, which company executives believe will have more appeal to OEMs than Durango's desk-top CPU/display/printer package. The company has also established an arm of its marketing organization to sell to OEMs.

To enter the OEM market, these companies often must alter software strategies. Both Cado and

DURANGO ADDS INTEL 186/286-BASED SYSTEMS

Under a development project called Flare, Durango Systems Inc. has come up with a transition plan to address the 16-bit microcomputer systems market. That plan should greatly expand the company's potential user base while retaining the software and—with a board-swap option—the hardware installed with 5000 end users. "Our weakness has not been our 8-bit systems as much as our narrow range," says marketing vice president and general manager Chuck Waggoner, adding that the new Durango line up should solve that problem. It adds both a lower priced entry-level product, the 500, and a high-end system, the 1000, supporting as many as 12 users.

The company will expand in another sense as well. In addition to the distinctive 8085-based Durango desk-top system with its built-in printer, the company will offer new models in the line with modular packaging and separate terminals and printers, which it hopes will for the first time help spur OEM and private-label sales.

Another departure for Durango in the new series is a heavy reliance on industry-standard operating systems. At the low end of the new line, it is offering MS/DOS as standard and

CP/M-86 as an option. The high-end models will be shipped with Microsoft's XENIX implementation of the UNIX operating system. While the company is committed to making its Star BASIC language and applications run under XENIX, Waggoner says, it still has not decided whether Star BASIC compatibility is needed in the low-end series. However, the company will offer the proprietary DX85M operating system as an option on the low-end hardware.

The key product in the new series is the 1000, which is aimed at the multi-station small-business computing market. It is based on a single-board Intel 80286 microcomputer with as much as 1M byte of memory and an on-board Intel 80186 I/O controller. The basic unit includes a hard disk controller, a floppy disk controller and a communications controller as well as a five-slot expansion chassis. The 186 controller has its own 128K bytes of memory in addition to the basic 256K bytes on the 80286. A typical eight-user 1000 with a 40M-byte Winchester disk drive, 512K bytes of main memory, XENIX and the terminals is \$21,470. A system with 12 terminals, 60M bytes of disk, 1M byte of main memory and XENIX is \$35,935.

Below the 1000 is the 500, a scaled-down version of the 1000 that uses the same packaging as that used on the high-end models. In the 500, however, the 286 processor has been removed, leaving the 186 in charge. The 500 is positioned mainly as a single-user MS/DOS system, but can be upgraded to a multi-user XENIX system through a field installation of the 286. The 500 series starts with an entry-level 128K-byte, single-floppy disk system priced at \$3995 with MS/DOS. The same system with a 20M-byte disk drive is \$7995. A four-user system with the DX85M operating system, 256K bytes of RAM, a 10M-byte disk and terminals is \$12,500.

A final product in the series uses Durango's traditional 900 series packaging with its built-in variable matrix printer. The 950 is based on the 1000's 286 CPU and is priced at \$13,475 with 384K bytes of RAM, a 10M-byte Winchester and a double-sided diskette. The 951, essentially a 950 with a 20M-byte Winchester, is \$14,975. Two floppy-only versions using the 500's 186 CPU are priced at \$10,575 and \$12,475. The company plans to offer a two-board swap for 950 customers to trade their 8085-based CPUs for the 286 or 186.

CADO USES MULTIPLE-MICROPROCESSOR ARCHITECTURE TO SUPPORT 64 CRTS

Cado Systems Corp. has added two high-end models to its microcomputer systems line, one of which supports as many as 64 workstations. The Tiger ATS series is based on a multiple-microprocessor design that ties as many as 20 Intel 8086-type controllers along a modified Multibus. The basic workstation controller of the system is the transaction processor, which is based on an 8-MHZ 8086 and includes 16K bytes of RAM and 8K or 16K bytes of ROM. Each transaction processor supports as many as eight terminals. In addition to the transaction-processor memory, workstations can access as much as 1M byte of global memory. The terminals are hooked to the transaction processor via a 19.2K-bps RS232 asynchronous line. The system accommodates as many as eight transaction processors.

The second type of processor in the ATS architecture is the control bi-processor, which is based on the Intel 8089 DMA controller chip and can be used to address as much as 1.1G bytes of disk capacity on the ATS 64.

The third controller, the intra-net

processor, supervises the activities of the first two and performs compute-intensive functions that are off-loaded from the transaction processors. The intra-net processor is based on the 8086 and can be ordered with as much of 16K bytes of PROM in addition to a standard 32K-byte RAM.

The ATS series uses a new MM/IOS (multi-master interpretive) operating system that distributes portions of the code to as many as eight transaction processors and features "user-transparent time sharing," which enables the system to support 32 users with as little as 640K bytes of RAM. The operating system also has a file system designed to reduce disk drive head movement in searching for a record by arranging files randomly according to a special algorithm. The file-storage system can place the search keys and data on the same disk track. MM/IOS supports Cadol III, the latest version of Cado's BASIC-like language, and COBOL.

Prices of the basic ATS 32 start at \$26,500 in an eight-user configuration with 256K bytes of RAM, a 15M-byte

Winchester disk, a cartridge-tape drive and the MM/IOS operating system with Cadol III. List price of a high-end version supporting as many as 32 users is approximately \$55,000. The 32 comes in a desk-high cabinet with a nine-slot chassis and space for disk and tape subsystems. Maximum memory for each system is 1M byte.

Prices of the ATS 64 start at less than \$35,000 in an eight-user version. A typical 16-user configuration with 512K bytes of RAM, 30M bytes of Winchester disk and the MM/IOS package sells for \$37,800. List price of a high-end version that can support 64 terminals and including eight 142M-byte disks is \$225,000. The ATS 64 comes in a 17-slot cabinet.

Cado president William Patton says the company is looking for an industry-standard operating system to position the ATS series for OEM buyers, but maintains, "There is no socially acceptable operating system once you get beyond eight terminals." Among the operating systems under consideration is UNIX, which Patton hopes will be available by year-end.

Durango have proprietary operating systems they designed for their 8085-based systems. While maintaining compatibility with existing software to exploit vertical markets, they are expanding into industry-standard operating systems to attract OEMs. Durango already has XENIX, and Cado says it may add UNIX by year-end. Both Pertec and Rexon have used operating systems that run Basic Four Business BASIC packages, but both are expanding. Pertec has already added UNIX and is working on the Pick operating system and MPSI's MicroCOBOL package as well. Rexon plans to add UNIX within six months and will add other standard operating systems to its 16-bit line in six-month intervals thereafter.

Yet another strategy is the exploitation of vertical markets

through new application packages and packages written by dealers. Durango started focusing its energies on vertical markets two years ago with an insurance-agency package it developed in-house and has followed that with another three. An additional half-dozen are "in the mill," according to Durango. The company has launched a new software marketing and acquisition operation that is responsible for finding viable vertical packages written by Durango dealers. Some packages will be brought in-house and remarketed throughout the dealer network, and others will be made available on a less formal basis.

Cado president Patton also sees an opportunity in vertical markets that will enable his company to compete in areas in which compa-

nies like IBM Corp. have not yet gone. "We'll have high-end turnkey microcomputer systems for departments and small companies, and we'll have the distribution channel to reach where IBM can't go," he claims. Patton says Cado and its dealers have invested the equivalent of \$25 million in man-year expenditures to develop a base of 275 application programs.

Infocorp's Bushee points out, "Any company, large or small, can survive if it retreats into a niche it can control," but warns there are also dangers. "To succeed in vertical markets, they will need a strong nationwide presence. They need to go direct, through a national organization prominent in a certain market or through a strong nationwide chain," he says.

—Geoff Lewis

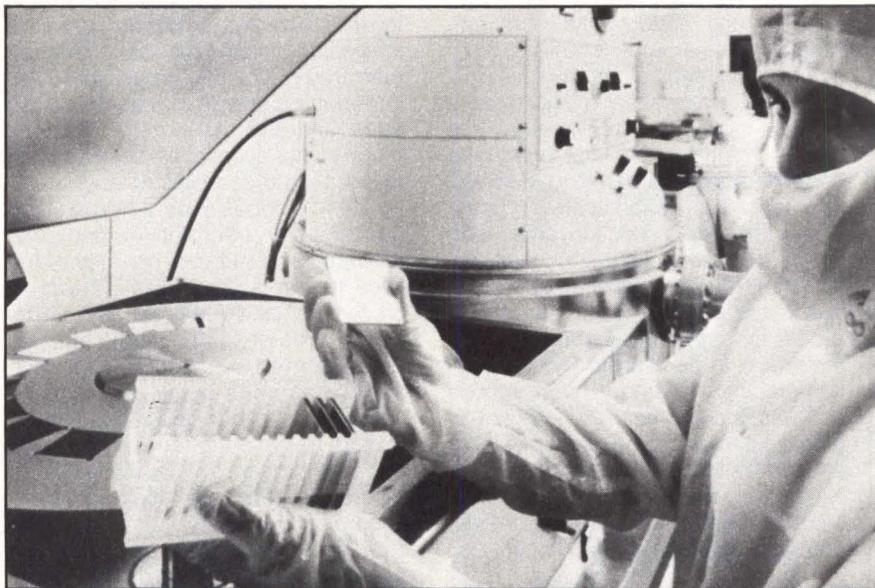
OEM thin-film drive competition heats up despite high start-up costs

The seemingly endless quest to produce small disk drives offering more bang for the buck promises to be hotter than ever this summer as start-ups and heavyweights—including Hewlett-Packard Co., Control Data Corp. and Digital Equipment Corp.—compete to introduce the first thin-film-head drive, despite high start-up costs. Pioneer Seagate Technology aborted an effort early last year to release a 5¼-in. thin-film-head drive because strong second sources and cost-effective production methods for such heads did not exist (MMS, January, 1982, p. 17).

The microscopic heads, which are cut from ceramic substrate wafers, promise to increase disk capacities as much as 25M bytes per 5¼-in. surface by allowing the heads to fly within 13 µin. of the disk surface.

Undaunted by a suit by IBM Corp. claiming theft of trade secrets, Cybernex Corp., a San Jose, Calif., firm founded by ex-IBM experts on thin-film heads, plans to deliver its first heads to the OEM market this summer (see, "IBM challenges Cybernex's rapid start up," p. 30). Also this summer, but before Cybernex's introduction, HP and CDC plan to release the products of their in-house thin-film development to their customers. HP has set the stage for what it hopes will be a leading role in what it believes is the recording technology of the future. A production line will be ramped up this month at the company's Boise, Idaho, Disk Memory Division, for the first of what HP expects to be a family of thin-film drives—including its first 5¼-in. drive manufactured in-house.

The production lines represent a 2½-year, \$25-million investment that began at HP's Santa Rosa,



Thin-film read/write heads manufactured at Cybernex Corp. are built on square wafers in Class 100 clean rooms, using processes similar to those employed in the semiconductor industry. Finished wafers are sliced into rows and polished to achieve a precise air-bearing surface. Finished heads are then mounted onto flexures and shipped. Thin-film heads manufactured by Cybernex are reportedly under evaluation by 14 disk drive vendors.

Calif., research labs. HP officials specify little about the new drives, but do indicate that all will be incorporated into HP systems and will not be available for the general OEM market.

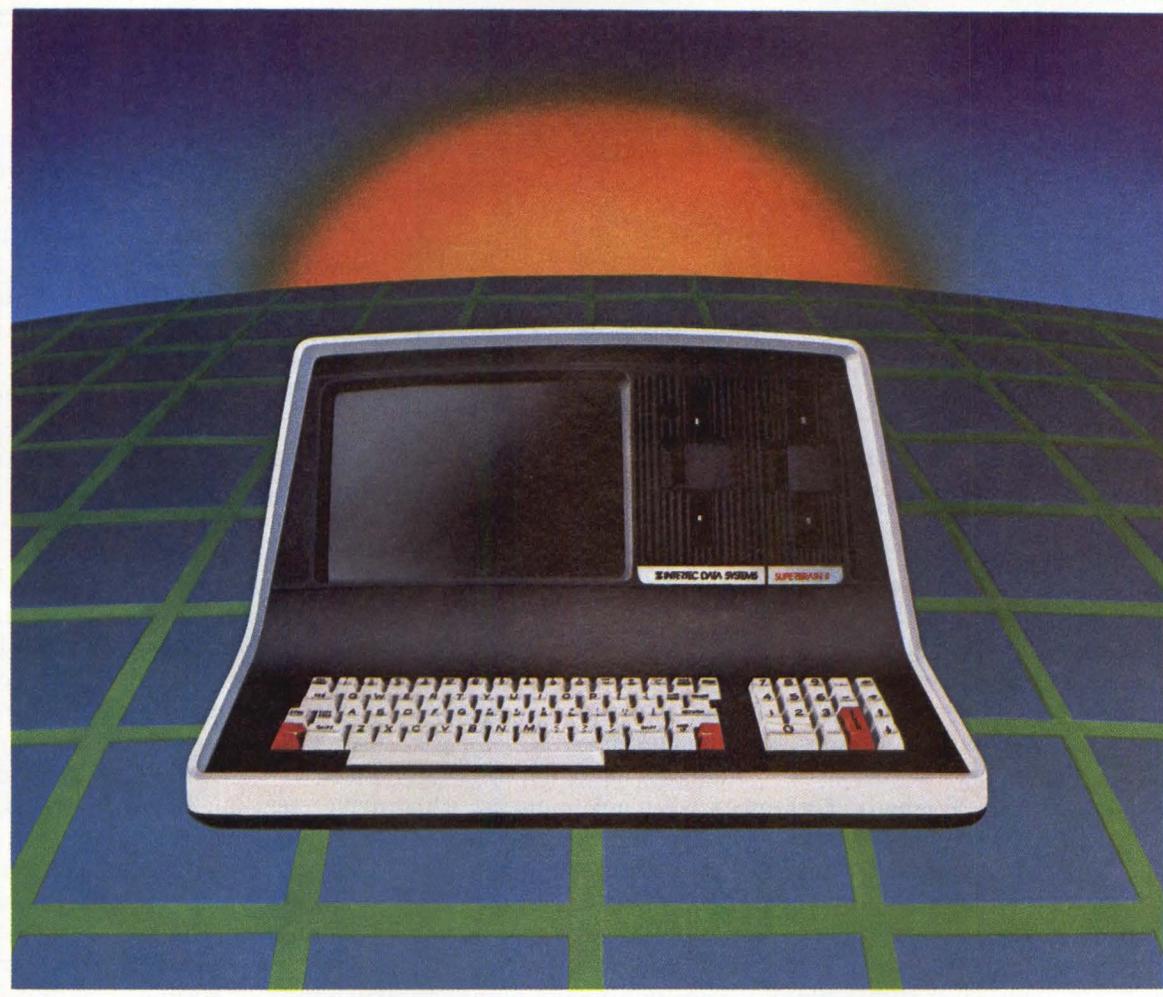
CDC was expected to release its first thin-film-head drive aimed at customers outside of the IBM plug-compatible market at last month's National Computer Conference (MMS, May, p. 32). The 3½-in. Cricket is claimed to be the first small drive using thin-film-head technology to be sold to the OEM market.

Digital Equipment Corp. is also believed to be working on the same types of drives, but DEC officials are not ready to say when the company's first small thin-film head drives will be introduced.

HP's and CDC's investments demonstrate that thin-film-head tech-

nology is not inexpensive and, as a result, the start-up firms preparing to enter the field are few and far between. Few thin-film-head programs have progressed without major production and financial difficulties. Even firms that can draw the most experienced technicians falter. In the 5¼-in. disk market, Dastek Corp. and CalMag Corp. have failed. CalMag founder Jim Money could not raise the capital for such a project. Because of production problems and a loss of key personnel, Dastek could not deliver heads in volume.

Money is now vice president of Cybernex, which might impact the OEM market, which it appears to have to itself—at least for now. But, because of others' past failures, Cybernex must also convince manufacturers of 5¼- and 8-in. rigid disk drives, which remain skeptical



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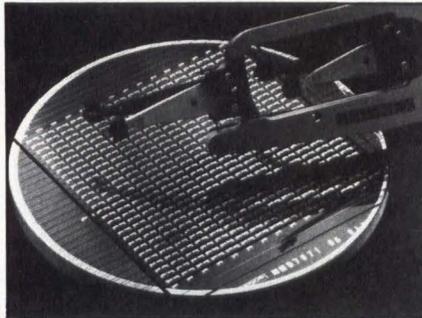
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about thin-film technology.

The primary technical challenge facing Cybernex and others is getting the proper chemical mixture to obtain high yields of usable heads from wafers. Yields now range from 250 to 300 heads per wafer. To bring thin-film-head technology closer to the cost of ferrite heads, yields must approach 400 heads per wafer. Thin-film heads are now priced at more than \$30 per head, about \$10 more than ferrite heads.

Ray Freeman, an independent disk drive consultant and president of Freeman Associates, Santa Barbara, Calif., says it is unlikely that thin-film-head technology will be a major market force this year. "I think it will be late 1984 before we see any volume manufacturing of thin-film-head drives in the 5¼- and 8-in. markets," he says.

Meanwhile Cybernex president William Klein says high start-up costs will prevent customers without the clout of an HP or a CDC from developing their own thin-film heads. "Whenever I hear of someone trying to go into competition with us, I invite them up to tour this facility," Klein says. "Once they see what kind of investment it takes, our potential competitors are



One major problem delaying the advent of thin-film-head technology has been achieving a cost-efficient yield from the wafers from which the heads are sliced. Ultimately, head manufacturers hope to get as many as 400 heads from a single wafer, dramatically reducing the costs of the new technology. Now they're getting an average of 250 usable heads.

more likely to become our customers." In 1981, Klein and four former IBM executives established Cybernex. Within months, the start-up won an unprecedented amount in venture capital—\$33 million—which paid for state-of-the-art semiconductor-like production equipment and a 40,000-sq.-ft. plant. The company plans to construct 30,000 sq. ft. more shortly.

Klein strongly believes that the era of frustration and delay in thin-film-head production is over, and he expects the company to

produce 2 million heads per year in its new plant. He says Cybernex has signed contracts and is delivering thin-film heads in evaluation quantities to 14 OEM customers. He is fully confident that, by 1986, more than half of all heads delivered will be thin film.

In the same neighborhood, Magnex Corp., another start-up, also hopes for a share of the OEM market. Magnex, somewhat older than Cybernex, was formed several years ago by Exxon Corp. It struggled through the "dog days" of thin-film head development. Exxon eventually unloaded Magnex late last year to the highest bidder, Ching Fong Investments, a Korean firm. Ching Fong has recently added another Silicon Valley disk drive start-up, Cogito Systems, to its acquisitions.

Magnex's vice president of marketing Joe Crespo says his company will take the pulse of the OEM market this year. If the market responds, Magnex will join Cybernex in manufacturing thin-film heads for the OEM market. Magnex is concentrating on the more active IBM plug-compatible mainframe market.

—Robert A. Sehr

IBM CHALLENGES CYBERNEX'S RAPID START UP

As Cybernex Corp. attempts to convince its customers that thin-film-head technology is ready for market, it also must convince a federal court that its success in bringing the technology to production within 2 years was the result of its own ingenuity, and not IBM Corp. trade secrets.

In a suit filed in March, IBM claims Cybernex president William Klein, who directed IBM's thin-film-head program for 18 years, and three other founders of the start-up used IBM technology and secrets in bringing the Cybernex product to market. The suit seeks unspecified damages and a

permanent restraining order on Cybernex, barring the company from using any of the technology in its products.

"There is no way Cybernex could have brought its production lines to its current level in such a short period of time without the use of patented IBM processes and the knowledge gained while the former IBM employees were employed at IBM," court documents claim.

IBM also is suing the three venture-capital companies that raised \$33 million for Cybernex's operation "knowing that the defendants would employ secrets and processes gained

through their employment at IBM," the suit claims. The companies named in the suit are the Hillman Co., Pittsburgh, Pa., and two Hillman subsidiaries: HCC Investments Inc. and CRF Investments Inc., both of Wilmington, Del.

At an April preliminary injunction hearing, a court master was appointed to investigate the dispute and report back on August 25.

Cybernex officials, meanwhile, discount the suit, saying only that they will continue their effort to move into full production this summer.

THE 8MBYTE FLOPPY SURPRISE

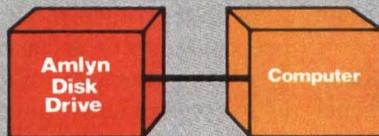
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Local dealers outraged at GSA's solicitation policies

The General Services Administration recently issued a bid solicitation for a private-sector microcomputer store at GSA headquarters. Agency officials say its pilot program may be extended to other federal agencies to speed the introduction of microcomputers to the desk tops of government bureaucrats and their clerical staffs. Instead of welcoming the potential business, local computer dealers are enraged that the contract will go to only one vendor. They believe the contract will create a computer monopoly to supply hardware and services potentially worth millions to the successful bidder.

The store would not be required to adhere to the current GSA price schedules for microcomputer equipment and would include a training center for user education, follow-on maintenance and operations services. Most local computer vendors will bid for the store, realizing that the successful bidder will hold a huge competitive edge in future government sales. The losers, say the dealers, could see their government microcomputer sales decimated by the GSA store.

GSA denies the store will decrease the level of competition for lucrative government orders. "We're building in the competition up front in the contract proposals," says Bill Frazer, GSA special assistant in charge of the program.

GSA estimates annual sales through the store at \$2.5 million. Orders cannot exceed \$100,000 each, and a ceiling of \$8 million has been placed on total annual sales. The contract solicitation guarantees a minimum sales level of \$100,000.

Although GSA does not specify



Illustration by Jim Carson

what hardware and software will be carried in the store, says Frazer, products from a variety of manufacturers must be represented. "Our criteria [for selecting the successful bidder] includes the market penetration of the products, as well as the price," he says. "What is carried in the store must have been commercially tested."

As outlined in the bid proposal, the GSA store will carry personal computers (excluding game and recreational equipment), executive workstations, printers, plotters, software, supplies, cables, disk and tape drives, modems, manuals, and documentation.

Reaction to the GSA proposal from local Washington computer dealers has been intense. "It's outrageous, anticompetitive and a violation of

the usual arm's-length relationship between vendors and the federal government," complains Michael Versace, owner and general manager of Community Computers, Arlington, Va. "No one can fairly represent 12 brands of modems."

Versace's concern, echoed by representatives of ComputerLand and other computer dealerships, is that no one dealer will be able to support the desired variety of equipment. Also at issue is the specter of creating what resembles a monopoly for walk-in federal computer business. "The success of this program will depend largely on what inspection process and audits GSA conducts," says Lorin Powell, Xerox Corp.'s national federal representative for GSA.

GSA's Frazer says that the store will be monitored closely to ensure that all brands are represented fairly. The vendor will be required to submit all sales orders monthly for review by the GSA.

While conceding that the proposal has met with "mixed reactions" from local dealers, the GSA official denies that the contract award for the store is anticompetitive, pointing to the ceiling imposed on individual orders. "The maximum permissible order (\$100,000) is not perceived as a large procurement. Above that level, competitive bidding procedures must be used."

The motivation for the GSA proposal is to boost productivity by increasing the rate of introduction of microcomputers into the federal government. According to GSA figures, the government has approximately 18,000 large general-purpose computers in place. Citing International Data Corp. estimates, GSA says the government will require 500,000 to 1 million microcomputers by 1990.

In a GSA announcement of the program, GSA administrator Gerald

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Mini-Micro World

NEWS

Carmen notes that it took 20 years to bring the 18,000 computers into the government. "Obviously, we cannot afford the luxury of such a long lead time now for the smaller, less expensive personal computers

that will be acquired in large numbers," Carmen states.

The GSA computer store will compete with other traditional GSA procurement approaches, including GSA schedule A, discount catalogs,

and competitive bids.

Bids for the GSA store were scheduled to be opened last month. The target date for opening the pilot store is September.

—Stephen J. Shaw

Diablo broadens product line with ink-jet, thermal printers

In a move designed to get a jump on competitors before the major spring trade shows, Diablo Systems Inc. has introduced a broad range of products including two printers.

Diablo introduced a color ink-jet printer, a thermal transfer printer, two new dot-matrix models, new paper-handling products and other upgrades for its printer line. "We are making a major thrust because we want people to think of us as the one-stop source for printers," says Craig Willison, Diablo's non-impact marketing and planning manager.

The Series C ink-jet printer uses drop-on-demand technology and can operate at 20 characters per sec. in unidirectional or bidirectional modes. The printer employs a 16-nozzle head capable of placing 120 × 120 dots per in. The printer has four color cartridges, each of which produces 250,000 characters. The cartridges can be replaced individually and Diablo hopes to price a package of four at under \$10. The printer uses plain or clay-coated paper.

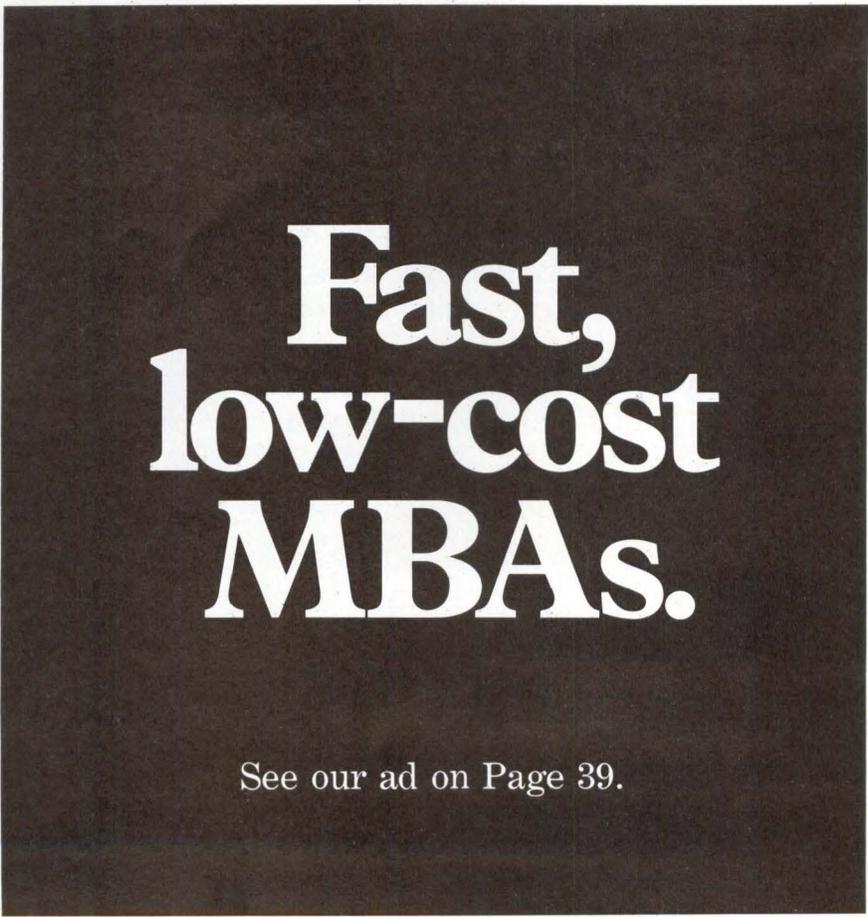
Diablo's thermal transfer printer, the Series 200 EPM, prints at 6 pages per min., at 200 dpi vertically and horizontally. The thermal transfer printer can use noncoated cut-sheet paper with an ink film that produces 1300 pages. Diablo is aiming at a price per page of 5¢.

To its line of four impact

dot-matrix printers, Diablo has added the models 11/A and 31/A, both intended to offer correspondence-quality printing with a 16 × 35 dot-matrix pattern. The Series 11 is an 80-column, 100-cps printer with a list price of less than \$650. The Series 31 is a 132-column,

100-cps printer priced at \$950. Both printers use a nine-needle head and feature a Centronics or an RS232C interface. The dot-matrix printers are supplied to Diablo under a contract with Honeywell Information Systems' Italia division.

Diablo also introduced paper-handling products for the company's 620 and 630 daisy-wheel printers. The accessories, all user installable, are a bidirectional tractor paper feeder, an electronic single-tray



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Mini-Micro World

NEWS

cut-sheet feeder for the model 630, and a two-bin plus envelope electronic feeder. The company also announced that the model 630 is now compatible with the IBM Personal Computer, and introduced a more fully featured version of its model 620 daisy-wheel printer, to be called the 620 Plus. Explaining the company's rash of announcements, Willison says, "Several years ago, the question 'Which technology is best?' was a logical one. But in the last two years, non-impact technological advances in printers have begun to produce a much wider range of alternatives." He believes that these options reflect the differences in intended applications, which have matured over time. "We've recognized that trend and are offering practical solutions," Willison says. He says the non-impact strategic business unit, which includes key executives, should keep the company abreast of technology.

Industry observers are not surprised that Diablo introduced a thermal transfer printer because the machine had been under development by Fuji-Xerox in Japan for several years; as a Xerox Corp. subsidiary, it made sense for Diablo to introduce it in the U.S. The ink-jet printer was more surprising because Diablo had not previously indicated much interest in ink-jet technology. Diablo officials will not comment on what company is producing the ink-jet printer, but some independent industry observers believe it is Sharp Electronics. "It is part of our strategy to give ourselves the option of internally manufacturing these products," says Willison. He says Diablo has made considerable capital investments in robotics, materials handling and other technologies, which will enable the company to manufacture the printers it sells.

Willison does not see non-impact

printers infringing on the company's bread-and-butter—daisy-wheel technology. Instead, he sees the two technologies complementing each other in applications such as color and graphics, to which fully-formed character printing does not lend itself. "The EPM is not a daisy-wheel replacement," he says. "It is intended to accompany our traditional products in the market by offering high-resolution text and graphics together." He says Diablo sees the color ink-jet printer as a way to offer high-quality color printing at a price affordable by personal-computer and business-system users.

Willison claims the two non-impact printers are the first in a series using these technologies. "We are going to continue to be very aggressive in taking advantage of

these new technologies," he adds. "We are not the same company we were a few years ago, when we were perhaps a little too laid back. Technology is going to continue to change the industry, and we plan to be the leaders," he says.

Evaluation units of both non-impact printers have been shipped. Production units of the ink-jet printer are scheduled to be shipped to OEMs and distributors in August. The targeted end-user price is \$1250. The thermal transfer printer, which will be sold only to OEMs, is expected to be shipped this month. Single-unit price is \$4995. The dot-matrix printer, which is already in production in Europe, will be marketed by Diablo through OEM and distributor channels.

—Edward S. Foster

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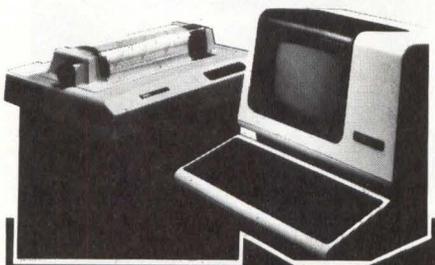
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Mini-Micro World

NEWS

Start-up's low overhead to set IBM PC subsystem price floor

As the computer industry matures and becomes more crowded with contenders for business, most "Horatio Alger" stories of garage shops becoming multi-million-dollar corporate giants like Apple Computer Inc. have been reduced to a standard formula. Using that formula, would-be company founders peddle business plans in search of millions of venture-capital dollars.

One start-up joining the crowded secondary market that has arisen for subsystems for the IBM personal computer plans to take a different tack. Interface Inc. plans to differentiate itself by keeping on a shoestring budget and offering prices far below both IBM and IBM-compatible suppliers. The one-year-old, Canoga Park, Calif., company has begun to market a subsystem for IBM's new PC-XT, a 15M-byte Winchester disk drive with two floppy disk drives for backup. Interface's price is \$2500, much less than IBM's price of \$3995 for a similar system that has only a 10M-byte Winchester drive and a single floppy drive. Other compatible competitors' prices are generally about 10 to 20 percent less than IBM's price.

Interface will sell into the volatile IBM PC market, first as a supplier of low-cost subsystems, then as the manufacturer of a software-compatible system that is expected to be announced by the fall Comdex show. In addition, the company also sells subsystems for Apple, Radio Shack and other computers.

A strong plus for Interface is founder Don Taylor, who most recently was vice president of Tandon Corp. and was also director of marketing at Pertec Computer Corp. Taylor joined Tandon in 1978

when it was primarily a manufacturer of disk-drive heads and posted sales of less than \$3.5 million per year. Taylor was part of the success driving Tandon to \$150 million per year in sales when he left in 1982. He also joined in Pertec's successful growth from \$2 million in 1968, when he joined, to \$140 million before Pertec was bought by Triumph-Adler.

Like many other entrepreneurs, Taylor becomes uncomfortable when a company's revenues exceed \$50 million, which necessitates establishing a bureaucratic structure. Taylor believes such a structure removes some cost efficiencies and price advantages. This is because a corporate giant must support many layers of management and cannot react as quickly to changes in the market.

Interface was started with a \$3000 investment, but it expects revenues in excess of \$12 million in its first full year of operation. Taylor's close friend to whom he reported at Tandon, Sirjang Lal Tandon, also started his company on a shoestring—\$7500. He built his investment through shrewd marketing strategies such as vertical integration and aggressive pricing that led the company to explosive sales volumes.

Taylor achieves most savings through low personnel cost. He buys the mechanical assemblies of drives from his former employer (and a few from Shugart Associates as well) and then adds his own printed-circuit board and controller. Only two people on the staff have extensive industry background, and the average age is 23.

—Robert A. Sehr

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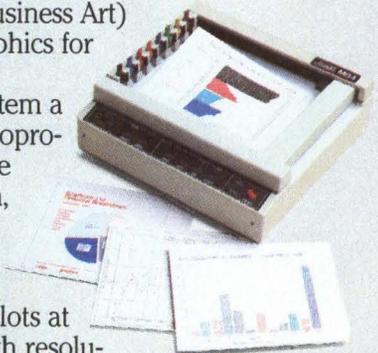
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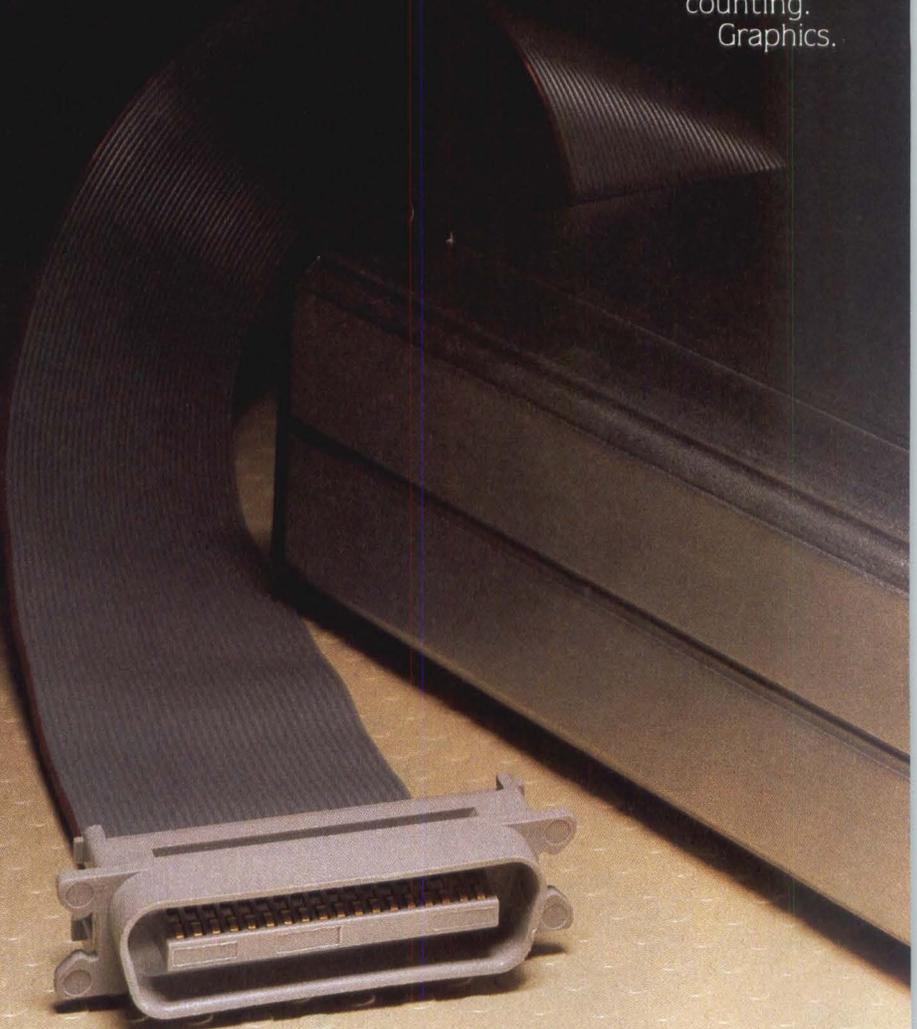
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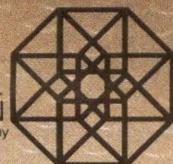
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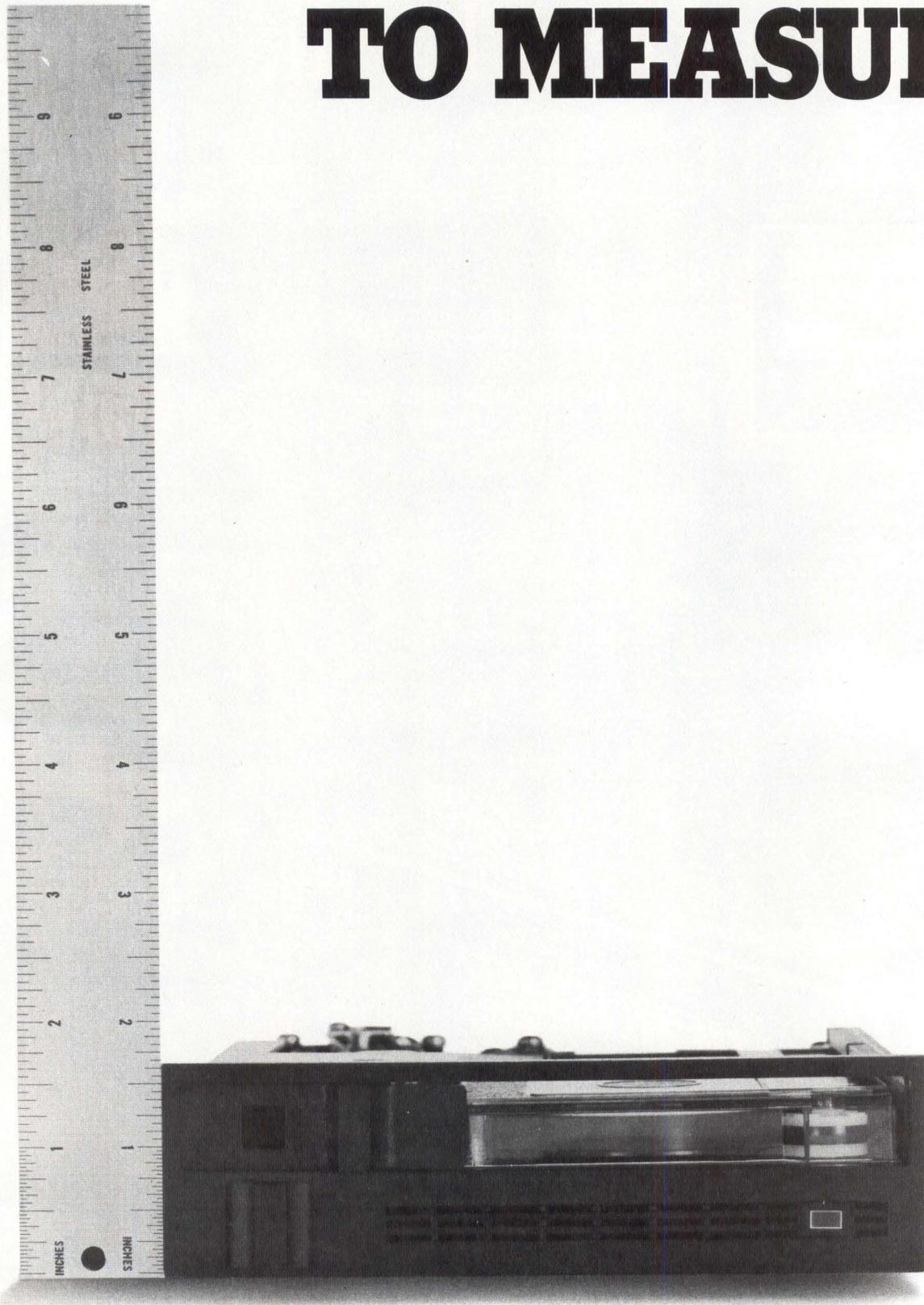
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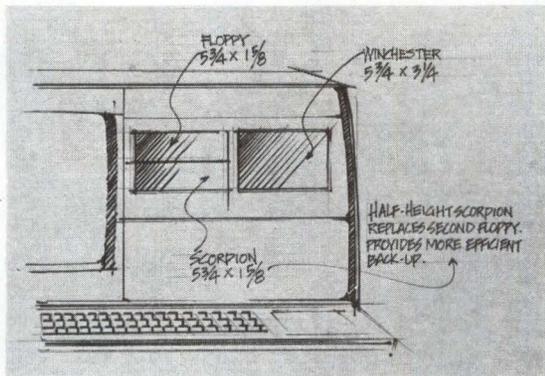
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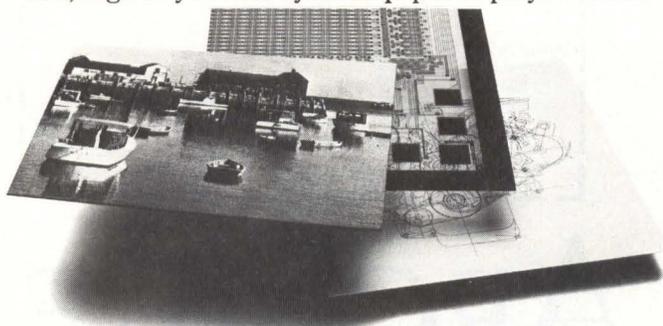
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Mini-Micro World

CORPORATE AND FINANCIAL

Convergent is poised to attack two new markets

With a second public offering and a new batch of major OEM contracts under its belt, Convergent Technologies Inc. is ready to take on the supermicrocomputer and portable computer markets. After coming within \$4 million of its \$100-million revenue goal for sales of its microcomputer workstations in 1982, the company floated a second public offering in March and has signed new OEM contracts with Gould S.E.L., C3 and Prime Computer Corp. that are expected to generate more than \$100 million in sales. The 4.9-million-share public offering, combined with a 4-million-share initial offering a year earlier, has raised more than \$175 million in capital.

The bankroll and backlog are being used to finance the four-year-old company's expansion into the two new markets. Convergent began its foray into the supermicro market last month with the introduction of the MegaFrame multiple microcomputer system (MMS, April, p. 157). The portable computer effort will be the product of the 10-month-old Advanced Information Products division headed by Matthew Sanders, formerly product design engineering manager. Sanders, who says, "We ain't talking," when asked about the division's plans, acknowledges that the operation is developing a family of portable computers. The division was set up like a start-up and is in a facility separate from Convergent's Santa Clara, Calif., headquarters. Sanders says the 30-employee division will introduce its first products early next year.

In the meantime, Convergent's Data Systems division, headed by



Convergent Technologies Inc. president Allen Michels claims the company's MegaFrame supermicro "represents the cornerstone of an important new business." Convergent is also developing a family of portable computers.

former sales and marketing vice president Eliot L. Wegbreit, has introduced the MegaFrame supermicro, which is meant to compete in what president Allen Michels calls the "emerging market for minicomputers." That new minicomputer market, he explains, is comprised of distributed data-processing, integrated office-systems, branch-automation and networking applications.

The MegaFrame system, which can be ordered with as many as 16 Motorola MC68010-based application processors and 32 Intel 80186-based disk and communications controllers, is available in packages priced from \$17,000 to more than \$130,000 and can support as many as 128 users. Wegbreit says the UNIX-based system will compete in the superminicomputer market against products such as the Digital

Equipment Corp. VAX family, the Hewlett-Packard Co. HP 3000 and the Data General Corp. MV series. "MegaFrame represents the cornerstone of an important new business," Michels says. "Because it enables users to run different operating systems in the same box, one of the ideal applications is a bridge for computer companies using old operating systems who want to shift to UNIX." He declines to say whether Burroughs Corp. and other OEMs have committed themselves to the system, but the company's recent prospectus indicates that Burroughs is expected to sign an agreement for the MegaFrame that would include manufacturing rights.

While Michels expects the MegaFrame to bring Convergent into more direct competition with companies such as DEC, DG and HP, he emphasizes the innovative role of the product. "You have to understand the nature of the company. What we do is something innovative and advanced and then let innovative people in the market draw their own conclusions as to how it should be used," Michels explains. "MegaFrame is a perfect example," he adds, "We designed the system as a general-purpose, commercial system, but our first customer is using it in an engineering application."

That first customer is Gould S.E.L., which has signed a multi-year order for the MegaFrame and Convergent workstations. Convergent officials decline to estimate the value of the contract, but sources at Gould say it will be comparable in size to Convergent's workstation contract with Burroughs. The Burroughs order amounted to \$46.3 million in Convergent revenues in 1982 and has been estimated to have a total value of \$100 million through 1985. Gould S.E.L. planned to

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CORPORATE AND FINANCIAL

introduce its implementation of the MegaFrame last month along with its own Advanced Micro Devices 2901-based systems as the first of a Distributed Systems Business Unit product line. The systems will be aimed initially at Gould S.E.L.'s base in engineering and design applications, but are also intended to fit manufacturing/production, software development and engineering office automation. Gould S.E.L. Distributed Systems vice president John Muczko says the products will form a family that can be clustered using an early version of Convergent's CT-NET local-area network.

Part of the Gould order will be a Convergent workstation that is based on the Intel 80186 and is designed to sell for as little as \$5000. The new workstation, which Convergent officials prefer not to describe before its official introduction next year, is composed of snap-together modules that consist of a CPU and floppy or hard disk storage units. The workstation is expected to run Microsoft's XENIX version of UNIX, CP/M-86 and MS-DOS, as well as Convergent's CTOS.

The new workstation, developed under the code name N-Gen for "new generation," is a response to the proliferation of 16-bit personal computers in office markets since the introduction of Convergent's original line. "It is very important to get pricing down. A less expensive workstation is a major commitment now," Michels says. "Each price point leads to broader usage, both in terms of numbers of systems and types of applications," he adds. The N-Gen series is expected to supplant the current AWS and IWS lines and will be priced to compete with high-volume 16-bit personal computer pricing, although Michels is quick to point out that Convergent is not interested in

pursuing the PC market per se.

Although neither company is talking about it, the new workstation is expected to be a major portion of Convergent's recent contract with Prime as well. Prime has contracted for an undisclosed number of workstations that will be used with its office-automation systems. Prime officials decline to say how or when they will add the Convergent product to the Prime system.

In addition to new contracts with Prime and Gould S.E.L., Convergent is renewing orders with its customers. At C3, for example, Convergent has landed a \$10-million, two-year contract with C3's recently established Micro Products Co. C3, one of Convergent's earliest customers, took more than \$10 million in Convergent workstations for its government OEM business last year. C3's Micro Products subsidiary, which has been manufacturing z80-based terminals, plans to take Convergent into dealer/retail channels for the first time. Dwight Self, vice president of marketing and sales, says Micro Products will take all Convergent product lines into retail distribution, acting as a master distributor. Micro Products has signed national distributors in the U.S. and Canada and 18 regional distributors. Self says C3 will maintain and support the products, which will be aimed at dealers and OEMs considering clus-

tered systems. The local distributors are expected to concentrate on end-user sales, especially in data-communications applications, Self says. He adds that the order can go well beyond \$10 million, depending on sales of new Convergent products.

Convergent has also had some setbacks in its OEM marketing programs, notably the cancellation of Savin's order last summer and the recent cancellation of a program to use Convergent hardware at Rolm Corp. In addition, the company faces the possible loss of orders from Thomson-CSF, its French OEM. Thomson has effectively left the computer market, Michels notes, and Convergent is negotiating with Cii Honeywell Bull, the government-controlled computer company, to represent Convergent in French markets. Although Convergent expects sales to Thomson-CSF to dry up if negotiations with Cii-HB are unsuccessful, Michels says, Cii-HB could become a more significant customer.

Michels, a marketing veteran of both Intel Corp. and DEC, avoids making predictions about Convergent's future success. "It's business as usual every day," Michels explains. He says the company has a plaque that reads: "Work hard, improve every day and ask the question 'How badly do I want it?'"

—Geoff Lewis

Shugart revenues increase, as image declines

For Shugart Associates, it is the best of times and the worst of times. One "best" is the bottom line on the company's balance sheet, which has Shugart accountants and Xerox Corp. stockholders smiling. The

company has shown a profit for eight years, and is off to a good start this year, with the best January in corporate history. (The company hopes to reach \$350 million in total revenues this year.) Most impor-

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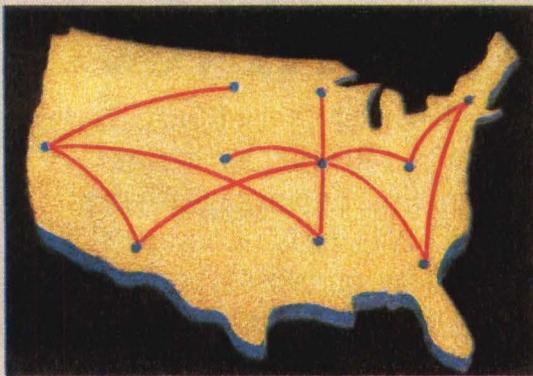
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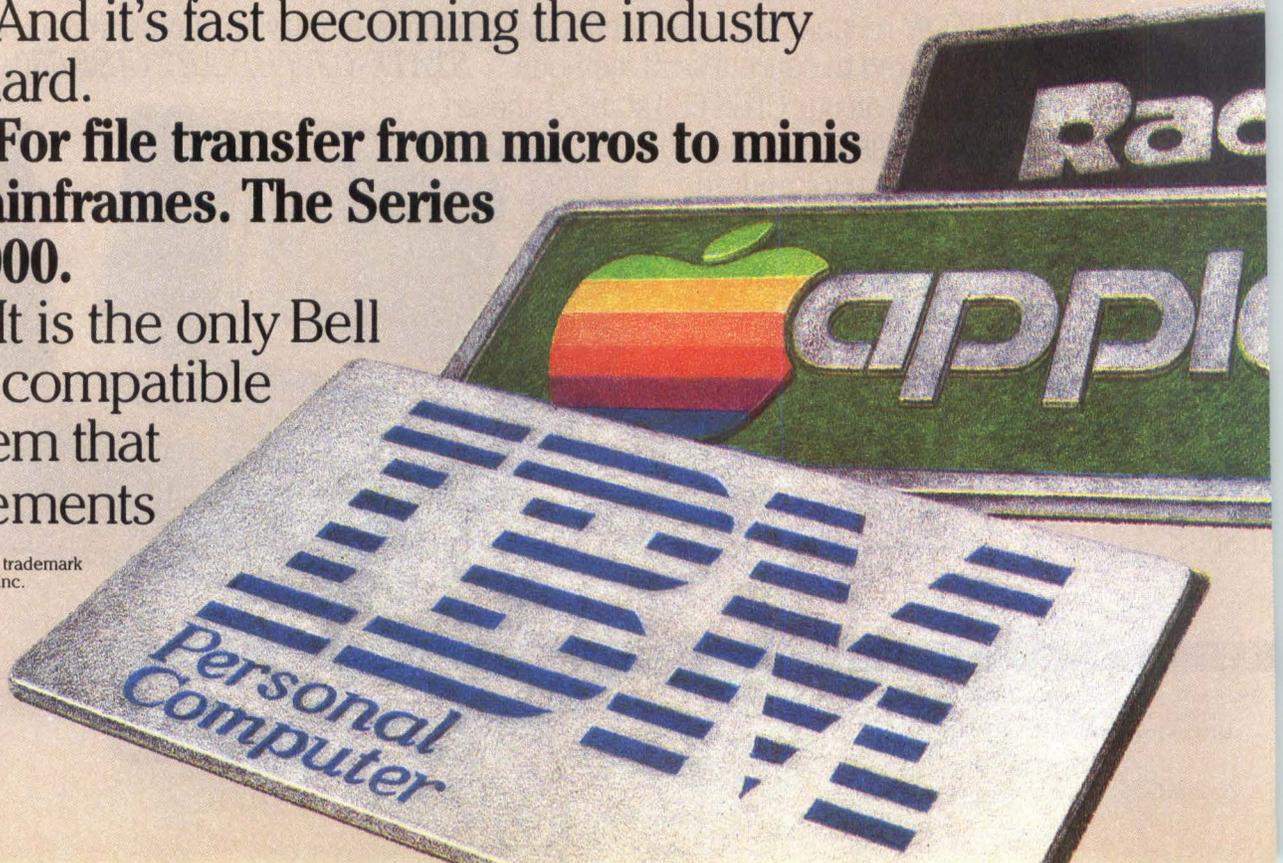
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tant, the company holds 20 percent of the low-end disk drive market.

Many observers in the image-conscious drive industry, however, feel that Shugart has one foot in bankruptcy court. Such observers have written off the decade-old pioneer in the low-end disk drive market as having no more than a supporting role in the office-automation market. That market is expected to fuel a \$28-billion market for disk drives in 1984.

Ironically, Shugart lit the fuse of the office-automation explosion when it developed the 5¼-in. minifloppy disk drive in 1978. Through the cooperation of Wang Laboratories Inc. and other office system manufacturers, Shugart discovered and filled a need for a system that fits conveniently on a desk.

In an industry that is used to overnight success stories, Shugart's growth from \$1 million in revenues in 1973 to \$257 million in 1982 was not extraordinary. But the industry that constantly asks, "What have you done for me lately?" will not tolerate the mere \$27-million revenue increase, which Shugart reported from 1981 to 1982.

Instead, the industry turns to the entrepreneurs of the hour—companies like Tandon Corp, which seized on Shugart's success with the minifloppy, and Seagate Technology, which inherited some of Shugart's founders. Both have taken prestige and potential revenues from Shugart, which in 1978 owned 90 percent of the floppy disk drive market.

The paradox of profits and declining image has not gone unnoticed by Shugart's corporate officials. George Sollmon, Shugart's vice president and general manager of marketing, is frustrated by the attention received by Shugart's two primary rivals, Seagate and



Shugart Associates marketing vice president and general manager George Sollmon is frustrated by the attention received by Shugart's two primary rivals, Seagate Technology and Tandon Corp.

Tandon. "What doesn't seem to get across is that Shugart's profits in the past three years have been higher than those of Tandon and Seagate combined," he says. The frustration is so strong that Sollmon and Shugart president James Campbell conducted an unusual press tour this spring to quiet rumors that Xerox had put Shugart on the auction block and to demonstrate the company's commitment to remaining viable. However, Shugart also admitted to some failures in bringing some recent products to market. Shugart's most surprising revelation is that it had sold only 2149 5¼-in. rigid disk drives in 1982. In contrast, the company claims, it sold 389,400 8-in. floppy disk drives, its highest volume product in 1982. "We didn't recognize the market quickly enough," Sollmon admits. Shugart's SA612 fixed 5¼-in. drive was pulled from production last year and retooled into a 12M-byte product. "The retooling took a lot longer than it should have."

The company also admitted that it

may not have been aggressive enough in keeping its talented personnel. All but one of Shugart's founders have gone to other companies, mainly start-ups. Al Shugart, the first president, and Finis Conner left to found Seagate. Second president Don Massaro recently left parent company Xerox to begin Metaphor Corp., and Herb Thompson started Drivetec Inc., a manufacturer of high-performance floppy disk drives. Of the original founders, only Al Chou remains. Chou leads a "venture group" responsible for developing manufacturing and marketing Shugart's half-height, 5¼-in. rigid disk drive announced at last fall's Comdex. In a similar venture, Yoshi Narahara is responsible for the company's 3½-in. floppy disk drive operation.

Although Chou, Narahara and their respective employees operate much as a start-up would, they needn't worry about venture financing. In addition, Shugart provides research and development and manufacturing assistance to the two groups. Each group member receives a bonus based on reaching milestones within specified time periods. Sollmon says the company has not lost any talent from either of the venture groups.

In addition to retaining some employees, the company hopes to regain the innovative leadership that led to the development of the minifloppy and to doubling revenues in 1978 and 1979. The company has started a \$43-million, multi-year capital improvement plan that will use robotics to eliminate many labor-intensive manufacturing jobs. This year, the company expects to invest \$26 million in R&D. That investment may not mean anything, however, if the company is tardy in getting its products to a market that waits for no one. "Shugart has recognized that half-high Winches-

SYSTEMS HOUSE SLAIN BY MICROCOMPUTER

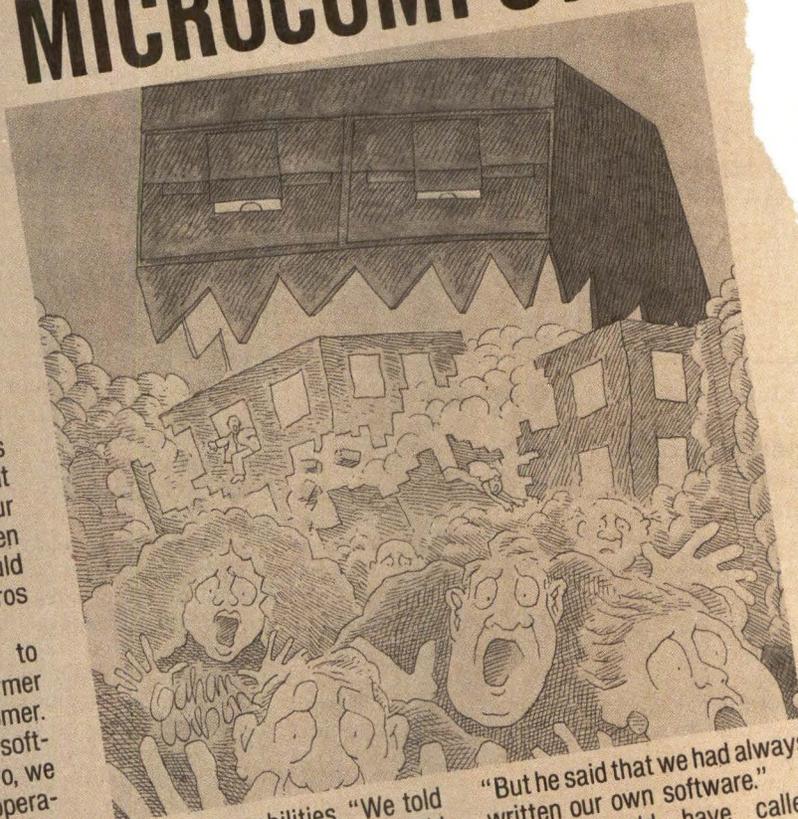
Beast devours entire customer base

BOSTON, MA—Bet Your Business Inc., a major systems house, was destroyed today when all its customers and prospects suddenly switched to business oriented microcomputers.

"We had no software," explained Bet Your Business President Sterling Hindsight from his hospital bed. "All our business programs were written for minicomputers. Who would have guessed that big micros would attack so suddenly?"

"We had to change to microcomputers," said a former Bet Your Business customer. "With Trac Line business software and an ordinary micro, we had better control of our operations than we ever got with a minicomputer. And for about one-tenth the cost!"

Distraught Bet Your Business employees said Hindsight was aware of Trac Line



software capabilities. "We told Hindsight that Trac Line could supply the software so that we could offer micros to our customers," one employee reported.

"But he said that we had always written our own software." "I should have called Trac Line," Mr. Hindsight conceded.

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ters and the microfloppy are essential to its future," says Jim Porter, an independent disk drive analyst. "Now, it must recognize that it has to get its products to

market on time."

Despite the image and viability problems, there have been far worse times for Shugart. The company was founded in the midst

of the 1973 recession, and struggled for a few months until it dropped its plans to market a system based on IBM Corp.'s then-new floppy disk drive. —Robert A. Sehr

GUEST FORUM

A column for guest experts to speak out

Thermal transfer printing: beware of the bandwagon effect

By Edward Webster
Datek Information Services Inc.

Change—or rather anticipation or fear of change by companies—is the lifeblood of the consulting game. Small wonder, then, that consultants often tend to pounce on any hint of new technology with glee, inflate it as much as possible and run with it. As an observer of printer technology for more than 20 years, I've seen consultants—myself included—misread leading-edge technologies with the result that they sell many reports, but accomplish little to guide firms on where to place their bets.

Around 1979 to 1980, with the advent of the Xerox 5700 and the IBM 6670, the buzzword of choice was "ICP," (intelligent copier/printer). Nobody agreed on exactly what an ICP was; some said a low-end laser printer with copier capability. Others said an ICP was any low-end page printer intended for office printing. But in any case, the ICP was going to play a key role in printing for the networked office of the future and, in fact, help spur this elusive concept into reality within a few years. Yet now, four years later, surveys by Datek Information Services Inc. and others indicate that low-end page printers have yet to displace more than a tiny percentage of daisy-wheel printers.

In 1981 to 1982, magnetic printing and ion projection were hot technologies. The Cii Honeywell Bull magnetic printer, which has been talked about for years, is scheduled for introduction this year at NCC. But

all magnetic-printing projects to date have been abortive, including those from such large firms as General Electric Co., whose TermiNet 8000 was the darling of the 1980 NCC. Ion projection looked as if it offered revolutionary bang for the buck at 60 pages per min. from a printer engine that sold for around \$8000 in volume. As offered now by Delphax Systems, ion projection looks like a viable technology for fast and relatively inexpensive page printers but hardly a quantum jump forward with current end-user manifestations priced at \$60,000 or more.

In contrast, we've seen some "sleepers." When a then-small California firm—Diablo Systems Inc.—introduced its HyType daisy-wheel printer in early 1972, the product was hardly noticed. Yet today, this technology dominates and continues to be one of the industry's major growth areas.

Suddenly, thermal-transfer printing technology is the one everybody's talking about. It has burst onto the U.S. printer scene not as an untested technology, but in the form of products that have been shipped and put to work in the Japanese market. On the surface, the products hold the promise of the simplicity, reliability, quietness and low-cost hardware of conventional, direct thermal printing combined with the advantage of a high-quality, archival image on plain paper.

Thermal transfer appears to be remarkably versatile. There are products in almost every digital printer market: low end, low resolution, black and white (Brother's EP20 electronic typewriter and the Sony Corp. Typecorder OA P110 compact printer); high resolution, low cost, serial (Toshiba TH100H and Kanji printers for more than a half-dozen Japanese word processors); bar-code printing (the Sato bar-code printer, now being marketed in the U.S. by Dennison Manufacturing Corp.); low-end page printing (the new 6-ppm

Diablo EPM1/Fuji Xerox P6); and in at least four color video hard copiers.

The overview of the technology Datek has just completed shows that no matter how promising, no technology is without potential pitfalls. Thermal transfer relies on a one-time transfer film, and to date this material tends to be a single-source item, and not inexpensive—prices can exceed \$50 per ribbon. Most use a low-melting-point, wax transfer ink. In the U.S. user environment, under varying environmental conditions, how will these ribbons ship, store and print? For the office, such printers offer near letter quality, but it's still not clear how acceptable such printing is in the office. Competing technologies such as low-cost ink-jet color printers and laser page printers, which are getting less expensive all the time, appear almost monthly.

In short, Datek has resisted the bandwagon impulse on this one. The technology shows great promise, but the success of these products in the U.S. is not a foregone conclusion. As with any new technology, no final verdict can be made in a report but will have to await the acid test of user experience.



Edward Webster is president of Datek Information Services Inc., a Newtonville, Mass., research firm specializing in the printer industry.

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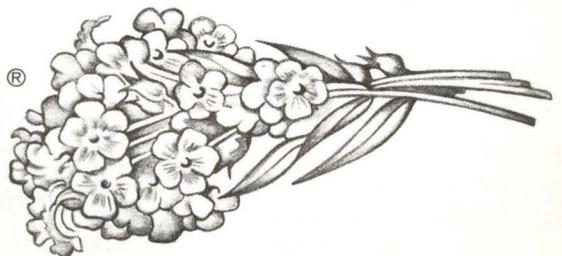
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Financings

Gavilan Computer Corp. (formerly Cosmos Computer Corp.), Campbell, Calif., has raised \$6 million in its second round of venture-capital funding. Company president Manny A. Fernandez says the money will be used for development and marketing of the firm's briefcase computer, which was introduced in April. The investors, who also provided the \$2.5 million in first-round financing a year ago, include New Enterprise Associates, San Francisco, Associated Venture Investors, Menlo Park, Calif., and Abingworth Ltd., London.

Wet ink

One of the largest contracts to date for Apple Computer Inc.'s Lisa personal computer was recently inked for a reported minimum of \$20 million. In the two-year deal, **Compugraphic Corp.**, Wilmington, Mass., will resell the Lisa with composition and typesetting software and hardware. The systems are designed to enable executives to generate publisher-quality reports....**Archive Corp.** has signed a \$2-million agreement to supply its 1/4-in. streaming-tape drives to Sysgen Inc., Santa Clara, Calif. The Archive 20M- and 45M-byte drives will be incorporated into Sysgen add-on storage subsystems for the IBM PC....IBM has agreed to purchase \$10 million worth of 1/2-in. streaming-tape drives from **Cipher Data Products Inc.**, San Diego, Calif., over a multiyear period. The drives will provide backup for IBM Series1 minis....**Plessey Peripheral Systems** has signed a two-year contract to purchase \$9 million worth of disk drives from Control Data Corp. The drives, which range from 32M to 675M bytes, will be used primarily in systems and subsystems of Plessey's Computer

BOX SCORE OF EARNINGS

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

Company	Period	Revenues	Earnings	EpS
Centronics Data Computer Corp.	6 mos 1/2/83	82,369,000	(18,609,000)	(1.66)
	6 mos 12/27/81	56,677,000	(4,623,000)	(.75)
CSP Inc.	6 mos. 2/28/83	5,719,000	894,000	.34
	6 mos. 2/28/82	4,600,000	578,000	.34
Cullinet Software	9 mos 11/31/83	55,082,000	8,016,000	.57
	9 mos 1/31/82	34,660,000	5,451,000	.40
Data General Corp.	24 wks. 3/12/83	368,400,000	8,100,000	.69
	24 wks. 3/13/82	365,100,000	20,500,000	1.92
IGOT Corp.	6 mos 1/29/83	9,408,000	(323,000)	(.04)
	6 mos 1/29/82	12,754,000	367,000	.05
IBM Corp..	3 mos 3/31/83	8,287,000,000	976,000,000	1.62
	3 mos 3/31/82	7,066,000,000	789,000,000	1.33
Intel Corp.	3 mos. 3/31/83	237,526,000	12,511,000	.24
	3 mos 3/31/82	207,110,000	5,405,000	.12
Monolithic Memories Inc.	24 wks 3/20/83	38,521,000	903,000	.11
	25 wks 3/21/82	29,469,000	375,000	.06
Timeplex Inc.	9 mos. 3/31/83	31,292,000	2,239,000	.38
	9 mos. 3/31/82	23,141,000	917,000	.18
Time Sharing Resources Inc.	9 mos 2/28/83	10,144,000	726,000	.64
	9 mos 2/28/82	9,105,000	721,000	.63
VLSI Technology Inc.	3 mos 3/27/83	7,579,000	(1,630,000)	(.19)
	3 mos 3/28/82	679,000	(564,000)	(.20)
Unitrode Corp.	year 1/31/83	120,081,507	12,912,399	2.18
	year 1/31/82	112,408,006	11,233,225	1.93

Comments: Cullinet Software revenues for the third quarter increased 62 percent to \$20 million compared to \$12 million a year earlier. Net income for the same period increased 51 percent to \$3 million or 21¢ per share, compared to \$2 million, or 15¢ per share. Commenting on its decline in earnings, **Data General Corp.** says it is continuing to stress cost containment and productivity programs. For the second 12-week period, DG revenues rose to

\$187.1 million from \$181.6 million a year earlier. Net income dropped to \$5 million, or 42¢ per share, from \$5.6 million, or 52¢ per share. **Intel Corp.** said it was able to more than double net income over the first quarter of 1982 by enacting across-the-board cost-cutting measures, such as a pay cut. The company also cites higher interest income as a determining factor in the improvement.

Systems Division....**GTE Telenet Communications Corp.**, Vienna, Va., has been awarded a contract worth an estimated total of \$160 million from the U.S. Department of Agriculture to supply all the USDA's data-communications equipment through 1990.

Industry monitor

An Internal Revenue Service proposal could cost the computer

industry and companies that develop their own software millions of dollars per year in taxes. The proposal would virtually eliminate the 25-percent software R&D tax credit, which was initiated on June 30, 1981 (MMS, November, 1982, p. 119). A credit would be allowed under the new system only if the operational feasibility of a program is seriously in doubt.

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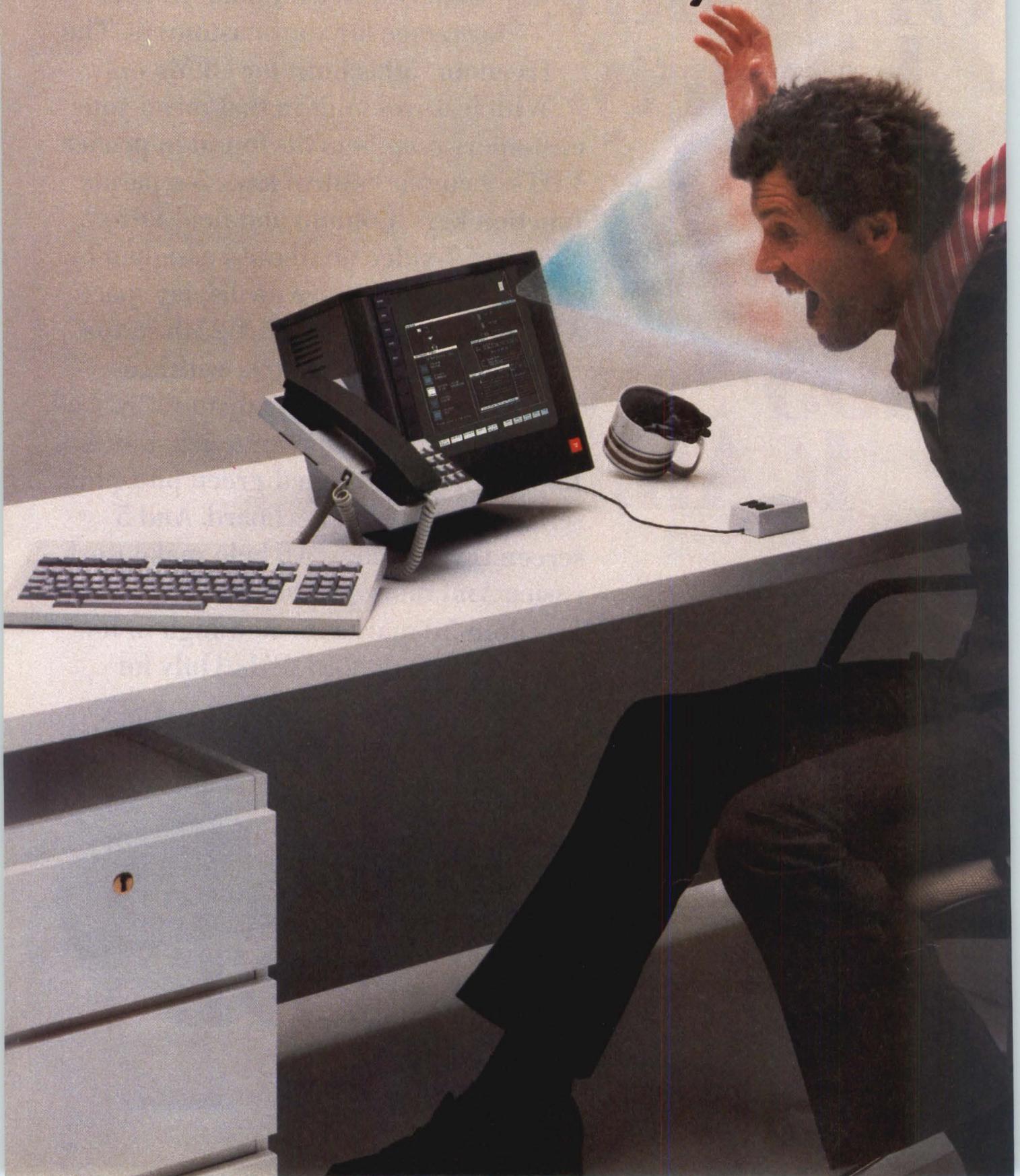
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Multi-computers, high performance, 16-300+ users. The 16-bit multi-computer Sydis Information Manager™ (SIM*) utilizes an enhanced Xenix™ operating system, which is Unix™ System III compatible. The SIM can be cost-effectively expanded to as many as 32 single board computers, each with up to 2 M bytes of memory. This, in combination with a high speed workstation link of 320 K bits/second, allows the SIM to accommodate 16 to 300+ users without performance slow-down.

Communications, personal computing, electronic office. The system workstation, VoiceStation 1, is small, only slightly larger than a 10 button phone. Yet it gives users access to advanced office automation applications through an icon-based, object-oriented user interface. Applications include: telephone services, electronic mail, file cabinet and wastebasket services. Also personal computer applications like word processing (with voice annotation), electronic spreadsheets, business graphics, database, forms and communications.

Replaces the phone, uses existing wire. Disconnect the present telephone and hook up VoiceStation 1. That's all. VoiceStation 1 communicates with the SIM via a twisted pair of telephone wire, so the cost of installing additional cable is eliminated. And the SIM can work with any existing PBX and central office phone services.

Let's talk price/performance margins. Sydis would like to speak to OEMs. Priced lower than other systems that don't support voice, the VoiceStation System is worth talking about.



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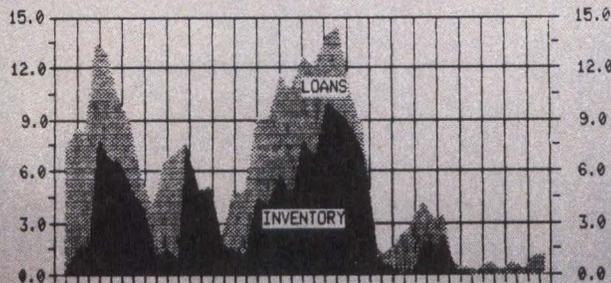
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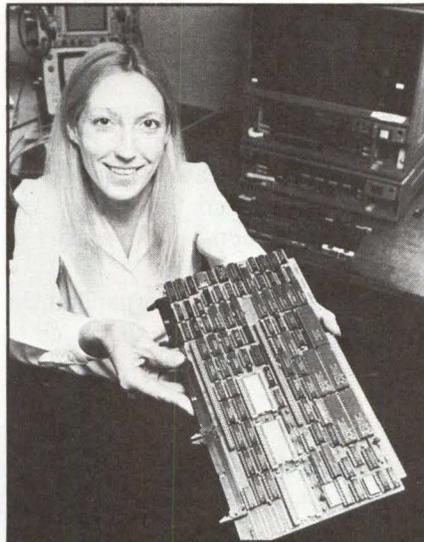
British firm offers 432-based system, claims advantages over Intel's 432/670

U.S. licensees and distributors are being sought for an expandable board-level microcomputer configured around the Intel iAPX 432 chip set. Called the HIS 432, the product is described as being "a quarter the physical size, one-third the price and twice as powerful" as Intel Corp.'s 432-based microcomputer, the System 432/670. Making this aggressive sales pitch is Daphne Gordon, managing director of the company that designed the HIS 432, High Integrity Systems Ltd., Sawbridgeworth, England.

Gordon notes that Intel has a nonexclusive option to build the HIS 432. Intel's Northern European marketing manager, David Mayes, who has close contact with the English company, has acknowledged the product as "the best 432 system implementation around that I know of." Gordon says no deal with Intel has been signed but stresses any future agreement will not prevent deals with other U.S. companies.

Gordon defines her company's role as purely that of a design and consulting firm for the 432 and a closely related technology, the Ada real-time programming language. Even in Britain, manufacture of the HIS 432 is done by other companies, mainly Ferranti Plc, one of the U.K.'s largest electronics manufacturers.

Intel sees hosting Ada programs as a major role for 432-based computer because of the 432's parallel architecture. Gordon believes the physical compactness of the HIS 432 lends itself "ideally" to embedded systems, a major application for Ada software. Gordon notes the HIS 432 boards—as few as two



Daphne Gordon, managing director of High Integrity Systems, England, holds the HIS 432's processor board showing the slots for the Intel 432 three-chip set.

for a complete machine—are designed to fit into any Multibus card cage. She says a complete HIS 432 can be buried in an Intel Microcomputer development system.

"The HIS 432 was designed after the 432/670, so we had something to shoot at," she says. "The HIS 432 offers complete 432/670 equivalence. But it achieves higher performance by employing a 64-bit-wide ribbon cable bus to link the processors directly with the memory." Intel uses the 32-bit-wide sysbus in the 432/670. Compactness has been achieved partly by using a compact four-chip bit-slice processor for memory arbitration rather than a whole board of TTL devices, she adds. Also, High Integrity employs plug-in cells (compact printed-circuit boards) very similar to the Multimodule design used by Intel in its 16-bit machines, but not in the 432/670. Thus, the HIS 432 can be expanded by plugging cells into

boards rather than adding extra boards. The typical price for a cell is about \$1500.

The chip density requires the use of 10-layer PC boards, while Intel uses four-layer boards. But 10-layer boards are easy to obtain, says Gordon. The boards do not lend themselves to automatic component insertion, but HIS 432 volumes are unlikely to be high enough within the next 18 months to need automatic insertion, she adds. Gordon Reed at Intel's Special Systems Division, Hillsboro, Ore., explains that the 432/670 uses standard boards rather than Multimodule cells to minimize manufacturing costs and maintain industry compatibility.

The HIS 432 employs two types of Multibus-sized boards. The processor board includes one 432 general data processor consisting of two chips and one single-chip 432 interface processor. The three chips form the 432 set supplied by Intel, although a five-chip set was announced this year. The processor board also holds the memory-arbitration devices and incorporates extension cell sockets. The other HIS 432 board, called the system board, includes 0.5M bytes of main memory, implemented in 64K-bit RAMs, a 32K-byte input/output memory and a socket for an I/O memory-extension cell, which adds 96K bytes to the basic 32K bytes. The sockets in the processor board are designed to accept two other types of cells. One type, the processor cell, provides two extra general data processors. The system cell comes with one general data processor and one interface processor. One processor cell can be

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added, either by itself or with a system cell, or a user can opt for two processor cells and no system cell. So a machine can have between one and five general data processors and one or two interface processors, supporting one or two I/O channels.

A second system board can be added to the basic two-board configuration to expand main memory as much as 1M byte and I/O memory as much as 256K bytes, (128K bytes for each I/O channel), if each system board has an I/O memory cell extension. A memory-extension board providing an extra 1M byte of main memory is also

available.

Gordon believes the price range for U.S. customers could be between \$8000 and \$23,000, with volume discounts for quantities of 6 or more. Rather than buying 432 chips from Intel in the U.S. and reexporting them, High Integrity will ship HIS 432 machines to the U.S. without the Intel devices. Gordon stresses that U.S. customers will be expected to have the necessary in-house expertise to integrate the 432 chips.

In the spring, Intel expanded the 432 chip set from three to five chips with two new devices, the bus

interface unit and the memory-control unit, which could replace the space-consuming chips used in the 432/670 for arbitration and memory control. Gordon is reluctant to reveal any plans for High Integrity to announce versions of the HIS 432 configured around the new 5-chip 432 set. She only remarks that High Integrity is considering it. Reed at Intel is hesitant to divulge any plans by his company to make a more compact alternative to the 432/670 similar to the HIS offering. But he acknowledges that the new 5-chip 432 set could be used in a future machine. —Keith Jones

OCCAM LANGUAGE IS SUITABLE TO PARALLEL PROCESSING ON INTEL 432-BASED SYSTEM

Occam is a language considerably less well-known than Ada. But, like Ada, it lends itself to the parallel-processor architecture of the Intel 432 says Daphne Gordon, managing director of High Integrity Systems Ltd., England. As a result High Integrity is considering developing an Occam compiler for the 432.

Occam was developed by professor Tony Hoare, head of the programming research group at Oxford University's computer laboratory. It is named for a fourteenth-century Oxford philosopher, William Occam, who proposed a method of tackling intellectual problems called Occam's Razor. Occam's Razor says that all unnecessary complications should be removed and is recognized as one of the origins of modern scientific method.

With Occam, Hoare attempts to follow William of Occam's philosophy by defining a language based on a few simple constructs. Each type of construct gathers a group of primitive processes (single-line instructions) into larger processes. Apart from conventional assignment statements such as A:=B, the only other primitive processes Occam uses are ones that use input/output channels to link concurrent processes. Single channels or arrays of channels can be declared using a key word, CHAN, and

channels can be actual input or output devices such as keyboards and screens. Two channels are used to transmit a value from one process and receive it by another.

To execute a group of primitive processes in parallel, they are preceded by the construct key word, PAR. Another construct, indicated by SEQ, says that a group of primitive processes should be executed in sequence, while a third, using ALT, says that only one process from the group following should be executed.

Occam also provides more conventional constructs, including WHILE and IF. Variables are declared using VAR. Abstractions that can be called from other parts of a program are declared by PROC.

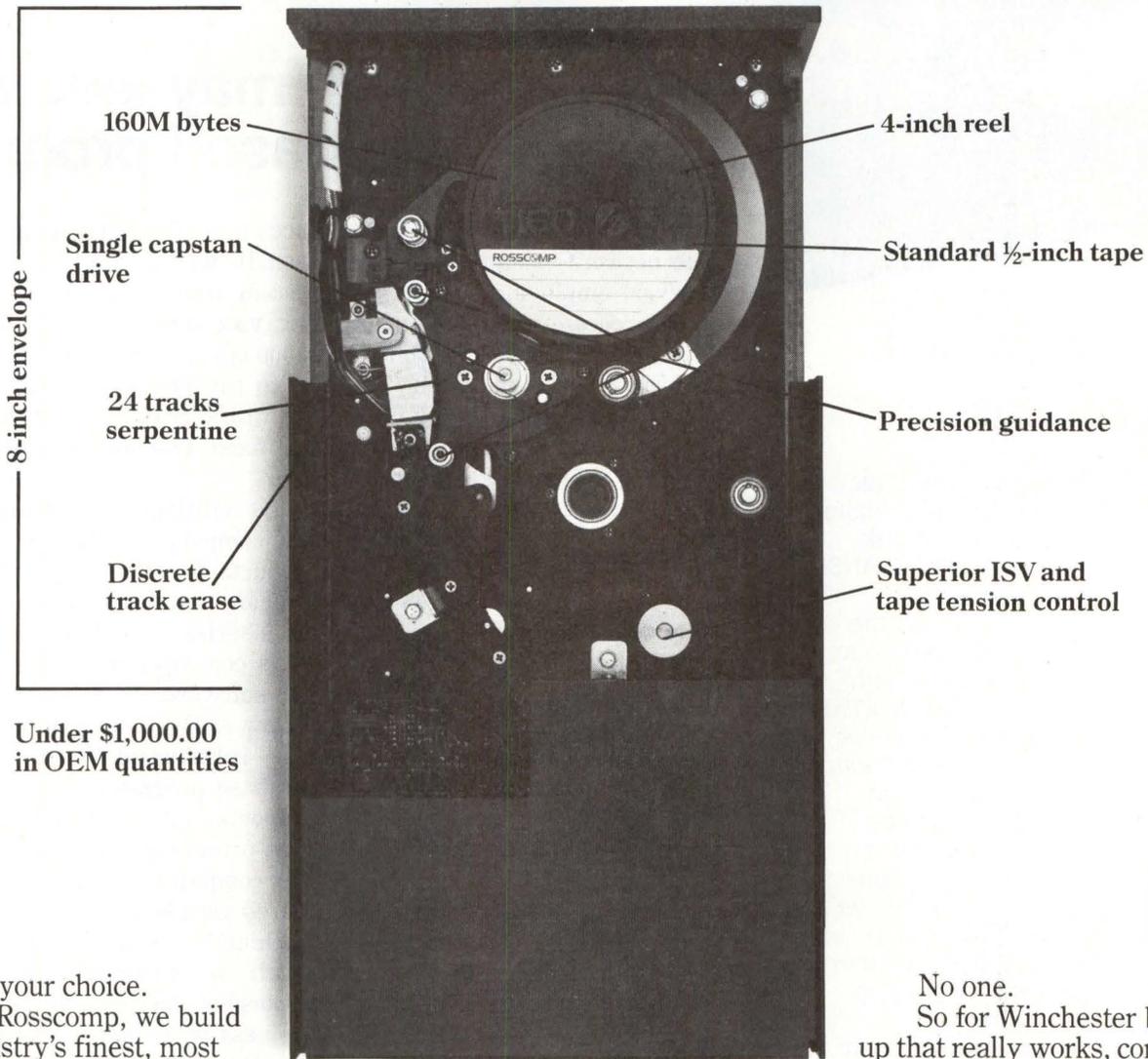
British semiconductor manufacturer Inmos Ltd., owns Occam. Inmos supplies an Occam evaluation kit for \$200 from its U.S. offices in Colorado Springs, Colo. It is supported by a variety of machines that host UCSD p-System Version IV, including the Apple II, the IBM PC and the DEC LSI-11 and VAX machines.

The only hardware systems Inmos now sells are memory devices, but the company is developing what it considers to be a revolutionary microprocessor for parallel processing. Called the Transputer, it is

intended to work with other identical devices and use Occam as an assembly level language. Inmos is secretive about the Transputer's architecture except to claim that it will combine 4K bytes of RAM, a high-performance processor and multiple channels on a single chip implemented in CMOS technology. The company envisages a computer consisting of 256 linked Transputers, on one wafer and providing 1M byte of main memory and a performance of 2.5 billion instructions per sec.—all for \$500.

But Inmos may never bring such a product to market because the company, majority owned by British government agency the British Technology Group, lost about \$30 million in its 1982 fiscal year ending Dec. 31, 1982, and had revenues of only \$20 million. Unless Inmos can approach profitability this year in the cutthroat market for 64K-bit dynamic RAMs, a Conservative government—strongly opposed to public ownership—may write off the more than \$150 million of public money invested in Inmos and dismantle the company. Meanwhile, Inmos has been forced to hunt for fresh funding from private sources rather than the government.

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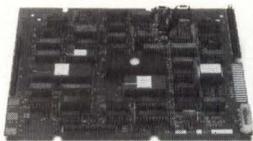
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CDC investment may lead to iAPX 286-, 432-based products

Innovative products such as a fail-safe network-oriented database file server employing four Intel iAPX 432 processors could be made available in the U.S. by Control Data Corp., Plymouth, Minn. The new products availability follows CDC's acquisition of a 38-percent holding in Systime Plc, one of Europe's largest system integrators. CDC is investing \$13 million in the hope that Systime will achieve its sales target of \$100 million this year, up 40 percent from fiscal year 1982. At press time, however, CDC had not yet acquired U.S. marketing rights to any Systime products, says a Systime spokesman.

Based in Leeds, England, Systime is a major CDC customer, having bought about \$15 million worth of CDC disk drives last year. Most of the units were FSD, RSD and Lark drives. Systime got its start in building and selling commercial systems configured around Digital Equipment Corp. PDP-11 and VAX processors. But Systime managing director John Gow notes that the company's strategy is to use Intel Corp.'s much less expensive processors while retaining compatibility with the large quantity of application software that Systime has developed for DEC-based machines.

Systime's s series computers are configured around the 16-bit Intel 8086 along with the 8087 numeric data co-processor. They run the Systime-developed, real-time, event-driven MPS (modular programming system) operating system, which looks to a user like DEC's RSTS, says Gow.

Systime's latest s series machine is scheduled for release in July. The

S4000 is configured around the iAPX 286. It will include an operating system resembling VMS on 32-bit DEC VAX superminicomputers. The S4000 is said to provide performance up to the PDP-11/70 level and will use CDC's latest 8-in. disk drives, the fixed FSD and the removable RSD.

CDC officials are reticent about the company's plans for Systime products in the U.S., although a company spokesperson notes that the s series is "an ideal vehicle" for CDC's computer-based Plato education software.

Gow at Systime says that CDC is also interested in Intel's 432 database processor chip set, which supports high-capacity disk drives. That processor could be used with a host computer such as the VAX or be shared via a local-area network. The machine is programmed in Ada, which is important to Systime because of the company's increasing business with the British military, says Gow.

Another Systime product that could be promoted by CDC in the U.S. is Systel, a powerful transaction-processing system for DEC machines, primarily the VAX. Systime launched Systel in the U.S. in 1981 from its Columbia, Md., office (MMS, September, 1981, p. 98) and acquired one large customer, Philip Morris. Systime suspended active selling last year, however, citing a shortage of staff to support the product.

The \$13-million capital injection from CDC, plus about \$8 million more from institutional investors, has diluted from nearly 30 percent to 12 percent the share in Systime



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The Case of the Spurious X-Off

The call came from one of my field service operatives late in the day. After spending hours at a customer's site he was thoroughly frustrated. The symptoms were certainly baffling. The customer had connected a new type of asynchronous ASCII terminal to an existing 4 wire leased line using a new 202, 1200 Baud modem. Despite the use of a four wire line, which permits constant carrier operation in both directions, the computer was set up to operate in the half duplex mode causing carrier to go on and off at the terminal end. Inexplicably, each time carrier detect came on, the terminal responded with a single X-off which is the ASCII control character that means do not transmit any more data to me until I send you an X-on character. The computer dutifully responded to the X-off by stopping transmission cold, and waiting in vain for an X-on from the terminal.

The customer's seemingly unreasonable hunch was that the modem at the terminal end must be at fault — and as another brand of 202 was at hand, the swap was made and by golly the system functioned perfectly! But how could a 202 modem, the simplest of all modems, even if defective, generate an X-off character or cause a CRT terminal to generate one, and why did changing the brand of modem make any difference?

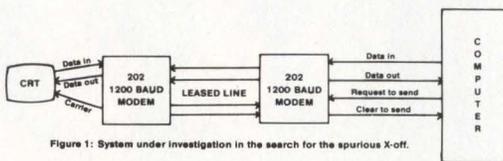


Figure 1: System under investigation in the search for the spurious X-off.

Putting a breakout box between the terminal and the suspect 202 modem showed at once that the X-off character was generated not by the modem but by the terminal the instant modem carrier was raised. Indeed, by using a jumper wire to pin 8 (carrier detect) from a positive voltage it was possible to get the terminal to send an X-off even with the modem completely disconnected. Apparently any pulse on the carrier detect input lead of the terminal triggered the internal logic of the terminal causing a spurious X-off to be outputted. The older modem brand worked because its carrier detect signal rise time was so sluggish it couldn't trigger the terminal logic. The quick fix was to strap the computer end modem to transmit constant carrier since a four wire line was being used anyway. A longer range solution was provided by the terminal manufacturer, who in the next production run eliminated the cross talk on the terminal circuit board.

—R.G.

NEXT MONTH:

The case of the Modem Operand!

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held by the British Technology Group, a British government-owned agency. BTG is reducing its shares in several British computer companies as part of the conservative government's policy of privatism. BTG is seeking a buyer for peripheral and terminal manufacturer Data Recording Instrument Co., whose subsidiary, disk drive builder United Peripherals Ltd., now shares one feature with Systime—a large minority holding by CDC—in this case, 24 percent (MMS, November, 1982, p. 145).

CDC has acquired all the stock and assets of another British company, Arbat Ltd., a supplier of DEC-based systems to the international banking community. Arbat provides facilities such as message switching and foreign-currency transaction processing. Based in London, Arbat has offices in New York, Hong Kong and Singapore. CDC says its purchase of Arbat around the same time as its deal with Systime is purely coincidental, adding that Arbat's systems complement CDC's mainframe-based bureau operation.

—Keith Jones

NEXT MONTH IN MMS

July's spotlight is computer graphics and MMS will feature two product focus articles. One will cover a wall size graphic projection system designed for mass viewing of CRT-generated color images. A second article highlights a computer terminal for measuring 3D objects. July will also feature a product profile of low-end graphic workstations for distributed graphics environments.

Other articles will cover:

- Fiber optics for local area networks.
- Graphics hardware compatibility.
- A desk-design station with multi-mode graphics.



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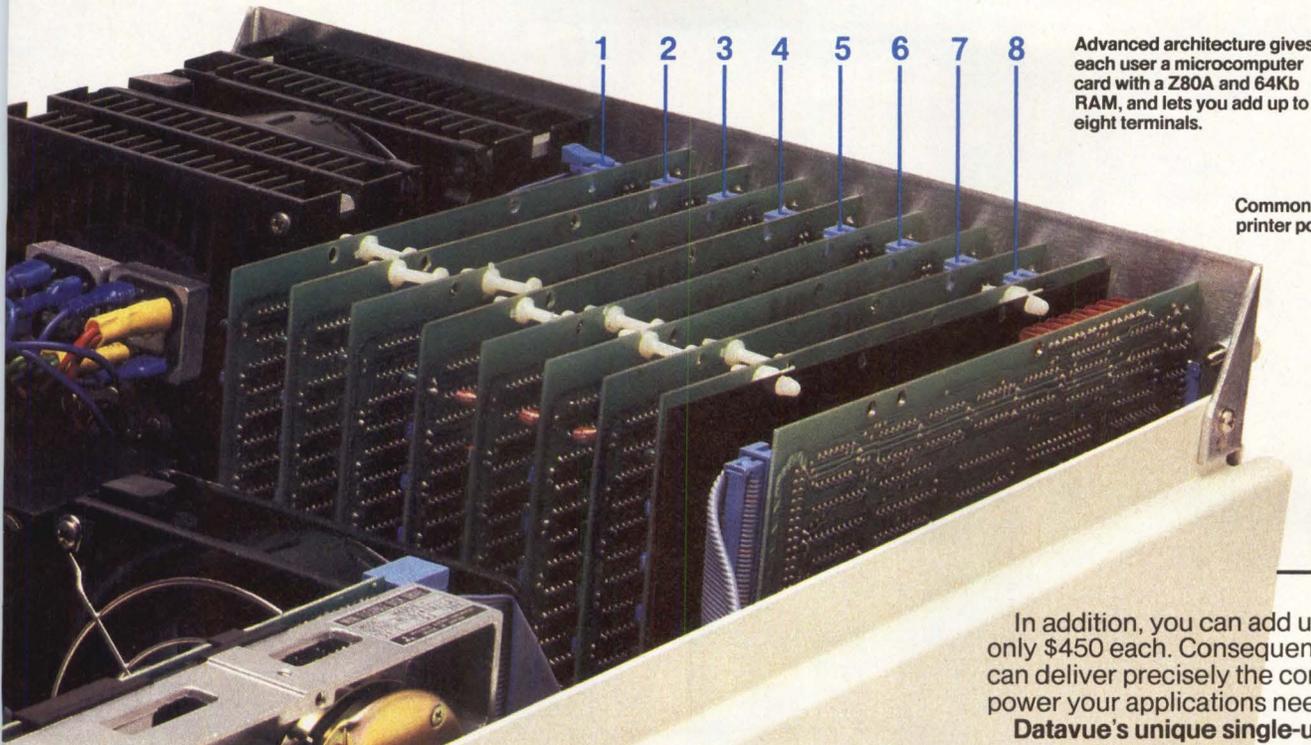
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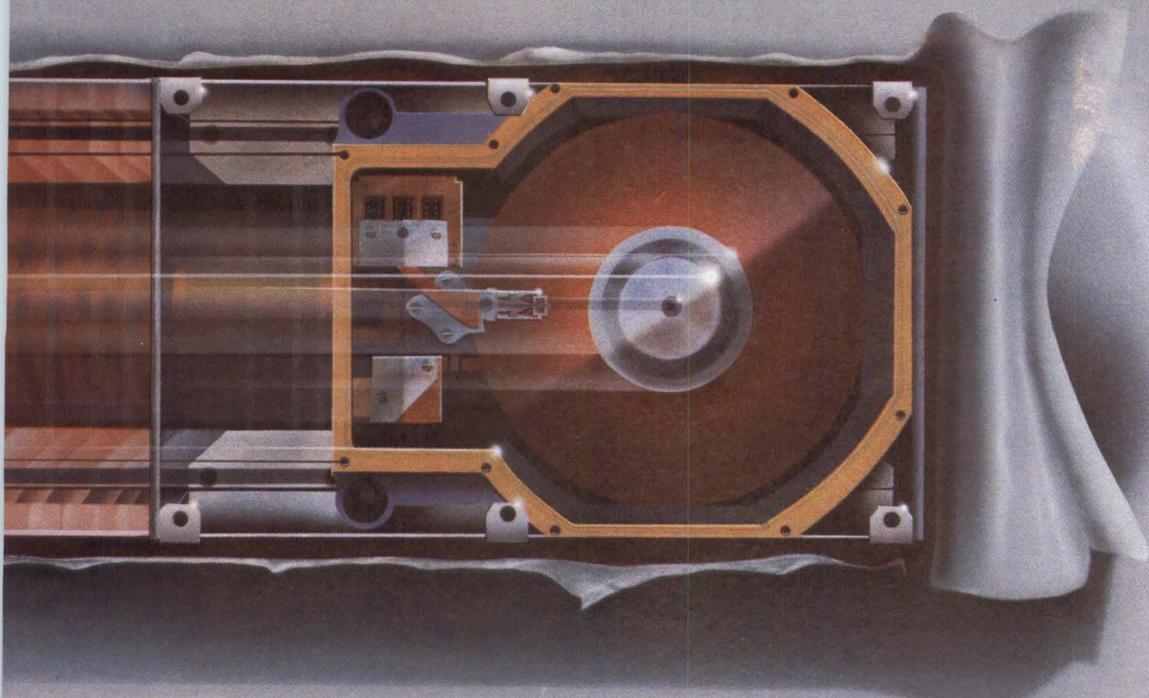
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Mini-Micro World

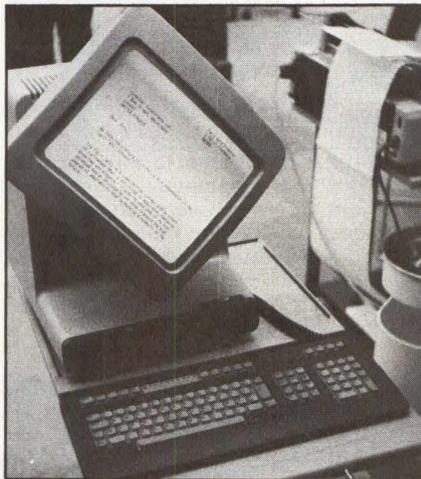
SHOWS AND CONFERENCES

Micros, communications products highlight Hanover Fair

Germany's Hanover Fair, April 13-20, this year again brought throngs of people to take in a host of new products. What was lacking in technological innovation was made up for by the volume of products directed to all levels of microcomputers—from hand-held units to supermicros (MMS, May, p.8). Also noteworthy were the number of large U.S. companies with videotex and teletext demonstrations including Wang Laboratories Inc. and IBM Corp.

Tricom Corp., Tokyo, Japan, unveiled a hand-held personal computer with a four-color graphics printer. Called the TPC-8300, the system is compatible with NEC Corp.'s 8000 personal computer. The TPC-8300, based on an 8-bit CMOS processor, is programmable in NEC's BASIC. It includes 20K bytes of system ROM, 6K bytes of RAM, CMOS battery backup, a 2-line, 24-character LCD and a 62-key keyboard with some user-definable function keys. Options include a Centronics-like printer and cassette interface and an expansion memory module for as much as 8K bytes of RAM. The product weighs about 2 lbs. The 100-employee company is seeking U.S. agents to integrate the product. The U.S. price is not determined. In Germany, the product was introduced at a price of about \$334 to \$417, including the attached printer and a briefcase. Tricom plans to add an RS232 interface by year-end.

Sharp Corp. debuted three microcomputers and demonstrated microcomputers driving industrial robot models. The model 8100 business computer is MC68000-based and runs UNIX System III. The 8100 has



Facit's Twist terminal can be rotated 90 degrees. The product is scheduled to be available during the third quarter of this year in the U.S. for about \$2100.

256K to 4M bytes of main memory and a 14-in. monochrome or color bit-mapped display that shows 16 colors (768 × 550 dots) simultaneously out of a choice of 512 colors. Peripherals include a variety of printers, 5¼-in. floppy disk drives and a 5¼-in. Winchester. The system is Multibus compatible and includes an Ethernet-compatible controller board. Programming languages are C, FORTRAN, COBOL and Pascal. A standard graphics package supports SIGGRAPH's Core Level III standard. The system can include a database-management system and supports 3270, 3780 and X.25 communications. The product is scheduled for availability in Germany in October or November, and will be priced at about \$7084 with dual floppy drives and \$10,834 with a 10M-byte Winchester drive. Sharp's MZ-3541 prototype office computer is Z80A-based and is programmable in BASIC. A 128K-byte RAM is standard, which can be expanded with two external 64K-

byte RAM modules. The system has two minifloppy drives, a 12-in. display, keyboard and interface cards.

Canon Inc. showed several microcomputers, including a new model, the AS-100, which includes two standard operating systems, CP/M-86 and MS-DOS. The system is 8088-based and uses 64K-bit RAM. Memory capacity is 512K bytes, with expansions available in 128K-, 256K- and 384K-byte increments. The 12-in. CRT screen can be purchased in green phosphor or color. Included in the system are dual, double-sided, 8-in. diskette drives that hold 1M byte of information each. Programming languages can include Canon BASIC, GW-BASIC, Level II COBOL, Pascal and FORTRAN.

Fujitsu Microelectronics' Professional Microsystems division showed the Micro 7 6809-based microcomputer, which is expected to be available in Germany in August or September, but which is not yet scheduled for U.S. introduction. The Micro 16S, an 8086-based product, which was introduced in the U.S. at last year's Comdex Show, is scheduled to be shipped next month. Priced at about \$1958 in Germany, the Micro 7 has 64K bytes of RAM and can have 48K bytes of graphic RAM. A color or monochrome monitor is available. The Micro 7 runs CP/M and can be programmed in BASIC. Optional soft cards for a Z80 and a controller are available.

West Germany leads the world in the promotion of ergonomic standards for computer terminals, so the Hanover show was an appropriate launchpad for a microcomputer

Mini-Micro World

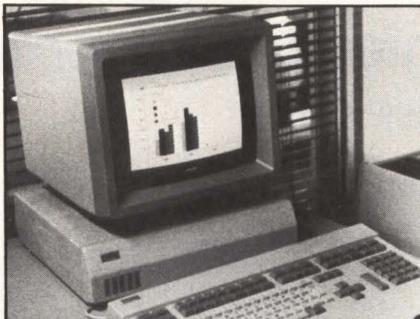
SHOWS AND CONFERENCES

said to conform with the ergonomics rulings added last year to the West German industrial safety laws. Unveiled by Nokia Data of Finland, the Nokia PC competes head-on with the IBM PC but offers several advantages over the IBM offering, according to Nokia. The Nokia PC is configured around the Intel 80186 microprocessor, which is faster than the 8088 in IBM's product. Nokia also points out its product's ergonomic advantages such as a black-and-white display.

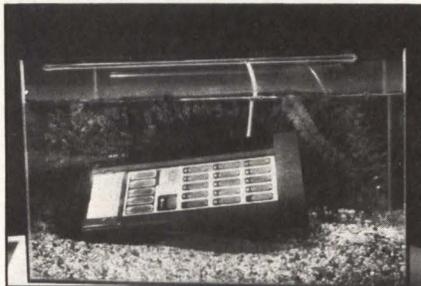
Sharp Corp. showed the IO-7000 prototype seven-color printer that operates bidirectionally at 20 cps and has a Centronics-compatible interface. The ink-jet printer was shown printing the screen information from an 8100 microcomputer, also debuted at Sharp's booth. Fujitsu showed its TTP16 16-dot head thermal transfer printer that works on both plain and coated paper, the company claims. The product prints unidirectionally in a single pass at 30 cps. Both parallel and RS232C interfaces are available.

Sharp Corp. unveiled two electro-luminescent yellow flat-panel graphic/character displays, which it also released at the recent Electro show in New York. The LJ-320U01 has 320 columns \times 240 rows of electrodes, while the LJ-512U01 has 512 columns \times 128 rows of electrodes. Prices for single-unit quantities in Japan start at the equivalent of \$1500. Sharp started production of the units last month. Also introduced was the LM-480001G graphic LCD, which has a 480- \times 128-dot matrix and combines the dot-matrix LCD panel with CMOS LSI on double-printed wiring boards. U.S. prices will be about \$220 in single-unit quantities. Samples are slated for delivery in July.

Although BASF ceased selling OEM disk drive products in the U.S. about two years ago, the company



Hewlett-Packard plans to introduce its Micro 1000 16-bit computer, code-named *Shoehorn*, in the U.S. late this month or early next month. The unit includes an HP1000 A Series processor, a 10M-byte Winchester disk drive, a Sony microfloppy disk drive and the RTEA operating system. Prices start at \$9500.



Also at HP's booth was the eye-catching ruggedized terminal displayed in a fish tank. The model 3081A data-entry terminal, slated for introduction this month, is targeted for industrial environments in which the air contains particulates.

remains extremely active in the European market. It used Hanover to unveil several new products. The 6138 floppy disk drive, a 5 $\frac{1}{4}$ -in. unit, is only about 1.34 in. high and said to be the flattest drive in the world. BASF quotes an unformatted capacity of 1M byte. A height of only 2.34 in. is a highlighted feature of a new 8-in. BASF floppy drive, the 6105. A third new product, the 6185 fixed disk drive, a 5 $\frac{1}{4}$ -in. unit, offers an unformatted capacity of 27.5M bytes on three platters.

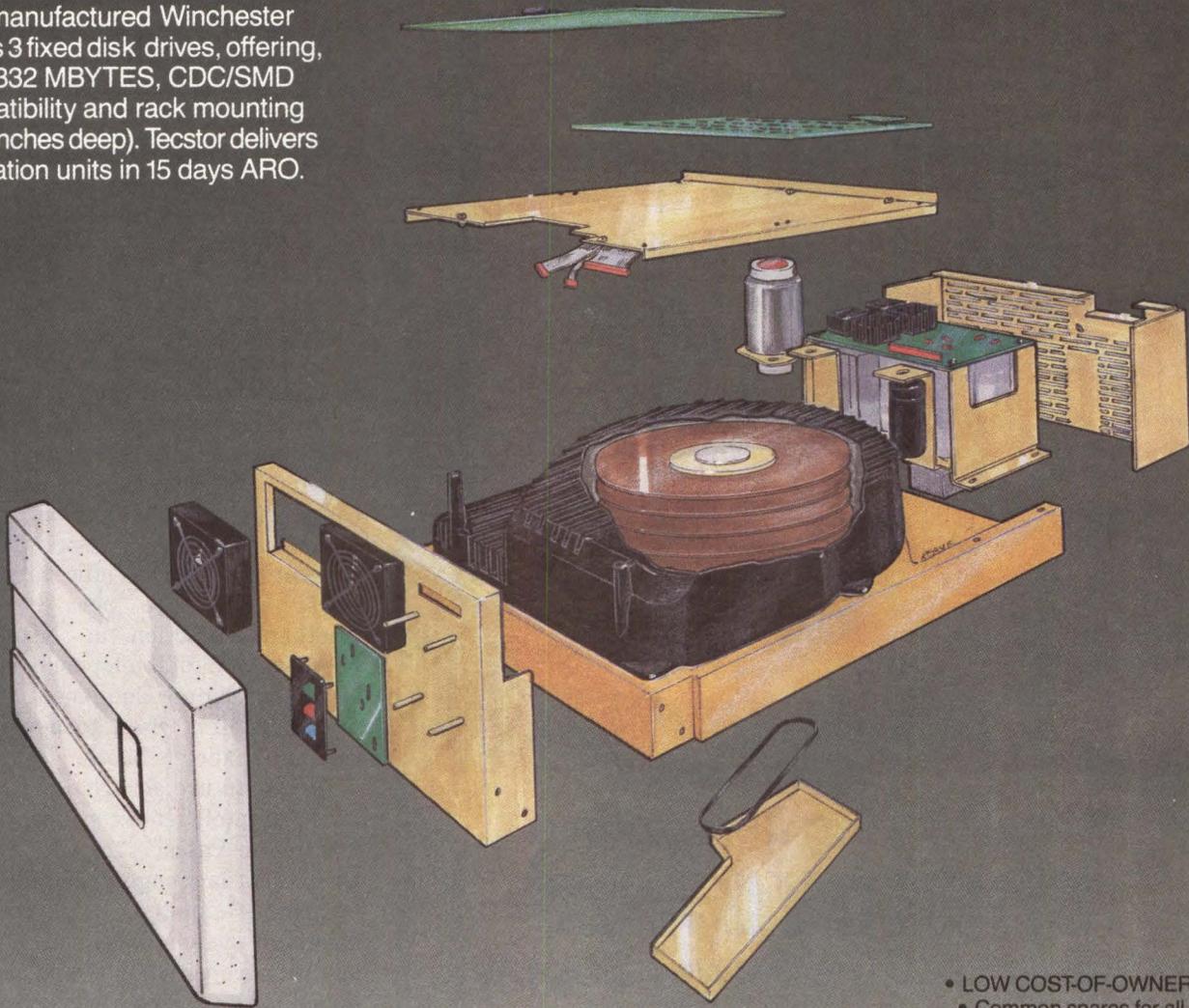
NEC Corp. showed a prototype X.25 fiber-optic network system that operates at 10M bps. As many as 120 NEC PC 8000 microcomputers can be connected using the network. Screen contents can be sent from PC

to PC with as much as 3 km. (about 1.86 mi.) between stations using repeaters. Called the C&C-Net Branch 4800, the network is based around a Star coupler that can link as many as six node stations, which can support four workstations. As many as 120 terminals can be connected in a data bus star-shape configuration. NEC plans to make the network compatible with OmniNet. Although similar to a fiber-optic networking scheme developed by Codenoll Technology in the U.S., NEC officials say its network components, except for the fiber-optic link, were developed in house. Codenoll's network is Ethernet compatible. Claimed advantages of fiber-optic links are lower electrical noise and no electrical shorts in the lines. The cable, however, still is relatively expensive. The 4800 system uses the CSMA/CD access method and two-wire duplicated fiber-optic cable, and it supports RS232C and 8-bit parallel interfaces. The system is installed in about 10 pilot sites in Japan. NEC officials in Tokyo say the release of the product in the U.S. and its price depend on reactions at these pilot sites. The price is expected to be lower than the price guidelines for Germany of \$417 including the node station and Star coupler that can link multiple node stations.

Nixdorf showed its dual Z80-based 8810 workstation for the first time at the Hanover Fair. The microcomputer is intended to work and be sold with Nixdorf's 8870 computers as either a personal computer or a dedicated terminal. Nixdorf officials say the company plans eventually to offer the 8810 with other Nixdorf products. The 8810 is expected to be released in the U.S. in the second half of this year and will be priced at about \$5000 in single-unit quantities.

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SHOWS AND CONFERENCES

Discounts of about 20 percent are available for quantities of 200. The 8810 is sold toward the 8870 base, Nixdorf officials claim, because of the large amount of software available for the 8870. Nixdorf is

trying to build distributor channels for the 8870, which, when coupled with the 8810, is said to give distributors a more powerful resale tool.

Another boost for distribution

will be a desk-top version of the 8870 scheduled for U.S. release in the third quarter of this year or the first quarter of next year. The 8810 and 8870 were shown working together at last year's Comdex show in Atlantic City, N.J. The 8810's price includes a display, CP/M compatibility, a keyboard, a 145-cps dot-matrix printer and dual mini-floppy disk drives. Nixdorf hopes to expand its distribution network from 20 distributors to 35 to 40 by year-end.

Another microcomputer, which may be introduced early next year in the U.S. for pilot installation, is the 88BK 8086-based system. The system integrates voice, data and text information, and may be introduced running MS-DOS. The product is aimed at office applications. Prices are not yet set. Another attraction at Nixdorf's booth was a digital telephone, which attracted Digital Equipment Corp. president Ken Olsen to a private room in Nixdorf's booth.

In the future for Nixdorf is an artificial-intelligence system now run by a Pascal program rather than an AI language. Thus far, the system is limited but provides computer-system-development consultation, repairs faulty cars, names an animal described by an operator, detects contradictions in an operator's input and detects circular arguments. The commercial implementation may be available in one or two years. One use for the AI system could be integrating semi-customized systems in branch sales offices of computer companies. The 88AAP (autonomic workstation) includes 128K bytes of MOS memory, two 8-in. floppy disk drives and a printer. There is no connection to a host computer. A full knowledge-based AI system, according to Nixdorf sources, would require 0.5M bytes of memory and a 20M-byte



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Winchester drive.

At the Hanover show, the head of Olivetti's OEM operations in the U.S., Riccardo Minuto, clarified the company's OEM printer and disk drive plans for the U.S. following

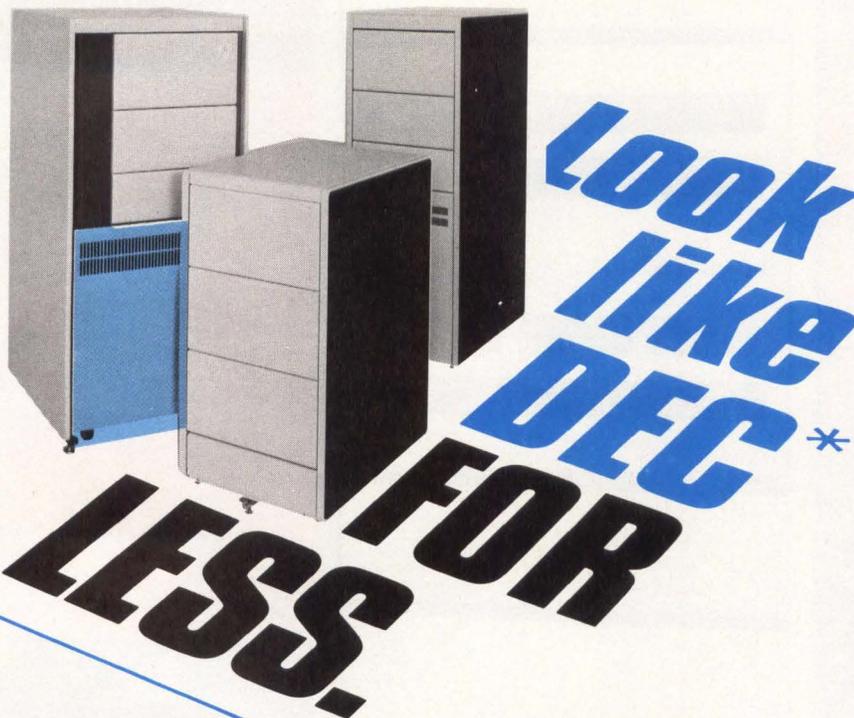
the demise this year of Irwin-Olivetti, Ann Arbor, Mich. Irwin-Olivetti was a joint company set up last year to sell both product lines. As expected, Olivetti has transferred its printer sales operation

from Ann Arbor to Tarrytown, N.Y., where it originated. It will operate there under the name OPE Printers Inc., with president Gianni Subrizi reporting to Minuto, who is based at Olivetti's headquarters in Ivrea, Italy. Minuto explained that OPE Printers will concentrate on selling two printer lines, the JP 101 spark ink-jet printer and the DY 250 daisy-wheel unit. Launched in 1982, the JP 101 employs an electrical spark to melt ink globules off of a graphite nib. It generates characters from a 9×9 matrix and has a quoted speed of 50 lines per min. The DY 250, also announced last year, offers a maximum speed of 35 cps and is the low end of a family of daisy-wheel units. Minuto confirmed Olivetti has ceased selling disk drives in the U.S. But he revealed Olivetti hopes to reenter the U.S. disk market this year with the HD 563, a $5\frac{1}{4}$ -in. Winchester drive unveiled for the first time at Hanover. The 563 offers a higher capacity than the existing HD 562, more than 19M bytes unformatted on three platters, compared with 11M bytes. The track-to-track access time is achieved using buffered stepping. Minuto could not say whether the HD 563 would be sold through OPE Printers, an independent distributor or some other U.S. sales office of Olivetti. He noted HD 562 users in the U.S. are being supported by Docutel Olivetti, a joint operation with bank teller terminal manufacturer Docutel. Docutel-Olivetti sells Olivetti's M20 microcomputer line and most other end-user products in the U.S.

—Lori Valigra and Keith Jones

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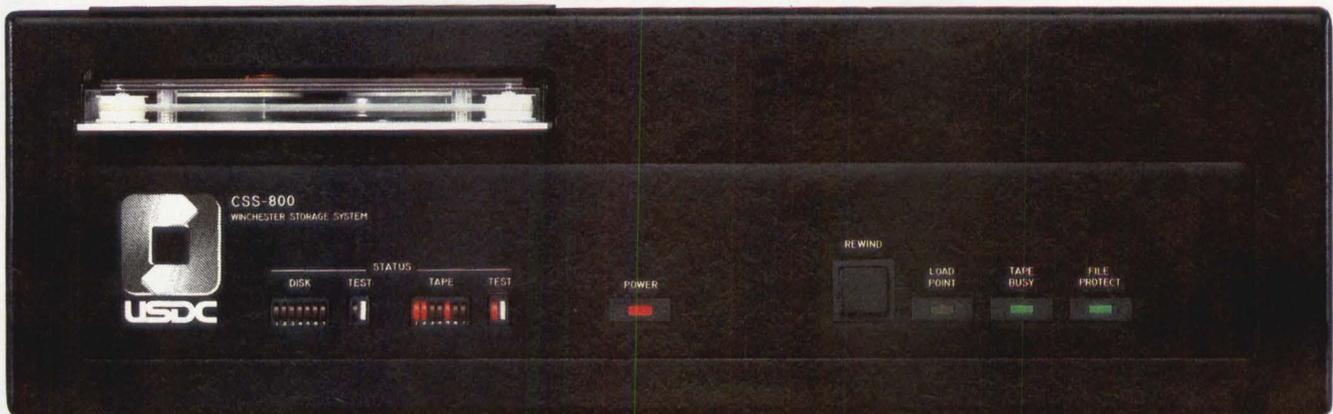
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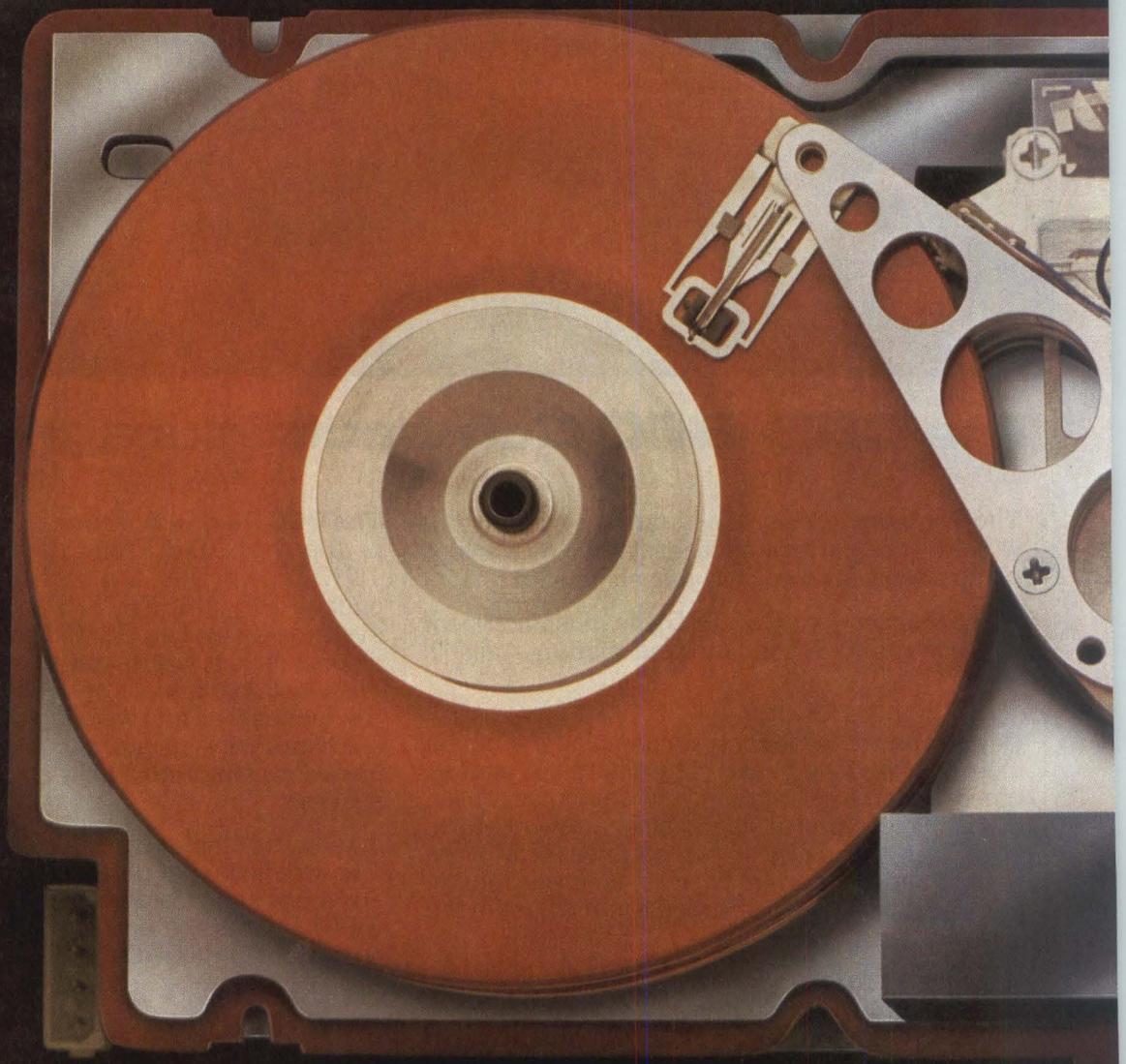
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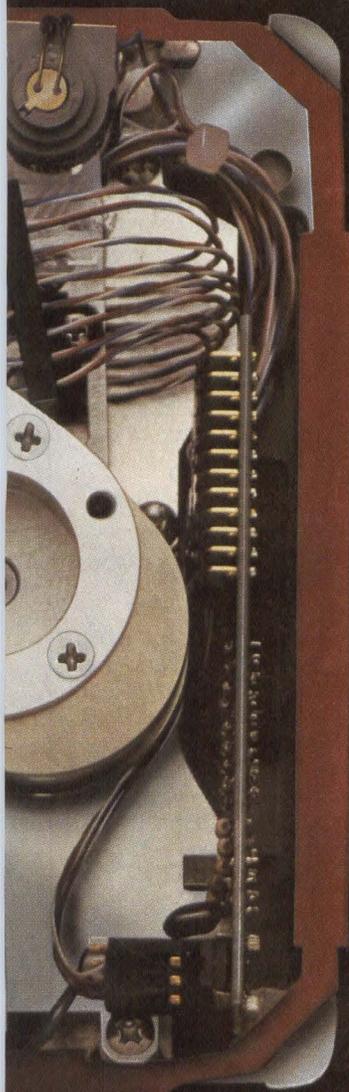
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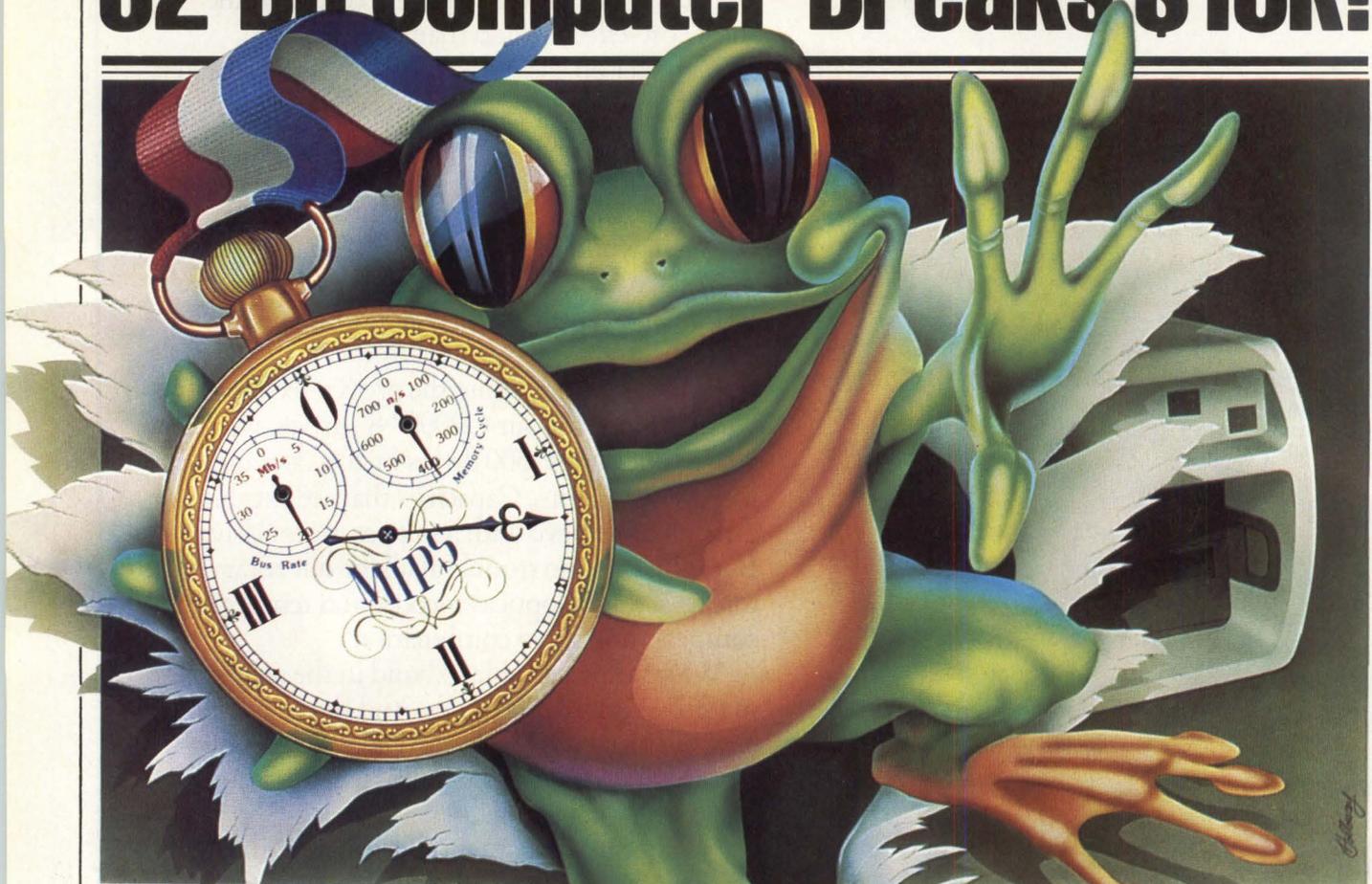
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★ ★ ★ E X T R A ★ ★ ★

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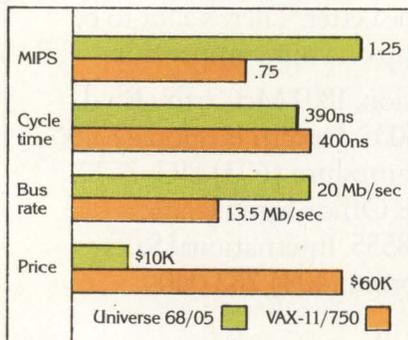


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CIRCLE NO. 50 ON INQUIRY CARD

Mini-Micro Interpreter

An analysis of news, issues and trends affecting the computer industry

Europeans set the pace for several Ada developments

By Keith Jones

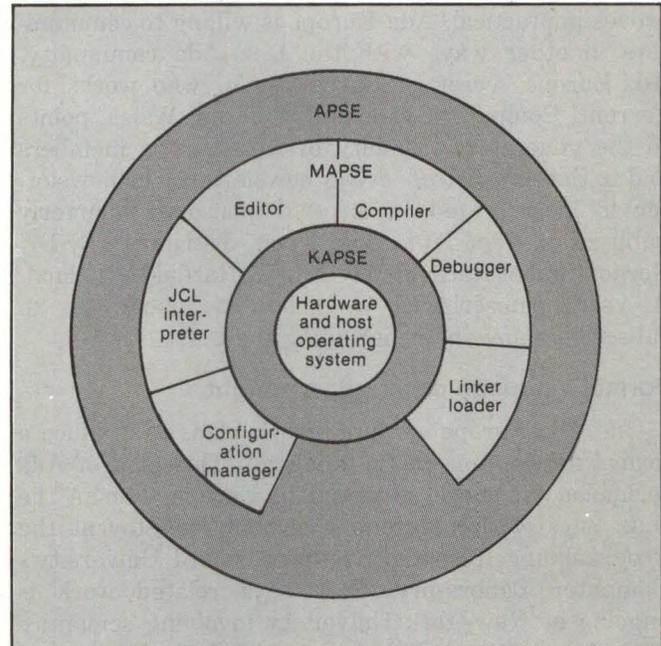
While development of the Ada language in the United States has been supervised closely by the Department of Defense, the European community believes the major Ada applications will be nonmilitary projects such as industrial control and telecommunications. It is therefore appropriate that in Western Europe—where Ada was designed—the main driving force behind pan-European Ada initiatives is a civil authority, the European Commission, Brussels, Belgium. This agency implements and administers the rulings of the European Economic Community.

Because the commission's policy is to share Ada projects between at least two organizations in at least two countries, its supervision solves some of the problems that often occur in Europe when hardware and software efforts are fragmented along country boundaries. Europe is stronger in software development than in hardware advances, and this relative strength is enhanced by the country/industry cooperation encouraged by the European Commission. The commission funds about a dozen projects, two of which involve product developments (see "Two Ada groups plan products," p. 87), and the rest representing mainly feasibility studies. It plans to support four other product-development projects scheduled to begin late this year.

Ada-Europe umbrella

The commission's other main contribution to European cooperation has been the establishment and support of Ada-Europe. Set up about three years ago, this body combines Ada experts from all over Europe into several specialist working groups. Apart from helping the European Ada community to exchange information and pool expertise, Ada-Europe advises the European Commission on project-funding activities.

Ada-Europe is roughly equivalent to AdaTec, a group set up by the Association for Computing Machinery's Special Interest Group for Programming Languages (SIGPLAN). Supported by the European Commission, Ada-Europe and AdaTec staged a joint conference in March in Brussels. Such joint meetings are likely to become annual events. The March conference included reports from European and U.S. delegates on the implementations of Ada compilers and



The Ada programming support environment is the design being followed by Ada product developers in the U.S. and Europe. The kernel APSE includes a run-time system and I/O. The minimal APSE, compared to the full APSE, provides a minimal set of tools for developing and supporting Ada programs.

Ada programming support environments.

Ada-Europe members come from more than 50 organizations, including major European computer manufacturers such as Philips, Nixdorf Computer Corp., Siemens Corp., Olivetti Corp. and Cii Honeywell Bull. Academic institutes and software houses also figure strongly in Ada-Europe's membership. Not surprisingly, therefore, Ada-Europe includes an information-dissemination working group aimed at establishing effective communication between members. Chairman of the group is Mel Jackson, principal research engineer at Standard Telecommunications Laboratories, Harlow, England, part of telecommunications-equipment manufacturer Standard Telephones and Cables Ltd. "The Ada community in the United States has benefited from using Arpanet," Jackson notes. "We will use a service called the Telematics Support System, which will operate over packet-switched networks." Jackson says the European Commission is funding the development of suitable communications software for users' machines. The system may

The Interpreter

also provide an interface with Arpanet, he adds, although there could be security problems because of the military information on Arpanet. "Ada-Europe is totally nonmilitary," says Jackson.

Even if transatlantic communication via Arpanet proves impractical, Ada-Europe is willing to communicate in other ways with the U.S. Ada community. Ada-Europe secretary Garth Glynn, who works for Ferranti Computer Systems, Cwmbran, Wales, points to the general accessibility of Ada-Europe members and to the *Ada-Europe News* newsletter. The newsletter is incorporated in an EEC-sponsored quarterly publication, *Real Time Data News*, distributed by Dr. Gordon Bull of Hatfield Polytechnic, Hatfield, England. A year's subscription sells for £5 (about \$8) to subscribers anywhere, including the U.S.

Formal language description sought

One Ada-Europe working group plans to produce a formal description of the language. This part of Ada technology is more advanced in Europe than in the U.S., says working group chairman Joe Stoy at the Programming Research Group in Oxford University's Computer Laboratory. Stoy says related work is ongoing at New York University involving semantics analysis with a translator written in the Setl language. But he believes that two partly completed European formal definition projects can provide wider facilities than the NYU project. "A formal definition with a precisely defined notation can expose the language to criticism, form the basis for design and implementation and precisely control the language," Stoy explains. He notes that the European Commission plans to fund the development of a formal definition as one of its four new Ada projects and believes that the contract will go to either the Danish Datamatic Center in Copenhagen, Denmark, or to System KG, Karlsruhe, West Germany. Their partial definitions employ different notations but use the same mathematics, Stoy says.

System KG, in cooperation with the University of Karlsruhe, has taken over responsibility for a formal definition partly completed by the French government research establishment, INRIA, near Paris. INRIA's activities were funded indirectly by the U.S. Department of Defense, via Honeywell, which won the DOD design contract in 1979, and Cii Honeywell Bull, which performed the design work and subcontracted the formal definition to INRIA. Stoy hopes that the formal definition will go out for bids this year and that it will be completed by the end of 1984. "It will be too late to help with the prototype compilers being developed now," Stoy says. "But it should influence work on production

compilers and, most importantly, applications." He says precise informal definitions will also be much easier to write using a formal definition. A formal definition must be widely accepted before the first five-year review of the Ada standard adopted this year by the American National Standards Institute, he adds.

Stoy's remarks point out the immaturity of even fundamental Ada systems software, but Ada-Europe is already hatching fledgling application-oriented groups, three of which are telecommunications, computer-integrated manufacturing and numerical analysis.

Transporting Ada between compilers

One of the most active Ada-Europe working groups, the Portability Group, has produced a guide on the considerations involved in transporting Ada application programs between compilers. Even though Ada is a standard language, problems can develop when different Ada compilers are used to produce code for one target machine or when one compiler is used for different target CPUs. Portability Group chairman John Nissen of GEC Telecommunications Ltd., Coventry, England, says, "Ada compilers have no common front end, and there are lots of little things the programmer can trip on in host-target application-program development." He adds, "The defined types in Ada, for example, are affected by the word length of the target machine."

Nissen says that the portability guide originally covered the 1980 Ada definition, but it is being updated to examine ANSI-standard Ada and will soon be available in book form. The same applies to the working group's guide on compiler specification and selection. A third guide on Ada application writing style will also be available soon, Nissen says.

Another working group is advising the European Commission on the role of a European Ada validation center similar to the U.S.'s Ada Compiler Validation Organization. The European group is examining the feasibility of using the validation software developed by Softech Inc.

Another group directly helping the commission is examining a community-funded project to produce a portable Ada programming support environment. The group plans to produce a user's guide to the minimal APSE, which provides the essential tools for producing Ada programs, including a debugger, an editor and a linker/loader (see chart, p. 81). The Environment Group is also considering links with the Kapse Interface Team Industry and Academia, a U.S. group developing standards to promote interoperability among APSES. Established as a spin-off of the DOD-



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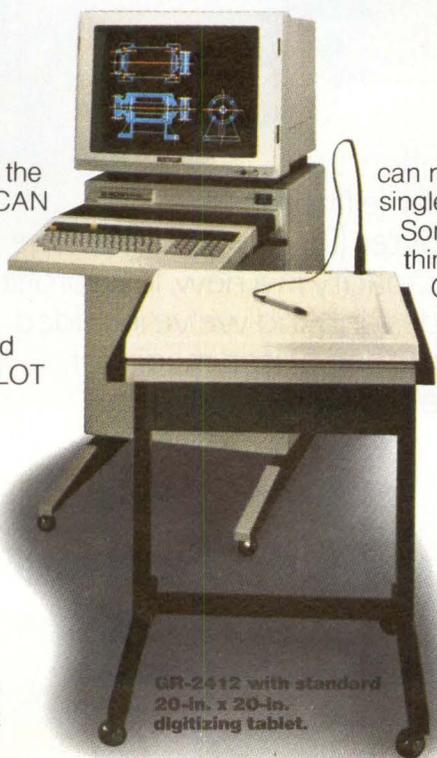
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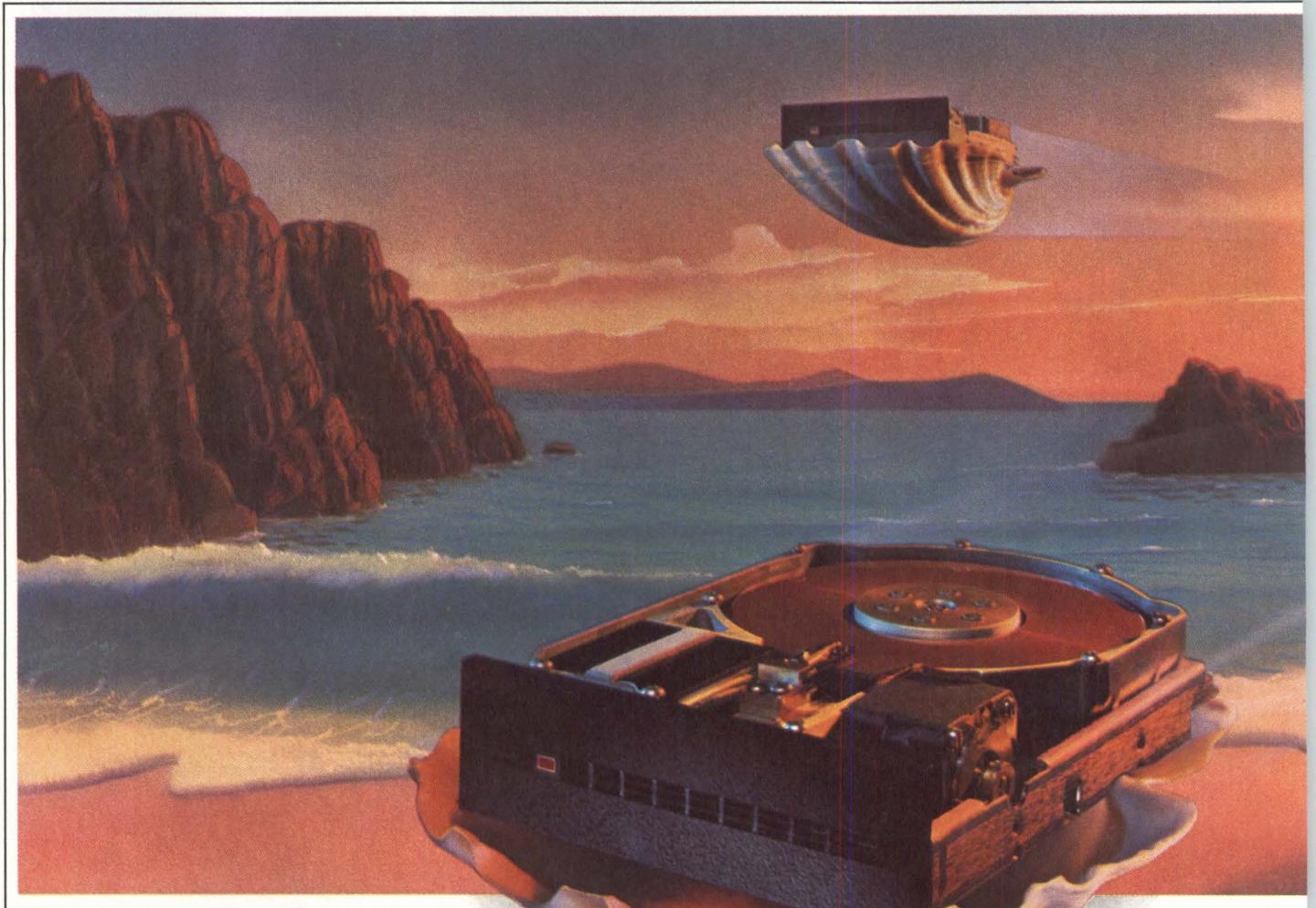
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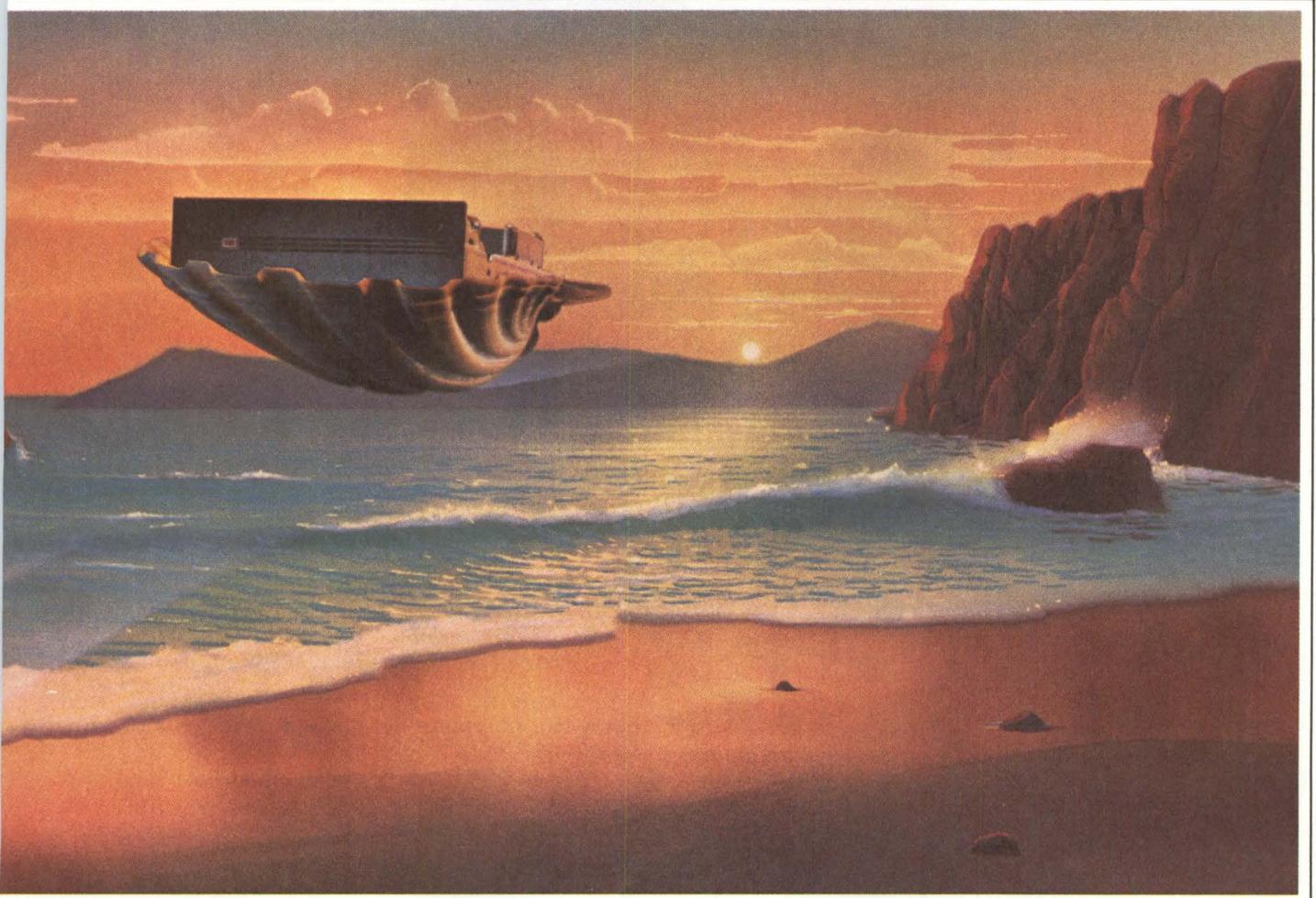
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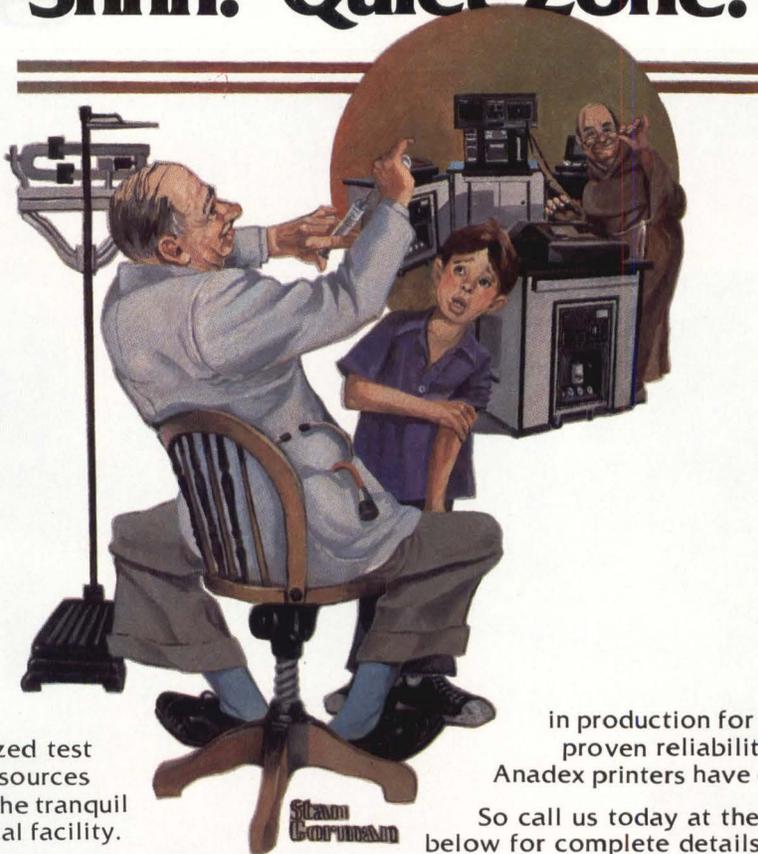
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backed Kapse Interface Team, KITIA's approximately 30 members include four from European companies with expertise in interoperability among APSES.

European Commission projects

A project aimed at developing tools to fit APSES is the largest project planned by the European Commission. Around 10 million European currency units (about \$10 million) have been allocated for this work, which should provide support tools for the whole life cycle of an Ada software program. The formal definition project will get 2 million ECUs, while the other two projects will receive 3 million and 5 million ECUs, respectively, and will cover software-writing techniques and pilot application development.

The feasibility studies supported by the commission can receive 100-percent funding to a total of 100,000 ECUs. One of the most important studies, performed by

TECSI-Software, Paris, and Systems Designers Ltd., Fleet, England, involves life-cycle support tools. John McDermid, senior consultant with Systems Designers, notes that the study's results are available. They describe a set of tools that can be used and interlocked with an APSE. The study investigates the CORE and A-7 system-development methodologies, both of which the study recommends for consideration in future APSE developments. The study team used CORE and A-7 to generate Ada coding and to make code changes that might be required later.

CORE, a European methodology, was used for developing an expression of requirements for a complex system in which the potentially conflicting views of several individuals must be reconciled. A-7, developed for the reimplementation of software in the U.S. Navy's A-7 aircraft, was used to amplify the expression of requirements into a formal, independent language.

TWO ADA GROUPS PLAN PRODUCTS

The two largest Ada projects funded by the European Commission may lead to products that could eventually be available in the U.S. Siemens and French companies Cii Honeywell Bull and Alsys, are working on a portable "root" Ada compiler. While Siemens and Cii Honeywell Bull are mounting the compiler on their mainframe hardware, Alsys is working on a fully optimized version for the Motorola 68000 (MMS, February, p. 72) and is considering compiler products for the Intel 8086 and IBM Personal Computer.

With its fault-tolerant 16-bit CR80 system, Christian Rovsing, Copenhagen, Denmark, will be one of the earliest companies to offer Ada in the U.S., says Borge Bestergaard, president of the company's U.S. Defense division in Thousand Oaks, Calif. CR is a member of the consortium handling the commission's second major development project, which centers on a portable minimal Ada programming support environment. Another partner in this project is the Danish Datamatic Center, Copenhagen, a consulting group mainly concerned with transferring technology from the academic community to industry.

The senior partner in the consortium is Italy's Olivetti, which is leading the work on the MAPSE, says project secretary Fabio Giammessi at

Olivetti's office-automation department in Pisa. Giammessi says Denmark's DDC is developing A Code, a portable, low-level, microprogrammable, intermediate language that will be supported by the MAPSE. Host hardware for the MAPSE at Olivetti is the company's S3000 processor, which forms the basis on which Olivetti's 16-bit Zilog Z8000-based microcomputer line, the M-20, is built. Giammessi reveals that Olivetti may use Ada to rewrite the S3000 operating system, which is currently implemented in Pascal.

Olivetti is also considering developing applications in Ada, although Giammessi acknowledges that Ada lacks COBOL's report-writing facilities. But he points to several Ada advantages, including the facility of interfacing Ada packages with each other and the extremely safe Ada compilation. He also says Olivetti plans to develop a subset of Ada. Giammessi is not sure if Olivetti will make its Ada offerings available in the U.S., although he notes that Zilog Inc. is assessing the products' potential.

In contrast to Olivetti's rather cautious approach to the U.S., CR has sold about 25 CR80s in the U.S. over the last five years. Bestergaard of CR points to the strong need for his company to offer Ada in the U.S. because most of CR's U.S. sales are to

"government agencies," Bestergaard says.

CR's Ada project manager in Copenhagen, Nils Joergensen, says that CR and DDC plan to make A Code portable across stack-oriented machines. He also points to work on IML 7, a higher level intermediate language designed to run on any target machine for which a run-time system has been prepared. The Motorola 68000 and Intel's 16-bit iAPX 186 are under consideration. IML 7 differs from Diana, the high-level intermediate language employed by Alsys and by Intermetrics Inc. in the U.S., which is developing an APSE for the U.S. Air Force.

The European Commission is prepared to give a maximum of 50 percent toward the cost of development projects, as opposed to feasibility studies, which can get as much as 100-percent funding. Development funds can be in the form of a loan with or without interest if the project is intended to culminate in a commercial product. But if the work does not lead to commercial exploitation within a five-year period, the beneficiary is released from its obligation to repay the loan, as long as the commission is satisfied with the beneficiary's reasons.

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Finally, Ada-oriented design specifications were produced using ANNA, a language developed at Stanford University for annotating Ada programs. The study concludes that ANNA is difficult to use, although it recommends that a new version should be investigated. McDermid at Systems Designers also points to Special A, an ANNA alternative that was developed by Cii Honeywell Bull in France.

Distributed shortcomings

Nearing completion is another study that reveals that Ada is far from ideal for distributed microprocessor systems that don't share one main memory—that is, in which multiple processors and memories are distributed among multiple buses. Italian industrial systems house Zeltron Automazione, Milan, and SPL International, Abingdon, England, conducted the study. Study team member Roger Stammers of SPL says, "Distributed hardware was not considered in the design of Ada. It can be used, but only if restrictions are imposed." Stammers notes that two Ada tasks cannot share a data structure if they do not share a memory, so program-

mers are restricted to Ada's task-*rendezvous* feature, the only way to communicate between tasks. Another important distribution problem, Stammers says, is that Ada assumes there is a single central "heap" administered by the run-time system and onto which access objects—pointers to other objects—are placed. He concludes that programs in distributed systems must employ a pragma (instruction to the compiler) indicating which heap partition is being used for an access type. A third problem Stammers mentions is Ada's provision of a special package that gives information, such as word length, about the target machine hardware. He says several versions of that package will be needed in a distributed system supporting different microprocessors.

The commission also supports cooperation among about a dozen European companies and institutes researching Ada's effectiveness for specifying systems. Professor Stephen Goldsack of Imperial College, London, the prime contractor, says the organizations involved are studying features, such as formalized comments, that can be added to Ada while not abandoning the legal version of the language. Goldsack cites Ada features, such as strong typing, that lend themselves to system specification.

Strong typing is also a feature of Pascal. Another commission-backed study is researching the ease with which Pascal programs can be converted to Ada. The participants are Hollandse Signaalapparaten BV, Hengelo, the Netherlands, and SPL International.

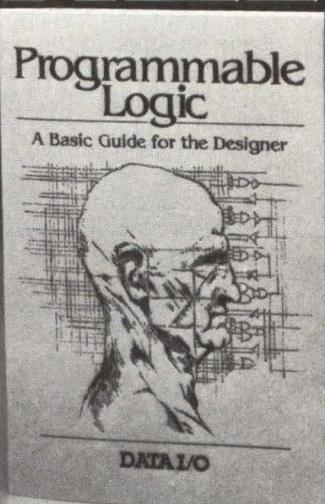
Another English/Dutch project is a study aimed at producing guidelines to ensure that Ada program library packages are portable. The participants are Mathematisch Centrum, Amsterdam, the Netherlands, and the National Physical Laboratory, Teddington, England.

Nissen at GEC Telecommunications says at least one commission-backed study is the subject of controversy. Conducted by GEC and the Danish Datamatics Center, the study is exploring the possibility of using the APSE to support not only Ada but also CHILL, a language used in the telecommunications community. Nissen notes that CHILL was developed in parallel with Ada and unsuccessfully competed with the language design that became Ada. However, fundamental similarities exist between CHILL and Ada, he says, including CHILL's suitability to embedded systems and real-time applications. CHILL has been adopted as a standard by international telecommunications body CCITT, but Nissen believes that Ada will be adopted more widely because of its popularity among the academic community. □

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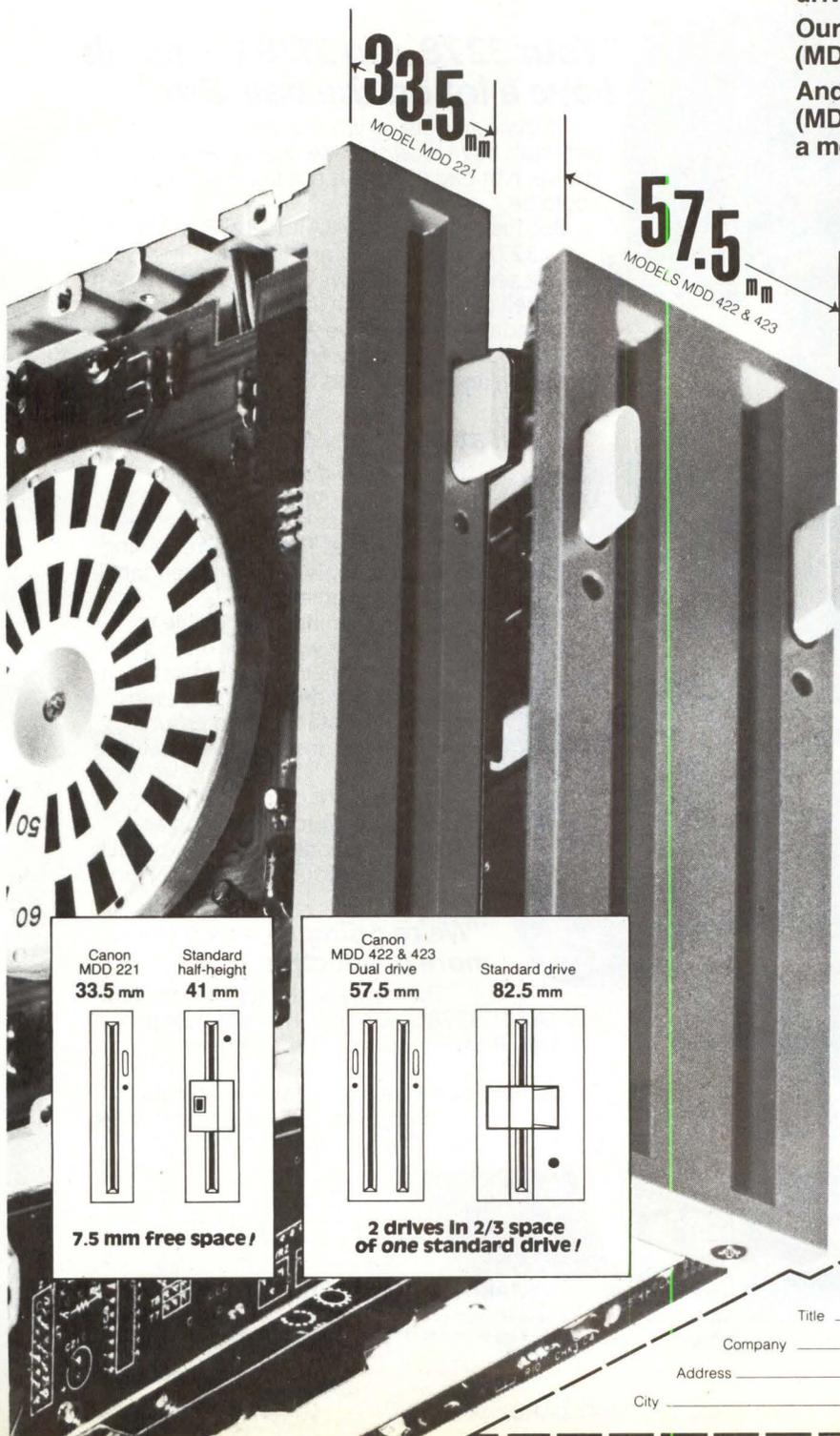
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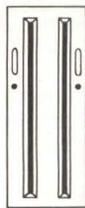


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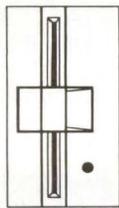


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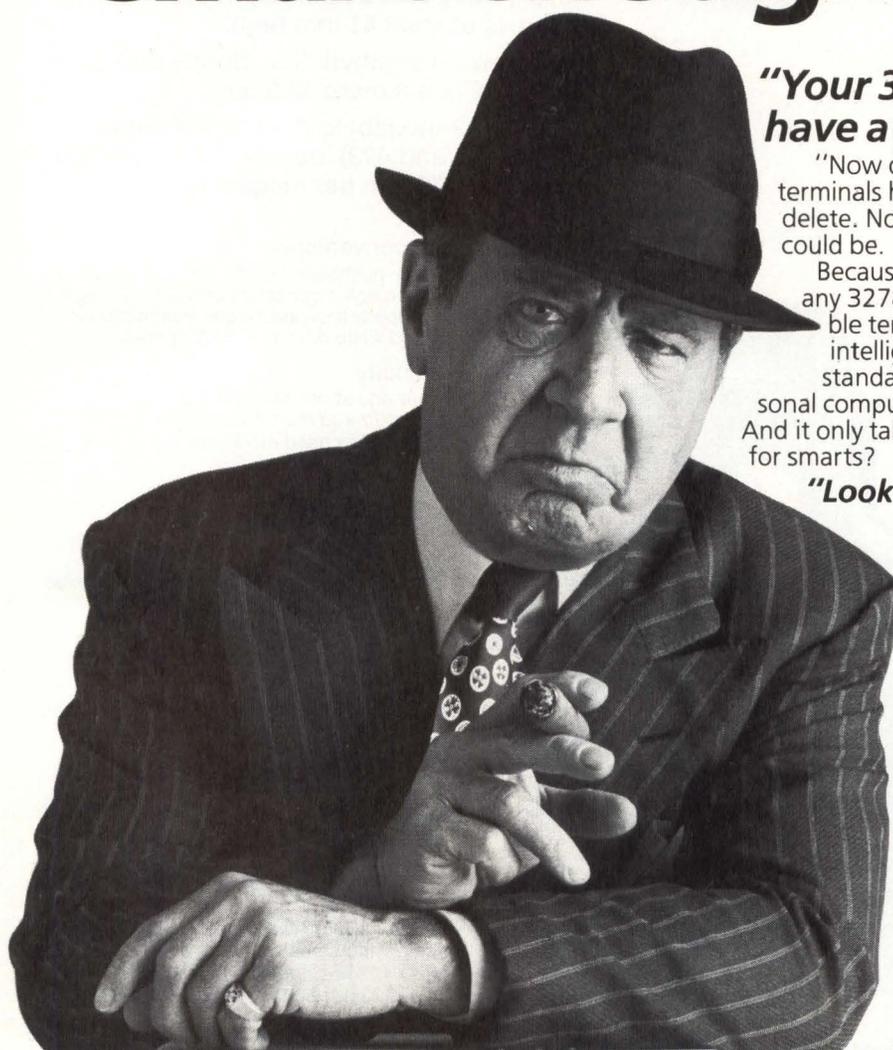


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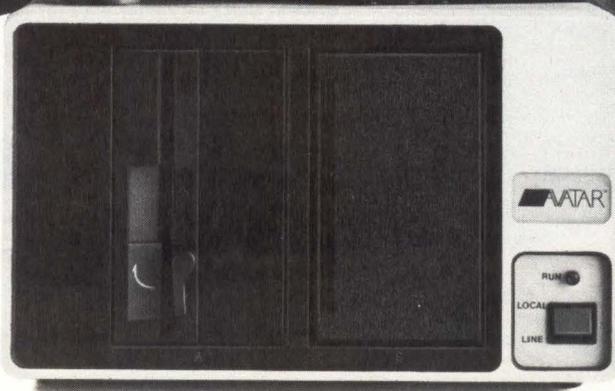
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The Interpreter

Personal computers' entry further clouds terminal market boundaries

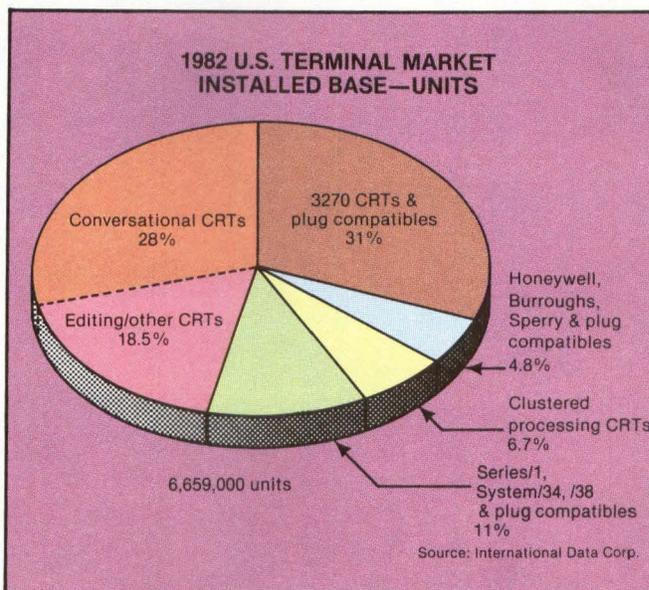
By Dwight B. Davis

CRT terminal manufacturers recently started getting new competition from personal computers masquerading as networked terminals. These brash newcomers, often carrying the communications-oriented moniker of "intelligent workstations," couldn't compete with commodity-level terminals on a price basis. But they could offer a major advantage that helped offset their higher prices: along with performing standard-terminal database entry and access functions, the personal computers/workstations could offer local processing on users' desks. Some terminal manufacturers have welcomed this trend toward networked personal computers and have introduced their own workstation products based on their traditional terminal lines.

Long before personal computers began to dissolve the boundary between user-programmable intelligent terminals and microcomputers, the internal divisions between classes of terminals had started to blur. One of the main distinguishing features between "dumb" and "smart" terminals—the latter's enhanced editing capabilities—became so inexpensive that Al Maurer, vice president of marketing at Esprit Systems Inc., Commack, N.Y., is prompted to say, "The 'dumb' and 'smart' terminology has faded into obsolescence over time. There is no longer any such thing as 'dumb.'"

Even at Lear Seigler Inc., Anaheim, Calif., which trademarked the "dumb" terminology for its low-end terminals, the distinction between dumb and smart products is very hazy. "There are terminals like the DEC VT100 that by traditional definition are dumb terminals because they operate in a conversational mode, but they sure do have a lot of features too," says Catherine Raftery, Lear Seigler's director of marketing. She points out that dumb and smart terminals serve essentially the same applications, with the system software determining which type of terminal is used. "It all depends upon if the writer of the system software put the burden on the host or on the terminal to do certain functions," she says. "System software can emulate most of the functions of a smart terminal and, to the user, it's transparent whether something is happening in the terminal or the host."

Regardless of how the terminal market is sliced, however, most vendors agree on several trends. Terminal unit shipments are expected to continue growing in the 20- to 25-percent range each year for the

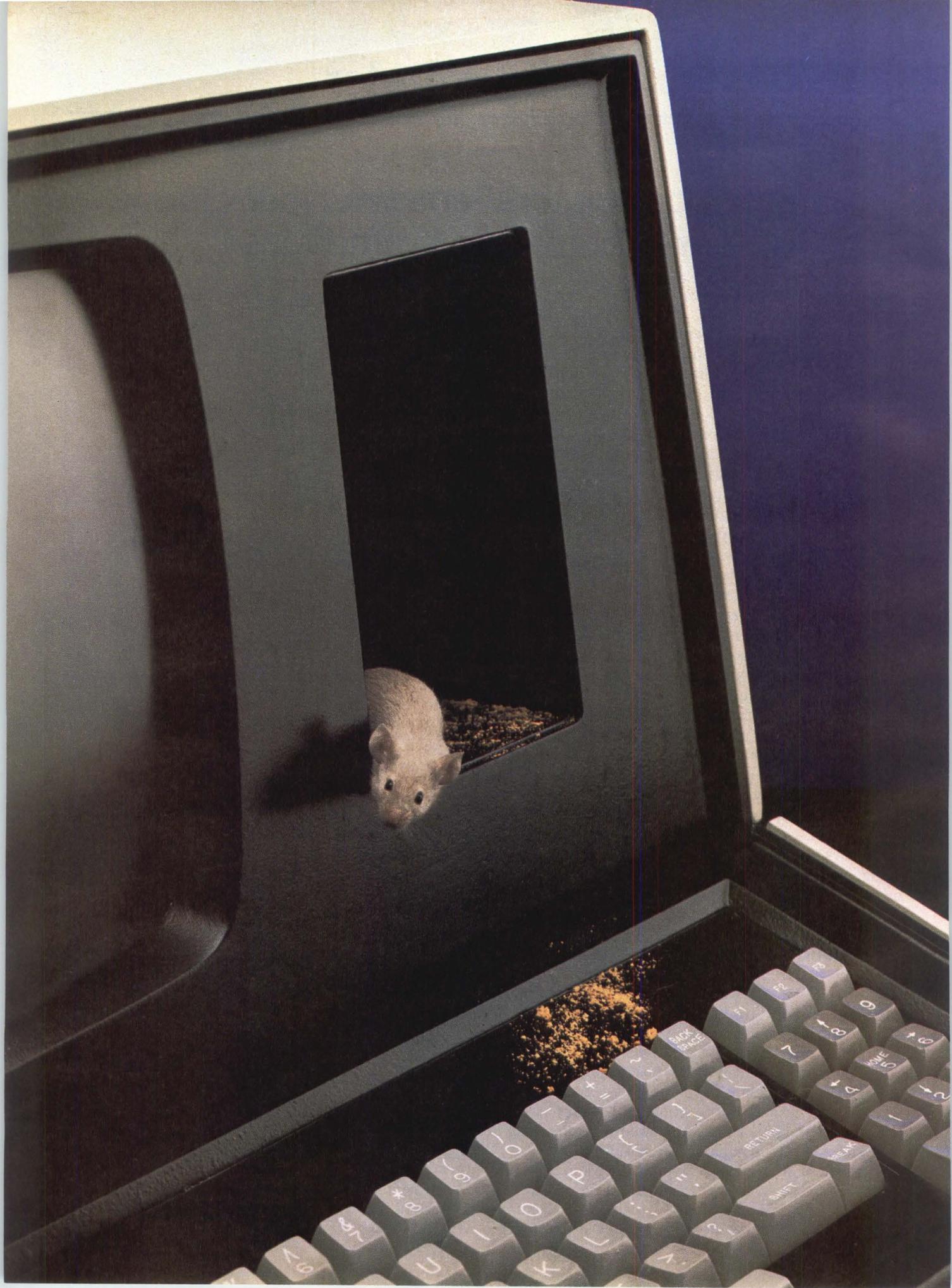


International Data Corp.'s view of the 1982 U.S. terminal market indicates that IBM terminals and plug-compatible products account for 42 percent of the installed base. Mary Lynn, a research analyst with IDC, says future reports covering the terminal market will probably merge the conversational CRT and editing/other CRT segments because the distinction between them has become so hazy. IDC predicts that the installed base will grow at a 23.19-percent rate annually between 1982 and 1987.

foreseeable future. Dropping terminal prices and margins, however, will keep revenue growth lower, perhaps about 15 percent each year. To keep the margins respectable as prices drop, almost all major U.S. terminal vendors now use offshore manufacturing facilities. And, although it's becoming less expensive to add features and intelligence to terminals, the terminal vendors believe the inevitable price differential between their products and personal computers will ensure that the traditional terminal market remains healthy for a long time.

Micro threat still limited

Aside from the price differential between terminals and microcomputer systems, terminal vendors believe that many generic applications will always be straightforward database-access operations with no requirements for local processing capabilities. "The smart terminal is still sought by companies that have an investment in a system and its software," says Richard Fadem, director of display products development at Applied Digital Data Systems Inc., Hauppauge, N.Y.



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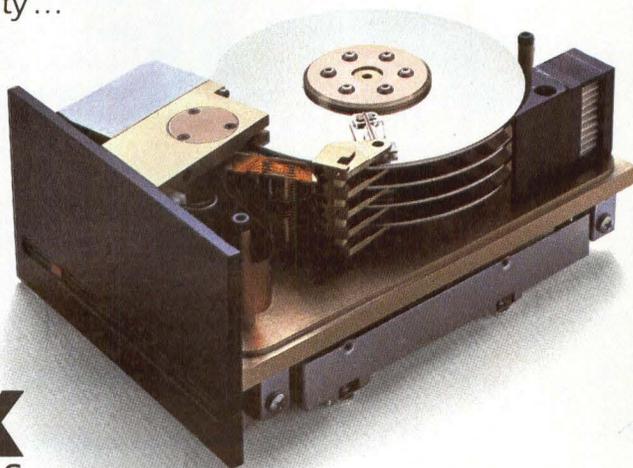
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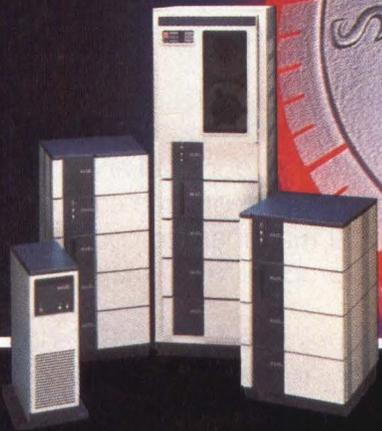


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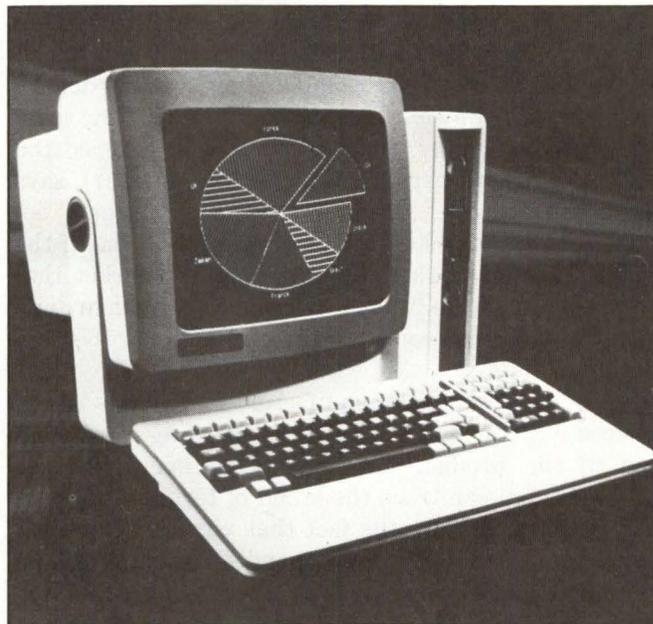
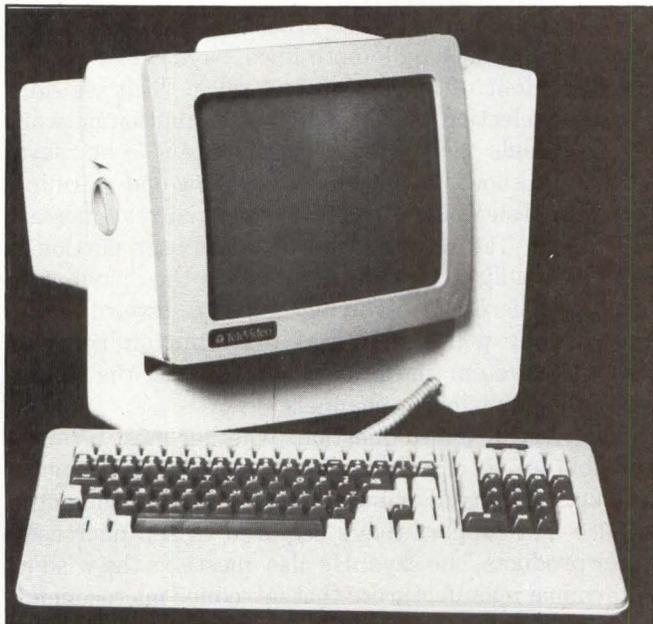
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The Interpreter



TeleVideo Systems Inc.'s 970 terminal (left) and TS803 personal computer illustrate how terminal manufacturers base their micro systems on their product lines. To turn the 970 into a personal computer, TeleVideo essentially added two disk drives, the CP/M operating system and 64K bytes of memory to the display and keyboard.

"They don't want to blow that away."

Keith Rapp, director of marketing at Qume Corp., notes that changing work-place demographics will also keep the terminal market active. "As we get further into this information age," he says, "the number of white-collar workers per terminal will decrease from eight presently to two over the next five years. That trend indicates there will be a lot of additional applications that need to be discovered and addressed by each manufacturer." Some of these new applications will be filled by personal computers/workstations, but because Qume already sells its terminals to OEMs of such systems, the company will be able to profit regardless of the terminal/system split.

An ironic twist to the terminal/personal computer merger is that, while low-end microcomputers encroach upon the terminal market, high-end microcomputer systems will dramatically expand the terminal market. "One company, Altos, probably ships about 2000 8-bit, multi-user microcomputer systems each month to its dealers and OEMs," estimates John McPhail, vice president of marketing at Beehive International, Salt Lake City, Utah. "Each of those systems has five ports on it, and there will be either a printer or a terminal dropped off at least 60 percent of those ports. So Altos alone is creating a need for at least 3000 terminals per month. When you multiply that by all the other companies that are in the same business as Altos, you

get a lot of ports out there that are looking for something to put on them."

Adding micros to terminal lines

Although he's optimistic about the potential growth of terminal unit shipments, McPhail notes that Beehive recently entered the desk-top microcomputer market with its Topper product (MMS, September, 1982, p. 80). While he expects the company's terminal shipments to continue growing, McPhail says that three years from now, 50 percent of Beehive's revenues should come from its workstation products.

In the peripherals industry, McPhail believes, "Except for rare exceptions, a company reaches a point where the number of units it sells becomes finite—around 50,000 to 60,000 units. And, depending upon what the average selling price per unit is, that volume limit determines your maximum revenue potential." With the average selling price of a Beehive terminal likely to drop from about \$1000 to \$800 over the next few years, McPhail says, Beehive had to branch out if it wanted to become more than a \$50-million company. "The obvious choice for us was a computer that looks like a terminal," he says.

Other terminal companies haven't yet reached the growth plateau that McPhail ascribes to Beehive. Lear Siegler's Raftery says that the company will continue to look at the market, but has no plans to produce a

The Interpreter

microcomputer product. "There's still enough of a price differential between a microcomputer and a CRT that if the function of a microcomputer is not needed, a customer won't buy one for use as a terminal," she says. And Rapp at Qume, which only recently entered the low-end terminal market (MMS, February, p. 21), says Beehive is experiencing growth constraints only because it addressed such a narrow vertical niche of the entire terminal market. "In the broader market that we're playing in, we project a continued growth in units of about 24 percent compounded annually over the next 10 years," he says.

Even if a terminal manufacturer's growth seems assured, other considerations may encourage an expansion of the product line to include microcomputer systems. "You can trace the trend of terminal vendors introducing micros to the fact that virtually the same channel of distribution can handle the upgrade to micros," says Esprit's Maurer. Other terminal vendors question this assertion, however.

TeleVideo Systems Inc., which markets both termi-

nal and personal computer products, does have some distributors that handle both lines, says Steve Tatum, vice president of marketing and sales. "But we do a different selection process on our distribution network for terminals and for microcomputers," he says. Although known primarily as a low-end terminal company, TeleVideo's computer/terminal revenues are split 60:40, Tatum says, and the computer portion is moving rapidly to 70 percent. He says the distribution for the micros is evolving rapidly toward retail operations, while terminal distribution remains "through system integrators, OEMs and the classic peripheral distributor channels."

Rapp at Qume also questions whether most terminal distributors can effectively handle microcomputer products. "Some distributors don't offer the amount of service and support that's required to sell microcomputer products," he says. He also questions the wisdom of terminal manufacturers that introduce microcomputer products that, in effect, compete with products manufactured by the terminal companies' OEMs. "Deal-

IBM ENDORSES TERMINALS AS COMPUTERS AND PERSONAL COMPUTERS AS TERMINALS

If there were any doubts about the likelihood of terminals and personal computers competing for similar applications, IBM Corp. has assuaged them by supporting a mix-and-match approach. IBM's provision of a 3270 emulation option for its PC has blessed the concept of substituting personal computers for terminals, says Robert Katzive, vice president of the computer division at Gnostic Concepts. "IBM's move will have a tremendous psychological impact on the market," he says.

Now, in a move that may further blur the distinction between terminals and personal computers, IBM has announced its 3270 Personal Computer attachment and keyboard-less PC system units, which essentially permit an IBM 3278 display terminal to function in a local-processing, "personal-computer mode." The attachment uses the 3278 display station and keyboard, along with Personal Computer display adapters. A 3278 PC adapter provides the ability to accept screen images from the 3278 internal logic or from the PC color/graphics monitor or mono-

chrome display. It also provides printer adapters and a path for data transfer between the 3278 and the PC. A second element, the IBM PC 3278 attachment option, provides an adapter in the PC system unit that connects to the 3278 keyboard and display and provides cables for connecting the PC unit to the 3278 display and keyboard.

IBM announced three PC system units without keyboards to be used with the 3270 PC attachment. Prices for the three system units range from \$1594 to \$2363, with volume discounts available. The 3270 PC attachment sells for \$1700, with volume discounts ranging from 12 percent for 20 to 49 units to 20 percent for 150 to 249 units.

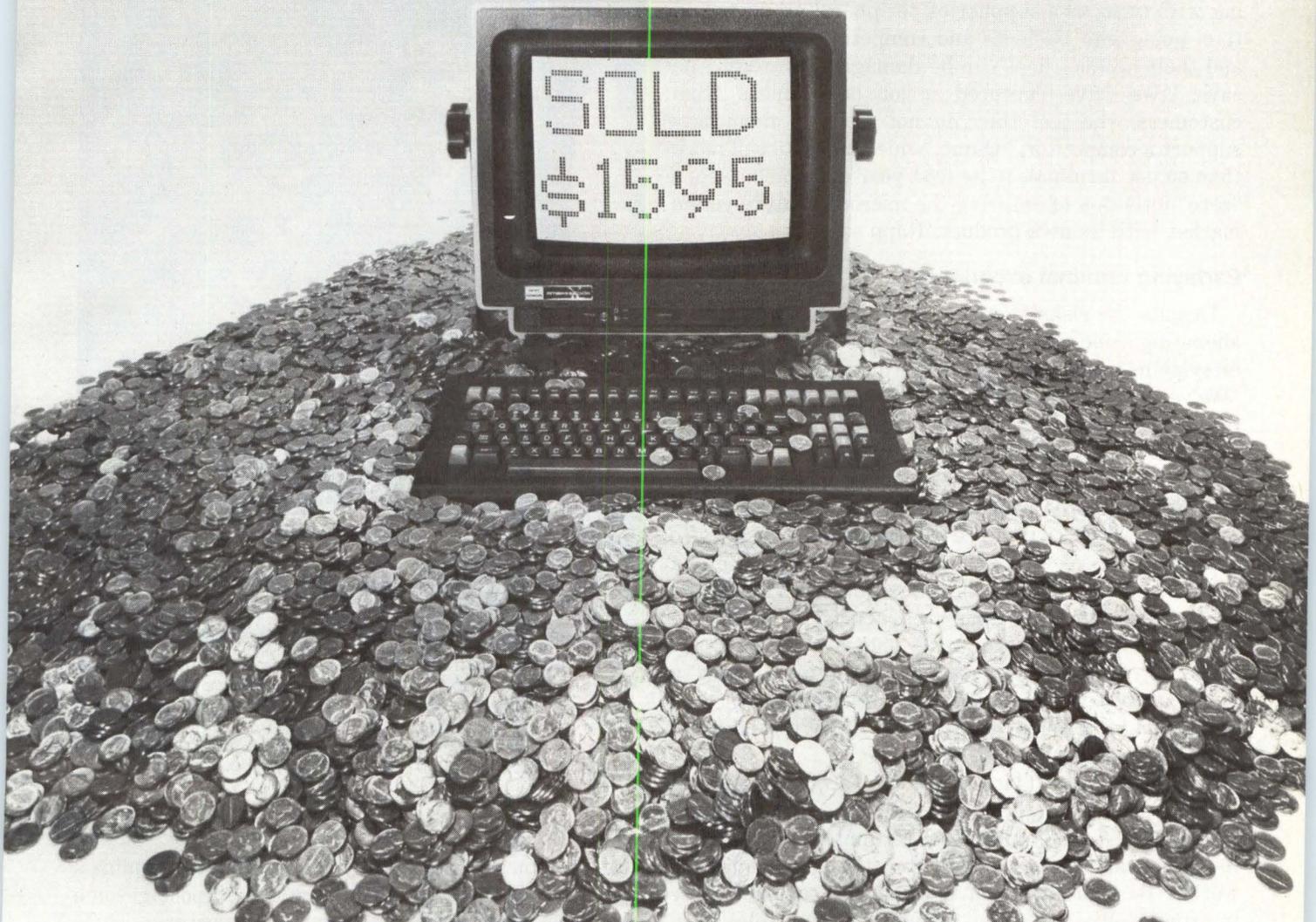
A key distinction between the 3270 PC attachment system and a standard PC that emulates a 3270 or 3770 terminal is the ability of the former to perform concurrent operations, says Bob Baden, a senior product administrator at IBM. With the attachment, host and PC programs can operate concurrently. When a standard PC runs a 3270 or 3770 emulator, it is the only thing then running in the

machine.

Baden says no clear-cut boundary exists between applications best served by standard PCs and those best served by the 3270 PC attachment. Choosing one approach over the other depends on the percentage of time a user requires a connection to the host. "If the connection is predominately a casual one, and the majority use is as a personal computer, then the customer would probably be best off having a Personal Computer with a telephone-line connection to the host," he says.

The 3270 PC attachment, on the other hand, communicates to the host through an IBM 3274 control unit, which can support multiple remote terminals over a single leased line. "So, if you are remote from the host system and have the need to cluster Personal Computers, the 3278 approach would be the way to go," Baden says. "The standard Personal Computer approach would either require a modem that would allow you to multiplex or individual lines for each Personal Computer."

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The Interpreter

ing with OEMs as a supplier of peripheral products and then going into business and competing against them and their product lines can be damaging strategy," he says. "We have captured a lot of business from customers who feel they do not want to financially support a competitor." Qume, which hopes to sell more than 60,000 terminals in its first year of shipments, has "zero" intention of entering the microcomputer system market with its own product, Rapp says.

Parlaying terminal experience

Despite the risks of entering a market, and possibly alienating some customers, the jump into microcomputer systems is a natural one for terminal manufacturers. "We've already done firmware, and we know how to package things ergonomically," says Beehive's McPhail. Terminal vendors also understand the networking world and use that experience when they build personal computers/workstations. And Maurer at Esprit, says, "The micro is the easy part of the system. To build a Z80 board with 64K of memory is not much of a chore. And if you make it compatible with CP/M and MS-DOS, then you've eliminated a good deal of your software problems." He adds, however, "We'd get killed if we tried to compete head-on against a stand-alone personal computer instead of staying in a networking environment. We can't stray too far from what we know."

Robert Katzive, vice president of the computer division at market research firm Gnostic Concepts, Menlo Park, Calif., agrees that terminal manufacturers must be cautious as they enter the microcomputer world. "Basically, they have to emulate somebody else in order to fly," he says. "Maybe if you're TeleVideo, you've got enough breadth to handle the whole cluster on your own. But even TeleVideo has found that the software and support aspects of personal computers are a bit more than it bargained for."

And, even though terminal manufacturers can ride the coattails of CP/M or other popular operating systems into the microcomputer market, the market for networked micro workstations—the segment closest to the terminal vendors' experience—is still relatively small. "To really use workstations well in an integrated environment, you've got to write a tremendous amount of well-thought-out software that allows you to exchange data or build databases locally, and still keeps the workstations compatible with the schema in the host computer," Katzive explains. "The business of building databases, when you want to maintain some continuity with the past, can drive you absolutely crazy."



Beehive International vice president of marketing John McPhail says the firm's Topper "telecommuting" console will give the company visibility and experience in the workstation market. The Topper can run as a stand-alone computer running CP/M or can emulate an IBM 3278 terminal or serve as a personal RJE station by using a BSC/SNA protocol converter.

If the competition and synergy between terminals and personal computers/workstations is posing some problems for traditional terminal manufacturers, it is also starting to muddy the decisions that system integrators and end users must make. When deciding between a terminal and a personal computer that also acts as a terminal, "It's getting more difficult for system integrators to evaluate what to choose," says Bob Sanekoff, manager of the display terminal industry service at Dataquest Inc., Cupertino, Calif. "There is quite a bit of vacillation and quite a bit of confusion."

Tatum at TeleVideo, however, believes the buyers' decisions are still clear-cut. "But we are seeing more and more OEM integrators looking to offer upward mobility on peripherals—to hook a terminal into a system but also having intelligent-workstation functions." And, on the end-user side, Tatum says, "If you talk to people in large corporations who are responsible for buying devices, you find that most are thinking about intelligent workstations. That's what they want to put on everybody's desk." □

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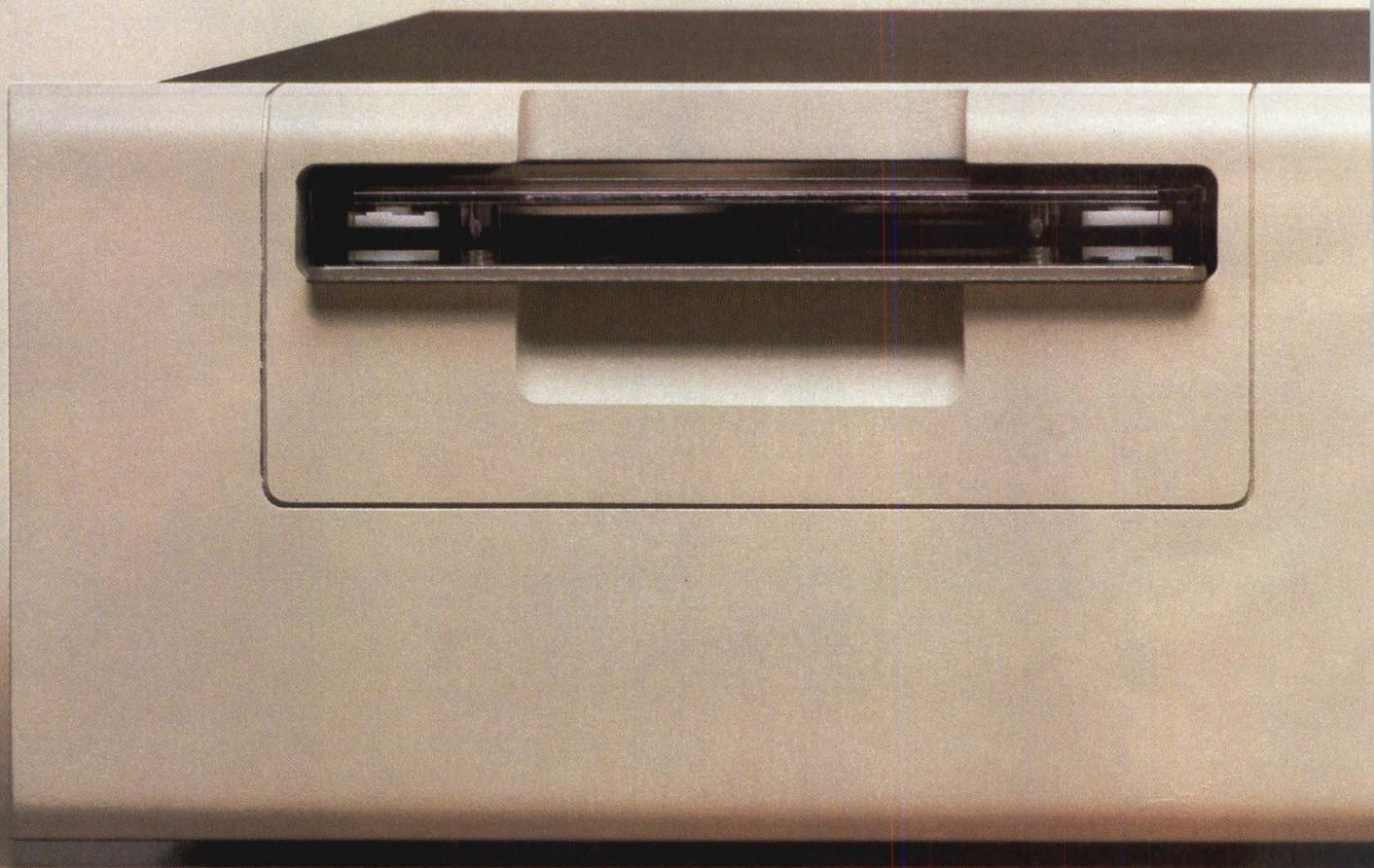
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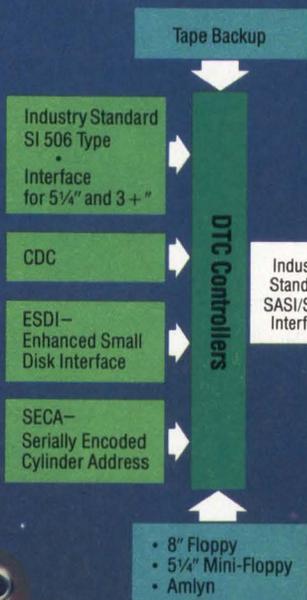
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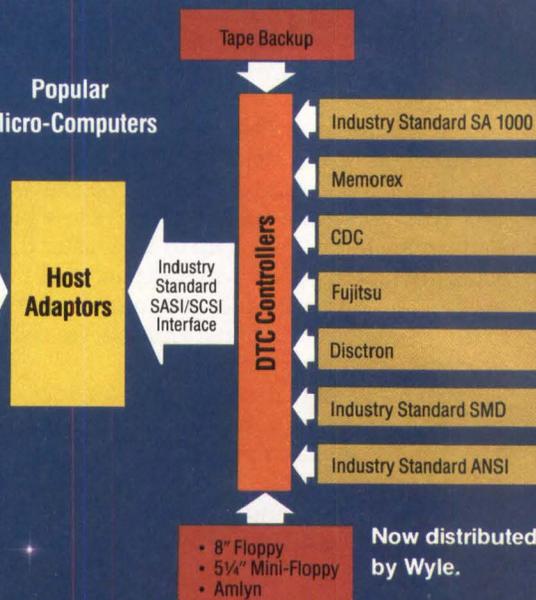


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Serial printer market warms to thermal transfer technology

By Edward Foster

Depending upon which printer vendor you talk to, projections of the market for thermal transfer printers range from lukewarm to red-hot. Proponents of thermal transfer printing—which heats an inked film medium to transfer characters to paper—believe it will fill many more applications than standard thermal printing, which forms characters directly on coated thermal paper. Enthusiasts of the transfer method say it will function in almost every serial printer niche, including word processing, color graphics and home computers. Some proponents believe thermal transfer will also become a major force in the line and page printer markets.

Optimistic growth projections from market research firms such as Dataquest Inc. (see charts, p.107) lend credence to thermal transfer's supporters. But some industry sources urge caution about expecting too much from this printing approach. "Thermal transfer has a lot going for it," says Neil Kleinfeld, marketing and planning manager at Centronics Data Computer Corp. "You can print on plain paper, it's quiet, and it's fast. There are going to be some problems, though, and certainly cost of consumables will be one. When everyone gets this excited about an idea, I can't help but think back to things like bubble memory and how sure we all were about that technology."

Japanese leading market

Although widespread interest in thermal transfer printing has surfaced only recently, the technology has been available for several years in Japan. The requirements of printing Kanji characters led the Japanese to concentrate on facsimile thermal printing some time ago, and companies such as Mitsubishi Electronics, Oki Electric, Sony, Fujitsu and Shinko are, or plan to be, active in the thermal transfer market. The American market, which has always found it difficult to accept thermal printing's paper requirements, is looking much more favorably upon thermal transfer with its "plain-paper" capability.

Despite a general perception that thermal transfer has solved the paper problem, however, specific grades of paper are still required for such printers. These grades are much closer to plain paper than the paper required by standard thermal printers. But Bruce Thatcher, director of peripheral product marketing for

NEC Information Systems, Lexington, Mass., says, "The biggest problem for the technology is still paper." He puts this problem in perspective, however, by noting that the thermal transfer paper requirements are not as strict as the paper requirements for ink-jet printers, with which the thermal method may compete.

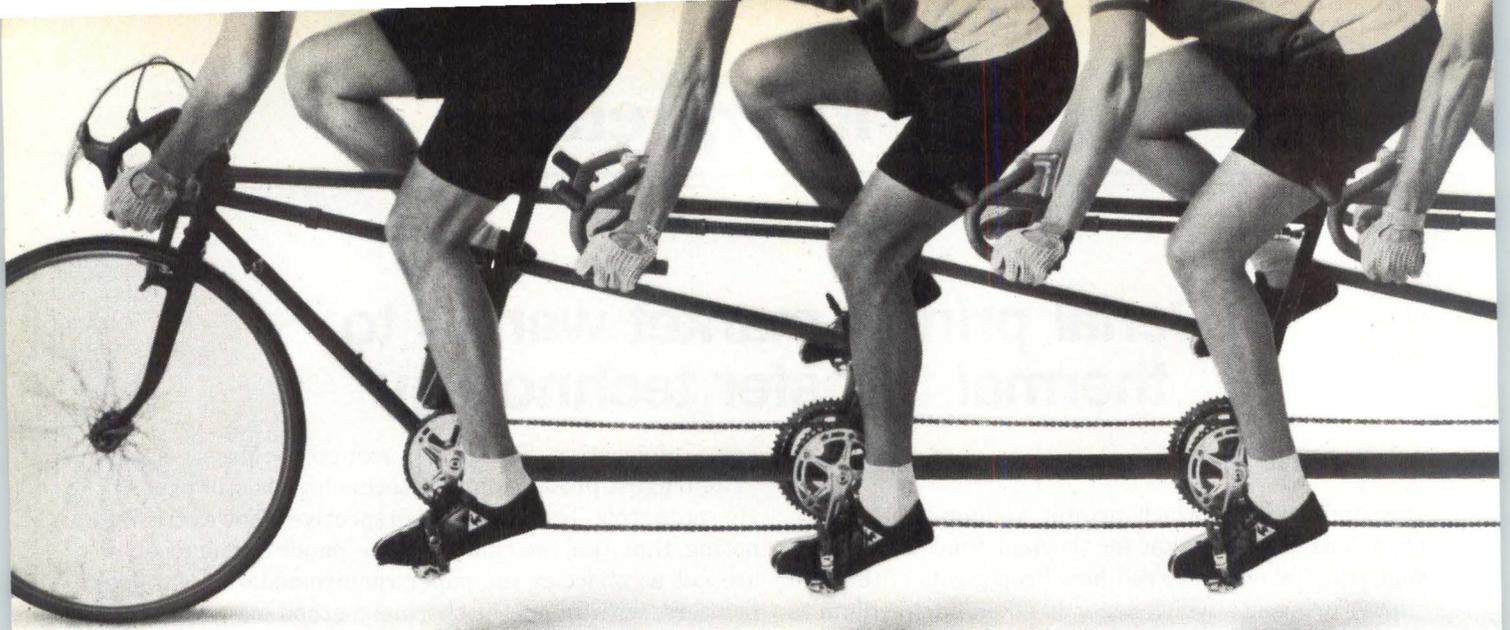
The overriding attractiveness of the technology is its simplicity. "About all you really need is the print head, a power supply and a few motors to make a thermal transfer printer," says Bob Peckham, thermal print head product manager at Rohm Corp., Irvine, Calif., a leading print-head supplier. "It is a very simple machine and very inexpensive to make. And as we begin to see economies of scale build up, prices for these printers will drop even more."

Word processing/color graphics

Peckham believes thermal transfer will greatly influence several applications. "I think the first market we're going to see it really penetrate is word processing. The new Diablo machine [the Series 200 EPM] is just the first of a number of introductions we're going to see in that sector" (see "Diablo broadens product lines...", p. 35). Peckham believes that, by the end of this year or early next year, thermal transfer printers



Bob Peckham, thermal print head product manager at Rohm Corp., believes thermal transfer printers will make dramatic improvements in resolution, speed and color over the next year.



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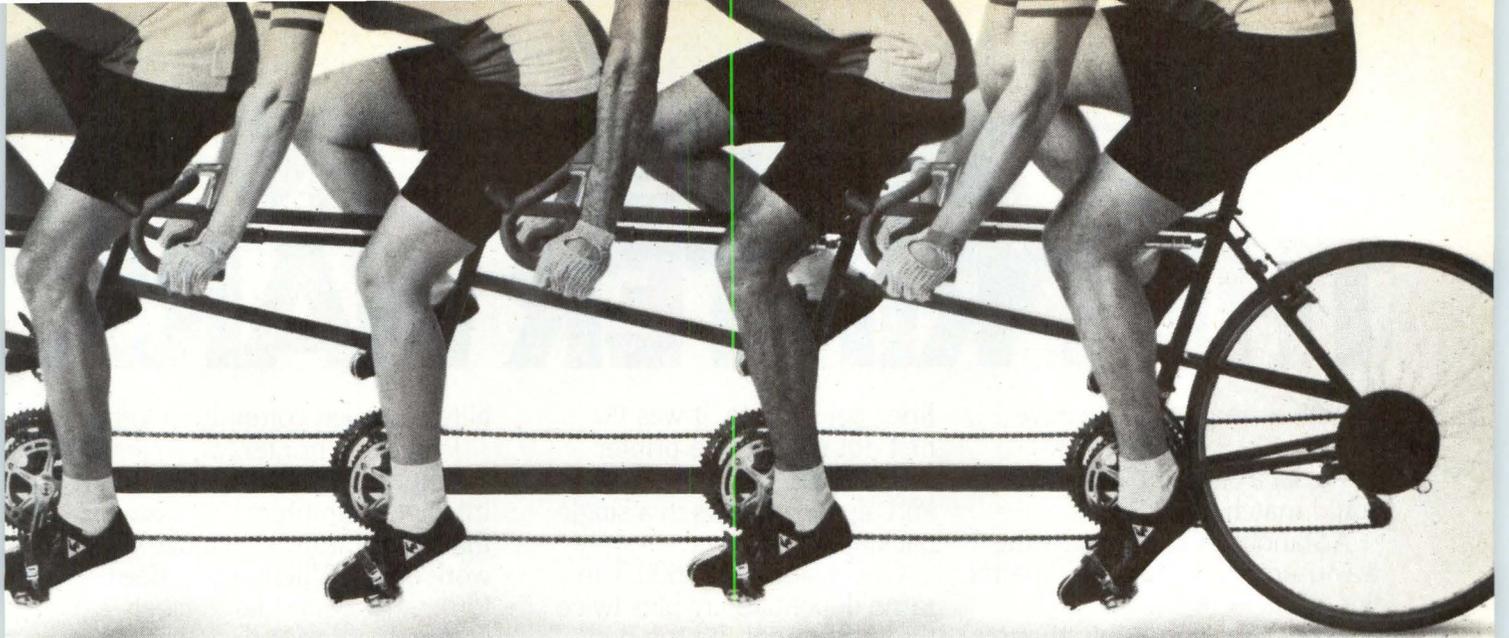
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on the market will have print quality that surpasses any typewriter. He also expects that, with the development of new print heads by Rohm and others, it won't be long before thermal transfer machines print at rates of 20 pages per min.

Following closely behind word processing as a prime application for thermal transfer is color graphics, hard-copy production, Peckham says. Many others in the industry believe color printing may be thermal transfer's true calling, especially if methods can be found to decrease ribbon costs (see "Color non-impact printers hit the market," p. 217).

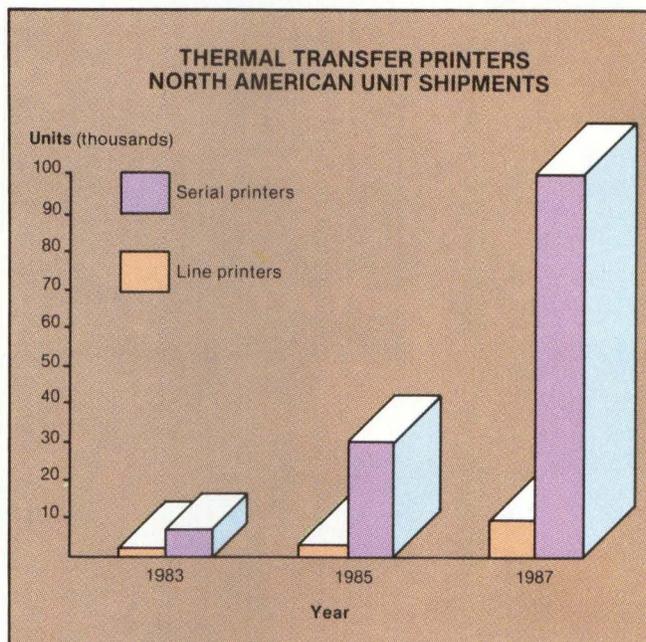
Although skeptics of thermal transfer printing usually point first to the costs of consumables, particularly transfer ribbons, Peckham says they may be overstating the problem. "They fail to see how economies of scale are going to affect the cost as mass production and competition grows," he says. Peckham says transfer films are improving rapidly because ribbon manufacturers recognize how large the market will be. He expects multistrike ribbons will be available by year-end.

Peckham says he has witnessed a demonstration of a multistrike ribbon on which the film was used 20 times in one spot. "By the twenty-first time, it was looking like the sixth carbon," he admits. "Up to about the tenth time, however, the difference was hardly noticeable." He believes that users will be able to use such transfer films at least five or six times each.

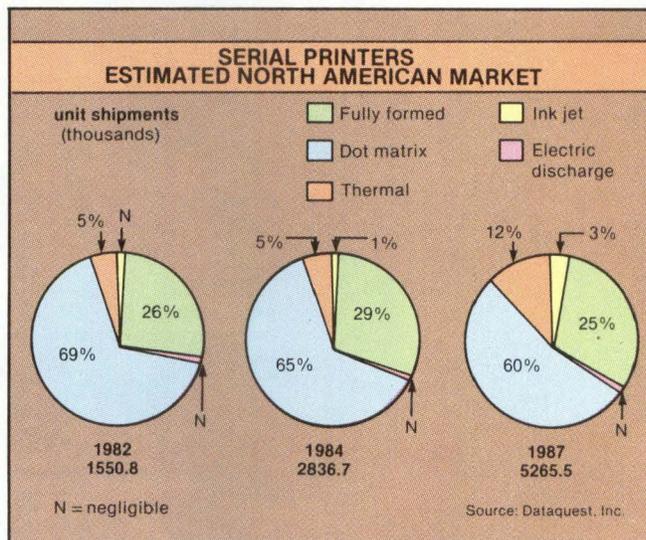
Less sweeping projections

While many in the printer industry agree with the general advantages that Peckham ascribes to thermal transfer technology, few believe it will have an across-the-board impact. "We are particularly enthusiastic about the color advantages of thermal transfer," says Harry Schofield, design engineering manager at Gulton Industries, East Greenwich, R.I. "We feel the inherent reliability of the technology for color is a little higher than for ink jet, and it allows you to get both high-quality color production and good print speed at a reasonable cost." Schofield also believes that thermal transfer will eventually compete in word-processing environments as well. "It is still a matter of the user's own needs," he says, noting that he believes thermal transfer can generate a document that is good enough to send as a letter.

Unlike Schofield, Thatcher at NEC does not see thermal transfer's strength as being in color or word-processing applications. "We see the requirements for a thermal transfer machine as similar to those of a quality dot-matrix printer," he says. "The real advantages it will have is the mix of text and graphics



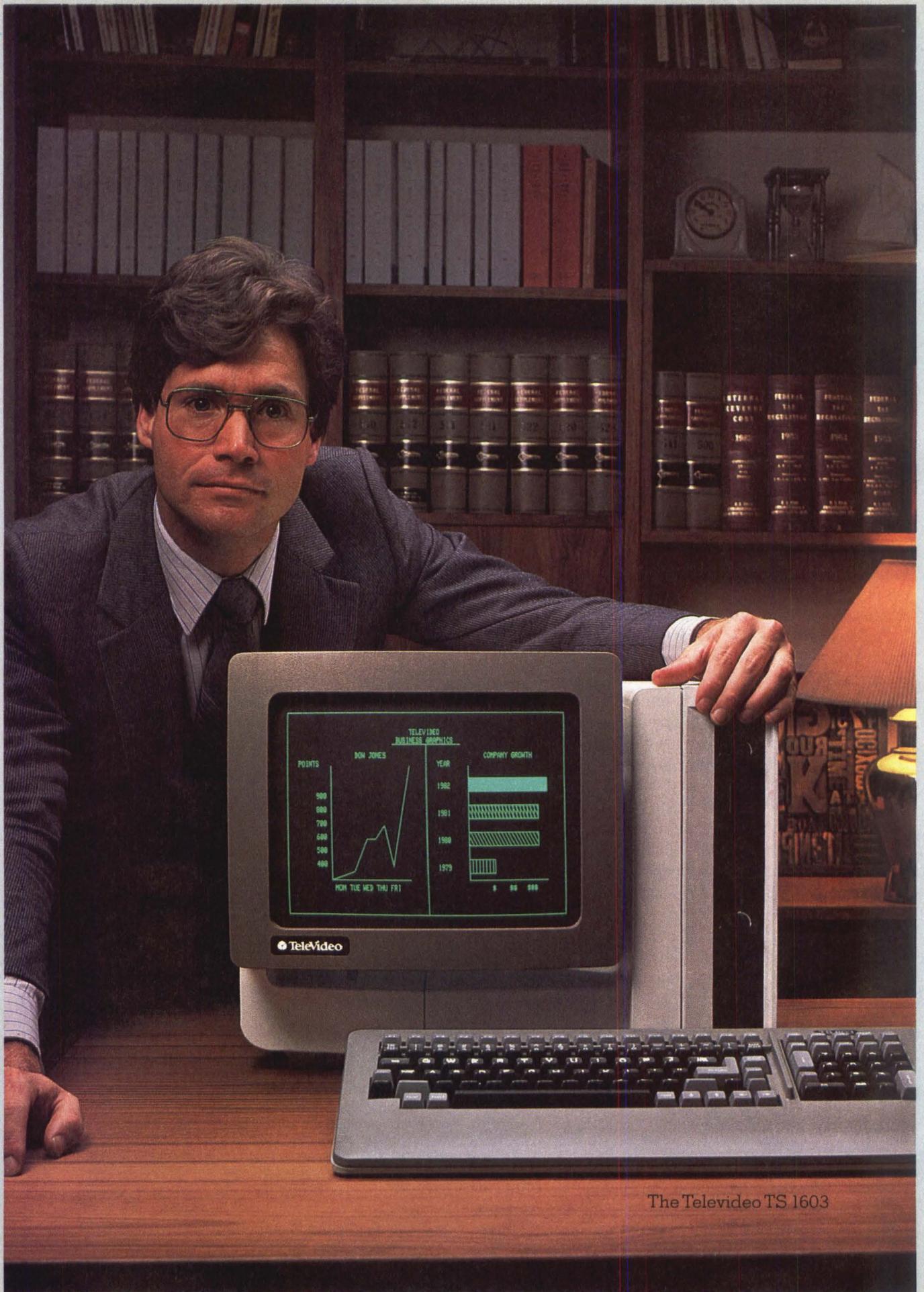
The market for thermal transfer printers will show impressive growth over the next four years, according to these figures from Dataquest Inc. Although the market research firm expects little activity in the line printer segment, with only about 5000 units shipped in 1985, it expects serial thermal printers to grow from shipments of about 4900 units this year to about 99,000 units in 1987.



The thermal printer market segment, which includes standard thermal printers as well as thermal transfer printers, will account for 12 percent of the entire serial printer market in 1987. Dataquest estimates that the dollar volume of the 1987 serial printer market will be \$10 billion, with thermal printers representing 5 percent of these revenues.

and the fact that it will be low cost, probably under \$1000 in the near future."

Interestingly, NEC is assuming that even without



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The Interpreter

targeting word-processing applications, the company will still attempt to provide its print heads with a density of about 300×300 dots per in.—about 50 percent higher resolution than any thermal transfer product so far introduced in the U.S. Thatcher says the requirements for a thermal transfer printer for use in application graphics are a denser print head, 5- to 6-page-per-min. speed, a one-pass ribbon, automatic sheet feeding, overhead transparency production, unlimited fonts and raster printing directly from CRTs. "We don't see it competing directly with fully formed characters, and it would also be a very hard battle to bring a thermal transfer printer in now to compete against the low-end dot-matrix machines," he says.

Home computer applications

David Zimmerman, market requirements and planning manager at Okidata Corp., Mount Laurel, N.J., also expects thermal transfer to have only specialized applications at first. "You'll find a number of applications in the low-end market," he says, "not so much in the business computer market as in home use. For a home computer user who may be producing 20 pages a week at most, changing the ribbon frequently is not going to hurt. For the type of user who needs to make a 50-page dump, thermal transfer may be the wrong type of printer."

Although Zimmerman emphasizes low-end prospects for the technology, he does believe some business exists in the high-end serial printer market. He sees this business as relatively low-volume applications in which ribbon costs will not be as big a handicap. He also believes color graphics will take off in the next couple of years, and thermal transfer will have a share of that market, particularly for overhead transparencies, "We'll probably also see some word-processing applications, particularly as part of the general trend accepting correspondence quality," Zimmerman says. "I don't think thermal transfer is ready, however, to totally dominate the fully formed character market. From a technical point of view, it is not an impossibility, but I think it will be some time in coming."

Robert Cowan, vice president of C. Itoh Electronics Inc., Los Angeles, also believes low-end applications represent the natural target for thermal transfer printers. "Full-page thermal printing is going to be hard to cost-justify," he says. "It is going to be a while before ribbon costs come down sufficiently for that volume of printing to work. In terms of simple one-color printing for personal computers, however, it seems ideal. Thermal transfer printers are inexpensive, lightweight and quiet, and that's going to make them



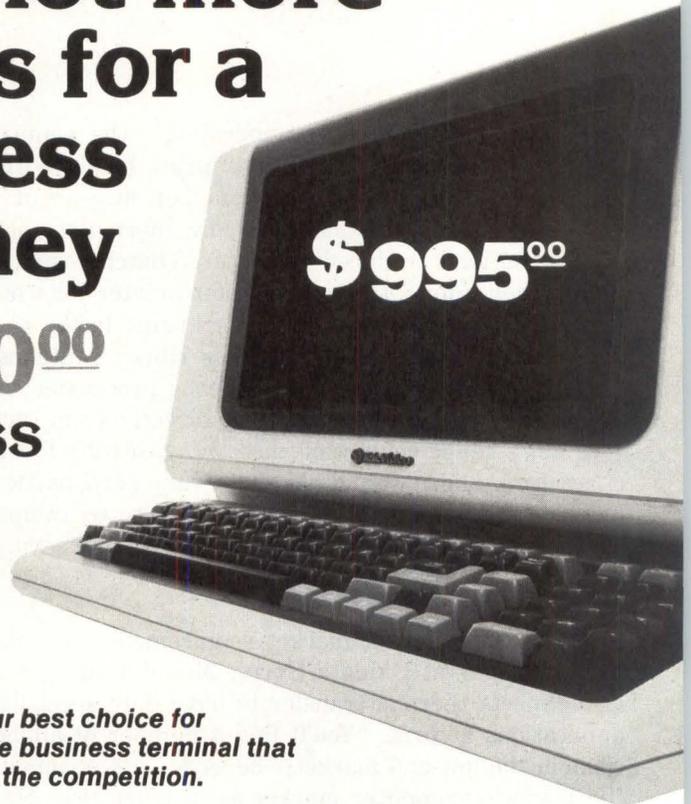
Robert Cowan, C. Itoh Electronics vice president, believes established impact technologies will continue to have the advantage over thermal transfer in many applications.

hard to beat at the low end of the dot-matrix market." Cowan does not believe, however, that the limits of impact technology have been reached.

Low-cost transfer typewriter

One company involved at the low end of the thermal transfer market is Brother Industries, Irvine, Calif. Brother's EP-20 portable typewriter is not a printer, but it does illustrate the low cost of thermal transfer technology. "If we were to make a receive-only model of the current typewriter, we could probably offer it for about \$250," estimates Brother's chief of marketing, Toshikazu Koike. "The course we should take with this kind of product is to upgrade the print-head density and enhance the speed," he says. He sees three main problems with thermal transfer when competing against dot-matrix and daisy-wheel products: ribbons that can be used only once and that must be changed, low print speed and the need for a finely finished paper. Koike believes the plain paper aspect of thermal transfer has been overemphasized. "It sounds good in advertising, but many customers are going to be disappointed if they try to use just any kind of paper," he says. "With the EP-20, we are now recommending that our customers buy paper from us specifically intended for the machine." The EP-20 can also be used as a standard thermal device, by using thermal paper without the ribbon, and Koike would not be surprised if many future thermal transfer printing systems encourage users to try standard thermal printing as an option. Development of thermal paper in Japan has solved many of the problems U.S. users associate with earlier types. It would be ironic if the major success of thermal transfer is to get the U.S. market to take a second, more favorable, look at thermal transfer's predecessor, standard thermal printing. □

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Systems in Manufacturing

Exploring the use of computers in the factory

Data-collection devices play key role in automated factories

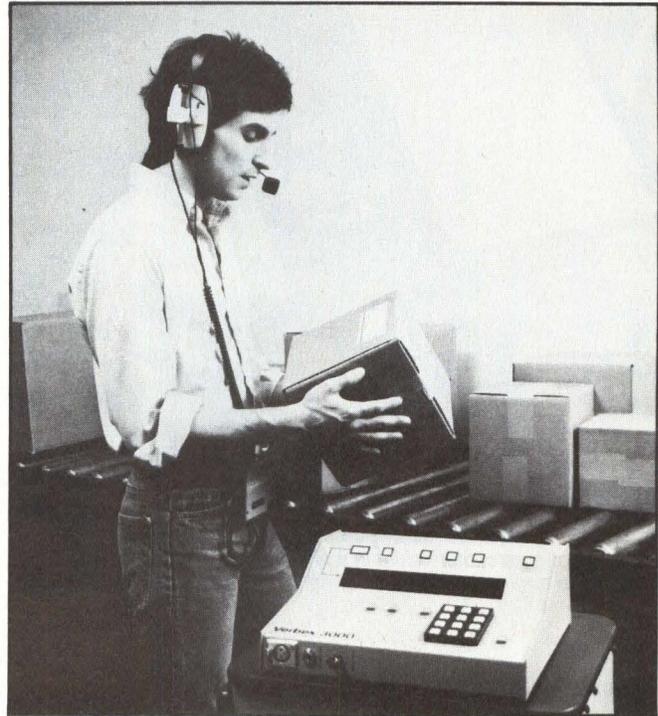
By Frank Catalano

Without on-line factory-floor data-capture devices, all the sophisticated, much-publicized, computer-based machinery and administrative controls for manufacturing would be nothing more than costly clutter that could not perform the tasks for which it was designed. The factory market for data-entry systems, although still small relative to the office market, is expected to expand over the next several years as part of the overall factory-automation effort. Suppliers of keyboard-based terminals will enjoy the most market growth, but vendors of bar-code readers and voice-recognition products will also share a large piece of the action.

"Data is the root of all this automation that we keep reading about," notes Alan Strass, a data-collection specialist for General Electric Co.'s Computer Management Operations group. "Whether we're talking about computers controlling robots or computers calculating inventory requirements, they are all intelligent devices that improve production efficiencies through data manipulation."

Gerald Michael, a senior researcher with the Computer Integrated Manufacturing group at Arthur D. Little Inc., Cambridge, Mass., estimates that the sales of computer systems for manufacturing will increase from \$3.8 billion in 1982 to \$28 billion by 1992. While sales of data-entry devices represented a negligible share of total 1982 computer system sales, Michael says that share will become more substantial in the coming years. "If you believe in the trend in the factory towards flexible manufacturing systems, then you've got to recognize the huge potential of the data-entry market segment," says Michael.

Bob Katzi, vice president of the computer market research group of Gnostic Concepts Inc., Menlo Park, Calif., notes that purchases by factory users accounted for 14 percent of the \$3.4 billion spent on keyboard-based terminals in 1982. He adds that factory purchases accounted for about 40 percent of the \$42 million spent on bar-code systems and 60 to 70 percent of the \$8 million spent on voice-recognition devices. Keyboard-based terminals are the least expensive computerized data-entry devices, with prices starting at less than \$900. Bar-code systems range in price from \$1000 to \$100,000, and voice-recognition systems range from \$2000 to \$50,000. "I think the factory market for

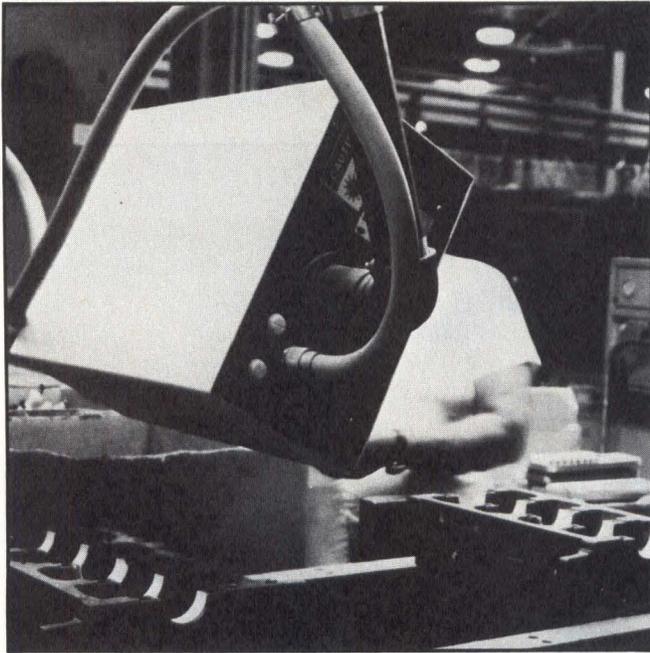


The Verbox model 3000 voice-recognition terminal includes a speech-processing unit, a terminal with an optional keyboard and a microphone. With prices starting at approximately \$20,000, the model 3000 is the first continuous-speech system on the market. Available with vocabularies of as many as 360 words, the system can operate with background of noise as loud as 85 dB.

data-collection devices has been a long time coming, but it's been hampered by the lack of understanding of the technology by factory users and the reluctance of management to invest in support systems," says Katzi. "But adding such systems is now the ideologically popular thing to do."

GE's Strass says that three years ago he could count on one hand the number of voice-recognition and bar-code systems that GE had installed in its worldwide manufacturing sites. Today, however, these installations are too numerous to list, he says. Lockheed Missiles and Space Co., Sunnyvale, Calif., is one of the largest users of voice-recognition data-entry systems, having spent more than \$420,000 on such systems. Leon Lerman, a consulting engineer in electronics manufacturing at Lockheed, says his company is experimenting with bar-code systems and expects to have them installed by next year.

Systems in Manufacturing



A Computer Identics' laser scanning bar-code reader installed in an automotive assembly plant in a production-accounting application counts the engine blocks moving off of a production line.

The antiquated clipboard method

Despite growing interest in computerized data entry, most manufacturers still use the traditional "clipboard" method of recording data with a pen and paper, then filing hard copy or entering data in batches into a computer. Russel Craig, a consultant specializing in high technology at McKinsey and Co., Boston, says this technique is costly to the manufacturer because it wastes valuable labor time, is prone to error and does not provide users with timely information.

"If the data is really valuable for process- or quality-control purposes, then the quicker you get it into the computer, the quicker you can manipulate your process to remove any problems," he says. Craig adds that the shorter the path between the factory floor and the computer and the fewer people handling the data, the greater the data integrity.

GE's Strass explains, "What we're looking for is a means of getting reliable data more efficiently into the computer so that it can be readily used in flexible manufacturing systems."

The standard keyboard

The most popular data-entry alternatives to clipboards are keyboard-based terminals. Craig says keyboards are ideal for applications in which much data

must be entered into the computer by workers whose hands are not busy doing another task. "Suppose you get something returned to the factory for warranty repair," says Craig. "Usually, there's a handwritten tag on the piece, and the tag contains a tremendous amount of information from the customer about the defect. You can't bar code the information, and you can't use voice because the vocabularies of voice systems are not large enough. The only alternative is the keyboard."

But although keyboard-based systems are less expensive than bar-code and voice-recognition systems, Craig says, they are not always the most cost-effective. "In evaluating these various technologies, it's the total cost of entering data—the cost of capital equipment and human labor—that has to be taken into account," he explains. "The expensive component of keyboard data entry is the man who's entering data. If you pay that person \$30,000 a year and you cut his efficiency in half with a keyboard, then it might be advantageous to look at other technologies."

Dean Szajna, a research director at Symscan Inc., Rochester, N.Y.—an engineering consulting firm specializing in automatic data collection—says that, although keyboards offer users improved accuracy over clipboard data-capture techniques, they are still prone to error. He notes that trained operators who can type 60 to 70 words per min. make an average of one mistake in 200 key entries. "Most of the time, factory operators are not close to that level of typing competency," says Szajna. On the average, he says, 3 to 15 percent of what most factory users type into a keyboard is inaccurate because of keying errors.

Lockheed's Lerman says that, besides errors, manufacturers must consider the job descriptions of workers who record data. "If an assembler or an inspector is spending 40 percent of his time keying in data, then that's a lot of time that that person is not doing his assigned job," he says. "You're creating a big drain on labor costs."

Bar-code systems provide increased accuracy

In many applications, bar-code technology is the most cost-effective data-entry alternative (MMS, September, 1982, p. 155). "You cannot have an automated factory unless you have automatic data capture," notes Edward Anderson, director of market development for Computer Identics Corp., Westwood, Mass., and president of the Automatic Identification Manufacturers Association. "If you're going to have a person sitting in front of a keyboard recording information, then you're not going to have an automated system. Bar-code technology is the only technology that can eliminate the

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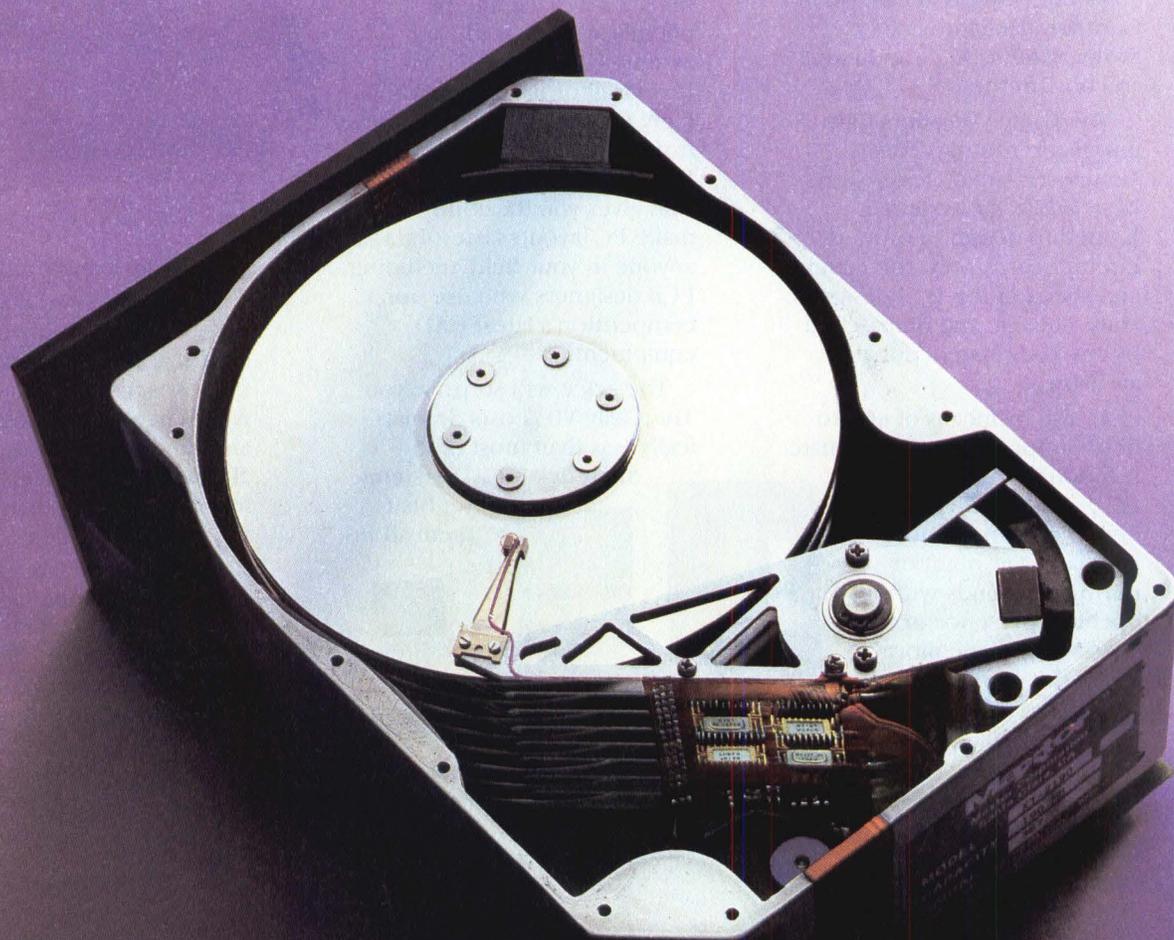
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Systems in Manufacturing

human factor from data collection." Anderson claims that using bar code makes errors "literally nonexistent."

In a U.S. Department of Defense study of various data-entry techniques, 1.2 million bar-code labels were read, and only four errors were recorded. The DOD also found that bar-code systems were 300 times less error prone than optical-character-recognition systems, and OCR systems were 10,000 times less error prone than keyboard-based systems. As a result, the DOD recommended that all containers supplied to it incorporate bar-coded identification labels. The requirement affects the more than 50,000 manufacturers supplying products to the DOD.

The automotive industry has adopted a similar specification that will affect more than 28,000 suppliers. "We're on a roll now," says Anderson. "Virtually everyone who distributes or manufactures a product has an application for bar codes. We feel that the factory market will dwarf all other markets."

McKinsey and Co.'s Craig says bar-code technology is ideal for recording repetitious data such as part numbers and worker IDs and is well-suited for tracking materials, parts or subassemblies through a factory. "If you have a bar-code label on a part," he explains, "you can have a grip on where that part is located throughout the factory by reading the label at each point it passes. Plus, you can know who supplied the part, who's worked on it and where the part is headed—whether it be to a subassembly operation or to a customer." Tracking, he adds, is important in labor-reporting, quality-control and inventory-control applications.

ADL's Michael describes tracking as a passive data-entry application in which recorded data are stored in a computer for later analysis. However, he says that bar-code technology can also be used for active data entry in which the recorded data are used to prompt a worker to take immediate action or to trigger a machine such as a robot to perform an operation on a part or subassembly.

Active data entry is a crucial ingredient of flexible manufacturing systems, says Symscan's Szajna. "If a robot is equipped with a bar-code reader and is programmed to perform a variety of operations on a number of parts, then it can decide what operation to perform on a specific part passing in front of it on the basis of the bar-code label on that part," he says. "The bar code can tell the robot what to do."

The adolescence of voice recognition

While GE's Strass considers bar-code technology

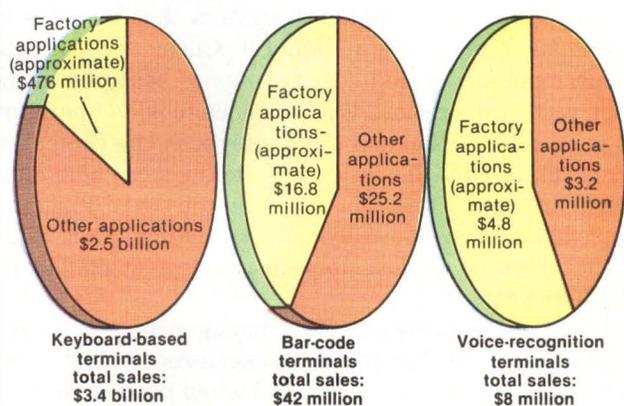
"mature" and says it has been proven in both retail and factory applications, he calls voice recognition "up-and-coming," particularly in factories (MMS, October, 1982, p. 165). Gnostic Concepts' Katzi agrees, noting, "Voice technology is where bar-code technology was 10 to 15 years ago." But the technology is still relatively new and subject to problems, including high cost, the fact that recognition is limited to isolated words, the need for speaker training, small and restricted vocabularies and extreme variability in recognition accuracy. Despite those problems, voice-recognition systems are proving effective in applications in which a worker's hands and eyes are busy performing other tasks. Such applications include materials handling and quality control.

Materials handling is an active data-entry application in which an automated materials-handling system directs a part, subassembly or assembly to a storage location, according to an instruction spoken by an operator. Many airlines use voice to transfer baggage to baggage-claim areas, as does United Parcel Service to direct packages to shipping bins. Without voice, an operator would have to interrupt his normal work to pick up a package, move it to a conveyor belt or pallet loader and key in a designated destination.

Quality control is a passive data-entry application in which an inspector logs a defect into the computer for later statistical analysis. By speaking into a voice-recognition system rather than keying in data, the inspector's hands are free to feel the part he is inspecting or manually adjust test equipment.

Voice-recognition systems increase not only workers' throughput, but also their accuracy, claims Chris

FACTORY-APPLICATION SHARES OF 1982 KEYBOARD, BAR-CODE AND VOICE-RECOGNITION SYSTEM SALES



Source: Gnostic Concepts Inc.

Systems in Manufacturing

DISTRIBUTION ROUTES VARY IN DATA-ENTRY MARKET

Data-entry systems enter factories through different distribution pathways that vary from technology to technology. Russ Craig, a consultant specializing in high technology at McKinsey and Co., says most keyboard-based terminal products reach factory users either through data-processing OEMs, such as Digital Equipment Corp. and Data General Corp., or through factory-specialized OEMs and system integrators such as suppliers of manufacturing-resource-planning packages, automatic test-and-inspection equipment, process-control systems and materials-handling systems. Very few terminal suppliers sell directly to factory end users, he says.

On the other hand, Computer Identics Corp.'s director of market development, Edward Anderson, says that his company's bar-code products reach factory users via direct sales as well as through data-processing and factory-specialized OEMs and system integrators. Anderson says large end users, such as Xerox Corp. and IBM

Corp., bear the responsibility of integrating the bar-code systems with their other factory systems. But Computer Identics also provides application-engineering assistance to small end users who lack application expertise. In 1982, Anderson says, his company's sales were divided in thirds among data-processing OEMs, factory-specialized OEMs/system integrators and end users.

Although there are exceptions, most voice-recognition products reach end users directly through suppliers and exclude OEM and system-integrator channels, says Dean Szajna, a research director at Symscan Inc. Because voice-recognition technology is so new, Szajna says, it's difficult for OEMs and system integrators to gather documentation on products and to develop application expertise. "Look at it from the point of view of a materials-handling system provider, for example," he says. "That guy already has a tough enough nut to crack trying to convince a manufacturer to add a new

computer-controlled materials-handling system without further scaring the customer with a new, sophisticated technology that adds a sizable cost to the system." Szajna says large end users such as General Electric Co., Lockheed Missile and Space Co. and General Motors Corp. install and implement voice products themselves. Most end users, however, rely on voice-recognition product suppliers for application assistance.

Chris Seelbach, president of Verbex Corp., says although his company is concentrating on end-user sales, it will eventually sell solely to OEMs. "We think this business has not taken off as fast as it should have because suppliers were basically sending hardware out to customers and not providing application assistance," he says. "To really make this market move, we believe that we have to get systems out there and working in factories. By doing so, we'll create a pull demand on the OEMs."

Seelbach, president of Verbex Corp., Bedford, Mass., an Exxon subsidiary that supplies voice-recognition products. "Most factory workers don't know how to type, but they all know how to speak," Seelbach says.

Lerman says his company has installed 36 voice-recognition terminals for quality control in its microelectronics area, in which hybrid circuits are mounted and packaged, and in the assembly area, in which the circuits are stuffed into circuit boards. In the hybrid-circuit application a \$250,000 system that includes 23 terminals and a Data General Corp. Eclipse 130 minicomputer, yielded cost savings of \$400,000 in the first year of operation. While it once took 68 operators to print information and then enter it in the computer, it now takes only 42 operators to do the same amount of work in real time. In the circuit-board-assembly application, a \$170,000 system consisting of 13 voice-input terminals yielded labor-cost savings of \$250,000 in the first year.

Dan Fink, speech-activities manager at Intel Corp., Santa Clara, Calif., says that speech-recognition products are most beneficial to users when used with other data-entry techniques. "We encourage the use of speech systems not in lieu of, but in addition to, other

data-entry systems," says Fink. "Speech recognition is a complementary new dimension to computer input."

Fink notes that in a paint-inspection task at an automotive assembly plant, a bar-code system could be used to record fixed data such as the serial number of a part, and a voice-recognition system could be used to record variable data such as the quality of the paint job on that part.

But Symscan's Szajna says the problems associated with the technology must be solved before speech recognition will have a major impact on the factory data-input market. "When the technology develops further, voice-recognition systems have the potential of replacing keyboards in many applications," he says. "Most people think that's at least 20 years away. I think it's a lot closer than that."

Correction

The February Systems in Manufacturing article, "Cadlink provides a bridge between design and manufacturing," contained two inaccuracies. Cadlink should have been spelled "Cadlinc," and the company's location is Elk Grove, Ill., not Elk Grove, Mich.

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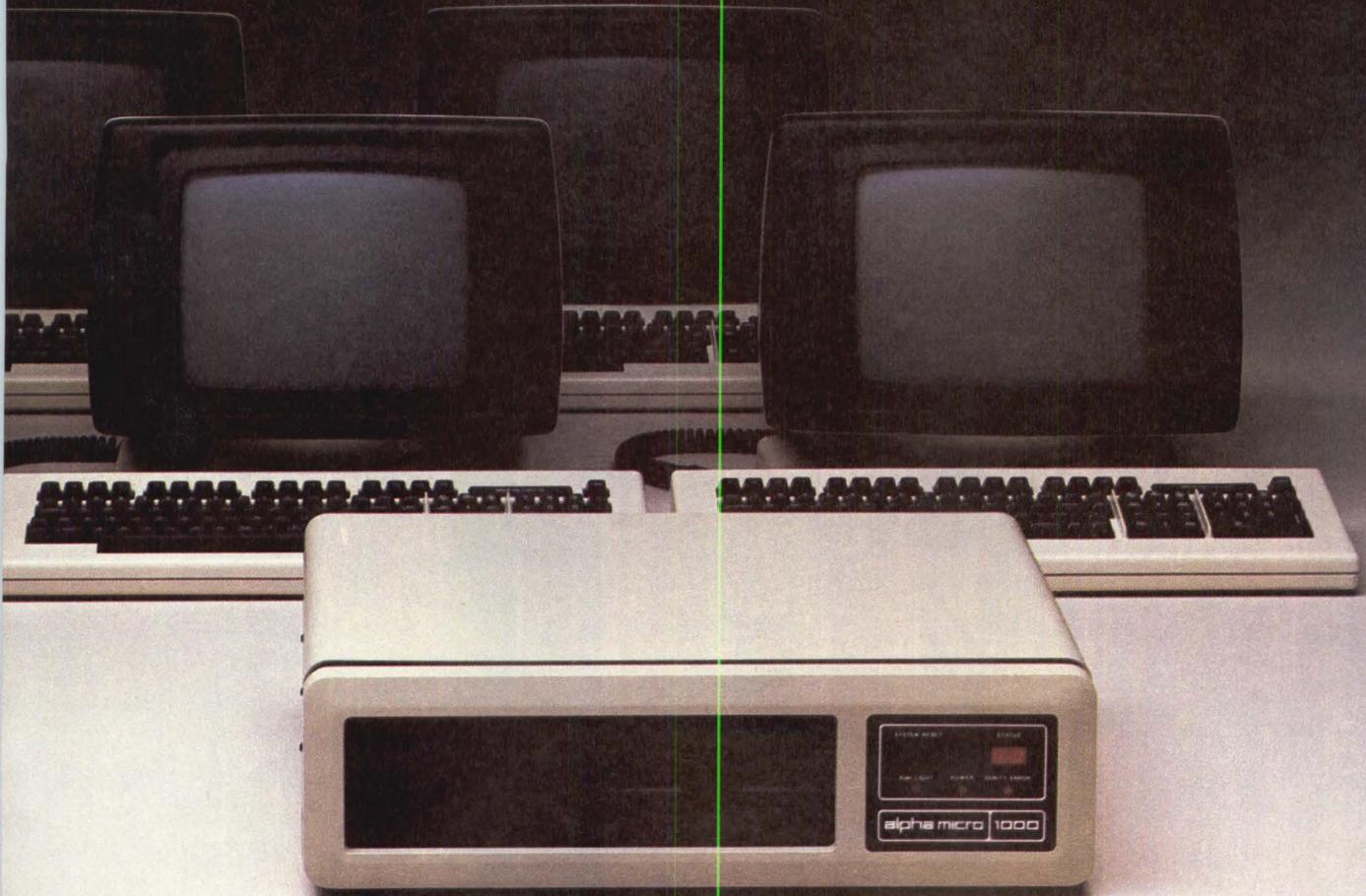
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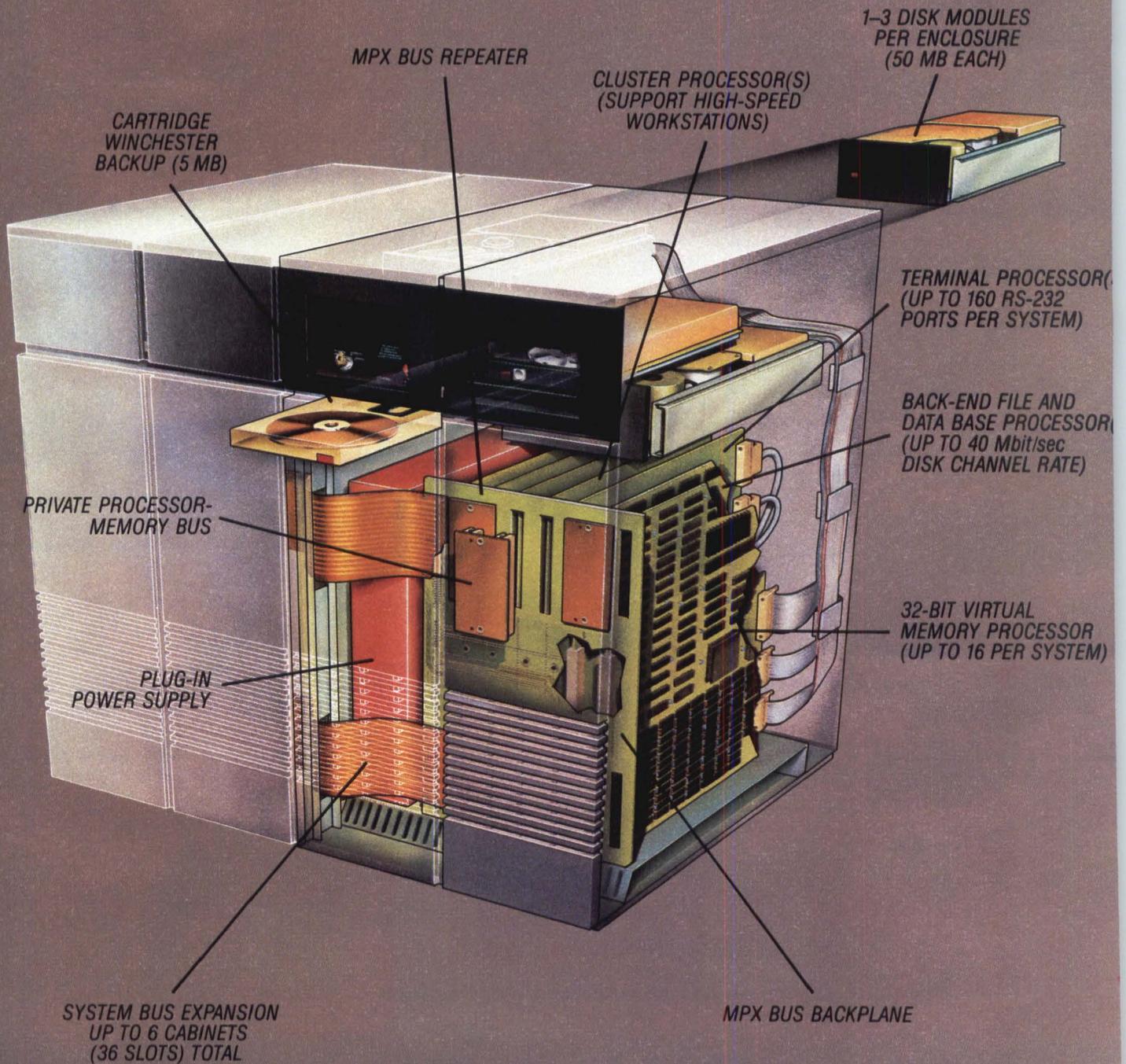
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The various Megaframe processors can be installed in multiples, depending on the requirements of the specific application.

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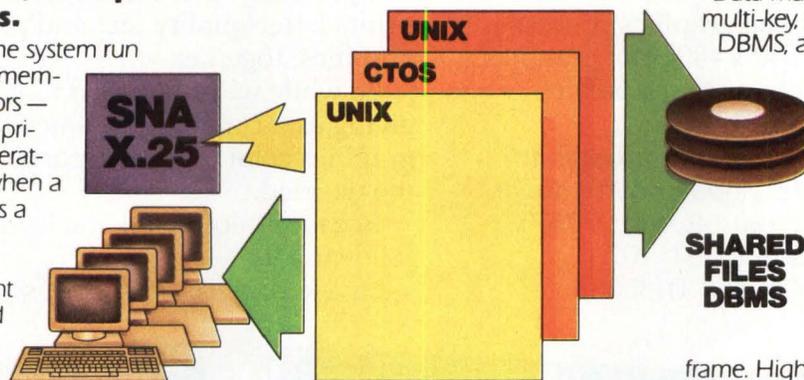
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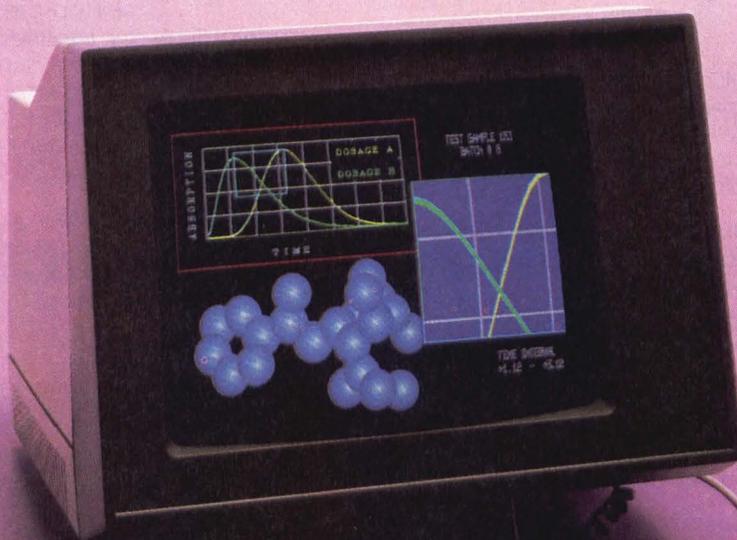
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Systems in Manufacturing

European firms eye U.S. vision-system market

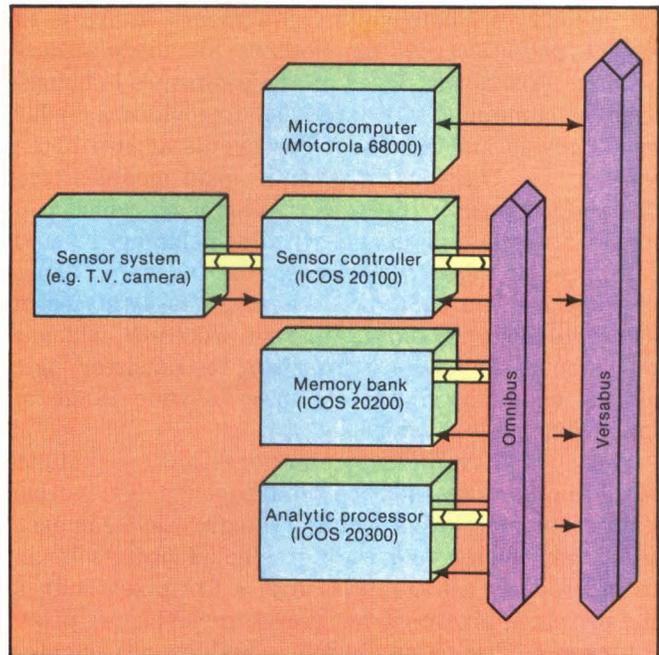
By Keith Jones

Several European companies are beginning to sell their machine-vision products in the growing U.S. industrial-automation market. The market for vision systems, while young, has come of age quickly, according to "Machine Vision for Robotics and Automated Inspection," a 350-page report published by Technical Insights Inc., Fort Lee, N.J. "Only one year ago, machine vision was in its infancy," the report states. "Today it is a practical and cost effective tool for industrial automation." Technical Insights also quotes a National Bureau of Standards report asserting that computer vision systems will perform 90 percent of all industrial inspection activities requiring vision within the next decade.

By entering the U.S. market, the European firms will be competing with several domestic vendors such as Automatrix Inc., Billerica, Mass., and Machine Intelligence Corp., Sunnyvale, Calif., which offers vision systems as feedback units for robots. But Richard Miller, a Madison, Ga., consultant who wrote the Technical Insights vision report, believes industrial inspection, not robotics, will be the fastest growing application for machine vision.

It's easy to enter the machine-vision market, Miller says, noting, "You can just buy someone else's computer and a camera." He quotes \$5000 as a typical price for a stand-alone system that can process black-and-white images. Processing gray-scale images is more complex, he says, and systems capable of gray-scale processing typically sell for about \$50,000. U.S. companies that offer gray-scale processing systems include General Electric Co., Schenectady, N.Y., Object Recognition Systems, Princeton, N.J., and Octec Inc., Burlington, Mass.

One European company active in the U.S. machine-vision market is Cambridge Instruments Ltd., Cambridge, England. Its products include the \$30,000 Quantimet 10, sold on an OEM basis to builders of industrial-inspection systems. Another firm, Image Computer Systems N.V., Schilde, Belgium, is seeking a U.S. distributor for its powerful ICOS 20000 system, while a third company, Stonefield Omicron Electronics Ltd., Horsham, England, is seeking OEM customers for an innovative parallel image-processing system based on a custom-designed integrated circuit called CLIP-4 (cellular logic array processor).



ICOS 20000 system components include three main modules linked by Image Computer Systems' Omnibus. The Omnibus carries data between modules at speeds as high as 40M bytes per sec. A Motorola 68000, linked to the Omnibus via a Versabus, controls the overall system and performs pattern recognition of images that have been reduced by the analytic processor.

Geoffrey Jenkinson, image analysis business manager with Cambridge Instruments, explains that Quantimet 10 is available in the U.S. through his company's offices in Monsey, N.Y., or through Olympus Microscope Inc., New York, a division of Japanese camera manufacturer Olympus. The Quantimet 10 can process images with 900×700 pixels, each pixel represented by 8 bits. User programming for specific applications runs on an integral Zilog Z80-based processor under the CP/M operating system.

Cambridge Instruments has been selling image-analysis systems in the U.S. since 1964. Jenkinson says that Quantimet 10's big brother, the Quantimet 900, introduced about 18 months ago, is being used by customers that include IBM Corp., Lockheed Corp. and chemical giant Monsanto Corp. at its Pensacola, Fla., fibers development division. The 900 sells for \$80,000 to \$110,000 and incorporates a Digital Equipment Corp. LSI-11/23 processor for user programming. Applications include identifying IC faults, distributing pig-

Systems in Manufacturing

ments in paints and separating carbon fibers in aircraft engine blades.

Alfons Buts, marketing manager of Image Computer Systems, says his company used the annual Congress of the Society of Photo Optical Engineers in April to contact potential U.S. distributors for modular-bus-oriented ICOS 20000. Based on the company's in-house-designed Omnibus, the ICOS 20000 provides a 32-bit data highway and processes bus events at 40M bytes per sec. The Omnibus links three main modules (see illustration, p.127): the sensor controller, which can handle a variety of image sensors including TV and charge-coupled-device cameras; the memory bank, which provides a capacity of as much as 4M bytes in 256K-byte modules; and the analytic processor, which is implemented in standard transistor-to-transistor logic devices and, says Buts, executes "a wide range of data-reduction operations."

The data-reduction operations include histogramming—calculating the frequency distribution of different gray levels—adding the gray levels in each histogram column and coding selected objects in an image. Images can comprise 512×512 pixels with 8 bits per pixel, providing 256 gray-scale levels per pixel.

Linked to the three Omnibus modules via its own Versabus is a Motorola 68000 programmed in assembly

code and Pascal. This processor controls the system and performs pattern recognition after reduction by the analytic processor. The ICOS 20000's \$32,500 U.S. end-user price does not include dedicated software for a customer's application.

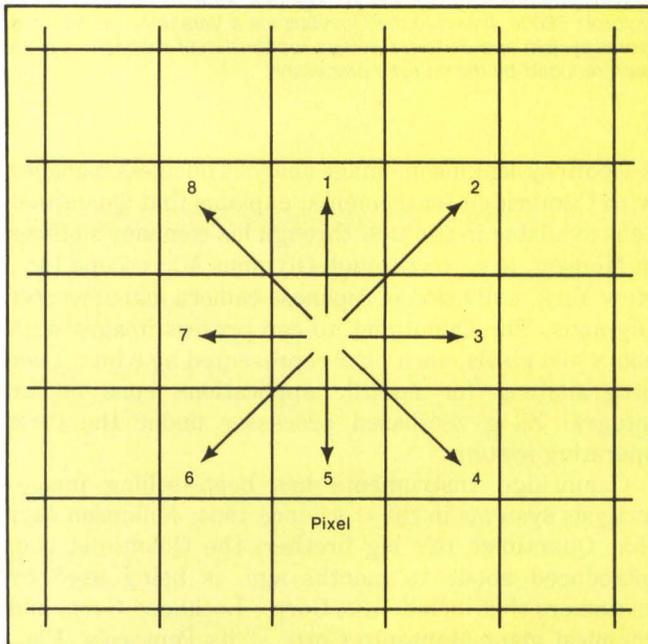
Stonefield Omicron Electronics is seeking volume agreements with U.S. system integrators with image-processing expertise, says the company's sales director, Nigel Hudson. Stonefield is designing PC-board products with prices starting at around \$4000. The products will each contain an array of CLIP-4 chips.

Stonefield recently won the worldwide exclusive license to configure products around CLIP-4. The technology was developed at University College in London and is owned by a government agency, the British Technology Group. Implemented as a 40-pin custom NMOS device, every CLIP-4 contains eight processors, each of which handles one pixel of an image. All the CLIP-4 processors operate in parallel, and arrays of CLIP-4 chips can be interconnected to process any number of pixels in parallel. The devices are connected in such a way that each processor is connected to its eight nearest neighbors (see illustration, left). This design enables functions such as image edge detection and image shrinking/expanding to be performed in a single machine cycle. Areas within an image can be blanked or filled in, also within a single cycle.

Each pixel can be represented by as many as 32 bits within each processor, and corresponding bits are linked between processors to form 32-bit planes across the whole machine. Two images stored in two planes, for example, can be added, and the result can be stored in a third plane. The actual speed of processing depends on the gray scale. A 1-in-256 gray scale would require eight planes to store an image, and processing would take eight times longer than for black-and-white images.

Hudson stresses that Stonefield does not intend to sell complete vision systems. Customers must purchase interfacing cameras and other input/output devices separately and must write their own application software. Customer programs can call any of nearly 100 routines developed at University College, and Stonefield can supply the routines with hardware. The subroutines provide fundamental image-processing tasks such as filtering, histogramming, rotating and shifting.

Hudson explains that the CLIP-4 chips will be fabricated by several British semiconductor manufacturers and says the company plans to move eventually from NMOS to CMOS. He hopes that the first board-based products will be shipped within six months. □



Systems based on the CLIP-4 chips marketed by Stonefield Omicron Electronics permit each system process to be linked to its nearest eight neighbors. This architecture permits functions such as image edge detection and image shrinking/expanding to be performed in a single machine cycle.

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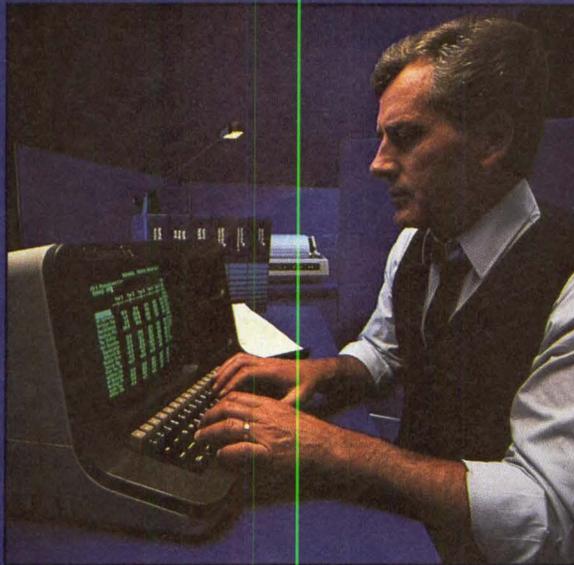
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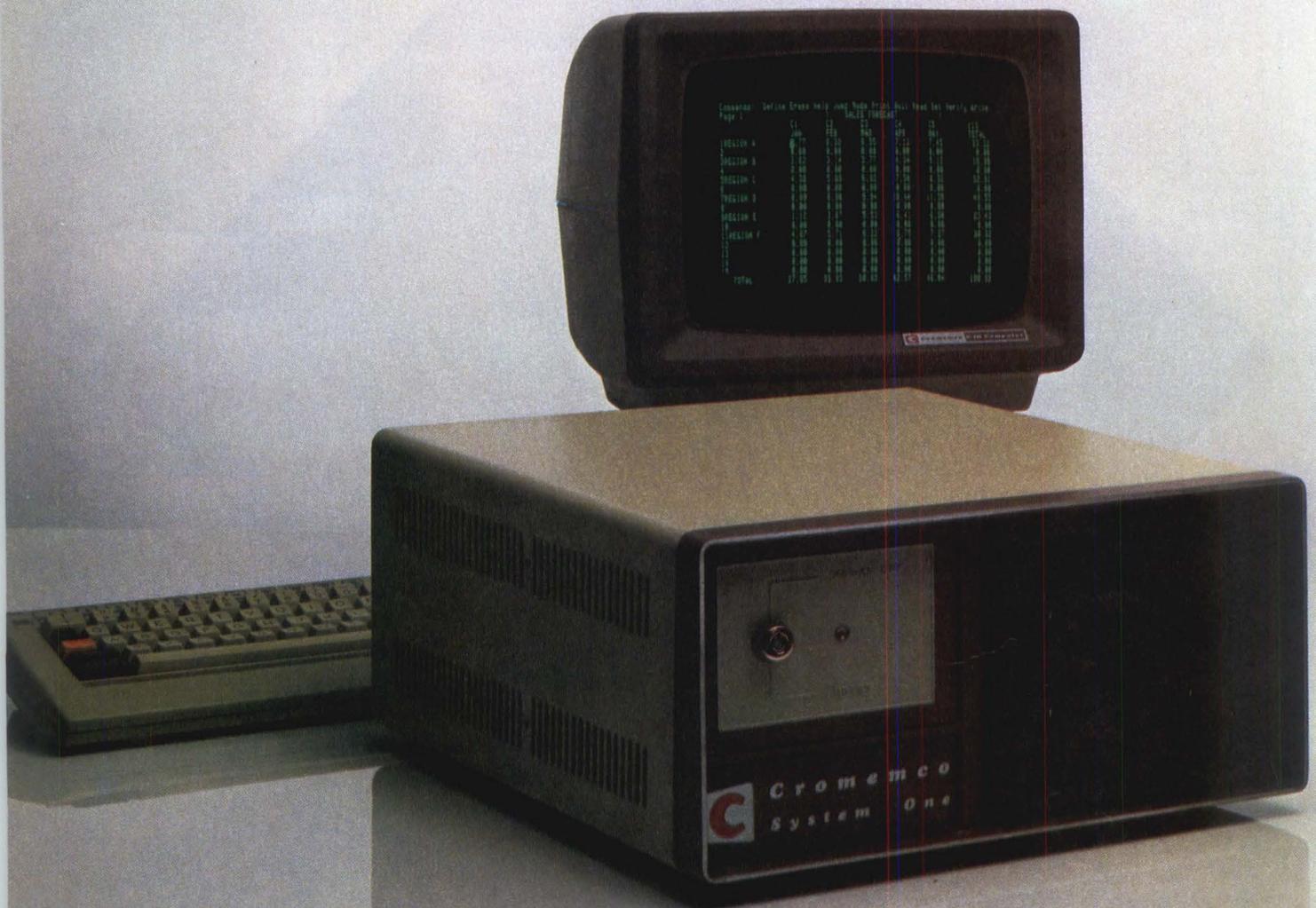
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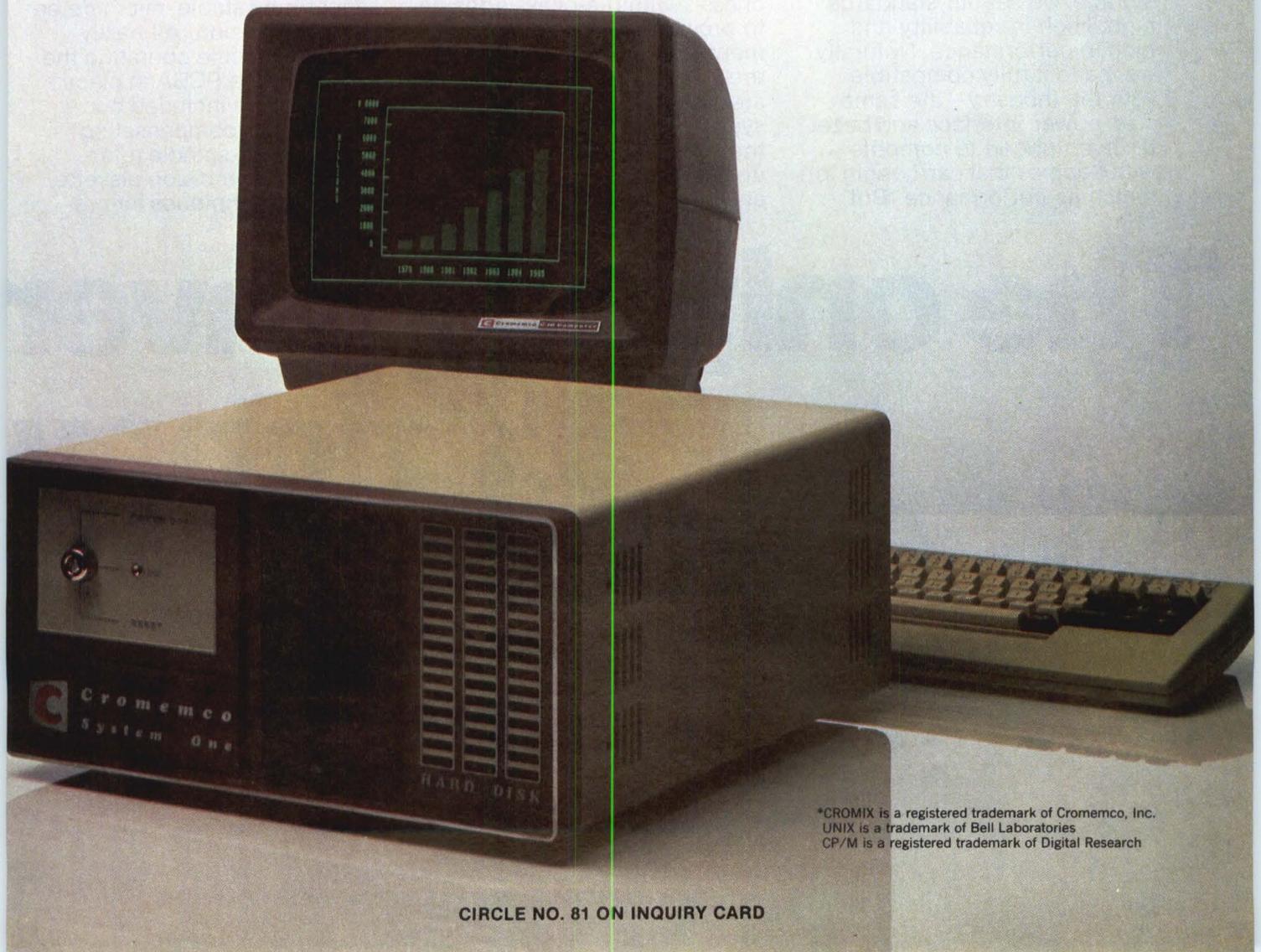
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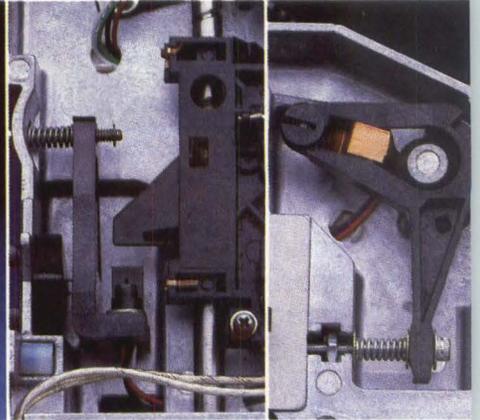
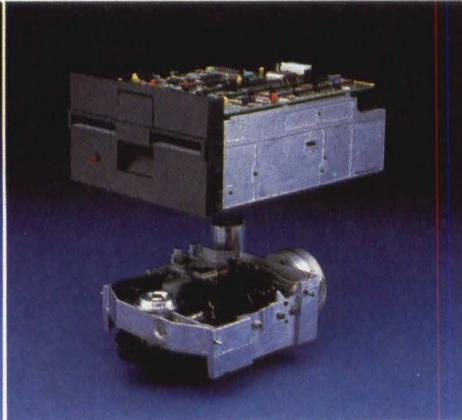
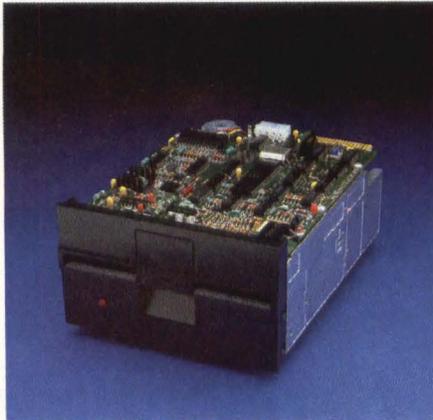
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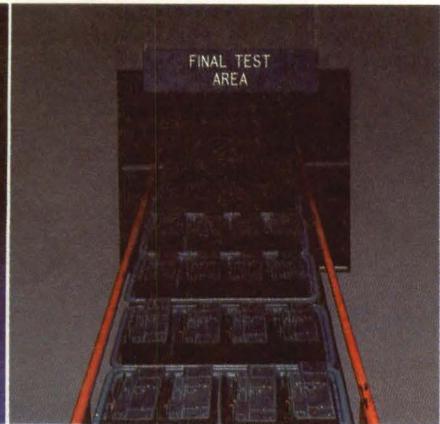
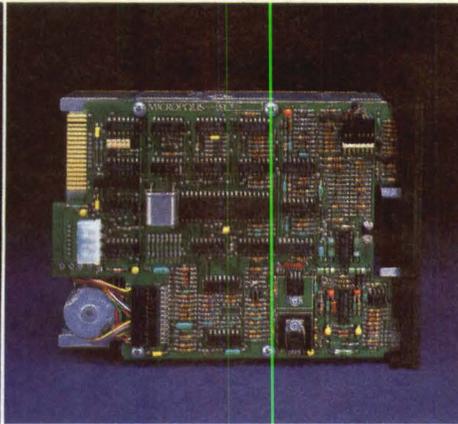
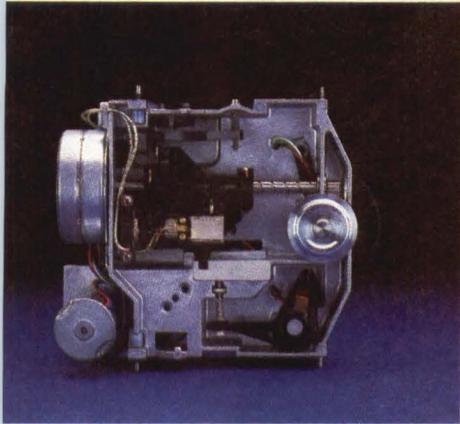
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You can optimize the reading capability of your HP 16800A simply by selecting the HP wand that best fits your needs. Our new wand design offers a 45 degree scan angle, rugged,

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HP bar code readers can be programmed to give you real-time feedback. A multitone beeper and two LED indicators allow fast computer verification.

The HP 16800A is a high-performance, programmable bar code reader. For non-programmable applications, select HP's 16801A. In quantities of 10, the HP 16800A is priced at \$1090* and the HP 16801A is

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*Suggested U.S. domestic price only.



**HEWLETT
PACKARD**

Systems in Manufacturing

Farsighted manufacturer computerizes data entry, analysis

By Roger Heuppchen

Quality and the ability to ship quickly are important in the manufacture of optical blanks used in eyeglasses, and Signet Optical, San Diego, Calif., has smoothed the process with the aid of a computer. Because of the nature of the optical blanks and the very large volumes that the company handles, Signet needed an on-line system to provide instant information on various aspects of the operation. Signet wanted to track order entry and billing while obtaining specialized reports as well, including auditing yields to scrap, tracking inspector performance and checking inventory status.

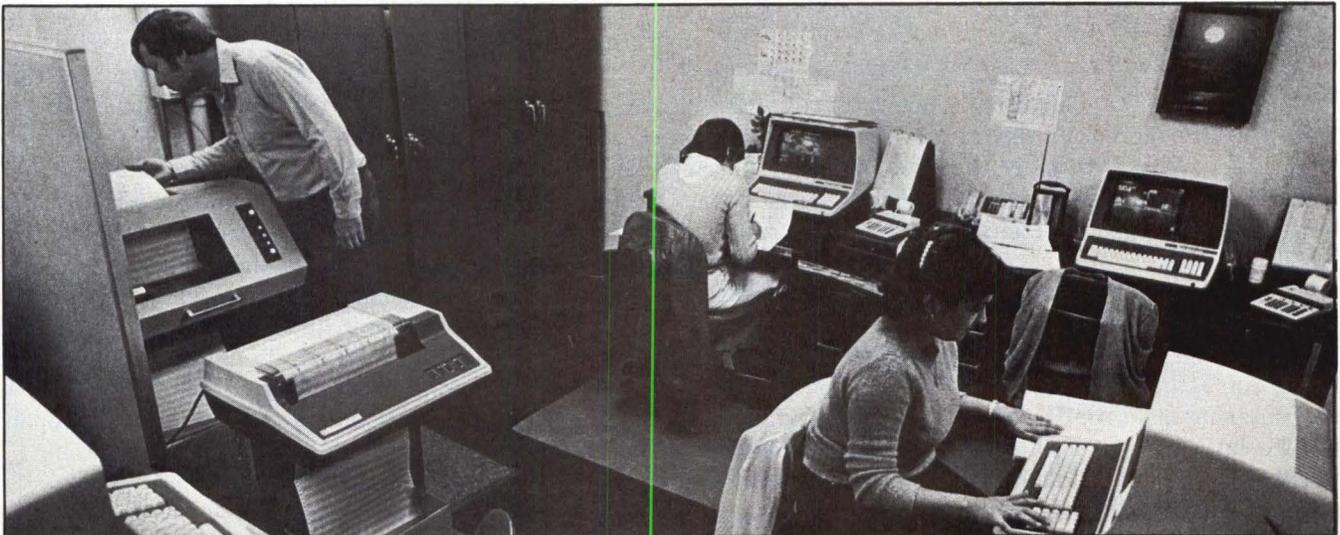
The optical supply business is extremely competitive, and manufacturers such as Signet must carefully watch quality control and volumes. Moreover, because the optical blanks the company manufactures are plastic, it must also be extremely aware of quality and yields. When tracking was done manually, reports were several weeks behind schedule, which meant Signet couldn't always respond as quickly as necessary when a problem arose.

After evaluating its needs, Signet spent about a year comparing prices quoted by data-processing vendors. The company decided to begin automating data entry and analysis using Budget Computer Systems, a

turnkey systems house specializing in manufacturing, distribution and finance applications along with operating as a service bureau. About 80 percent of Signet's software was custom-developed by Budget, San Diego, from Signet's specifications.

Once the programs were in place on Budget's service bureau, Signet acquired an Applied Digital Data Systems Mentor Computer to begin running most of the applications in house. Budget sold Signet the ADDS system, which is compatible with the software that was already running. Total cost, including software, was about \$100,000. The hardware, consisting of the Mentor computer with 256K bytes of memory, two 60M-byte disk drives, eight display terminals, a 300-line-per-min. printer and a 150-character-per-sec. printer, accounted for about \$52,000 of the \$100,000.

One important report Signet requires is auditing yields to scrap. In operation, a high-grade optical resin is poured into special molds and placed in a curing tank. Once the blank is cured, a process that varies depending on the lens, the mold is taken to an opening station, which is Signet's first inspection point. A technician carefully examines the blank for obvious visual defects and either passes it to final inspection or scraps it. Each opening station tallies the number forwarded and the number scrapped. This information



Signet Optical uses six of its eight terminals for order entry and inventory updating, one for inquiry and one at the manufacturing site for entry of mold-routing and inventory data. The company's two printers produce custom-designed reports tracking such parameters as yields to scrap, inspector performance and customer orders.

Systems in Manufacturing



Roger Heuppchen examines a lens blank at Signet Optical. Because the lens molds are inspected daily to ensure proper physical parameters, the lenses need only be inspected for nine potential visual defects such as scratches and bubbles.

is then entered into the computer for comparison.

Once the lens leaves the opening station, it passes to the next process, during which it is cosmetically inspected for visual defects. A data-input sheet details the inspector, the yield to reject and the reason for rejection. Each lens is tracked by an inspector in both stages, enabling Signet to ensure the quality level of the inspectors. The company ensures that one inspector is neither more nor less critical than another.

Like the lenses, the lens molds are monitored daily. The molds are designed by optical engineers and milled to exact tolerances. The information entered into the computer about the molds is referenced to the actual yields and inspectors' tally sheets. Signet can then generate performance reports that quickly pinpoint problems.

Signet is concerned with maintaining high-level productivity. It handles more than 300 orders daily, manufactures more than 2800 types of prescription lens blanks and deals with more than 650 optical wholesalers. Thus, Signet must respond quickly to customer orders and match production schedules to current and projected needs.

In operation, the Mentor system's two printers handle billing and report generation. Six terminals are used in order entry and inventory update, one is used for inquiry, and one is used at the manufacturing site for entering mold-routing and inventory information.

The introduction of the data-processing operations went smoothly and streamlined business and manufacturing. Signet could go only so far with a manual system. Percentage comparisons and track yields were previously done by cure cycle, a cumbersome and labor-intensive manual job, which the computer has

simplified.

Along with allowing management to catch and correct problems early, the system has paid for itself. Signet had planned to hire three or four new staff members, but the computer system has made these hirings unnecessary, and business has not dropped.

Because Signet offers more than 2800 lens-blank configurations, it must carefully monitor inventory levels in relationship to production and current shipping levels. It uses a standard inventory program that tracks inventory, inventory locations and shipping status. Signet has tied this program into the order-entry system, allowing the company to take phone orders, generate packing lists and update accounts receivable for billing. With this system, Signet can closely track customer requirements and maintain the necessary inventory levels. The company can now ship large orders within one day and can ship very small orders on the same day if the order is received before 3 PM.

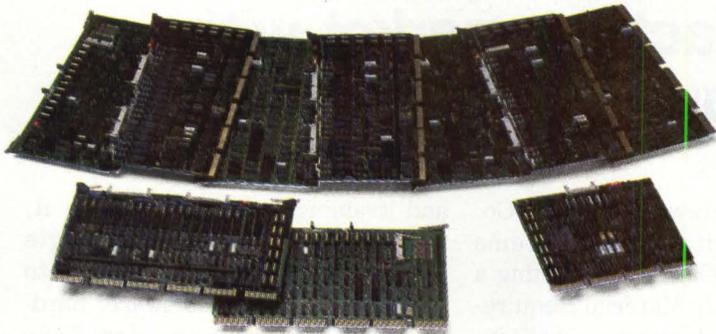
By providing interaction between the inventory-control functions and accounts receivable, the Mentor system lets Signet instantly update all records when an order is entered. Furthermore, payables are updated as supplies are purchased. Supply costs are automatically compared to sales prices, thus giving Signet management up-to-date information on the cost of doing business.

Because the optical business isn't static, Signet is always looking for new product developments such as lenses with scratch-proof coatings or photochromic properties. Using the Mentor system, Signet can track customer requests and see how its offerings are faring. It can then use that information to make projections.

Signet is developing a sales-projection application program, which will be run on an outside computer service that can handle the statistical analysis required. The program will evaluate historical and current market information to project demand for the firm's major types of lens blanks over the next 12 months. Once the analysis is performed on the service bureau's computer, the resulting information will be placed in the Mentor system for inclusion in Signet's standard reports. Other future applications for the in-house system may be the automation of production-cost buildups and the development of programs that report information to management on an exception basis. □

Roger Heuppchen is the controller at Signet Optical, San Diego, Calif.

Five reasons why DEC users should buy Emulex communications controllers.



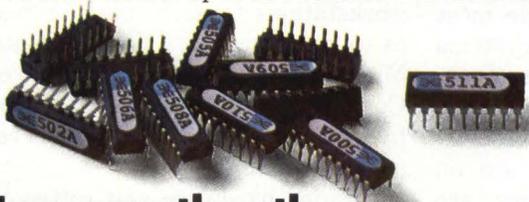
Broad product line featuring our new DMF-32 emulation.

Nobody covers LSI-11, PDP-11, and VAX-11 users' needs like Emulex. More than 15 software-transparent controllers emulating DH11, DZ11, DV11 and DMF-32. All deliver improved line-handling capabilities, in a smaller package, at lower costs.



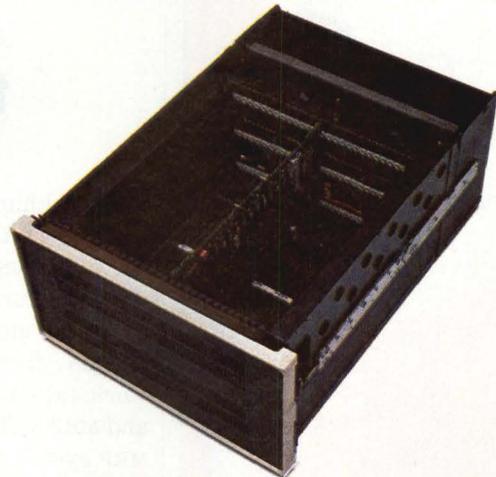
More channels.

Emulex's new DMF-32 emulation is typical. One controller board handles up to 64 lines, vs. only eight per DEC module. And Emulex offers *all* lines with modem control, not just two. For even more lines, Emulex's Statcon Series is the answer. We simply add a low-cost port concentrator, so that with one controller board you can connect up to 256 remote *and* local terminals.



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Emulex communications controllers pack so much capability onto each board that fewer boards are needed. Take a 64-line DH11 emulation. Emulex does on one board what it takes DEC to do on 36. Think of the savings in rack space, to say nothing of price.

Lower prices.

For instance, a DEC DH11 controller lists at \$8,950 per 16 lines, with expansion chassis costing \$3,000 or more. Compare that to Emulex's CS11/H at \$4,500 for the first 16 lines and \$3,000 for each additional 16 lines. At 64 lines, you suddenly have savings of about \$23,000 and a lot of extra slots to boot.



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Systems in Manufacturing

Digital Microsystems attacks factory market with turnkey MRP system

Mimicking a Hewlett-Packard Co. strategy, Digital Microsystems Inc., Oakland, Calif., is providing a complete turnkey Material Requirements Planning system that includes five of the company's workstations, a local-area network and MRP software. But while the HP MRP system is based on the HP 3000 minicomputer, the Digital Microsystems package is microcomputer based.

Called HiNet/MRP, the system, priced at \$39,900, is targeted for small to medium manufacturers with \$5 million to \$15 million in annual sales.

Thomas Gunn, an analyst specializing in Computer Integrated Manufacturing at Arthur D. Little Inc., Cambridge, Mass., says that, over the next decade, the emergence of low-priced microcomputer-based MRP systems will help boost the total revenues generated by MRP-system sales from \$200 million in 1982 to \$500 million by 1992. "In the past, the smaller manufacturers who said that they needed MRP systems couldn't afford them," notes Chuck Morrissey, vice president of sales and marketing at Digital Microsystems. "While most minicomputer-based MRP systems are priced at more than \$140,000, our package is less than \$40,000."

Although seven other microcomputer-based MRP packages are on the market, those packages are offered by independent software vendors and do not include hardware (MMS, July, 1982, p. 145). Morrissey says that, because of the complexities of implementing MRP

and training operators to use it, MRP systems should be single sourced. "Users should not have to deal with separate software, hardware and service providers," he says. "That kind of situation might be fine for word processing but not for MRP." Digital Microsystems will use its own direct sales force to get HiNet/MRP to market rather than rely on dealers and distributors.

The MRP software consists of five modules that include sales-order entry, purchase-order entry, inventory, bill of materials and MRP. The MRP module uses data collected with the other four modules to determine a company's material requirements. The system also includes two DMS 5000 workstations and three DMS 1280 workstations. The DMS 5000 is based on the 16-bit Intel 8086 microprocessor and uses the CP/M operating system. The DMS 1280 is based on the 8-bit Zilog Z80 microprocessor and runs on CP/M. Each workstation includes 64K bytes of RAM.

The HiNet packet-switching local-area network provides 500K-bit-per-sec. serial data transmission with SDLC protocol and links the workstations to each other as well as to a central data file. A Digital Microsystems-supplied Memorex Corp./Fujitsu America Ltd., 46M-byte Winchester disk drive serves as the central file.

Besides hardware and software, Digital Microsystems also provides service and training. Announced in late May, HiNet/MRP will be available for shipment in early July.

—Frank Catalano

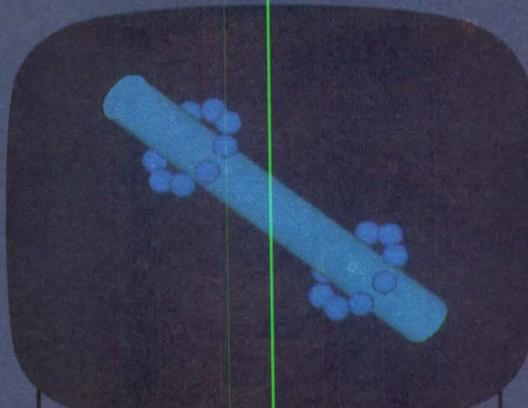
Now you can build in seconds what used to take forever.

If you have been waiting to view your solid models, your waiting days (or even minutes) are over. Now there's SOLIDVIEW.™ A revolutionary, new display technology for viewing solid models that significantly increases system speed. And significantly decreases host overhead, software development time, and total system cost.

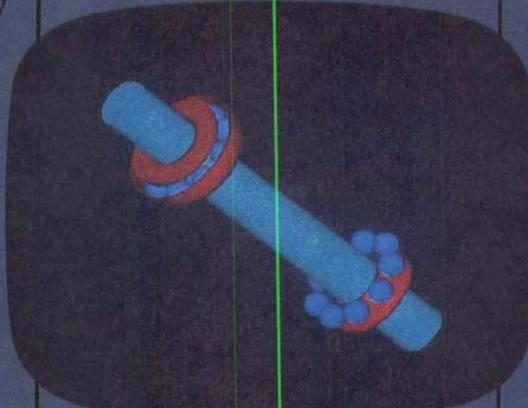
By processing tasks like hidden surface removal, visible surface shading, sectional views, contouring, and even piercing objects, SOLIDVIEW slashes image construction time from minutes to seconds. The host is then free to handle viewing transformations and clipping concurrently; system throughput is greatly improved.

What's more, SOLIDVIEW constructs images using polygons instead of pixels. These images are built piece by piece, instead of line by line. So you not only get more speed; but more information.

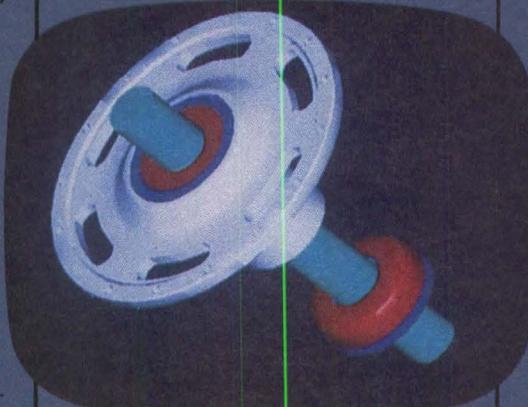
You can also do more with



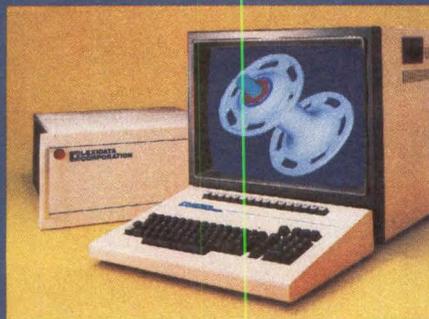
Construct images in less than four seconds.



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SOLIDVIEW. You can add new parts without redrawing the entire screen. You can manipulate objects with a minimum of recalculating. You can make exploded or sectional views in seconds. You can even use translucent shading to see behind surfaces.

SOLIDVIEW is available in two models, with a wide array of features. Both offer you 12 × 24 color lookup table, 19" monitor, and the power required to view your images interactively for the first time. Options include pan/zoom, four overlays, hardware cursor, serial interface, and a selection of peripherals.

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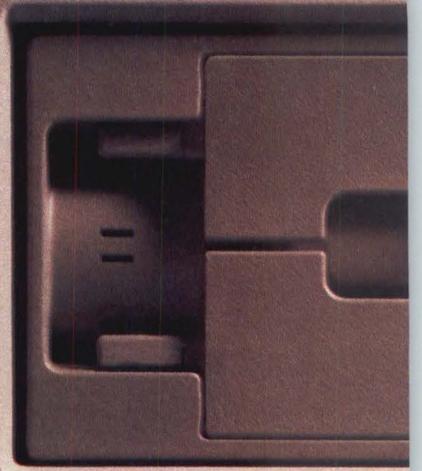
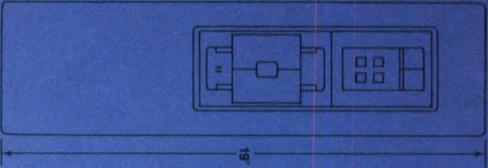
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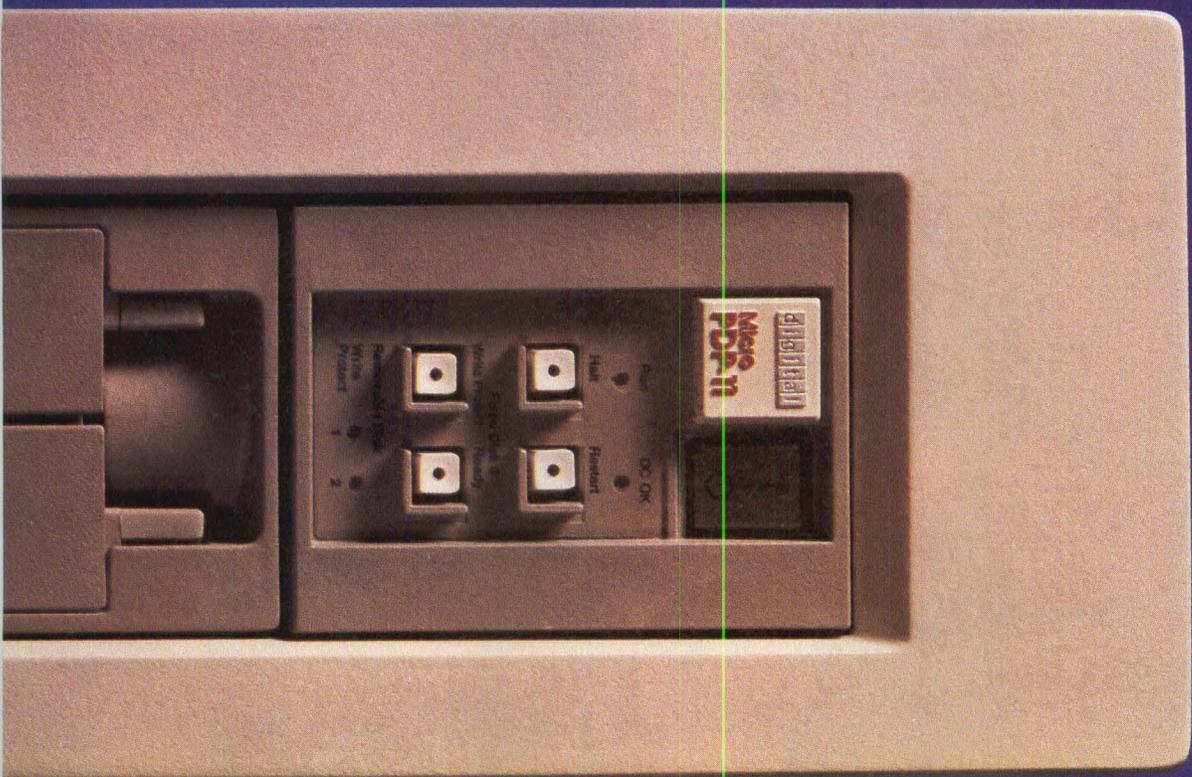
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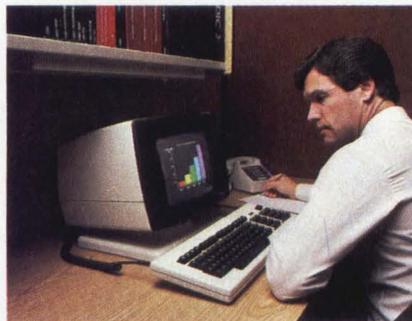
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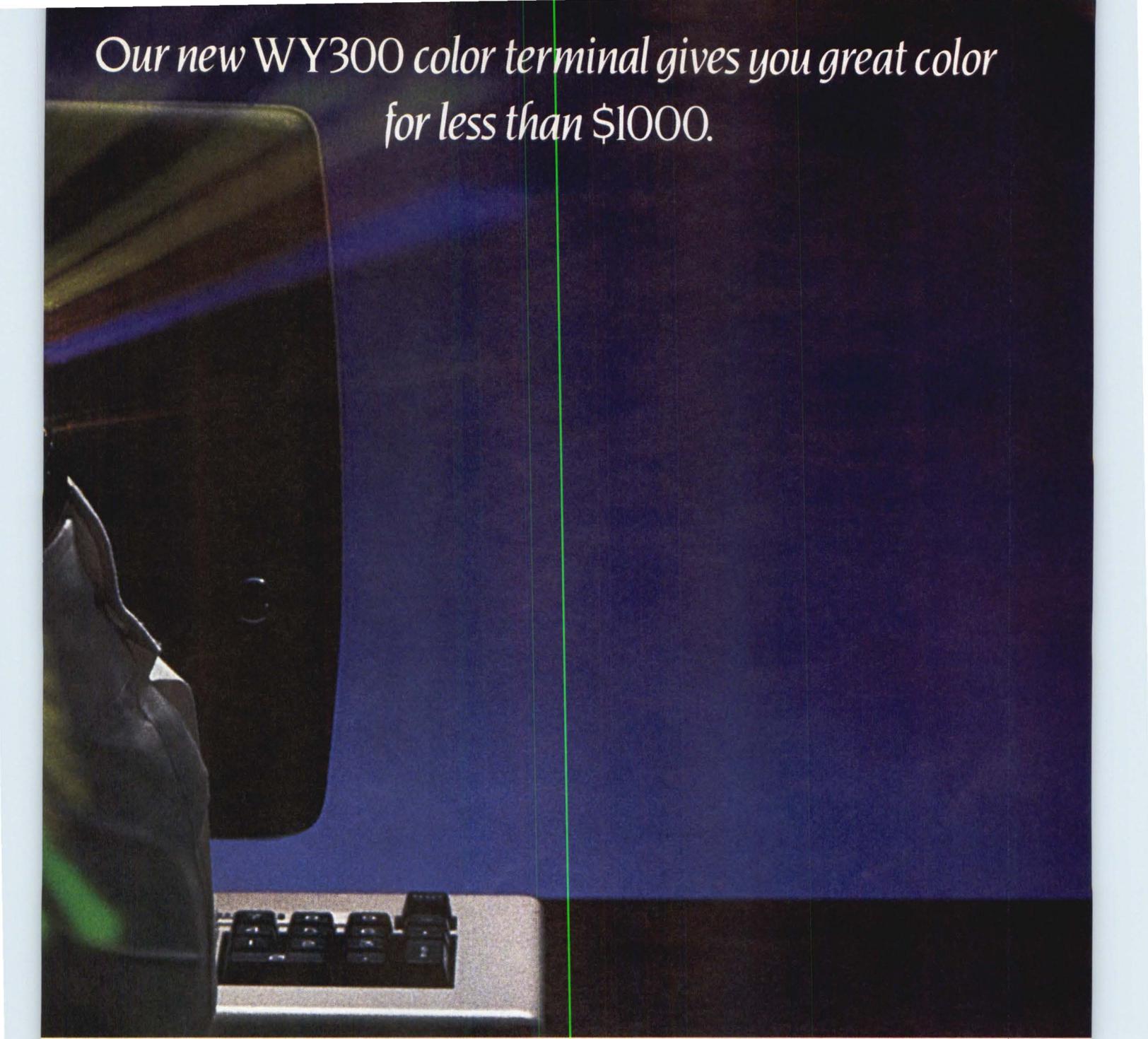
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Ergonomically designed with a swivel and tilt CRT and a detachable keyboard, the compact WY300 fits into the workplace as comfortably as it does into your budget.

On top of that, the WY300 gives you a host of features like a soft downloadable character generator; extensive alphanumeric and line drawing symbols; and

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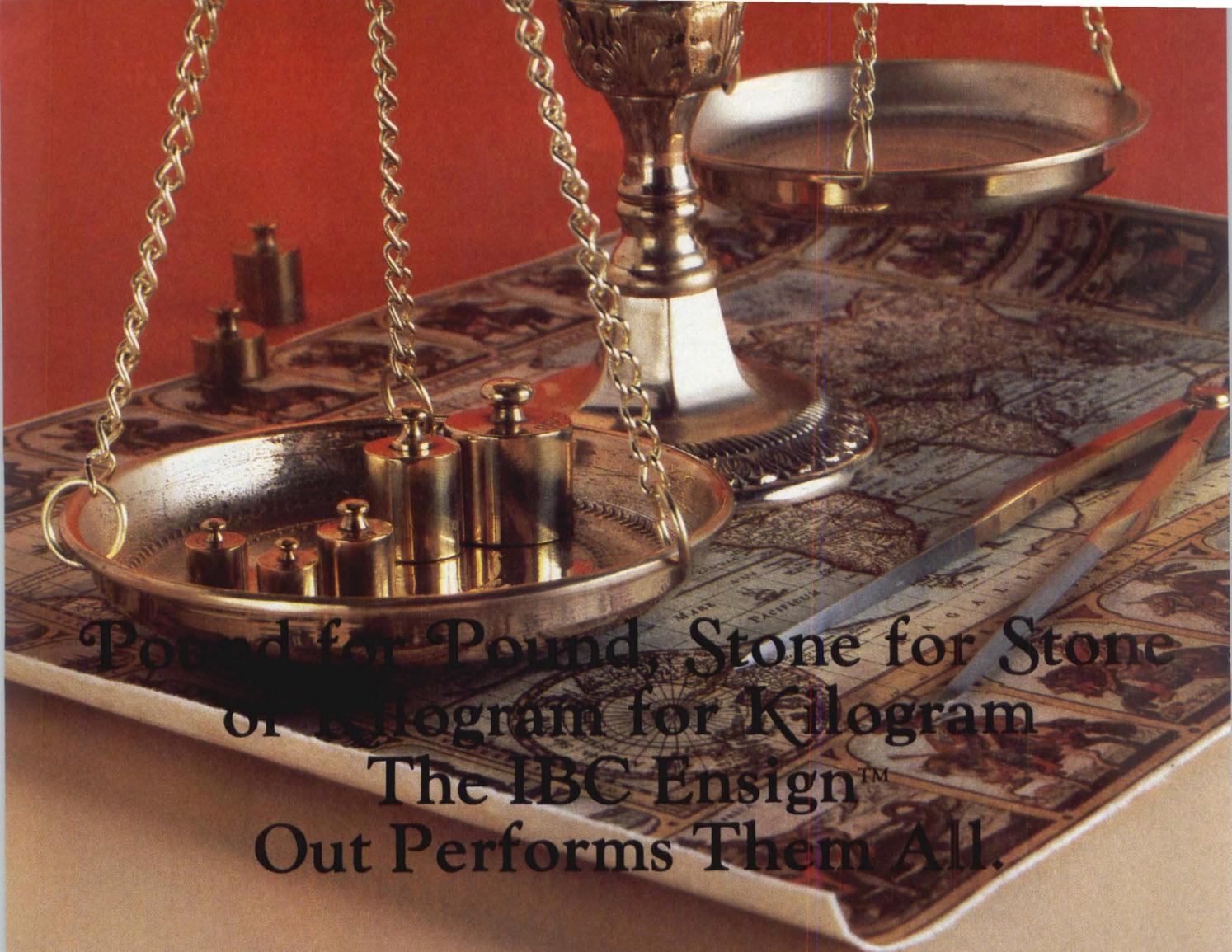
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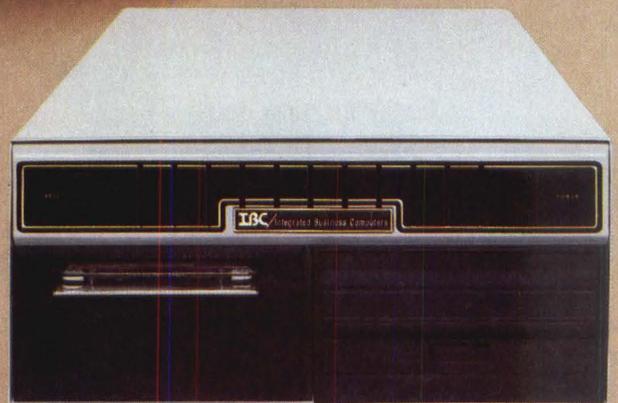


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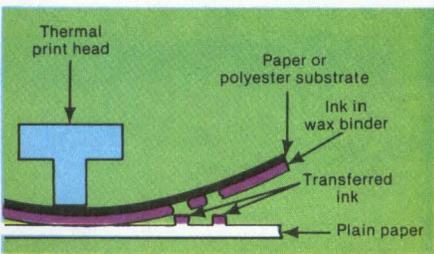
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FEATURE HIGHLIGHTS



SBCs: Small business systems have changed more in the last 10 years than full-sized cars. And while price, performance, reliability and adaptability considerations influence the selection of cars and computers, application-based definitions are necessary in both cases to ensure consistent comparison of technically diverse products. See p. 151 for a closer look at SBCs today, and be sure to peruse the profile lists which follow the article.



PERIPHERALS: Although **high-capacity disk drives** encompass a number of applications and technologies, they can be divided into two broad categories: removable and fixed. Each has had separate development stages, marked by milestone products and culminating in today's highest capacity drives. Several product tables accompany this feature, which starts on p. 197. . . Until recently, **ink-jet and thermal printers** have taken a back seat to other printing techniques in competition for market shares and development dollars. However, thanks to new color graphics capabilities, ink-jet and thermal printers are gaining popularity. See p. 217 for more information. . . Connecting the more than 2 million IBM Corp. 3270 display terminals in use today to their host computers is a large local-area-networking headache, both in cost and in convenience. **Multiplexers** can reduce network costs by eliminating many cable runs, and the multiplexers themselves are relatively inexpensive. If you find yourself with just such a problem, turn to p. 249 for answers.

Commands:

- F Format
- H Help
- I Insert
- L Load
- !B

Other commands:

- ! followed by
- M Merge
- O Order
- P Print
- Q Quit
- !C
- R Recalc
- S Save
- W What
- G or <TAB>
- !D
- + Extend
- = Lock
- ? Space
- Goto
- !E
- Misc-
- !R Curs Pos
- !? Evaluate
- !^ Data Togl
- !<ESC>Cancel

255	306	308	354

8761			

Product	'81	'82	'83	'84	'85
Pineapples	\$15	\$18	\$20	\$23	\$25
Oranges	5	10	12	20	30
Bananas	25	22	20	16	18
Sugar Cane	40	41	42	43	44
Total	\$85	\$91	\$94	\$102	\$110

ALSO: Software: More than 1 million spread-sheet packages have been sold since VisiCalc was introduced in 1979, and a new wave of "second-generation" spread-sheets has been billed as even more powerful, flexible and friendly. . . See p. 205 for an analysis and profile of these new offerings. **Text retrieval:** Most schemes for allowing a computer to retrieve and disseminate selected pieces of text require extensive text pre-processing to develop index terms. The General Electric Co. GESCAN 2 high-speed text search and retrieval system addresses the speed problem of sequential search processes through a text array processor that can increase matching speed as much as 2 million characters per sec. For a closer peek at GE's TAP, see p. 227. . . **Data entry:** Today's low-cost, high computing power has emphasized the need to get data into systems quickly, inexpensively and conveniently. Optical character recognition offers a possible solution, and two other automated data-entry schemes promise to extend the solution to retail, industrial and consumer areas. The information on p. 239 may offer a solution to your data-processing problems.



An OEM Computer Company Of A Different Stripe.

Each of the computer systems on the left is different. Not just outside because of color. But inside as well, because each is configured for a totally different set of user needs.

They are Momentum 32/4s,[™] inside and out perhaps the most versatile desktop business systems ever offered to OEMs.

Styled By Bertone. Powered By 68000[™] And System III UNIX.[™]

The look of the Momentum 32/4 gives you an immediate sense for its capabilities. Its lines wrap smartly around the most compact chassis in its class, a chassis really in a class by itself, thanks to the styling of Italian master designer, Bertone.

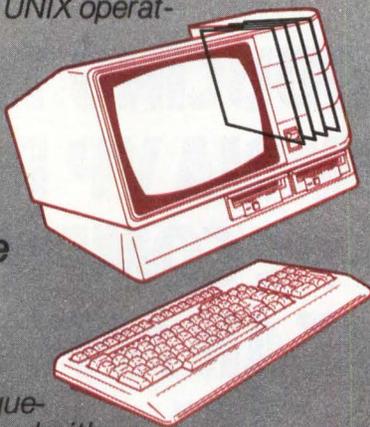
But while style can catch the attention of the OEM, only performance can keep it. And with the Momentum 32/4, that performance starts substantially with the industry-standard M68000 microprocessor and the enhanced System III UNIX operating system—but there's more of the same.

More Innovation And Versatility: From The Graphics Package To The Storage Package.

For OEMs, market edge comes with system uniqueness. Uniqueness achieved with the least hassle for the fewest dollars.

The Momentum 32/4 performance features give OEMs that edge.

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There's Direct Memory Access and the proprietary Memory Management Unit, both of which significantly enhance system throughput. There's 1/2 megabyte of RAM memory, standard. Three additional serial ports, standard. Word processing and spread-sheet, standard.

The versatility of the Momentum 32/4 is apparent everywhere. There's a completely customizable external I/O board. A powerful graphics board option, controlled by its own 68000 processor, features 256K of RAM and functions that are totally software definable. Even the storage package offers the versatility of two Winchester cartridge drives, delivering ten megabytes of on-line capacity as well as removable backup capability.

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CIRCLE NO. 91 ON INQUIRY CARD

SMALL-BUSINESS SYSTEMS

Product profile: small-business systems

PATRICK KENEALY, Senior Editor

Multi-user, micro-based systems take over

Small-business systems have changed more in the last 10 years than full-sized cars. Small-business systems still automate small businesses, and full-sized cars still carry five adults. But today's microprocessor-based small-business system has less in common with its minicomputer-based ancestors than a four-cylinder, full-sized Mercury has with its 20-ft., eight-cylinder namesake from 1971. While price, performance, reliability and adaptability considerations influence the selection of cars and computers, application-based definitions are necessary in both cases to ensure consistent comparison of technically diverse products.

Small-business systems defined

Qualitative (applications) and quantitative constraints have been placed on the systems covered in this profile. A small-business system is defined as a multi-user computer system that sells for less than \$25,000 in a typical configuration and is designed primarily for general business applications. End-user systems sold with application software as well as OEM systems intended for eventual business use are covered.

The price constraint is a way to quantify the "small" in small business. It excludes mainframes and superminicomputers not intended for typical small-business environments. Personal computers designed primarily for stand-alone operation were also excluded. Systems designed primarily for scientific applications such as Apollo Corp.'s Domain, Perkin-Elmer Corp.'s 3200 or

Three Rivers Computer Corp.'s Perq were not covered, although there is an attempt to include general-purpose systems that have been used for or seem well-suited to commercial applications. Distributed microcomputer systems designed for general business (rather than executive automation) applications are included if they meet the price constraint. In general, business systems rather than office-automation systems are covered, but the distinctions between the two are blurring.

Given that businessmen buy solutions to their problems rather than specific hardware configurations,

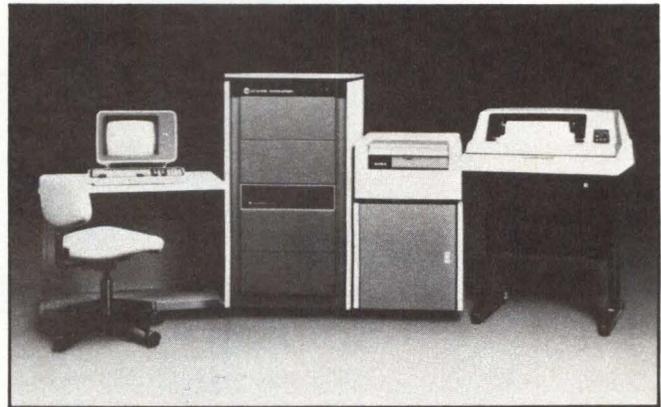


Fig. 1. General-purpose minicomputer systems such as this General Automation 900 are often used by system integrators to configure powerful, multitasking small-business systems. The system above uses a bit-slice processor, gate-array logic chips and an optional cache memory to increase performance. It is the second most powerful member of a five-system family.

the diversity of the hardware that meets our constraints for a small-business system is still surprising. General application software and peripherals are quite similar from one system to another, but architecture and performance vary widely.

Different architectural approaches

Small-business systems are generally configured around a traditional 16-bit minicomputer, around a high-performance microprocessor or around several linked microprocessors. Traditional mini-based systems (Fig. 1) are based on Digital Equipment Corp.'s PDP-11s, IBM Corp.'s s/3s, Data General Corp.'s Novas, Computer Automation Inc.'s Naked Minis, General Automation Inc.'s GA-16s and similar CPUs. They have large language, application and system software bases, but consume more space, electricity and air conditioning than newer microcomputer-based units. Manufacturers of systems based on minicomputers are far down the manufacturing learning curves for their products. Economies of scale and low-cost components are making their systems less expensive than ever before. Mini-based systems usually have proven upgrade paths as well as proven software and hardware reliability records.

Single-microprocessor-based systems (Fig. 2) are

sometimes configured around 8-bit microprocessors (running MP/M, for example) but are more often built around 8-/16-, 16- and 16-/32-bit microprocessors such as Intel Corp.'s 8086, Motorola Inc.'s MC68000 and Zilog Inc.'s Z8000. Single-micro-based systems such as those sold by Wicat Systems Inc., Fortune Systems Corp. and Charles River Data Systems typically support a half dozen users at a performance level claimed to match that of a PDP-11/44. Integrated Business Computers Inc. claims its 68000-based Ensign system supports 32 users.

Small Winchesters have done as much as microprocessors to make small-business systems inexpensive.

Single-micro-based systems like the Ensign actually use more than one microprocessor but still rely on single multitasking CPUs. I/O support, floating-point arithmetic, memory management, communications and other "support chips" are used to keep CPUs free for running programs. Cache memories, bank switching, microprogramming and other techniques also boost performance, but the raw price/performance of single-micro systems can't always overcome buyer reservations about reliability and upgrade paths.

Single-micro-based systems use both industry-

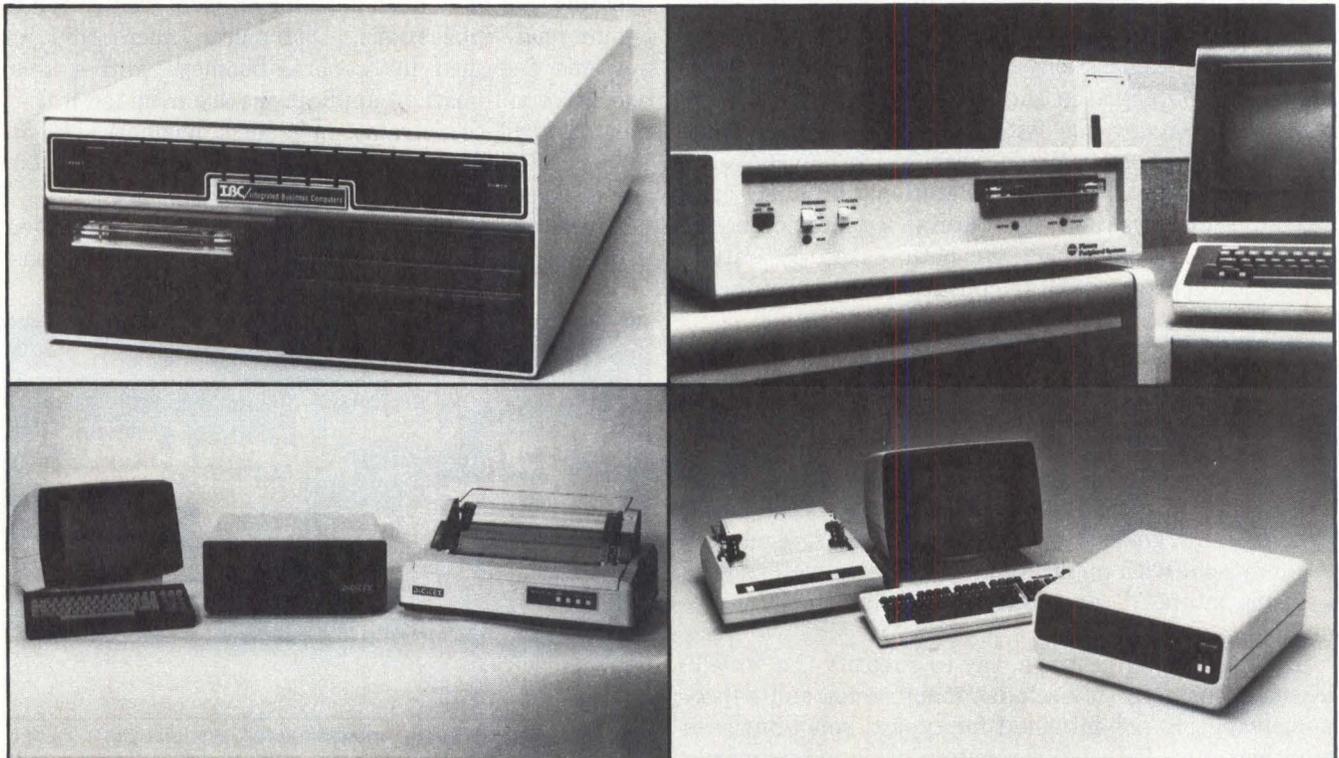


Fig. 2. Single-microprocessor-based small-business systems are based around multitasking, high-performance microprocessors such as the Motorola MC68000, Zilog Z8000 and Intel 8086 and 80186. The single-micro-based systems above are (clockwise from top left) the MC68000-based IBC Ensign, the LSI-11-based Plessey Peripheral Systems 6200, the 8086-based Micro Five System 1000 and Z80B-based Digitex 8000.

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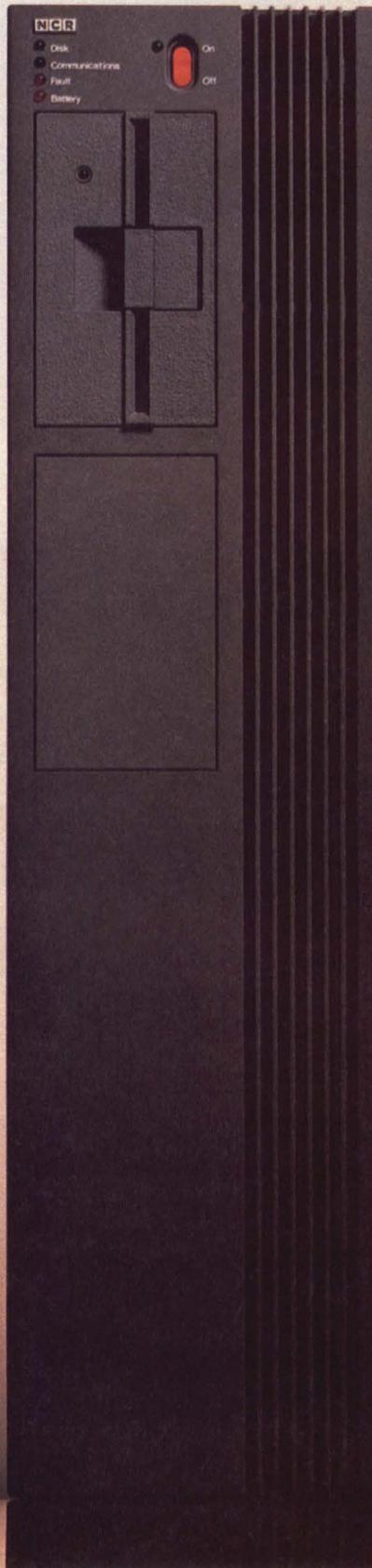
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standard and proprietary architectures and components. Codata Systems Corp.'s 3300 system and NCR Corp.'s Tower 1632 use IEEE796/Multibus components. Vector Graphic Inc., Systems Group, IMS International, Digitex, CompuPro Systems and Cromemco Inc. use IEEE696/S-100 components. Victory Computer and others use the VME bus sanctioned by Motorola, Philips/Signetics and Mostek Corp. Plessey Peripheral Systems and Western Digital Corp. base their products around DEC processors, and Bytronix Corp. and others produce DG Nova-based processors. A number of manufacturers use hybrid and custom chips in proprietary architectures. The Seiko Series 8600 (Fig. 3) is implemented with custom system components packaged in sealed plastic cassettes that are replaceable by a novice user without any tools.

Multi-microprocessor systems (Fig. 4) distribute processing power to users or clusters of users and share disk storage, printer and software resources. Most multi-micro systems are based around personal-computer-like workstations linked by a disk server or local-area network. The LAN multi-micro architecture has proven very popular with office-automation and workstation vendors and is in small-business systems made by Datapoint Corp., Datamac Computer Systems, Corvus Systems Inc., Pertec Computer Corp., Micro Five Corp., Zilog and others. Multi-micro-based systems have low entry-level prices and can be expanded in small increments because each user has dedicated processing power. LAN-based small business systems should become much more numerous as LAN standards solidify and LAN communications speeds increase.

The distributed intelligence of multi-micro systems makes it hard to measure their overall performance. It

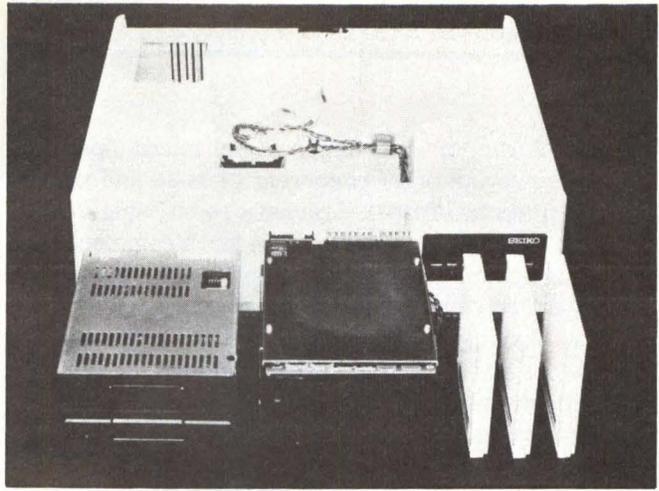


Fig. 3. Proprietary packaging makes this Seiko Series 8600 small-business computer easy to service. All internal system components are sealed in plastic cassettes called MEM-PACKS, and all components, including the disk and diskette drives, can be removed without tools.

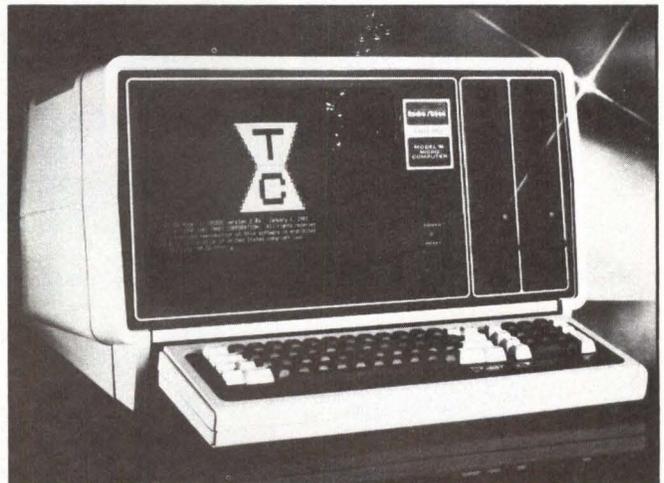
also prevents a user from solving problems that require more than the amount of local processing power dedicated to that user. A minicomputer user can use the system during off-hours or run large programs at the expense of other users; a LAN-based system user can't. Ultimate expansion limits for LAN-based systems are another question. Expandability depends on network and disk controller speeds and on the sophistication of record locking and other system software.

Standard software

The considerable differences among minicomputer operating systems reflect their heritages and hardware configurations. This is not generally the case with microcomputer operating systems, which are comparatively homogeneous. Likewise, most languages and application packages are available on most systems in the survey.



Fig. 4. Multi-microprocessor-based small-business systems distribute processors to users or groups of users. As many as 23 Pertec 1000s (left) can be connected using Pertec's REACH local-area network. MC68000-based Tandy Corp. TRS-80 model 16s (right) can be linked using Datapoint's ARCnet and can be tied into Datapoint business systems.



SMALL-BUSINESS SYSTEMS

MP/M is the most common 8-bit micro operating system surveyed, and Concurrent CP/M-86 and various implementations of UNIX dominate 16-bit, single-micro systems. LAN-based systems often run a common micro operating system such as MS-DOS or CP/M at every user station and rely on disk-server or network software for resource sharing. While implementations differ, system integrators and application programmers face standard operating systems that support a plethora of compilers, interpreters and application packages. Programming languages are also quite standard. COBOL is still the most popular business programming language, although structured languages such as Pascal and many advanced BASICs are gaining popularity.

The integration of office-automation functions into small-business systems (and vice versa) is a major trend. General-ledger packages are still used to link inventory, accounting and reporting packages, but word-processing, spread-sheet, database, electronic-

mail, appointment-scheduling and business-graphics capabilities make small-business systems more useful and easier to sell. A few vendors base their application-development software around database packages, and friendly application generators and others use integrated computing environments such as Context Manage-

Users of every type of architecture are committed to growth paths involving next-generation microprocessors.

ment's MBA, Lotus Development's 1-2-3 and Visicorp's Visi^{On}. Purchasing off-the-shelf application packages can potentially turn any system with a standard operating system or programming environment into a small-business system.

All this standardization of software often leaves dozens or even hundreds of choices for system integrators looking for basic business packages. More than a dozen companies publish on-line and paper references

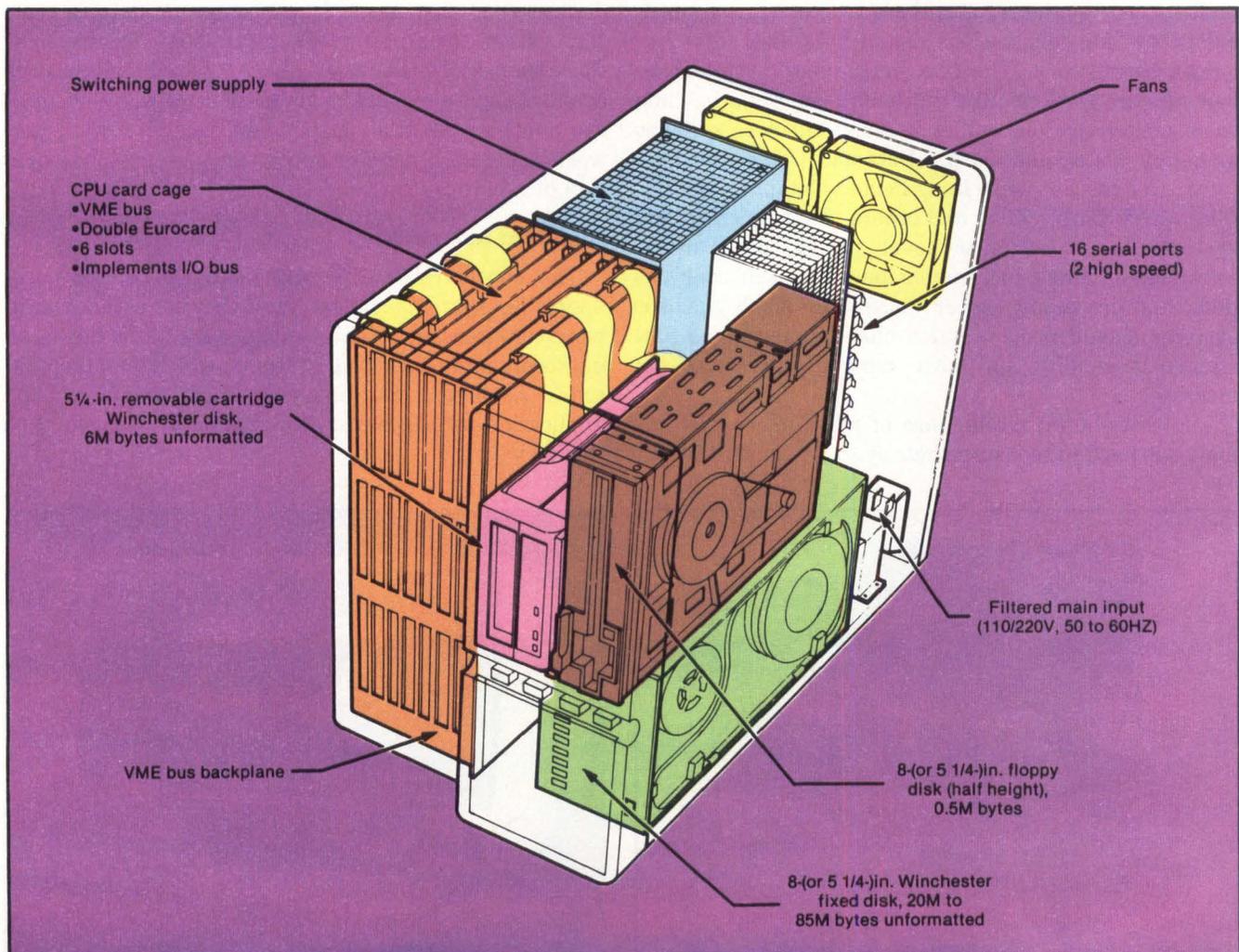
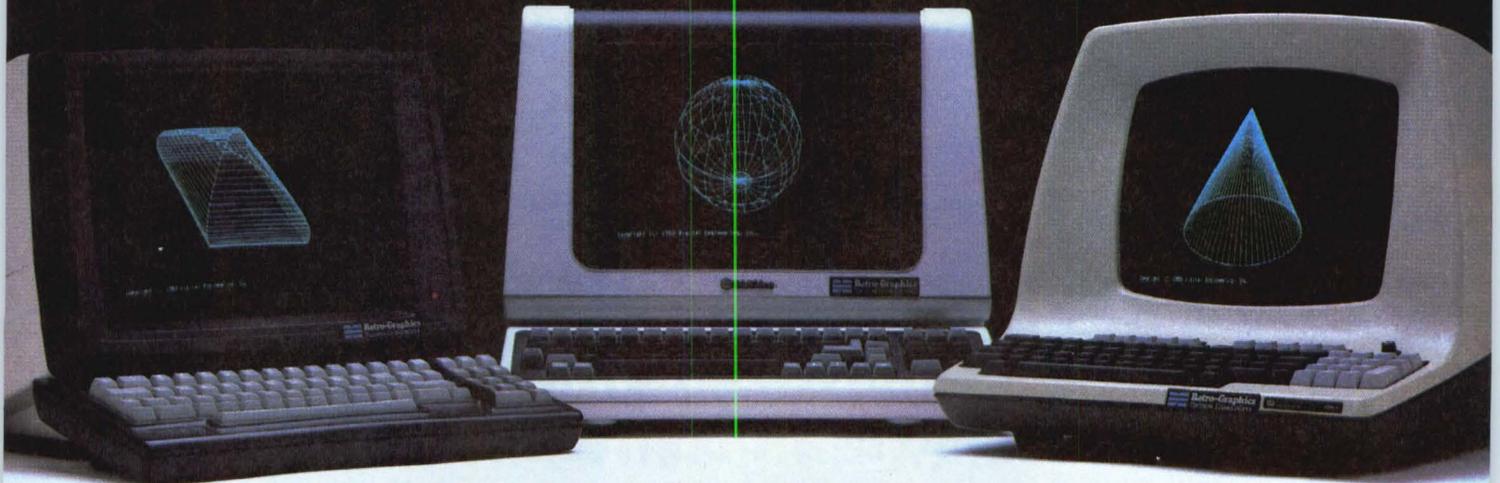


Fig. 5. Small-business computer building blocks include processors, memory cards, disks, diskettes, power supplies and cooling components, all available from many OEMs. This phantom view of the Victory Computer Systems Spirit business computer highlights the sub-assemblies that can be enclosed in a desk-top or pedestal form factor.

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SMALL-BUSINESS SYSTEMS

to assist in comparing business software packages. Comparison shopping is still difficult because most business packages are more complex than their low prices indicate.

Plenty of peripherals

Most small-business systems are sold by system integrators that don't make their own peripherals (Fig. 5). The giants still do, but even DEC and IBM buy disks, printers and other small-business peripherals from OEMs. Inexpensive Winchester disk drives that store tens of megabytes have done as much as microprocessors to make small-business systems inexpensive, and 5¼- or 8-in. Winchesters are part of virtually every

The integration of office-automation functions into small-business systems is a major trend.

system surveyed. Capacities for 5¼-in. drives now top 150M bytes. Tandon Corp., Cipher Data Products, Archive Corp. and others offer cost-effective start/stop and streaming-tape backup drives for small-business-sized disks. Alpha Micro Systems and Corvus even offer video-cassette-recorder backup devices.

Multimode matrix serial printers are also part of the base configurations of most systems. They offer high speed and near-letter-quality printing. Daisy-wheel and other letter-quality serial printers are popular but too slow for general business applications. Both impact and non-impact line printers are too expensive for an average user. Lower priced band printers and the imminent appearance of inexpensive, desk-top, non-impact printers promise to make small-business sys-

tems more capable but will place new demands on their processors.

Small-business systems offer a wide assortment of dumb, editing and intelligent terminals. Most are bought from OEMs and are customized or pre-programmed for specific applications and for product

Current software and standards stability makes a wait-and-see attitude seem too cautious.

differentiation.

All this mixing and matching can lead to vendor support problems for both end users and system integrators. End users should make sure their system vendors stock or repair sub-assemblies, just as system integrators should check their suppliers' return and repair policies. It's getting easier than ever to become a system integrator, and small-business-system buyers should look for hardware, software and business expertise in any potential supplier.

More choices to come

The emerging generation of 16-/32-bit and true 32-bit microprocessors promises to change hardware alternatives again, but vendors are striving to provide stable growth paths within all three architectural approaches. Multibus, S-100 bus, VME bus and STD bus system vendors promise to accommodate the new micros. Minicomputer manufacturers promise to produce more powerful and better integrated processors that are software compatible with the manufacturers' discrete-component products, such as DEC's Micro J-11, LSI-11 and rumored VAX-on-a-chip. LAN-based system vendors promise to integrate the new chips into their workstations and to upgrade their networks and software to support them.

Small-business-system technology is changing faster than ever, but there is enough software and standards stability to make a wait-and-see strategy seem too cautious. □

Manufacturers' listings start on page 168.

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(408) 735-1744
Circle No. 767

Columbia Data Products Inc.
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Columbia, Md. 21045
(301) 992-3400
Circle No. 768

CompuPro Systems
Oakland Airport, Calif. 94614
(415) 562-0638
Circle No. 769

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18651 Von Karman Ave.
Irvine, Calif. 92713
(714) 833-8830
Circle No. 770

Control Data Business Centers Inc.
500 W. Putnam Ave.
Greenwich, Conn. 06836
(203) 622-2000
Circle No. 771

Corvus Systems Inc.
2029 O'Toole Ave.
San Jose, Calif. 95131
(408) 946-7700
Circle No. 772

Cromemco Inc.
280 Bernardo Ave.
Mountain View, Calif. 94043
(415) 964-7400
Circle No. 773

Data General Corp.
4400 Computer Dr.
Westboro, Mass. 01580
(617) 366-8911
Circle No. 774

Datapoint Corp.
9725 Datapoint Dr.
San Antonio, Texas 78284
(512) 699-7552
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Dataram Corp.
Princeton Rd.
Cranbury, N.J. 08512
(609) 799-0071
Circle No. 776

Digilog Business Systems
1370 Welsh Rd., P.O. Box 425
Montgomeryville, Pa. 18936
(214) 628-4810
Circle No. 777

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Maynard, Mass. 01754
(617) 897-5111
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2044 Armacost Ave.
Los Angeles, Calif. 90025
(213) 826-4500
Circle No. 780

Dual Systems Control Corp.
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Berkeley, Calif. 94702
(415) 549-3854
Circle No. 781

Durango Systems Inc.
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San Jose, Calif. 95134
(408) 946-5000
Circle No. 782

Eagle Computer Inc.
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Los Gatos, Calif. 95030
(408) 395-5005
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General Automation Inc.
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Anaheim, Calif. 92803
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Circle No. 785

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(617) 895-3658
Circle No. 787

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Chatworth, Calif. 91311
(213) 882-9007
Circle No. 788

IBM Corp.
Information Systems Group
1133 Westchester Ave.
White Plains, N.Y. 10601
(914) 696-1900
Circle No. 789

IMS International
2800 Lockheed Way
Carson City, Nev. 89701
(702) 883-7611
Circle No. 790

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Pixel Division
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Andover, Mass. 01810
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Columbia, S.C. 29210
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To your host CPU our Winchester Disk backup looks just like your Winchester Disk.

Now, costly interface designs are eliminated when you specify EPI's STR[®]-Stream. That's because this compact, reliable 1/4" cartridge incremental recorder has a system designed interface that emulates both the power requirements and interfacing of Winchester disks. Interfaces available include SA1000, ST506, PRIAM, and DEI Funnel* look-alikes.

STR[®]-Stream offers the highest data integrity (< one soft error in 10⁹ bits), and unit-to-unit compatibility of any recorder in its class. To achieve this, it utilizes a wide write track, narrow read track, read-after-write circuitry and CRC verification.

The recorder stores up to 17 Mbytes (unformatted) on a DC-300XL cartridge, yet takes up no more physical space than an 8" floppy.

Each STR[®]-Stream comes complete and ready to plug into your compatible controller. Domestic U.S. price is less than \$1,000 in OEM quantities.

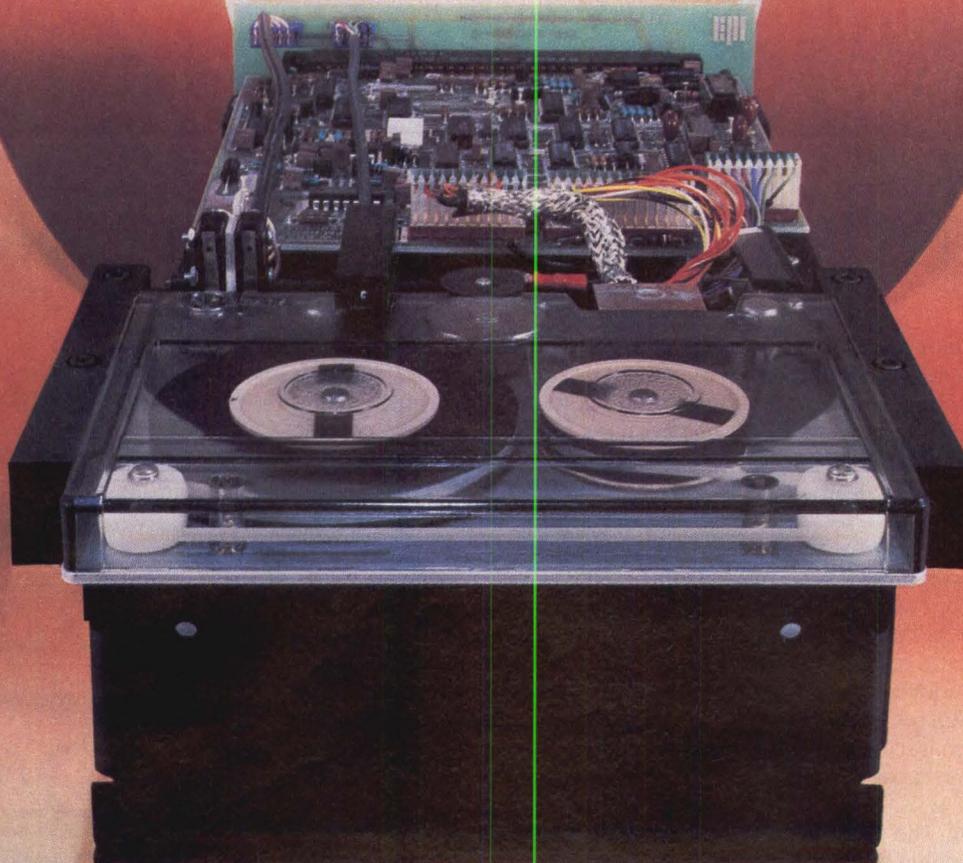
EPI, with more than 10 years experience moving tape, has the technology and resources to back you and your Winchester disks.

For complete information on STR[®]-Stream, write to Electronic Processors, Inc., P.O. Box 569, Englewood, CO 80110. Phone (303) 761-8540.

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CIRCLE NO. 95 ON INQUIRY CARD



NOW, A TASK FORCE OF ONE BRINGS REVOLUTIONARY NEW SKILLS TO DOT MATRIX PRINTING.

Outmaneuvers Lines and Daisies at 350 cps. Okidata's new multifunction Pacemark 2410 combines three printers in one remarkable machine. At 350 cps, it pumps out data at line speeds up to 420 lpm. Delivers drafts with extra-dense characters at 175 cps. Its 85 cps correspondence quality is three times faster than most daisywheels.

But that's just the opening salvo. This high powered dot matrix printer has an arsenal of extra features. Two-color printing. Dot addressable graphics. 96-character ASCII set, plus resident and alternate 96-character downline loadable sets. Column capabilities range from 136 to 233.

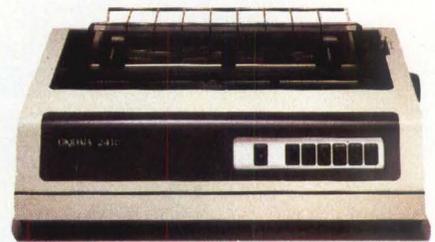
Tough As Nails. The 2410 won't suffer from battle fatigue or duty cycle

limitations. It's armed with our long-life, stored-energy print head with 9 tungsten pins to crank out up to 500 million characters with ruthless precision. Add laser-welded, precision-controlled construction and a rugged, stamped steel frame, and this machine's virtually invincible.

Compatibility Plus. Teams up with all the big guns in high performance desktops and small business computers, plus most low-end minis. Available with standard parallel or RS 232C serial interface with current loop. Additional interfaces on the way.

Mean Machine. Nice Price. It's capable. It's tough. It should cost a bundle. But it doesn't. Suggested retail is \$2995; \$2695 for its data-processing-only part-

ner, the Pacemark 2350. For more information, phone 1-800-OKIDATA. In New Jersey, (609) 235-2600.



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(714) 540-6730
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Molecular Computer
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San Jose, Calif. 95134
(408) 262-2122
Circle No. 796

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Sunnyvale, Calif. 94086
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Circle No. 800

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Waltham, Mass. 02154
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Harmingdale, N.Y. 11735
(516) 420-9740
Circle No. 802

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(415) 357-8500
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Sage Computer Technology
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Reno, Nev. 89502
(702) 322-6868
Circle No. 811

Sci-Com Computer Systems
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Bridgewater, N.J. 08807
(201) 685-0070
Circle No. 812

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Cincinnati, Ohio 45242
(513) 984-6622
Circle No. 813

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P.O. Box 28810
Dallas, Texas 75228
(214) 271-4667
Circle No. 814

Smoke Signal Broadcasting
31336 Via Colinas
Westlake Village, Calif. 91362
(213) 889-9340
Circle No. 815

Systems Group
1601 Orangewood Ave.
Orange, Calif. 92668
(714) 633-4460
Circle No. 816

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Forth Worth, Texas 76102
(817) 390-3300
Circle No. 817

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(714) 540-8340
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Data Systems Group
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Circle No. 821

Wicat Systems Inc.
P.O. Box 539, 1875 S. State
Orem, Utah 84057
(801) 224-6400
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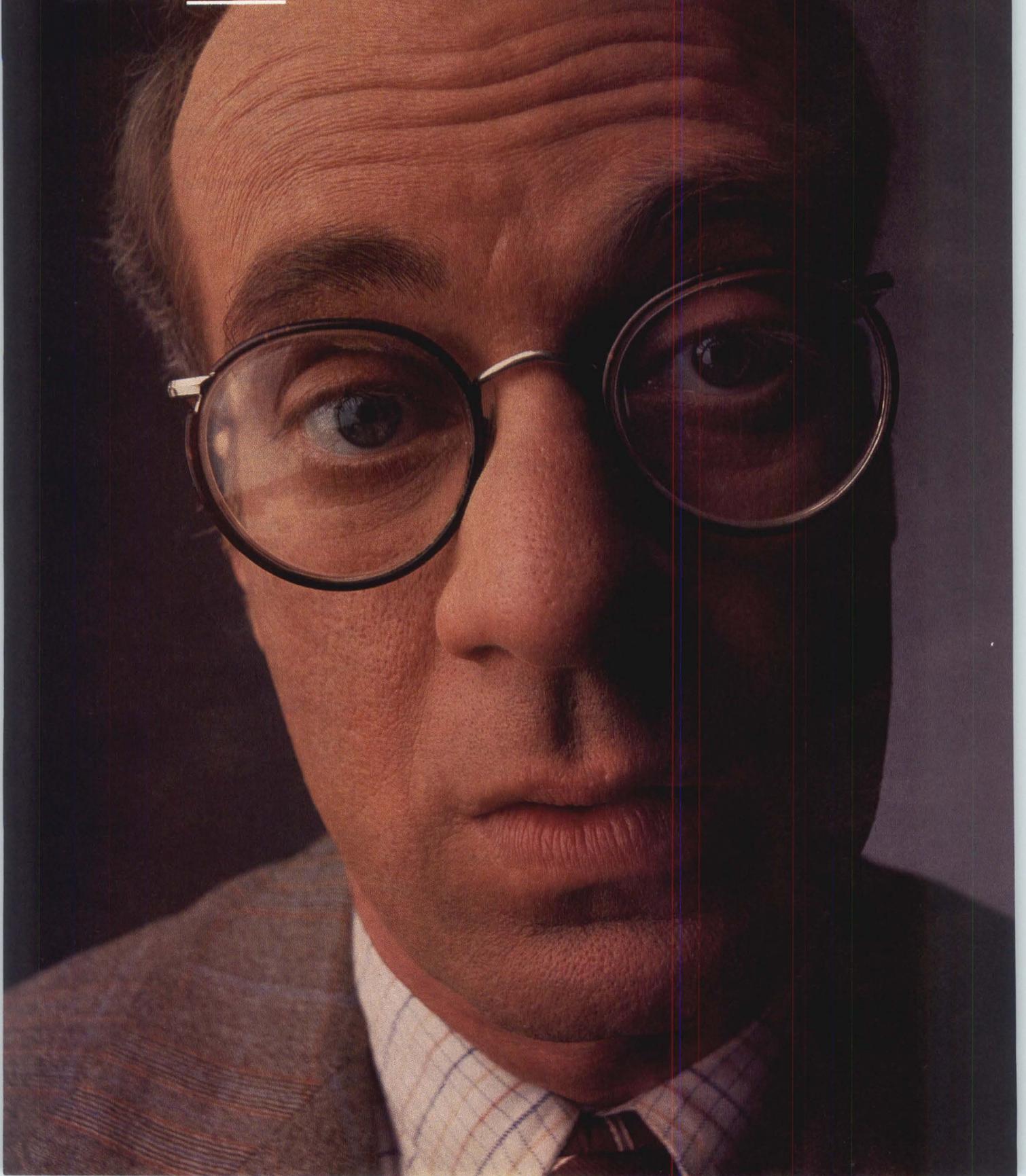
Zendex
6644 Sierra Lane
Dublin, Calif. 94568
(415) 828-3000
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Zentec
2400 Walsh Ave.
Santa Clara, Calif. 95050
(408) 727-7662
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Campbell, Calif. 95008
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*Manufacturers' listings
start on page 168.*

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"YOU CAN WITH PERSYST."

The Persyst DCP/88. A breakthrough front end communications processor for the IBM PC or XT.

The Persyst DCP/88 is a unique breakthrough in expansion products for the IBM PC.

A companion processor that supports up to 4 multiple discipline communications lines. Including SDLC, HDLC, async and bisync, plus a high speed parallel printer option.

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When Persyst designed the DCP/88, we thoughtfully utilized the Intel 8088 microprocessor chip—the same processor used on the IBM PC mother board.

Result? The DCP/88 offers processing power equivalent to the PC itself. And because the DCP/88 supports both async and sync communications, its application potential is virtually unlimited.

In fact, the DCP/88 handles virtually any front end serial data application—communications or peripherals—without burdening the PC.

Multiply your PC processing power and run two programs—simultaneously.

The DCP/88 gives your PC unprecedented processing power.

You can execute a program in the DCP/88 while you're running a completely independent program on the PC. For example, process incoming and outgoing communications while you perform another task.

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With optional ASD asynchronous driver or BSD bisynchronous driver software, which include the DCP Real-Time Executive operating system, you can develop your own application software with exceptional ease and speed.

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PC/HASP uses bisync communications and emulates an IBM 360/20 Mod 5 HASP/RJE workstation, supporting up to seven input and seven output multi-leaved data streams.

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PC/HASP gives you the same performance you would get with a traditional, dedicated RJE workstation, and at significantly less cost. Plus the processing capability of the IBM PC when you're not running HASP.

And it's only available with the Persyst DCP/88 and PC/HASP.

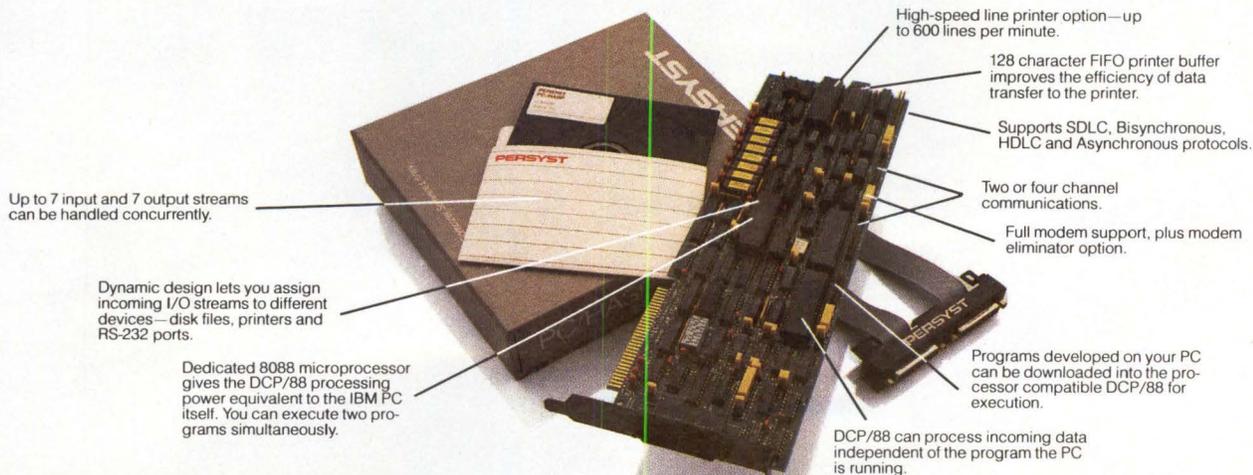
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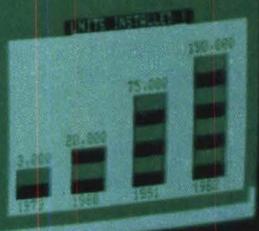


TELEVIDEO PRODUCTS

MODEL	DESCRIPTION	LIST PRICE
51T	BLOCK NOTE	10000.00
52A	PRICE PERFORMANCE	10000.00
53E	SMART	10000.00
54D	TEST SMART	10000.00
55V	TEST SMART	10000.00

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CONTACT

TELEVIDEO SYSTEMS INC.
1170 MORSE AVENUE
SUNNYVALE, CA, 94086
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Model 924

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The 924 is comfortable, with a tilt and swivel non-glare screen. Its lightweight, low profile keyboard fits your fingers naturally. Our 32 programmable, non-volatile function keys turn often used instructions into simple one-button commands. The 924 provides extra display features, including full screen editing, character and block graphics, definable scrolling regions for multiple window operation, plus 32 character-by-character visual attributes.

The 924 has the intelligence you need too, with logical attributes to define protected and unprotected regions. And, with standard one page or optional four page memory, there's plenty of room to work.

If you don't need all the power of the 924, try our 915. It has all the design advantages of the 924, and is the superior terminal in its class. It just costs less.

The 924 and 915 mark a great new chapter in the TeleVideo story. And, like all TeleVideo terminals, they're reliable performers, backed nationwide by General Electric Instrumentation and Computer Service Centers. Contact us today about the 924 and 915 story and you'll enjoy the happy ending. Call 800-538-8725 (in California call (408) 745-7760), or send us this coupon.

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 **TeleVideo Systems, Inc.**

MULTIUSER SMALL BUSINESS SYSTEMS

Company, model	Word size, CPU	Minimum/Maximum memory (K bytes)	Minimum/Maximum no. of users	Operating systems	Languages	Typical price	Typical configuration	Circle No.
Advance Technology Corp.								692
	16-bit, 68000		/8	MCS, UNIX System III, COS 68000, CP/M emulator	BASIC, FORTRAN, COBOL, Pascal, APL, C, Assembler	\$7720		
Alcyon, AWS	16-bit, 68000	256/2M	4/12	Regulus	BASIC, FORTRAN, COBOL, Pascal, DIBOL	\$14,860	256K-byte RAM, 32K-byte ROM, 5K-byte fixed, 5K-byte cartridge, 24 x 80 VT100-compatible terminal, NEC Spinwriter	693
Alpha Micro Systems,								694
AM-1000	16-bit, 68000	128/256	/7	AMOS/L, CP/M-80	BASIC, FORTRAN, COBOL, Macro assembler	\$8000		
AM-1042	16-bit, 68000	512/3072	/26	AMOS/L	BASIC, FORTRAN, COBOL, Pascal, AlphaLISP, Macro assembler	\$10,800 (OEM)		
AM-1062	16-bit, 68000	512/4096	/68	AMOS/L	BASIC, FORTRAN, COBOL, Pascal, AlphaLISP, Macro assembler	\$12,900 (OEM)		
Altos Computer Systems,								695
Series 5	8-bit, Z80A	192/192	/3	MP/M II, CP/M, OASIS	BASIC, FORTRAN, COBOL	\$5490	122K-byte CPU, 5M-byte Winchester disk drive, MP/M	
Series 8000	8-bit, Z80A	208/208	/4	MP/M II, CP/M, OASIS	BASIC, FORTRAN, COBOL	\$7490	208K-byte CPU, 10M-byte Winchester disk drive, 15M-byte floppy disk drive, 6 serial ports, MP/M II	
586-10	16-bit, 8086	512/1000	/5	XENIX, MP/M-86, OASIS-16, Pick	BASIC, COBOL, Informix	\$7990	512K-byte CPU, 10M-byte Winchester disk drive, 1M-byte floppy disk drive, 6 serial ports	
Series 8600	16-bit, 8086	512/1000	/8	XENIX, MP/M-86	BASIC, COBOL, Pascal, Informix	\$12,500	512K-byte CPU, 10M-byte Winchester disk drive, 0.5-byte floppy disk drive	
Series 68000	16-bit, 68000	512/1000	/16	UNIX, RM/COS	BASIC, FORTRAN, COBOL, Pascal	\$12,990	512K-byte CPU, 20M-byte Winchester disk drive, 0.5M-byte floppy disk drive	
Billings Computer Corp.,								696
6000 series	8-bit, Z80A	64/576		Proprietary	BASIC, FORTRAN, COBOL, Assembler	Less than \$10,000	Model 6000 used as data center, model 5000 or 6000 used as user workstation	
Burroughs Corp.,								697
B21 series	16-bit, 8086	128/512	1/4	BTOS	BASIC, FORTRAN, COBOL, Pascal			
B22 series	16-bit, 8086	256/640	1/16	BTOS	BASIC, FORTRAN, COBOL, Pascal			
B-80	8-bit	60/124			COBOL, RPG			
B91	8-bit	512/512			COBOL, RPG			
B92	8-bit	512/512			COBOL, RPG, NDL-II, MPL-II			

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complete line of printers, from the 410 Series letter quality printer to the 1130-lpm band printer. A pair of user-friendly displays—plus RTA (remote technical assistance).

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as profitable business opportunities*

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MULTIUSER SMALL BUSINESS SYSTEMS

Company, model	Word size, CPU	Minimum/Maximum memory (K bytes)	Minimum/Maximum no. of users	Operating systems	Languages	Typical price	Typical configuration	Circle No.
Cado Systems Corp.,								698
Cat 3	8-bit, 8085	64/96	1/4	Proprietary	CADOL	\$10,500	CPU, 1.22M-byte floppy disk drive	
Tiger	16-bit; 2 8086s, 1 8089	256/1024	1/64	MMIOS	CADOL	Less than \$25,000	3 microprocessors, 15M-byte Winchester disk drive, 7 terminals, printer	
Cambridge Digital Systems, System 94								699
	PDP-11/23	256/4M		Enhanced UNIX System III, RSX-11M, RT-11, TSX-Plus		\$20,000	256K-byte CPU, 70M-byte Winchester disk drive, 20M-byte streaming-tape drive	
Century Computer Corp.,								700
Vanguard 8000	8-/16-bit, 8086/8085	128K/1M	/8	CP/M, CP/M-86, MP/M	BASIC, COBOL, Pascal, Assembler	\$10,000	128K-byte memory, 2 microprocessors, 6M-byte Winchester disk drive, 1.4M-byte floppy disk drive, real-time clock, 4 terminals	
Vanguard 7000	16-bit, 8086/8085	128/1M	8/15	CP/M, CP/M-86, MP/M	BASIC, COBOL, Pascal, Assembler	\$18,000	128K-byte memory, 2 microprocessors, 3 6M-byte Winchester disk drives, 1.4M-byte floppy disk drive, real-time clock, 8 terminals	
Charles River Data Systems Inc.,								701
Universe 68	32-bit, 68000	256/12M	4/64	UNOS	BASIC, FORTRAN, COBOL, Pascal, Proprietary version of C	\$18,000	256K-byte RAM, main processor, I/O processor, 10M-byte fixed disk drive, 1.26M-byte floppy disk drive, 4 serial ports, 3 terminals, language with operating system software	
CIE Systems Inc.,								702
680/30	16-bit, 68000	256/768	1/8	UNIX System III, Regulus	BASIC, FORTRAN, COBOL, Pascal, C, PRO-IV	\$26,190	512K-byte CPU, 10M-byte Winchester disk drive, 0.5M-byte floppy disk drive, async communications controller, 8 CIT terminals	
680/20	16-bit, 68000	256/512	1/4	UNIX System III, Regulus	BASIC, FORTRAN, COBOL, Pascal, PRO-IV, C	\$17,610	256K-byte CPU, 10M-byte Winchester disk drive, 0.5M-byte floppy disk drive, 4 CIT 101 terminals, async communications controller	
Codata Systems Corp.,								703
Codata 3300	16-bit, 68000	320/1500	2/8	UNISIS	BASIC, FORTRAN, COBOL, Pascal, APL	\$9600	320K-byte CPU, 33M-byte Winchester disk drive	
Columbia Data Products, Inc.,								704
Commander	8-bit, Z80A	128/256	1/8	CP/M-86, MP/M-86	BASIC, FORTRAN, COBOL, Pascal, Assembler	\$6500	256K-byte RAM, dual Z80 microprocessors, 2 0.8M-byte floppy disk drives	
MPC	16-bit, 8088	128/1M	1/8	MS-DOS, CP/M-86, MP/M-86	BASIC, FORTRAN, COBOL, Pascal, Assembler	\$10,800	Monitor, MP/M-86, 1M-byte memory	
CompuPro Systems,								705
System 816 family	8-/16-bit, 8085, 8088	256/1000	/16	MP/M 8-16, CP/M-80, CP/M-86	BASIC, FORTRAN, COBOL, Assembler	\$8995	384K-byte CPU, 2 1.2M-byte floppy disk drives, MP/M 8-16, SuperCalc 86, dBase, CP/M-80, CP/M-86	
Computer Automation Inc.,								706
Omnix 186	16-bit, 80/86	384/1M	4/16	OPUS-1, CP/M-86, Concurrent CP/M, MP/M-86	BASIC, FORTRAN, COBOL, Pascal	\$8990	384K-byte CPU, 5M-byte Winchester disk drive, 1M-byte floppy disk drive, 4 serial ports	

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The New Chromajet™ Series

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10 seconds a copy. Eight colors with 125 shades. Instant overhead transparency capability on a specially designed film from Polaroid Corporation. Using DuraPulse™, a self cleaning, self purging head technology which is warranted for two full years. These are just some of the features which make the first member of the Chromajet Series the state of the art in ink jet technology.

There's more. Every printer sub-system is designed to deliver high quality graphic images with minimum operator hassle. Continuous forms paper lets you go off and do other things while Chromajet prints your presentation hard copy or transparencies. Advanced Color Technology's special non-water based inks give you rich, saturated images, and clean operation. The snap in ink cartridge gives up to 3000 copies between replacements. Ideal for shared resource operation.

Advanced Color Technology wasn't satisfied with building the best color ink jet printer. They wanted to make it more reliable and easier to service. The best news is the price. In OEM quantities the price is under \$4300, including Centronics interface.

Call us today. Let Chromajet solve your color hard copy needs. 1-617-256-1222.



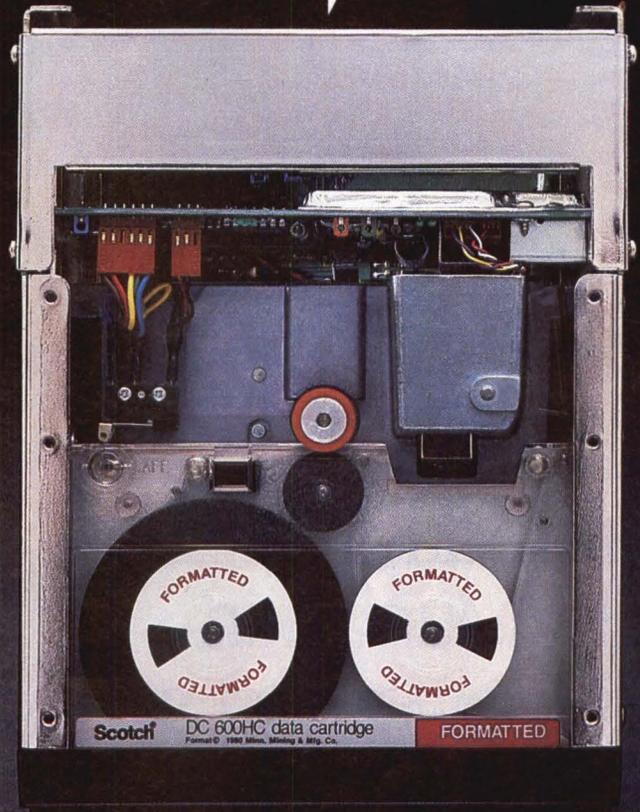
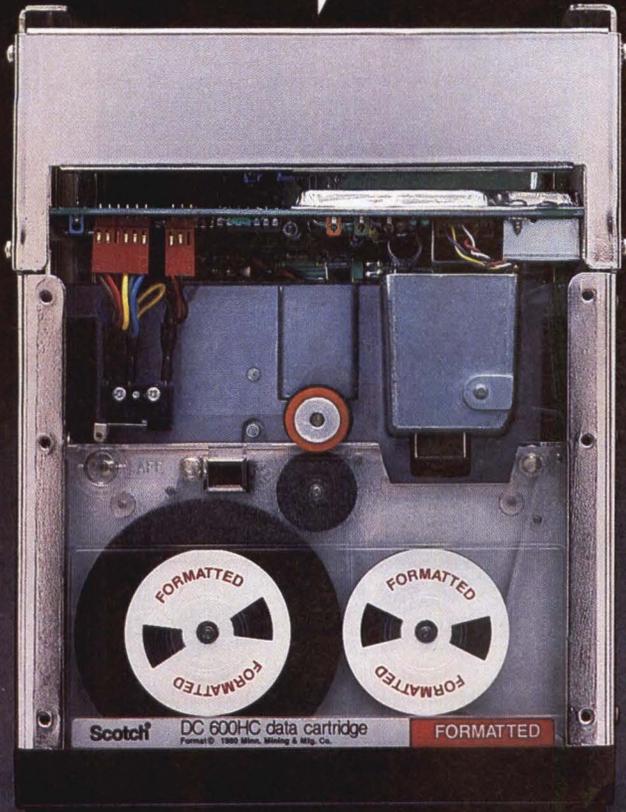
CIRCLE NO. 100 ON INQUIRY CARD 21 Alpha Road, Chelmsford, MA 01824

MULTIUSER SMALL BUSINESS SYSTEMS

Company model	Word size, CPU	Minimum/Maximum memory (K bytes)	Minimum/Maximum no. of users	Operating systems	Languages	Typical price	Typical configuration	Circle No.
Omnix CP80	8-/16-bit; Naked Mini 4/04, Z80A	128/128	1/8	OPUS-1, CP/M	BASIC	\$8500	128K-byte memory, 16-bit processor, Z80A processor, 2 1M-byte floppy disk drives, 3 terminals, 120-cps dot-matrix printer	
Control Data Business Centers Inc.,								707
CDC 114A	16-bit, Altos ACS 8600	512/1024	/6	XENIX	C	\$2100	512K-byte CPU, 20M-byte hard disk drive, 1.6M-byte floppy disk drive, XENIX, Financial Management System application, 2 terminals, 150-cps printer	
Corvus Systems Inc.,								708
Uniplex	16-bit, 68000	512/1M	/8	UNIX System III	BASIC, FORTRAN, COBOL, Pascal, C, Ada	\$5000	512K-byte CPU, 2 serial ports, Omninet local-area network capability	
Cromemco Inc.,								709
CS1	8-bit, Z80A	64/0.5M	1/5	CDOS, CROMIX	BASIC, FORTRAN, COBOL, C, RATFOR, LISP, RPG-II (CROMIX only)	\$11,015	192K-byte CPU, 3 serial ports, 390K-byte floppy disk drive, 21M-byte Winchester disk drive, controller, 2 CIO terminals	
CS1HD2	8-/16-bit; Z80A, 68000	256/1M	1/5	CROMIX-D	BASIC, FORTRAN, COBOL, Pascal, Macro assembler, C, RATFOR, LISP, RPG-II	\$10,720	256K-byte memory, 2 processors, 390K-byte floppy disk drive, 21M-byte Winchester disk drive, controller, 2 CIO terminals	
CS1HD5E	8-/16-bit; Z80A, 68000	0.5/1.5M	1/5	CROMIX-D		\$12,220	0.5M-byte ECC memory, 2 processors, 390K-byte floppy disk drive, 21M-byte Winchester disk drive, controller, 2 CIO terminals	
CS3H	8-bit, Z80A	64/0.5M	1/6	CDOS, CROMIX	BASIC, FORTRAN, COBOL, C, RATFOR, LISP, RPG-II (CROMIX only)	\$8585	256K-byte CPU, 21M-byte Winchester disk drive, 1.2M-byte floppy disk drive	
CS3HD2	8-/16-bit, Z80A, 68000	256/4M	1/8	CROMIX-D	BASIC, FORTRAN, COBOL, Pascal, Macro assembler, C, RATFOR, LISP, RPG-II	\$15,615	256K-byte memory, 2 processors, 1.2M-byte floppy disk drive, 21M-byte Winchester disk drive, 3 CIO terminals	
CS3HD5E	8-/16-bit, Z80A, 68000	512 (ECC)/4M	1/8	CROMIX-D	BASIC, FORTRAN, COBOL, Pascal, Macro assembler, C, RATFOR, LISP, RPG-II	\$17,615	256K-byte memory, 2 processors, 1.2M-byte floppy disk drive, 21M-byte Winchester disk drive, 3 CIO terminals	
Data General Corp.,								710
CS series 100	16-bit, microEclipse	128/2M	/16	RDOS	BASIC, COBOL	\$21,655	256K-byte CPU, 15M-byte Winchester disk drive, 1.2 M-byte floppy disk drive, terminal, operating system software	
CS series 200 A	16-bit, microEclipse	256/512	/13	AOS, RDOS	BASIC, COBOL	\$36,570	256K-byte CPU, 25M-byte Winchester disk drive, 1600-bps tape drive, terminal, operating system software	
CS series 200 B	16-bit, Eclipse	256/2M	/25	AOS, RDOS	BASIC, COBOL	\$52,560	256K-byte CPU, 73M-byte Winchester disk drive, 1600-bps tape drive, terminal, operating system software	
CS Series 200 C	16-bit, Eclipse	512/2000	/32	AOS, RDOS	BASIC, COBOL	\$57,130	512K-byte CPU, 50M-byte Winchester disk drive, 1600-bps tape drive, terminal, operating system software	

"I'M A
STREAMER."

"I'M BLOCK
ADDRESSABLE."



The HCD-75. It's both.

Meet the high capacity $\frac{1}{4}$ " cartridge back-up system with the split personality. The 3M HCD-75 does everything streamers do, and more! Now you don't have to choose between streaming and block addressability for data storage. The HCD-75 lets you design a reliable system that does both. Best of all, it's available right now — thousands of them are already in use — with the following high performance features:

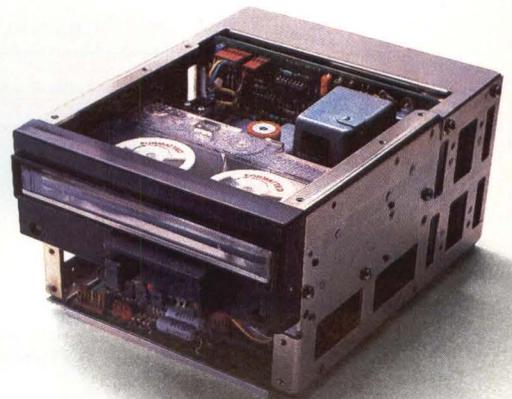
HIGH CAPACITY — a full 67 megabytes of formatted back-up storage — more than any other $\frac{1}{4}$ " system and most $\frac{1}{2}$ " systems.

DATA/CARTRIDGE INTERCHANGE — unlike some other systems, every HCD-75 drive

will read every 3M formatted data cartridge, no matter where it originated. A unique combination of stepper head and edge seek features allows unlimited cartridge interchange between drive systems.

COST EFFECTIVE — you get more for less. Total cost per megabyte with the HCD-75 is significantly lower than any other tape system.

Put it all together and you have one of the best friends a computer designer ever had: the 3M HCD-75 back-up system. For more information call (612) 736-9003 or write: Data Recording Products Division/3M, 3M Center 223/5N, St. Paul, MN 55144.



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Introducing the Munchkin™, the lower cost solution to 5¼" floppy disk control.

Looking for a lower cost solution to interfacing 5¼" floppy disk drives to your system? Let our new WD1770 show you the way. We call it the Munchkin. You'll call it the economical solution you need in today's price sensitive systems market.

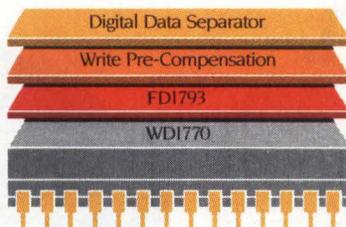
The WD1770 is a diminutive one-chip controller/formatter that masters both single and double density 5¼" floppies. It gives you all the features of our FD1793. Plus Digital Data Separation and Write Precompensation. On one chip. With just 28 pins. Component count is reduced, too. Which saves beaucoup

board space. And on-chip digital data separation eliminates the manufacturing cost of tweaking PLL data separation.

A single read line is the only input required to recover serial FM or MFM data from the disk. Data rates are selectable. So are sector lengths. And a new programmable Motor On feature pre-enables the spindle motor. Stepping rates are compatible with the FD1793. Or, for rates of 2, 3, 5 or 6 msec, specify the WD1772 version.

Why wait? Call our Controller Hotline at 714/966-7827 for immediate information. Or write Kathy Braun on your letterhead for a free sample. Then find out for yourself why we say the Munchkin is such a big deal.

™Munchkin is a trademark of Western Digital Corporation



Components Group, 2445 McCabe Way, Irvine, CA 92714, (714) 557-3550

WESTERN DIGITAL
C O R P O R A T I O N



MAKING THE LEADING EDGE WORK FOR YOU

Ding, dong,
the "Which" is dead.
Our newest low price
Winchester
disk controller
lowers the
boom.

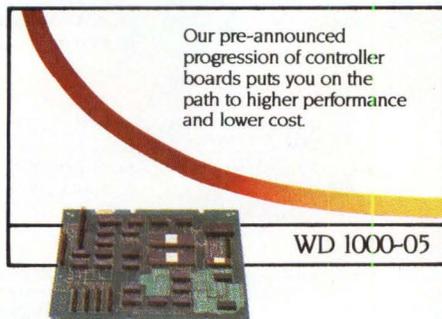
If, by any chance, you've been uncertain which company has the lowest price, highest value Winchester disk controllers, our new WD1000-05 will lay that "which" to rest.

Simply put, the WD1000-05 is the new price leader in hard disk controllers. How much a price leader? Our one-piece price, if you care to order an evaluation unit, is just \$150. Can you imagine what we must be selling these for in OEM quantities!

The WD1000-05 is designed for those systems builders who a) want to offer a hard-disk based system to stay competitive and, b) who recognize that shaving \$100 or more from their manufacturing costs could be the key to success.

Our new WD1000-05 is no stripped-down model, either. It includes our remarkable VLSI WD1010 Winchester Disk Controller, and WD1100-11 Support Device. There is on-board sector buffering, data separation, write precompensation and error-checking, too. All on one board, designed to mount atop a 5 1/4" drive.

Call our Controller Hotline, 714/966-7827, for up-to-date details. Or send us your company PO or check for \$150 and we'll send you an WD1000-05 board for evaluation. It's our way of keeping you on top of things.



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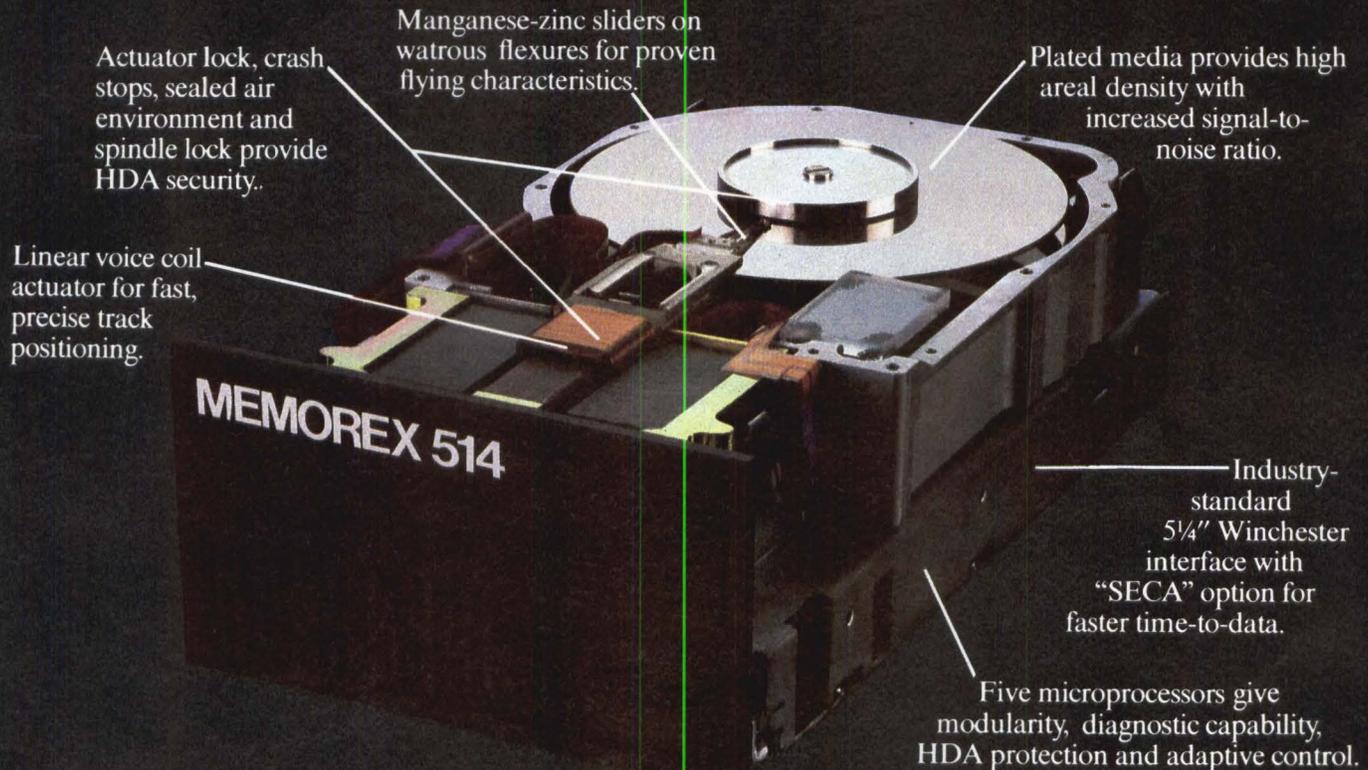
MINI-MICRO SYSTEMS/June 1983

WESTERN DIGITAL
C O R P O R A T I O N

MULTIUSER SMALL BUSINESS SYSTEMS

Company, model	Word size, CPU	Minimum/Maximum memory (K bytes)	Minimum/Maximum no. of users	Operating systems	Languages	Typical price	Typical configuration	Circle No.
Dataram Corp., A22	16-bit, LSI-11/23	256/4000		RT11, RSX-11, RSX-11M, RSX-11 Plus, UNIX, TSX-Plus		\$9800	256K-byte CPU, 10.4M-byte Winchester disk drive, floppy disk drive	711
Digilog Business Systems Inc., 1850	8-bit, 2 Z80As		1/16	TurboDOS	BASIC, COBOL, any CP/M- or MP/M-compatible language	\$25,975	720K-byte floppy disk drive, 42M-byte Winchester disk drive, 10M-byte hard disk drive, 4 model 900 workstations	712
1800	8-bit, 2 Z80As	128/	1/16	TurboDOS	BASIC, COBOL, any CP/M- or MP/M-compatible language	\$14,975	2 Z80 microprocessors with 64K-byte RAM each, 720K-byte floppy disk drive, 5M-byte Winchester disk drive, 4 model 900 workstations	
Digital Equipment Corp., LSI-11/2	16-bit, LSI-11	8/32		RT-11, RSX-11S	BASIC, FORTRAN, Macro II			713
LSI-11/23	16-bit, LSI-11	32/256		RT11, RSX-11M, RSX-11S	BASIC, FORTRAN, Macro II			
PDP-11/23	16-bit, PDP-11	32/256		RT-11, RSX-11M, RSX-11S	BASIC, FORTRAN, COBOL, APL, CORAL 86, RPG-II, Macro, DIBOL, DSM-11			
PDP-11/24	16-bit, PDP-11	128/1M		RT-11, RSX-11M, RSX-11A, RSTS/E	BASIC, FORTRAN, COBOL, APL, CORAL 66, RPG-II, Macro, DIBOL, DSM-11			
PDP-11/34	16-bit, PDP-11	64/256		RT-11, RSX-11M, RSX-11S, RSTS/E, IAS, DSM-11	BASIC, FORTRAN, COBOL, APL, CORAL 86, RPG-II, Macro, DIBOL, DSM-11			
Digital Microsystems Inc., DMS/100 series	8-bit, Z80B	64/	1/32	CP/M-80, CP/M-86	BASIC, FORTRAN, COBOL, Pascal	\$17,000	File processor with 64K-byte CPU, 46M-byte Winchester disk drive, 4 workstations	714
Digitex, 8000 series	8-bit, Z80B	128/512	/12	OASIS	BASIC, COBOL, Dataplus, C	\$12,000	256K-byte CPU, 10M-byte Winchester disk drive, 45-cps word-processing printer, OASIS, Spellbinder	715
Dual Systems Corp., System 83 series	16-bit, 68000	256/3.25M	1/16	UNIX System III	BASIC, FORTRAN, COBOL, Pascal, APL, C	\$16,660	512K-byte CPU, 20M-byte Winchester disk drive, 1M-byte floppy disk drive, 4 serial ports, nonvolatile clock, all system software, one-year warranty	716
Durango Systems Inc., Poppy	16-bit; 80186, 80286	128/1.152M bytes	1/12	MP/M-86, MS-DOS, CP/M-86, XENIX	StarBASIC	\$10,700	2 microprocessors, 128K-byte memory, 10M-byte Winchester disk drive, 800K-byte floppy disk drive, 4 terminals, MS-DOS	717
9XX series	16-bit; 80186, 80286	128/1.152M	1/12	MP/M-86, MS-DOS, CP/M-86, XENIX	StarBASIC	\$16,000	2 microprocessors, 128K-byte memory, 10M-byte Winchester disk drive, 800K-byte floppy disk drive, dot-matrix printer, 4 terminals	

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Memorex Introduces 14" Drive Capacity And Performance In A 5¼" Disc Drive Package.

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It's a Memorex tradition, a summary statement that speaks to our experience, technology and resources. And it's a commitment to supply a complete family of 5¼" rigid disc products, such as our 400 Series fixed/removable drives for system back-up, our 510 Series drives for high capacity with fast access, and products yet to be announced in the 400 and 500 Families.

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CIRCLE NO. 101 ON INQUIRY CARD Telex 411240, Liege, Belgium 041644544, Telex 23438

MULTIUSER SMALL BUSINESS SYSTEMS

Company, model	Word size, CPU	Minimum/Maximum memory (K bytes)	Minimum/Maximum no. of users	Operating systems	Languages	Typical price	Typical configuration	Circle No.
900	8-bit, 8085	64/192	/4	CP/M, MP/M, DX85M	StarBASIC, any CP/M- and MP/M-compatible language	\$14,895	CPU, Winchester disk drive, 946K-byte floppy disk drive, dot-matrix printer, 4 terminals	
Eagle Computer Inc., 1600 series	16-bit, 8086	128/512	/8	MS-DOS, CP/M-86, MP/M, OASIS, XENIX	BASIC, FORTRAN, COBOL, Pascal, APL			718
General Automation Inc., Zebra	16-bit, 68000	256/1M	1/32	Pick	BASIC	\$20,825	256K-byte CPU, 35M-byte Winchester disk drive, 1/4-in. streaming-tape drive	719
Zebra	16-bit, 68000	256/1.5M	1/16	XENIX	BASIC, FORTRAN, COBOL, Pascal, C	\$18,000	256K-byte CPU, 35M-byte Winchester disk drive, 1/4-in. streaming-tape drive	
Grid Systems Corp., Compass Central	16-bit, 80186/8086/8087	640/	1/32 hardware, plus 12 phone links	INGRID, MS-DOS	BASIC, FORTRAN, COBOL, Pascal, PL/M, C	\$26,000	Compass central, 2 Compass workstations	720
Hewlett-Packard Co., HP 250	16-bit, Proprietary	256/896	1/10	Proprietary	BASIC	\$17,000	256K-byte CPU, 9.7M-byte hard disk drive, 1.2M-byte floppy disk drive	721
Honeywell Information Systems Inc., MicroSystem 6/10	16-bit, Micro 6	128/512	1/2	GCOS 6 (General Comprehensive Operating System)	BASIC, FORTRAN, COBOL, Pascal	\$11,900	512K-byte, 20M-byte hard disk drive, 650K-byte floppy disk drive, GCOS operating system, VIP 7383 office-automation terminal	722
DPS 6/31	16-bit, Proprietary	256/1M	2/16	GCOS 6, MOD 400 R.3	BASIC, FORTRAN, COBOL, Pascal, RPG-II	\$24,785	256K-byte CPU, 13M-byte hard disk drive, 2 current-loop ports, 2 VIP 7201 terminals, 100-cps dot-matrix printer, GCOS 6 MOD 4 R.3 license	
IBC/Integrated Business Computers, Ensign	16-bit, 68000	512/8000	16/32	OASIS-16, UNIX	BASIC, FORTRAN, COBOL, Pascal, C, SIBOL	\$25,000	512K-byte CPU, 85M-byte Winchester disk drive, 16 I/O ports	723
Cadet	8-bit, Z80B	64/256	6/9	MP/M, OASIS, FAMOS	BASIC, COBOL	\$11,000	128K-byte CPU, 50M-byte Winchester disk drive, 6 I/O ports	
Middi-Cadet	8-bit, Z80B	256/512	10/10	MP/M, OASIS, FAMOS	BASIC, COBOL	\$7495	256K-byte CPU, 10 I/O ports, Centronics port, 20M-byte Winchester disk drive	
Super Cadet	8-bit, Z80B	256/1000	8/24	MP/M, OASIS, FAMOS	BASIC, COBOL	\$12,000	85M-byte Winchester disk drive, 8 I/O ports, 256K-byte CPU	
IBM Corp., Information Systems Group, Series/1 model 4952	16-bit	32/128		RPS, EDX, CPS	BASIC, FORTRAN, COBOL			724
Series/1 model 4953	16-bit	16/64		RPS, EDX, CPS	FORTRAN, COBOL, PL/1			

How do you create a microcomputer to match the power of the UNIX™ operating system?

Imagine. You are perfecting a revolutionary operating system. In about two years, it will be the system of choice for 16-bit microcomputers.

It will be called the UNIX operating system.

But the breakthrough features of this operating system are going to make stringent demands on the computer.

The microcomputer developed specifically for the UNIX operating system more than two years before its commercial distribution is called ONYX.™

ONYX will live up to every demand and expectation.

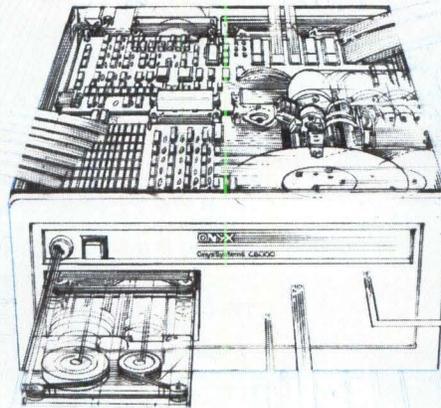
To achieve the ultimate flexibility, simplicity, efficiency and productivity, the UNIX operating system will incorporate a file system of highly uniform sets and sub-sets of directories, arranged in a tree-like hierarchical structure.

And flexible directory and file protection modes, allowing all combinations of "read," "write," and "execute" access, independently for each file or directory, for a group of users.

But these advantages will require intensive disk access, and superior memory management. In simple language, disk access must be as fast as possible, and the disk must have an unusual capacity to maintain complex file systems on-line at all times.

Floppy disks with their low capacities and high access times won't do.

Winchester disk drives that utilize slow-moving stepper motor head positioning devices won't do.



ONYX's IMI Winchester disk storage system, with its servo-driven voice coil head positioning, is more than twice as fast!

So, obviously the ONYX C8002 will do.

And, as developed, the ONYX C8002 features expandable memory up to 1 Mbyte, and disk storage up to 160 Mbytes on-line. Its cartridge tape backup offers cyclical redundancy checking on every backup. Both the Winchester disk storage system and the cartridge tape backup are *internal*.

In the UNIX operating system environment, the disk becomes an extension of main memory. "Swapping" programs between the disk and main memory



increases the number of operations that can run concurrently. ONYX's memory management system utilizes "scatter" instead of "contiguous" allocation, and the more efficient swapping minimizes demand on the disk channel. That's why ONYX assures a highly efficient environment for the UNIX operating system.

Now it's 1982. The UNIX system's pre-eminence among 16-bit operating systems is established. And ONYX is the only company that has significant production experience with UNIX systems.

ONYX has installed over 1500 UNIX systems.

Today there are a lot of systems being developed to operate UNIX (and "look-alike") operating systems. But there are many reasons why you should consider ONYX and the UNIX operating system as inseparable.

System III available now for immediate delivery.

Phone this special number: (408) 946-6330 Ext. 251. Ask about these System III enhancements, including:

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- "Term Cap" capability that supports a wide variety of terminal interfaces;
- Enhanced printer handling capability;
- SCCS to maintain edit histories in text management applications.

*UNIX is a trademark of Bell Laboratories.

Make the Connection

CIRCLE NO. 102 ON INQUIRY CARD

ONYX UNIX

OPERATING SYSTEM

Onyx Systems Inc., 25 East Trimble Road, San Jose, CA 95131

MULTIUSER SMALL BUSINESS SYSTEMS

Company, model	Word size, CPU	Minimum/Maximum memory (K bytes)	Minimum/Maximum no. of users	Operating systems	Languages	Typical price	Typical configuration	Circle No.
Series/1 models 4954A, 4954B, 4954C	16-bit	64/256		RPS, EDX, CPS	FORTRAN, COBOL, PL/1			
Series/1 model 4955 A/C	16-bit	16/64		RPS, EDX, CPS	BASIC, FORTRAN, COBOL, PL/1			
Series/1 model 4955 B/D	16-bit	32/128		RPS, EDX, CPS	BASIC, FORTRAN, COBOL, PL/1			
Series/1 model 4955 E/F	16-bit	64/512		RPS, EDX, CPS	BASIC, FORTRAN, COBOL, PL/1			
Series/1 model 4962	16-bit	128/128		RPS, EDX, CPS	FORTRAN, COBOL, PL/1			
System/34 model 5340	16-bit	32/256		SSP	BASIC, FORTRAN, COBOL, Assembly			
System/7 model 5010	16-bit				FORTRAN, APL			
IMS International,								725
5000	8-bit, Z80A	64/320	1/4	CP/M, MP/M, TurboDOS	BASIC, FORTRAN, COBOL			
5000SX	8-bit, Z80A	64/576	1/8	TurboDOS	BASIC, FORTRAN, COBOL			
8000SX	8-bit, Z80A	64/576	1/8	CP/M, MP/M, TurboDOS	BASIC, FORTRAN, COBOL			
8000S	8-bit, Z80A	64/1M	1/16	CP/M, MP/M, TurboDOS	BASIC, FORTRAN, COBOL			
Instrumentation Laboratory, Inc., Pixel Div.,								726
Pixel 80 Series	16-bit, 68000	512/6000	1/16	UNIX	BASIC, FORTRAN, COBOL, Pascal, APL, Assembler, C, Ada	\$19,900	1M-byte CPU; 40M-byte Winchester disk drive; choice of 2 floppy disk drives, 1 cartridge Winchester disk drive or 1 streaming-tape drive; high-resolution display sub system; UNIX	
Intertec Data Systems Corp.,								727
CompuStar	8-bit, Z80A	64/64	1/255	CP/M 2.2	BASIC, FORTRAN, COBOL, Pascal, APL	\$13,500	10M-byte Winchester disk drive with built-in controller, 3 intelligent workstations with 64K-byte memory each, intelligent workstation with 64K-byte memory and 2 375K-byte floppy disk drives	
Logical Business Machines,								728
ADAM business computer	16-bit, 8086	128/256	1/4	Proprietary	Logical	\$20,000 to \$25,000	20M-byte Winchester disk drive; 20M-byte streaming cartridge tape drive; 1 to 4 workstations; 128K-byte CPU; operating software including Filer dbm, 1 language (English)	
MAI Basic Four Information Systems,								729
S/10	8-bit, Z80	128/128	1/2	CP/M 2.2, BB/M	BASIC	\$3995	128K-byte CPU, 655K-byte floppy disk drive	
S/80	8-bit, Z80A	64/	1/4	BOSS	BASIC	\$14,635	File manager with 64K-byte memory, 10M-byte Winchester disk drive, 1.2M-byte floppy disk drive, 12-in. display terminal, 45-cps letter quality printer, BOSS	

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Putting Technology To Work For You

CIRCLE NO. 103 ON INQUIRY CARD

ADAPTEC'S PIPELINE TO PERFORMANCE

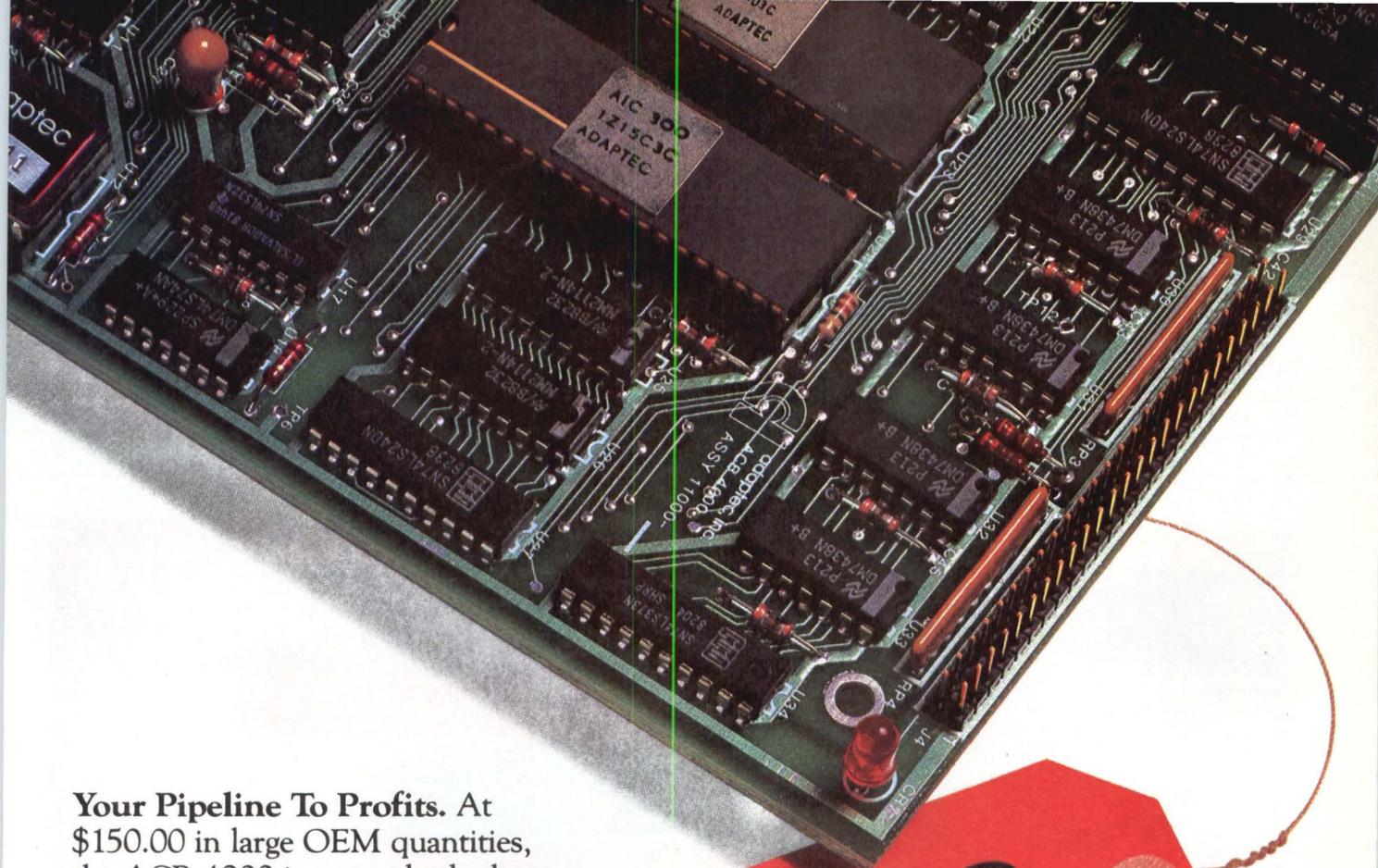
Break the I/O Bottleneck With High Performance Winchester Controllers for \$150.00. Or Less.

Wrench Open Your System's Performance. Adaptec's ACB-4000 Winchester disk controller is the highest performance, lowest cost small disk controller available today.

Period. Features like non-interleaved operation provide up to four times the performance of competitive controllers in I/O operations. Sector-level defect skipping slashes seek times while yielding more usable disk capacity. And

since Adaptec controllers offer extended SASI/ANSI SCSI compatibility, they are more flexible and easy to integrate. So getting your 8/16-bit system to market fast is more than a pipe dream.





Your Pipeline To Profits. At \$150.00 in large OEM quantities, the ACB-4000 is not only the lowest cost, but also the most cost effective complete controller solution available today. SASI/ANSI SCSI compatibility provides a number of important benefits like reduced system design time, and device independent operation. ACB-4000 power consumption is only about half of competitive controllers', further saving you time and money. But just as important, the ACB-4000 provides a direct, easy upgrade path to our multi-user system controller, the ACB-5000. So your present system is also your pipeline to the future.



The Best You Can Make ... Or Buy. The ACB-4000 solution is also available as a 3-chip set, the ACS-4000, with complete software, PCB design and manufacturing information. That means you can drive board costs way below \$150.00 by taking advantage of your high volume manufacturing economies. And of course, we'll be happy to provide complete ACB-4000 boards while you are ramping up production.

A Great Connection. For more information about Adaptec's high performance family of host adapters, Winchester controller boards, chips and chip sets, connect with Jeff Miller, Director of Marketing, (408) 946-8600. Or write Adaptec, 1625 McCarthy Boulevard, Milpitas, CA 95035.

 **adaptec, inc.**

**The best controller connection
you can make ... or buy**

CIRCLE NO. 104 ON INQUIRY CARD

MULTIUSER SMALL BUSINESS SYSTEMS

Company, model	Word size, CPU	Minimum/Maximum memory (K bytes)	Minimum/Maximum no. of users	Operating systems	Languages	Typical price	Typical configuration	Circle No.
110	8-bit, MOS	64/256	1/16	BOSS	BASIC	\$20,010	Dumb terminal, 10M-byte Winchester disk drive, 80-cps printer, 9.2M-byte cartridge tape drive, 64K-byte CPU	
210						\$28,280	64K-byte CPU, 10M-byte Winchester disk drive, 9.2M-byte cartridge-tape drive, dumb terminal, 80-cps printer.	
Microdata Corp.,								730
Reality 4700	8-bit, Proprietary	64/512	1/48	Proprietary Data Management System	English, Data BASIC, PROC, Screenpro	\$26,985	64K-byte CPU, 1/2-in. 1600-bpi streaming-tape drive, 32M-byte Winchester disk drive, 8-port async controller	
Molecular Computer,								731
Supermicro X series	8-bit; Z80B, Z80A	64/	1/64	n/STAR	BASIC, FORTRAN, COBOL, Pascal, Assembler, PL/1, C	\$18,995	256K-byte CPU, 60M-byte hard disk drive, 500K-byte floppy disk drive, 32 application processor slots, n/STAR	
Momentum Computer Systems International,								732
Hawk-32/4	16-bit, 68000	/1000	/4	UNIX	BASIC, FORTRAN, COBOL, Pascal, C, IDOL, Assembler			
Monolithic Systems Corp.,								733
MSC 8802-28	8-bit, three Z80As	128/1M	1/7	MP/M	any MP/M-compatible language	\$12,210	320K-byte memory, 3 Z80A microprocessors, 2 0.5M-byte floppy disk drives, 7-slot Multibus chassis, 3 terminals	
MSC 8805-01	8-bit; 2 Z80As for file management, one Z80A per user	64/	1/16	CP/NOS	any CP/M-compatible language	\$12,750	0.5M-byte floppy disk drive; 10M-byte Winchester disk drive; 7-slot chassis with user card, cabinet, power supply, 2 spooled printer ports	
NCR Corp.,								734
NCR Tower 1632	16-bit, 68000	256/2M	1/16	UNIX	BASIC, FORTRAN, COBOL, C	\$12,000	256K-byte memory, 10M-byte Winchester disk drive, 1M-byte floppy disk drive	
NEC Information Systems, Inc.,								735
Astra 210-200	16-bit, Proprietary	256/384	1/4		BASIC, FORTRAN, COBOL, SMART, Assembly			
Advanced Personal Computer	16-bit, 8086	128/256		CP/M-86, MS-DOS, UCSD-p system	BASIC, COBOL, RPG, Assembly	\$9981	256K-byte CPU, color display, 2 1M-byte floppy disk drives, 9.7M-byte hard disk drive, keyboard, 100-cps dot-matrix printer, graphics subsystem	
Nixdorf Computer Corp.,								736
8860/10; 8860/40	16-bit	/1M		DIPOS	COBOL			
8860/5	16-bit	750/750		DIPOS	COBOL			
8810	8-bit, Z80	64/192		CP/M, MP/M, NIROS	BASIC, FORTRAN, COBOL			
NoHALT Computers, Inc.,								737
NH-1000	8-bit, Z80	64/	1/16	any CP/M- and MP/M-compatible language	BASIC, FORTRAN, COBOL, Pascal, PL/1, RPG			



SEEING IS BELIEVING

NOW WANGTEK'S 1/4-INCH STREAMER PACKS 20 OR 45 MEGABYTES INTO A HALF-HIGH 5.25-INCH SPACE.

Wangtek now opens up new design and marketing options to the systems integrator and the OEM with its introduction of the Series 5000, the only available 20 or 45 Mbyte half-high 1/4-inch streamer; an ideal backup for 5 1/4-inch Winchester.

Check these advanced features:

Small size: The Series 5000 can be easily packaged with a half-high 5 1/4-inch floppy or half-high Winchester.

D.C. voltages: Uses the same voltages as a minifloppy and 5 1/4-inch Winchester (+5V, +12V).

QIC-compatibility: Packaged in an additional half-high module, the two-board intelligent formatter is capable of reading and writing the QIC-24 defined recording format facilitating data interchange and is I/O compatible to the QIC-02 defined intelligent interface standard.

Easy cartridge loading: The Series 5000 incorporates a unique single-action cartridge loading mechanism for easy operation.

Positive tape interchangeability: With its rigid and stable aluminum deck, stiffer head carriage assembly and track reference burst, the Series 5000 can consistently and precisely position the read-write heads over a desired track on a cartridge written on any 1/4-inch streamer.

Host adapter: The half-high intelligent formatter module contains an additional slot for a custom PCB that could be used as an adapter to any host CPU bus.

The Series 5000 is easy to integrate into existing systems and a must for future designs. Call now for delivery, pricing, and facts on Wangtek's new Peripheral Integration Program.

Wangtek, 5845 Uplander Way, Culver City, California 90230, (213) 410-1444, Telex: 664425.

 wangtek

CIRCLE NO. 105 ON INQUIRY CARD

MULTIUSER SMALL BUSINESS SYSTEMS

Company, model	Word size, CPU	Minimum/Maximum memory (K bytes)	Minimum/Maximum no. of users	Operating systems	Languages	Typical price	Typical configuration	Circle No.
								738
North Star Computers, Horizon	8-bit, Z80A	64/352	1/5	Proprietary, CP/M	BASIC, FORTRAN, COBOL, Pascal	\$3599	64K-byte CPU, 2 floppy disk drives	
								739
Onyx Systems, Inc., Sundance-16	16-bit, Z8000	256/512	1/5	UNIX	BASIC, FORTRAN, COBOL, Pascal, C	\$15,490	512K-byte CPU, 14M-byte Winchester disk drive, 132-col. display workstation	
Sundance II	8-bit, Z80A	128/256	1/3	CP/M, MP/M, OASIS	BASIC, COBOL	\$10,050	128K-byte CPU, 14M-byte Winchester disk drive, workstation	
System 2000	16-bit, 8088	64/256	1/4	MP/M-86, Business BASIC, OASIS-16	BASIC, COBOL	\$11,990	256K-byte CPU, 21M-byte Winchester disk drive	
System 3000	16-bit, 8088	64/512	1/4	OASIS-16, Business BASIC	BASIC, COBOL	\$15,500	256K-byte CPU, 40M-byte Winchester disk drive	
C5001 A	8-bit, Z80A	128/256	1/3	CP/M, MP/M, OASIS	BASIC, COBOL	\$6990	128K-byte CPU, 12M-byte Winchester disk drive	
C8002	16-bit, Z8000	256/1M	1/8	UNIX System III	BASIC, FORTRAN, COBOL, Pascal, C	\$17,000	256K-byte CPU, 20M-byte Winchester disk drive	
C 5002 A	16-bit, Z8000	256/512	1/5	UNIX System III	BASIC, FORTRAN, COBOL, Pascal, C	\$12,990	256K-byte CPU, 21M-byte Winchester disk drive	
C 8002A	16-bit, Z8000	256/512	1/5	UNIX System III	BASIC, FORTRAN, COBOL, Pascal, C	\$16,490	256K-byte CPU, 40M-byte Winchester disk drive	
C5001/MU	8-bit, Z80A	128/256	1/5	CP/M, MP/M, OASIS	BASIC, COBOL	\$10,350	256K-byte CPU, 21M-byte Winchester disk drive	
C8001/MU	8-bit, Z80A	128/256	1/5	CP/M, MP/M, OASIS	BASIC, COBOL	\$13,990	256K-byte CPU, 40M-byte Winchester disk drive	
								740
OSM Computer Corp., ZE μ S4	8-bit, Z80A	64 per user	1/4	MUSE	any CP/M-compatible language	\$4595	64K-byte CPU, 6.3M-byte Winchester disk drive, 250K-byte floppy disk, chassis	
ZE μ S3	8-bit, Z80A	64 per user	2/8	MUSE	any CP/M-compatible language	\$11,585	4 users, 12M-byte hard disk drive, 20M-byte streaming tape drive, MUSE operating system	
ZE μ S2	8-bit, Z80A	64 per user	1/64	MUSE	any CP/M-compatible language	\$19,725	4 users, 35M-byte hard disk drive, 20M-byte streaming tape drive, UPS, MUSE operating system	
								741
Pertec Computer Corp., 3000	16-bit, 68000	256/1.1M	1/18	3000 OS	BASIC, COBOL, APL, C	\$19,000	640K-byte CPU, 35M-byte Winchester disk drive, 1.2 M-byte floppy disk drive, 4 workstations	
2000	8-bit, 8085	64/128	/5	MTX	BASIC	\$12,500	128K-byte CPU, 5M-byte fixed hard disk drive, 5M-byte removable hard disk drive, 3 workstations, 1.2M-byte floppy disk drive	
								742
Plessey Peripheral Systems, 6200 series	16-bit, LSI-11/02-23	/256	/5	RT-11/TSX, RSX-11M M-11 (MUMPS), UNITY	BASIC, FORTRAN, COBOL, Pascal, Macro-11, MUMPS, C	\$11,760	20.8M-byte Winchester disk drive, 1/4-in. streaming-tape drive, 256K-byte CPU, chassis	

WILL YOUR COMPUTER MOVE UP WITH YOU?

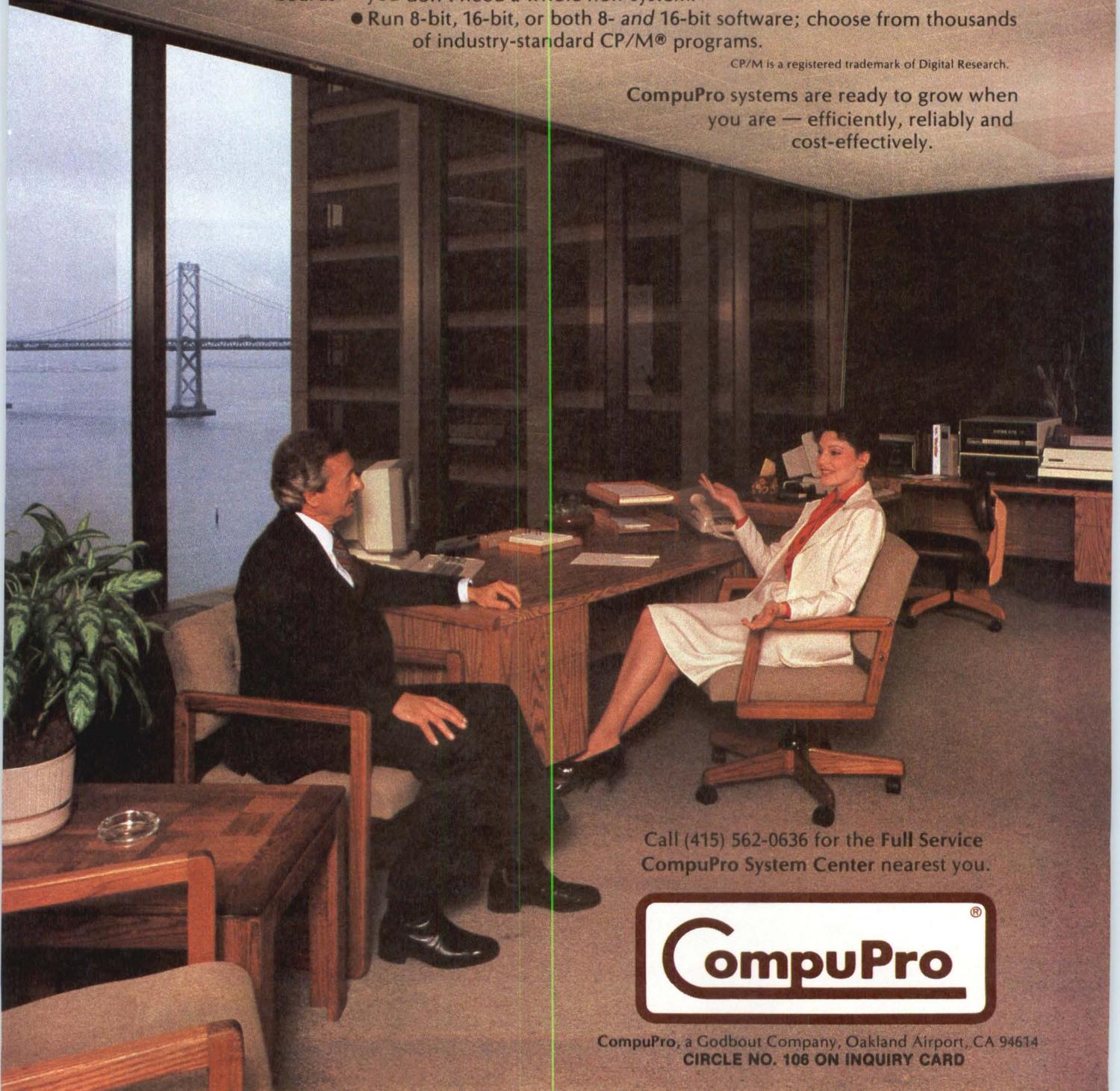
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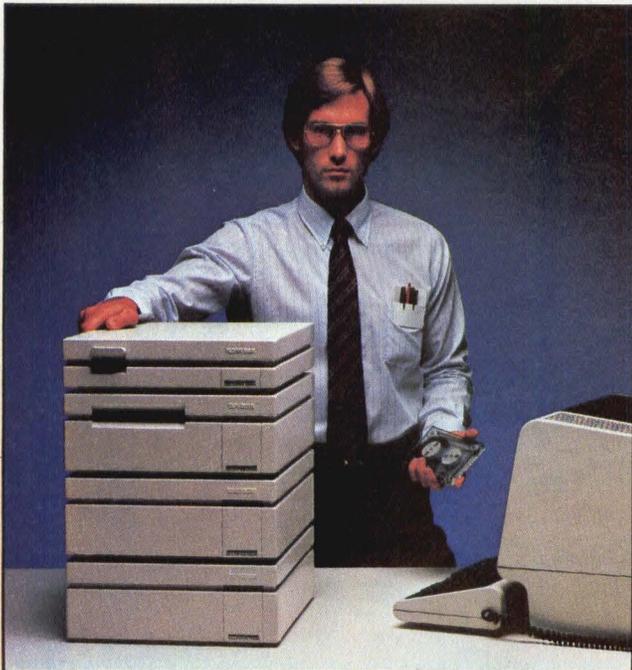
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This is a brand new deal for systems integrators. StacPac systems and modules. Modular storage and backplane units that stand alone or stack together to form the basis of a small but powerful tabletop computer.

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On the Multibus side, you can use our StacPac system to deliver serious minicomputer performance with microcomputer economy.



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CIRCLE NO. 107 ON INQUIRY CARD

MULTIUSER SMALL BUSINESS SYSTEMS

Company, model	Word size, CPU	Minimum/Maximum memory (K bytes)	Minimum/Maximum no. of users	Operating systems	Languages	Typical price	Typical configuration	Circle No.
								743
Plexus Computers, Inc., P/25	16-bit, Z8000	512/2M	1/16	UNIX	BASIC, FORTRAN, COBOL, Pascal, C	\$16,950	Job processor, communications processor, 512K-byte ECC memory, 16-bit intelligent mass-storage processor, 22M-byte Winchester disk drive, streaming cartridge-tape drive, 8 serial ports, parallel port	
P/35	16-/32-bit; 68000, 28000	512/2M	1/16	UNIX	BASIC, FORTRAN, COBOL, Pascal, C	\$19,950	Job processor, communications processor, 512K-byte ECC memory, 16-bit mass-storage processor, 22M-byte Winchester disk drive, streaming cartridge-tape drive, 8 serial ports, parallel port	
								744
PolyMorphic Systems, Inc., 8810/2	8-/16-bit, 8080 or Z80A plus 80/86	256/1M	1/5	CP/M-80, Concurrent CP/M-86	BASIC, FORTRAN, COBOL, Pascal, APL, C	\$8000	Z80A microprocessor; 3 80/86 microprocessors; 256K-byte memory; operating-system software; 2 700K-byte floppy disk drives; 3 terminals; word-processing, graphics software	
8813	8-bit/16-bit, 8080 or Z80A plus 80/86	256/1M	1/22	CP/M-80, Concurrent CP/M-86	BASIC, FORTRAN, COBOL, Pascal, APL, C	\$9500	Z80A microprocessor; 3 80/86 microprocessors; 256K-byte memory; 2 700K-byte floppy disk drives; 3 terminals; operating-system, word-processing and graphics software	
								745
Rexon Business Machines Corp., RX100	16-bit, 8086-2	128/960	/8	MP/M-86, RECAP	BASIC	\$11,350	128K-byte CPU, 10M-byte Winchester disk drive, 1/4-in. cartridge-tape drive	
								746
Sage Computer Technology, Sage IV	16/32, 68000	128/1M	1/6	P, CP/M-68K, Modula 2, HyperFORTH	BASIC, FORTRAN, Pascal, Modula, FORTH	\$12,000	1M-byte memory, 6M-byte Winchester disk drive, 6 terminals	
								747
SCI-COM Computer Systems, Series 8600	16-bit, 8086	128/512	1/4	MS-DOS, CP/M-86, MBOS, OASIS-16, UNIDOL, MP/M-86	BASIC, FORTRAN, COBOL, Pascal, C	\$12,890	256K-byte CPU, 640K-byte floppy disk drive, 10M-byte Winchester disk drive, 3 terminals, MBOS	
								748
Sentinel Computer Corp., 10	16-bit, 8086	64/1M	1/17	DBOS	BASIC, COBOL, DBL	\$15,000	160K-byte CPU, 2 1.6M-byte floppy disk drives, 2 terminals	
								749
Smoke Signal Broadcasting, Chieftain	16-bit, 6809	64/1M	1/12	DOS 690, Flex, OS9 Level 1, 2	BASIC, COBOL, Pascal, Assembler, Forth, C	\$4525	CPU, 2 750K-byte floppy disk drives, choice of 64K-byte static or 128K-byte dynamic RAM, DOS69D	
								750
Systems Group, System 2900	8-bit, Z80	64/512	4/20	OASIS, MP/M, Business Express	BASIC, FORTRAN, COBOL, Pascal, APL, Microsoft 5.0	\$10,000	Z80 CPU; 128K-byte RAM; 16M-byte disk drive with tape drive, 4 terminals	
								751
Tandy Corp./ Radio Shack, Model 16	8-/16-bit; Z80A, 68000	128/512	1/3		COBOL	\$5798	128K-byte memory; Z80A, 68000 microprocessors; 2 1.25M-byte floppy disk drives	
								752
TeleVideo Systems, Inc., TS806/20	8-bit, Z80A	64/64	1/6	CP/M 2.2, MMMost		\$7195	64K-byte CPU, 0.5M-byte floppy disk drive, 19.1M-byte Winchester disk drive	
TS816/40	8-bit, Z80A	128/128	1/16	CP/M 2.2, MMMost		\$12,995	128K-byte CPU, 42.7M-byte Winchester disk drive, 17.4M-byte tape drive	

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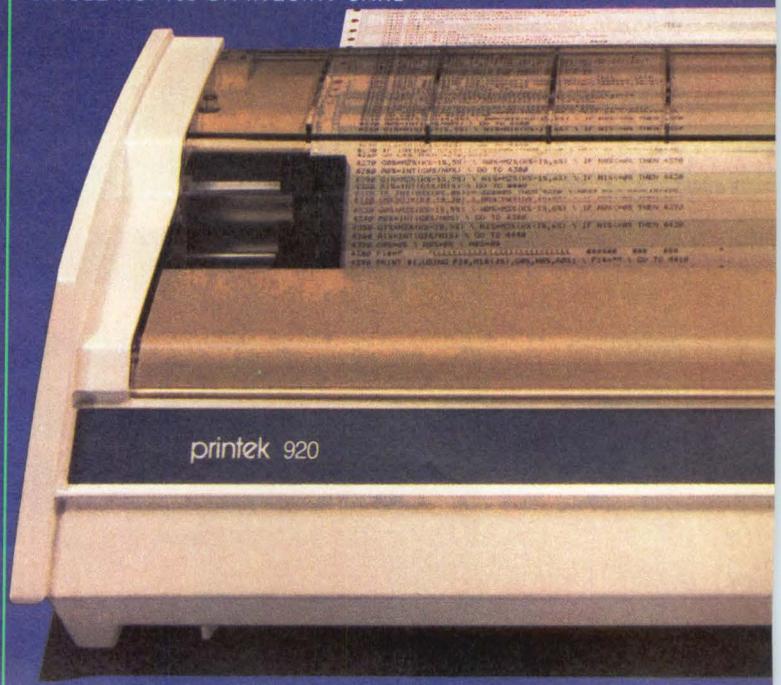
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CIRCLE NO. 108 ON INQUIRY CARD



MULTIUSER SMALL BUSINESS SYSTEMS

Company, model	Word size, CPU	Minimum/Maximum memory (K bytes)	Minimum/Maximum no. of users	Operating systems	Languages	Typical price	Typical configuration	Circle No.
Texas Instruments, Inc., Data Systems Group,								753
Business System 300 Series	16-bit, TMS9900 (Proprietary)	256/512	1/7	DX10 (Proprietary), UCSD-p System as a task under DX10	BASIC, FORTRAN, COBOL, Pascal	\$17,895	256K-byte CPU, 10M-byte Winchester disk drive, 1.2M-byte floppy disk drive, 3 terminals	
Thoughtworks								754
TW-800	8-bit, Z80A	64/	1/16	TurboDOS	any CP/M-compatible language	\$16,500	64K-byte CPU, 500K-byte floppy disk drive, TurboDOS, cabinet, 2 slave processor boards, 10M-byte hard disk drive, 2 terminals, printer	
Vector Graphic Inc.,								755
5E Series	8-bit, Z80B	128/	1/3	extended CP/M	BASIC, FORTRAN, COBOL, Assembler	\$11,995	128K-byte CPU, 32M-byte hard disk drive, 630K-byte floppy disk drive, extended CP/M, scope screen editor, versions of BASIC, Memorie III, Execuplan II, DDT	
Wang Laboratories, Inc.,								756
2200 MVP	24-bit, Proprietary 2200	16/512	1/13	Proprietary	BASIC, COBOL	\$17,700	64K-byte CPU, 4M-byte fixed disk drive, 1M-byte floppy disk drive, 2 workstations, 80-cps matrix printer	
VS 25	16-bit, Proprietary	512/1024	1/10	VS (Proprietary)	BASIC, FORTRAN, COBOL, PL/1, Assembler, RPG-II	\$25,000	512K-byte CPU, bus processor, 1.2M-byte floppy disk drive, 16-port serial controller; disk controller, 34M-byte fixed disk drive, VS operating system, choice of one compiler	
VS 45	16-bit, Proprietary	512/1024	1/20	VS (Proprietary)	BASIC, FORTRAN, COBOL, PL/1, Assembler, RPG-II	\$21,000	512K-byte CPU, bus processor, 1.2M-byte floppy disk drive, 32-port serial controller, VS operating system, choice of one compiler	
Wicat Systems, Inc.,								757
150 WS	16-bit, 68000	256/1.5M	1/6	MCS, UNIX, UniPlus	BASIC, FORTRAN, COBOL, Pascal, APL, Assembler, C, DIBOL			
160	16-bit, 68000	512/4.5M	1/12	MCS, UNIX, UniPlus	BASIC, FORTRAN, COBOL, Pascal, APL, C, Assembler, DIBOL			
System 200	16-bit, 68000	512/5M	8/32	UNIX, MCS, UniPlus	BASIC, FORTRAN, COBOL, Pascal, APL, Assembler, C, DIBOL			
Zendex Corp.,								758
9586	16-bit, 8086/8087 combination	0.5M/1M	1/9	RMX-86	FORTRAN, Pascal, C, PLM	\$24,950	0.5M-byte CPU, clock/calendar board, 2 1M-byte floppy disk drives, 42M-byte Winchester disk drive, 8 intelligent channels	
Zentec Corp.,								759
Series 2000	16-bit, 8086	256/1M	1/6	Xenix	BASIC, FORTRAN, COBOL, Pascal, C	\$13,500	512K-byte CPU, 10M-byte Winchester disk drive, 750K-byte floppy disk drive, integral workstation, 2 additional workstations	
Zilog Inc.,								691
System 8000 line	16-bit, Z8000	256/4M	8/24	enhanced UNIX	BASIC, FORTRAN, COBOL, Pascal, C	\$29,950	1M-byte CPU, 32M-byte Winchester disk drive, 17M-byte cartridge-tape drive	

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A new magnetic tape unit—The 4968 is an inexpensive way to backup data and programs. It provides automatic loading, which means faster, more convenient use.

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On November 16, 1976, we announced the IBM Series/1 computer. Since then, we've introduced many improvements to the system. If you had acquired a Series/1 over the past six years, with its open architecture you could have simply plugged in most of those improvements. Without sacrificing your original investment.

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6-83

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Company _____

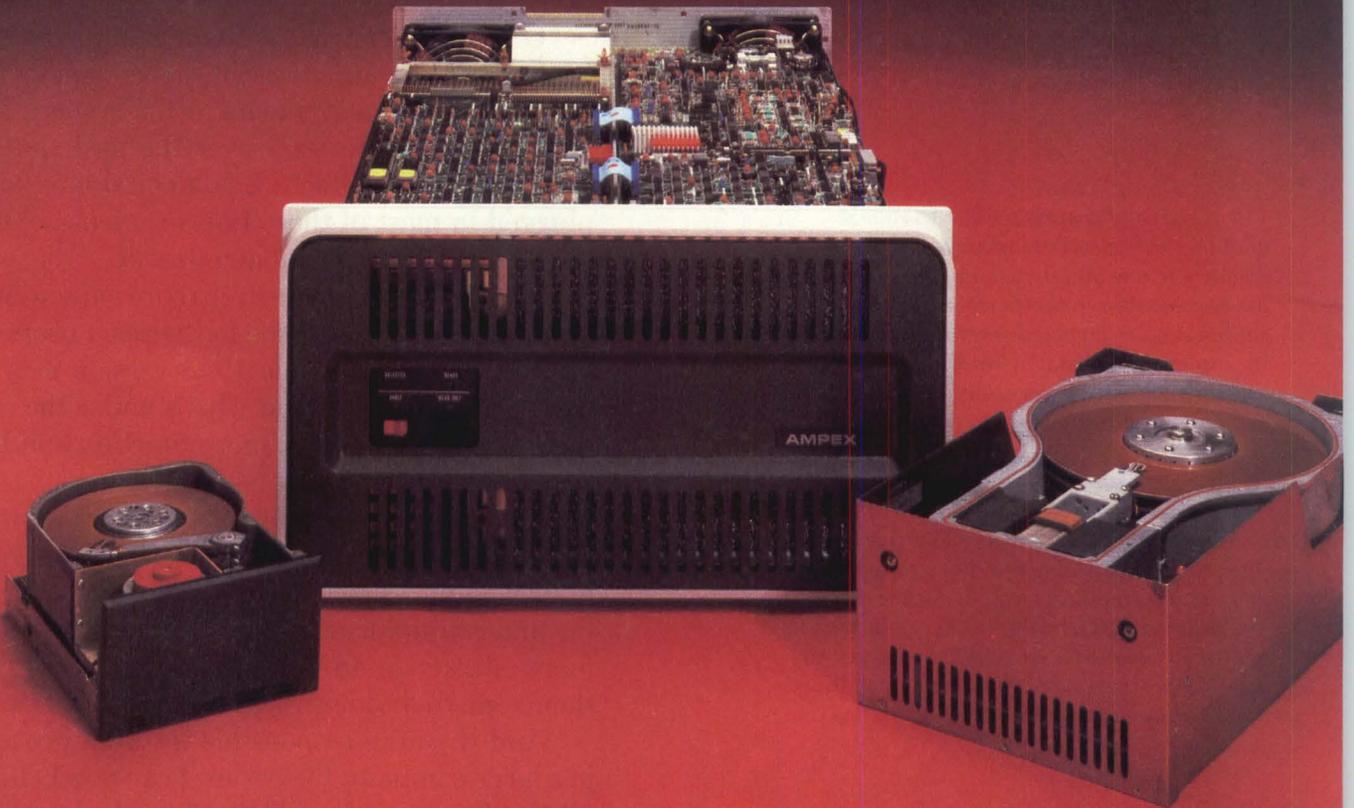
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DISK DRIVES

Large disks: greater capacities, greater choice

HAROLD J. McLAUGHLIN, Business Research Consultants

*Vendors of 14-in. fixed and removable disks
offer a range of products
reaching gigabytes in capacity*

Although high-capacity disk drives encompass a number of applications and technologies, they can be divided into two broad categories: removable and fixed. Each has had separate development stages, marked by milestone products and culminating in today's highest capacity drives.

Fixed media drives with high capacities (Table 2) were first available in 1973 with IBM Corp.'s model 3340, which stored as much as 70M bytes on six 14-in. data surfaces, recording at 300 tpi and 5636 bpi. This product marked IBM's withdrawal as a manufacturer of removable media drives. As IBM improved its technology with its models 3350, 3370 and 3380, capacity increased from 70M to 1.25G bytes per spindle (Table 1).

OEM suppliers have marketed several products emulating IBM's technology (Table 4). Capacities of 14-in. drives have increased steadily from the modest 26M bytes of Control Data Corp.'s 9730-24 mini module drive in early 1977 to 675M bytes on a single spindle from CDC in early 1980 with its model 9775 fixed media drive. Memorex Corp.'s 678M-byte model 659 was first shipped in 1981, while Storage Technology Corp. and Ibis Systems Inc. both have IBM plug-compatible product offerings with more than 1G-byte capacity. Tecstor Inc. is expanding the capacity of its rack-mountable product offerings from 330M to 660M bytes by increasing flux density from 6450 to 8556 fcpi and changing from modified-frequency-modulation code to

the more efficient run-length-limited code. Track densities will remain at 680 tpi, maintaining compatibility with available media. Other OEM drive suppliers will increase capacity into the multi-gigabyte range in the near future.

Removable disks first achieved high capacities in the

Table 1: IBM removable media drives

Model	3340	3350	3370	3380
Disk diameter (in.)	14	14	14	14
Storage capacity:				
drive (M bytes)	35/70	317.5	571.4	1260.5
track (bytes)	16736	19069	31744	47476
Configuration:				
tracks per surface	696	1110	1500	1770
data heads/surface	2	2	2	2
data surfaces	3/6	15	12	15
actuator type	linear voice coil	linear voice coil	linear voice coil	linear voice coil
Access time (msec.):				
avg. position time	25	25	20	16
avg. latency	10.1	8.4	10.1	8.3
avg. access time	35.1	33.4	30.1	24.3
Density:				
tpi	300	478	635	800 +
bpi	5636	6425	12134	15200
Transfer rate (M bytes/sec.):	0.885	1.198	1.859	3

DISK DRIVES

early '70s with the IBM 3330-1 14-in. removable disk drive with 192 tracks per in. and 4040 bits per in. The resultant 100M bytes, distributed over 19 data surfaces on a single spindle, was then considered quite large. By 1973, the same package (called the 3330-11) provided 200M bytes by increasing track density to 392 tpi. In 1974, CDC increased packing density to 6038 bpi in a removable, rack-mountable drive; this first storage module drive stored 80M bytes on three disks comprising five data surfaces and one servo surface. By 1976, CDC had learned to apply the same principles to a floor-standing drive (the 9766), increasing SMD drive capacity to 300M bytes distributed over 19 data surfaces.

Products with similar features are available from many manufacturers (Table 3), and many are compatible with those mentioned. All these removable drives,

however, are limited by restrictions on track and bit densities to a maximum of 300M bytes per spindle. These restrictions are essentially mechanical, involving drive spindle run-out and pack seating and locking tolerances, which compound the fundamental limitations of magnetic recording technology.

Because of the greater mechanical complexity required for removability, most removable drives in the 300M-byte range sell for about \$40 per megabyte, compared to \$25 per megabyte for fixed drives. For the same reason, mean time between failures for removable drives is about half that of fixed drives (4000 to 5000 hours versus 10,000 hours). But many users requiring backup without the long wait for tape drives find the increased purchase and maintenance costs of removable drives—as well as the \$300 to \$700 cost per disk pack—acceptable. □

Dr. Harold J. McLaughlin is president of Business Research Consultants Inc., San Jose, Calif., an independent consulting firm specializing in the disk drive industry.

Table 2: Representative large fixed media drives

Manufacturer Model Disk diameter (in.)	Ampex DM-980 14	Ampex DM-9160 14	Ampex DM-9300 14	Ball BD-80 14	Ball BD-160 14	Century T-82 14
Unformatted capacity:						
drive (M bytes)	82.9	165.8	312	82.1	165.8	82.1
cylinder (M bytes)	0.1008	0.1008	0.383	0.1008	0.1008	0.1008
track (bytes)	20160	20160	20160	20160	20160	20160
Configuration:						
cylinders	823	1645	815	815	1645	823
data heads	5	5	19	5	5	5
data surfaces	5	5	19	5	5	5
actuator type	linear voice coil	linear voice coil	linear voice coil	linear voice coil	linear voice coil	linear voice coil
Access time (msec.):						
track to track	6	6	6	5	5	6
average	28	28	28	30	30	30
maximum	55	55	55	55	55	55
average latency	8.5	8.5	8.5	8.5	8.5	8.3
Density:						
tpi	384	768	370	370	768	370
bpi	6038	6038	6038			6060
code	MFM	MFM	MFM	MFM	MFM	MFM
Transfer rate (M bytes/sec.):	1.209	1.209	1.209	1.2	1.2	1.209
Interface	SMD	SMD	SMD	SMD	SMD	SMD
Features:						
dual port	optional	optional	optional			optional
internal diagnostics				standard	standard	
sectors	hard-64	hard-64	hard-64			hard/soft
power supply	standard	standard	standard	standard	standard	standard
MTBF (hrs.)						4000
MTTR (hrs.)						1
Power dissipation (watts)				865	865	860
height (in.)	10.5	10.5	38	10.5	10.5	10.4
width (in.)	17.25	17.25	19.25	17.5	17.5	17.5
depth (in.)	30	30	34	31.5	31.5	32
weight (lb.)	165	165	465	180	180	220
Price (quantity 100)	\$5540	\$6250	\$9775	\$5500	\$6500	\$5935

**Table 3: Cost per megabyte comparison:
removable versus fixed drives**

Removable				
Manufacturer	Model	Storage	Quantity 100 Price*	Cost/ M byte
Ampex	DM980	82.9	\$ 5540	\$67
	DM9160	165.8	6250	38
	DM9300	312	9775	31
Ball	BD-80	82.1	5500	67
	BD-160	165.8	6500	39
Century	T-82	82.1	5935	72
	T-306	315	10,515	33
CDC	9762	81.5	6715	82
	9766	309.5	12,355	40
	9710	82.9	5500	66

*Prices were obtained from individual quotations and the 1981 Disk/Trend report.

Fixed				
Ampex	Cap. 165	165.9	\$ 5540	\$33
	Cap. 330	330.3	5155	16
	Scor. 80	82.9	3350	40
APS	4830/35	202.2	7500	37
	4830/35	404.5	9060	22
CDC	FSD9715	165.9	6135	37
	9730/160	165.9	6980	42
Century	M-80	80.64	3200	40
	M-160	161	4000	25
	AMS380	378.5	7700	20
Fujitsu	M2312K	84.4	3795	45
	M2284	165.8	4600	28
	M2249K/N	335.5	6500	19
	M2351/AF	474.2	9000	19
Megavault	MV116	116	3450	30
Priam	15450	158.2	4370	28
	804	100	4185	42
Tecstor	S-85	85	4899	58
	S-165	165	5450	33
	S-200	200	6000	30
	S-300	331.8	6551	20

Century T-306 14	CDC 9762 14	CDC 9764 14	CDC 9766 14	CDC 9710 8	IBM 3330-1 14	IBM 3330-11 14
315.2	81.5	154.8	309.5	82.9	100	200
0.383	0.1008	0.383	0.383	0.1008	0.2746	0.2746
20160	20160	20160	20160	20160	13030	13030
823	823	411	823	823	411	815
19	5	19	19	5	19	19
19	5	19	19	5	19	19
linear voice coil	linear voice coil	linear voice coil	linear voice coil	linear voice coil	linear voice coil	linear voice coil
6	6	6	6	6	10	10
30	30	30	30	30	30	30
55	55	55	55	55	55	55
8.3	8.3	8.3	8.3	8.3	8.3	8.3
384	384	192	384	550	192	370
6060	6038	6038	6038	10000	4040	4040
MFM	MFM	MFM	MFM	2/7 RLL	MFM	MFM
1.209	1.209	1.209	1.209	1.209	0.806	0.806
SMD	SMD	SMD	SMD	SMD	IBM	IBM
optional	optional	optional	optional	optional		
hard/soft standard	hard/soft standard	hard/soft standard	hard/soft standard	hard/soft standard	hard/soft standard	
4000	4000	4000	4000	8000		
1	1.5	1.5	1.5			
1040	840	1460	1500	200		
36	10.5	36.2	36.2	10.2		
19.5	19	23	23	8.5		
33	30	36	36	30		
480	160	556	556	60		
\$10,515	\$6715		\$12,355	\$5500		

Table 4: Representative OEM fixed media drives

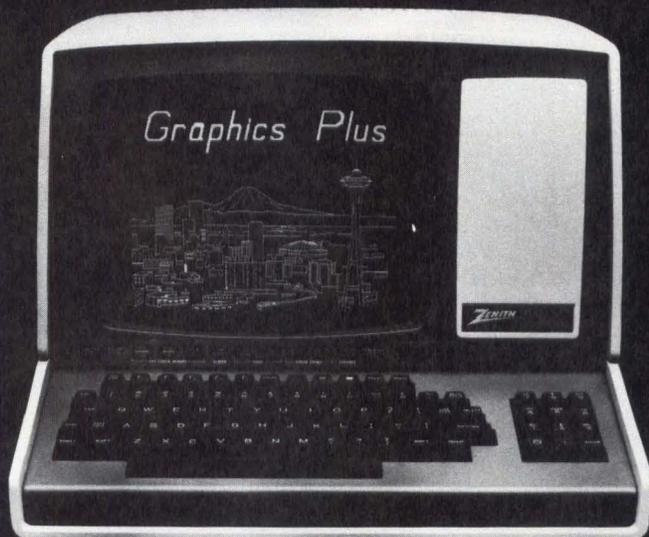
Manufacturer Model Disk diameter (in.)	Ampex CAP 165 14	Ampex CAP 165E 14	Ampex CAP 330 14	Ampex SCOR 80 8	Ampex CAP 660 14	APS 4830 14
Unformatted capacity: drive (M bytes) cylinder (M bytes) track (bytes)	165.9 .2016 20160	165.9 .1008 20160	330.3 .3226 20160	82.9 .1008 20160	660.6 .6451 40320	202.2 .12 40960
Configuration: cylinders data heads disks data surfaces actuator type	823 10 3 5 linear	1645 5 3 5 linear	1024 16 5 8 linear	823 5 3 5 linear	1024 16 5 8 linear	823 6 4 3 linear
Access time (msec.): track to track average maximum average latency	6 30 50 8.3	6 30 50 8.3	6 30 55 8.3	6 32 55 8.3	6 30 50 8.3	5 25 55 16.8/10.1
Density: tpi bpi code	960 5950	960 5950	960 6250	826 10104 RLL	960 125000 2,7 RLL	694 12877 RLL
Transfer rate (M bytes/sec.):	1.209	1.209	1.209	1.209	2.418	1.2/2
Interface	SMD	SMD	SMD	SMD	SMD	SMD
MTBF (hrs.)	9000	9000	9000	10000	12000	
MTTR (hrs.)	0.5	0.5	0.5	0.5	0.5	
height (in.)	10.4	10.4	10.4	5.12	10.4	10.25
width (in.)	17.53	17.53	17.53	8.55	17.53	17.75
depth (in.)	28.03	28.03	28.03	14.25	28.03	29.31
weight (lb.)	128	128	128	25	128	150
Price quantity 100 quantity 500	\$5440		\$5155	\$3350	\$7050	\$7500
Manufacturer Model Disk diameter (in.)	Century AMS 380 14	DEC RA80 14	DEC RM80 14	DEC RA81 14	Fujitsu M2312K 8	Fujitsu M2284 14
Unformatted capacity: drive (M bytes) cylinder (M bytes) track (bytes)	378.5 .448 32000	160(121F) .222 15872	160(124F) .222 15872	465(F) .3656 26112	84.4 .1434 20480	168.5 .2048 20480
Configuration: cylinders data heads disks data surfaces actuator type	845 14 4 7 linear	1092 14 4 7 rotary voice coil	561(X2) 14 4 7 rotary voice coil	1248(X2) 14 4 7 rotary voice coil	589 7 4 7 rotary voice coil	823 10 3 5 rotary voice coil
Access time (msec.): track to track average maximum average latency	6 25 50 12.5	6 25 50 8.3	6 25 50 8.33	6 28 52 8.33	5 20 40 8.3	6 27 55 10.12
Density: tpi bpi code	712 10000 MFM	478 6339	478 6339 MFM	960 11400	720 9550	680 6850 MFM
Transfer rate (M bytes/sec.):	1.28	1.2	1.2	2.2	1.229	1.012
Interface	SMD	UDAunibus	MASSBUS	UDAunibus	SMD	SMD
MTBF (hrs.)	9000				10000	10000
MTTR (hrs.)	1				0.5	1
height (in.)	8.75	10.5	39	10.5	5.1	9.84
width (in.)	19	18.9	21.5	17.5	8.5	16.38
depth (in.)	28.25	28.1	33	26.5	15	25.9
weight (lb.)	135	148	370	148	24.2	88
Price quantity 100 quantity 500	\$7700				\$3795	\$4600

Representative OEM fixed media drives

APS 4835 14	APS 4830/35 14	CDC FSD 9715 9	CDC 9730/160 14	Century M-80 14	Century M-160 14	Century AMS 190 14
337.1 .201 40960	404.5 .2419 40960	165.9 .2016 20160	165.9 .2016 20160	80.64 .144 24000	161 .192 32000	191 .336 24000
823 10 4 5 linear	823 12 4 6 linear	823 10 6 10 rotary voice coil	823 10 3 5 rotary voice coil	569 6 torque	845 6 torque	569 14 4 7 linear
5 25 55 16.8/10.1	5 25 55 16.8/10.1	8.5	38.3 8.3	12 50 100 12.5	12 50 100 12.5	6 25 50 12.5
694 12877 RLL	694 12877 RLL	550 10000	680 6220 MFM	480 7545	712 10000	480 7540 MFM
1.2/2.0	1.2/2.0	1.2	1.209	0.96	1.28	0.96
SMD	SMD	SMD	SMD	SMD	SMD	SMD
		10000	8000 1	8000 0.5	8000 0.5	9000 1
10.25 17.75 29.31 150	10.25 17.75 29.31 150		10.2 16.75 30 85			8.75 19 28.25 135
	\$9060	\$6135 \$4405	\$6980	\$3200	\$4000	\$4950
Fujitsu M2249K/N 14	Fujitsu M2351/AF 10.5	Ibis 1250 14	Kennedy 53160 14	Megavault MV116 8	Micropolis Sers. 1400 8	Priam DSK15450 14
335.5 .3277 20480	474.2 .5632 28160	1250(F) .708/psnr 88483	165 0.2016 21060	116 20160	160 20160	158.2 0.1545 20160
1024 16 5 8 rotary voice coil	842 20 6 10 rotary voice coil	890 positioner 16 positioner 9 16 2 positioners	823 10 3 5	823 7 4 7 rotary voice coil	823 10 10 rotary voice coil	1024 7 2 4 linear
6 27 55 10.12	5 18 35 7.58	2.5 16 32 8.3	5 30 55 10.1	7 45 70 8.33	8 26 54 8.3	8 40 75 9.7
850 6500 MFM	880 12790 MFM	763 15294	680 5330 MFM	600 11500 GCR	960 9287 MFM	960 6430 MFM
1.012	1.859	3	1	1.2	1.21	1.04
SMD	mod. SMD	IBM3380	SMD	SMD/ANSI	SMD	SMD
10000 1	10000 0.5	10000 0.5	10000 1			8000 0.5
9.84 16.38 25.59 99	10.4 19 27.6 132	50 24 44.75 650	7 19 24.75 75	5.2 8.85 19.5 30	8-in. floppy 8-in. floppy 8-in. floppy	6.9 16.6 17.6 20
\$6500	\$9000		\$4075	\$3450 \$2900	\$3500	\$4370 \$3680

Table 4: Representative OEM fixed media drives

Manufacturer Model	Priam DSKO 804	Tecstor SAPP160	Tecstor SAPP85	Tecstor SAPP165	Tecstor SAPP200	Tecstor SAPP300
Disk diameter (in.)	8	14	14	14	14	14
Unformatted capacity; drive (M bytes)	100	160	85	165	200	331.8
cylinder (M bytes)			0.1008	0.2016	0.2419	0.383
track bytes	20160	20160	20160	20160	20160	20160
Configuration:						
cylinders		567	823	823	823	823
data heads		12	5	10	12	19
disks	3	4	2	3	4	5
data surfaces	5	7	3	5	6	9.5
actuator type	linear	rotary voice coil				
Access time (msec.):						
track to track		8	6	6	6	6
average		35	30	30	30	30
maximum		65	58	58	58	58
average latency	8.3	10	8.3	8.3	8.3	8.3
Density:						
tpi	960	600	680	680	680	680
bpi	10000	6400	6450	6450	6450	6450
code		MFM	MFM	MFM	MFM	MFM
Transfer rate (M bytes/sec.)	1.2	1	1.209	1.209	1.209	1.209
Interface	SMD	SMD	SMD	SMD	SMD	SMD
MTBF. (hrs.)		8000	9000	9000	9000	9000
MTTR. (hrs.)		0.5	0.5	0.5	0.5	0.5
height (in.)	4.62	9.84	10.47	10.47	10.47	10.47
width (in.)	8.55	16.54	16.46	16.46	16.46	16.46
depth (in.)	14.25	24.4	25.5	25.5	25.5	25.5
weight (lb.)	20	88	98	98	98	98
Price:						
quantity 100	\$4185		\$4899	\$5450	\$6000	\$6551
quantity 500			\$4111	\$4600	\$5035	\$5497



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Start/Stop Performance

CacheTape provides superior performance versus tension arm, vacuum column, 100/25 ips streaming, and 50 ips 6250 bpi (GCR) tape drives. As an example, the following benchmark comparison provides typical performance data for a file-oriented backup application:

	Benchmark Time*
Streaming Tape (variable speed, 1600 bpi)23 min.
Vacuum Column (125 ips, 1600 bpi)7 min.
CacheTape Model 891 (1600 bpi)7 min.
50 ips 6250 bpi (GCR)	6.4 min. (calculated)
CacheTape Model 891 (3200 bpi)59 min.

*Benchmark measured on a DEC PDP-11/34 under RSTS™ for available tape drives.

**OEM Quantities

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For higher capacity disk backup, 3200 bpi density offers 184 MB of disk backup with only one reel change.

CacheTape offers field-proven streaming mechanics, fully automatic loading and threading, and compact package size...and still performs disk backup and transactional applications as well. CacheTape is the total solution to your tape drive needs.

Call or write for a free benchmark brochure that explains the performance advantages and how to calculate in advance the benefits of CacheTape.



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CacheTape easily interfaces and operates with industry-standard tape adapters. CacheTape is completely interface compatible with existing couplers for products from DEC, DG, and TI, and couplers for Multibus, S-100, and other popular mini- and micro-computers. Take advantage of CacheTape's easy integration features and increase your system performance while eliminating extra time and expense from your budget. With CacheTape, you can use your current controller investment wisely and effectively... plug in CacheTape for immediate benefits.

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Cipher's CacheTape products are completely software transparent with current vacuum column or tension arm start/stop tape software. CacheTape provides start/stop tape performance for tape applications such as file-oriented disk backup, transactional journaling, tape sort/merge, and data acquisition. Utilization of a cache memory in the tape drive means that CacheTape can provide higher performance than existing tension arm or vacuum column tape drives at much less cost. Just plug CacheTape into your system now...and benefit from total software compatibility.

Up to 40% Less Cost

CacheTape Model 891 (with 1600 bpi)	\$3420**
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versus 125 ips vacuum column	\$6100
versus 50 ips 6250 bpi (GCR)	\$7000 (estimated)

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Programmable function keys	Yes	No	Yes
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Smooth scrolling	Yes	No	Yes
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CIRCLE NO. 113 ON INQUIRY CARD

SOFTWARE

New spread-sheet packages do more than model

ALAN HIRSCH, Datapro Research Corp.

Highly evolved first-generation programs are giving way to integrated second-generation packages

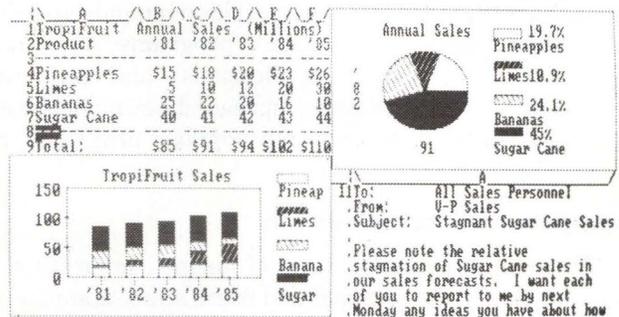
Electronic spread-sheet packages are the most popular business application programs for microcomputers. More than 1 million spread-sheet packages have been sold since VisiCalc was introduced in 1979, one for every five microcomputers sold to date. More than 50 VisiCalc clones are on the market, but a new wave of "second-generation" spread sheets threatens to make them obsolete. These second-generation programs (Table 1) are billed as powerful, flexible, friendly, all-in-one microcomputer software solutions, but they are best understood as the direct descendants of last year's diverse spread-sheet software offerings.

Spreadsheet basics

Why have business people embraced spread sheets so heartily? The reason is that ledger-sheet analysis is a singularly tedious, repetitive and error-prone task. Imagine this scenario: a manager of a large company must submit a report that projects income for the next five years. The manager must assume values for sales revenues, overhead costs, interest rates, repeat business and cost of materials. The manager makes a ledger sheet containing all the information and submits it to the company's controller, who asks that the repeat business be assumed at 80 percent instead of 75 percent. The manager must then recalculate all the ledger values that have been affected by this one change in the repeat-business category. Manually recalculating the effects of this single change is so arduous and time-consuming that very few managers make more than two assumptions per category.

A spread-sheet program transforms a microcomputer screen into a huge ledger sheet. By simulating the rows and columns of a ledger sheet, the program lets a

M B A: FOLDER-SAMPLE1: DEMOS1, DOCMT-TROPICFRUIT, CONTEXT-MODEL 748 135



Second-generation spread-sheet packages such as Context Management's MBA integrate text processing, database management and graphics. The MBA screen can be split into as many as four independent windows, and, if the values in the upper left window are changed, MBA automatically changes the bar and pie charts in the other windows to reflect the changes.

user work with a large number of interrelated values. When a user changes a given value on the spread sheet, the program automatically recalculates any affected values in seconds. The program not only makes managers' projections less time-consuming and more accurate, it also encourages them to ask more "what-if" questions and to make more complex assumptions.

Although originally intended for accountants, spread-sheet programs are now being used by nearly everyone with a microcomputer who needs to juggle figures. Spread-sheet programs are used to produce budgets, action and profit plans and sales forecasts. They also help produce income statements, cash-flow projections, currency conversions, expense reports and job-cost analyses.

REPRESENTATIVE SECOND-GENERATION SPREADSHEET PACKAGES

Vendor and Program Name	Context Management Systems MBA	Lotus Development Corp. 1-2-3	Microsoft Multiplan	VisiCorp VisiCalc Advanced Version
Operating system supported	UCSD p-System (Included), HP 200, PC-DOS	PC-DCS, MS-DOS	CP/M-80, MS-DOS, Xenix, Apple-DOS	Apple III, DEC P/OS, MS-DOS
System characteristics				
Minimum memory required, bytes	256K	128K	64K recommended	128K
Maximum usable memory, bytes	16M	544K	Machine dependent	178K
Memory taken by program after loading	192K	93K	Machine dependent	Varies
Virtual memory	Yes	No	No	No
Media on which software is supplied	5¼-in. or 3½-in. diskette	5¼-in. diskette	5¼-in. or 8-in. diskettes	5¼-in. diskette
Is program copy protected?	Yes	Yes	Yes	Yes
Screen characteristics				
Maximum number of columns	95	255	63	64
Maximum number of rows	999	2048	255	254
Maximum number of entries	94,905	33,000	16,065	16,256
Number of windows per screen	4	2	8	2
Variable width display of multiple cells	Yes	Yes	Yes	Yes
Edit functions				
Duplicate a row	Yes	Yes	Yes	Yes
Duplicate a column	Yes	Yes	Yes	Yes
Duplicate entire screen (or larger) to another position on model	Yes	Yes	Yes	Yes
Global search and replace	No	No (programmable)	No	No
Page scrolling	Yes	Yes	No	No
Sorting	Yes	Yes	Yes	No
Insert non-global rows or columns	No	Yes	Yes	Yes
Can \$ be displayed?	Yes	Yes	Yes	Yes
Can commas be used with numbers?	No	Yes	Yes	Yes
Right, left, or centered cell justification	Yes	Yes	Yes	Yes
Underline, flashing, or inverse video capability	No	No	Yes	Yes
Protect/unprotect individual cells, rows, etc.	No	Yes	Yes	Yes
Other	Graphic displays in all windows	Text labels may be integrated into formulas	Text labels may be integrated into formulas; titles displayed across cell boundaries	
Calculations				
Auto recalculation w/o manual intervention	No	Yes	Yes	Yes
Programming-like statements	If-then-else, compare a to b, greater/less than	Yes (built-in Macro language)	If-then-else	Greater/less than, if-then-else
Simultaneous access to more than one model	Yes	Yes	Yes	No
Automatic form mode	No	Yes	Yes	Yes
Average	Yes	Yes	Yes	Yes
Depreciation	No	No (programmable)	No	No
Percentage	Yes	Yes	Yes	Yes
Logarithmic	Yes	Yes	Yes	Yes
Trigonometric	Yes	Yes	Yes	Yes
Other	Internal rate of return, net present value	Internal rate of return, net present value, future value, std. deviation		Net present value, internal rate of return, table lookup
File handling				
Interactive with word processing, database management or other applications	Includes database, word processor, graphics, and communications	Yes	Compile file format (SYLK) permits interaction with most programs	Database, communications, graphics, etc.
Files displayed and selected from menu	Yes	Yes	Yes	Yes
Print characteristics				
Print screen contents	Yes	Yes	Yes	No
Print italics or other fonts or character sets	No	Yes	Yes	No
Report generation	Yes	Yes	Yes	Yes
Support				
On-screen help menu at all levels	Yes	Yes	Yes	Yes
On-screen tutorials	No	Yes	No	Yes
Audio or video cassette training with package	No	No	No	No
Demonstration diskette	Yes	Yes	No	No
Telephone support directly from vendor	Yes	Yes	Yes	Yes
Other		Dealer training		
Price				
One-time license or purchase price	\$695, (\$750, HP);	\$495	\$275	\$400
Charges for special support services	VisiCalc to MBA converter, \$49; new releases, \$150	—	—	Yes, back-up copies
Installed data				
Date of first installation	June 1982	February 1983	July 1982	September 1982
Number installed to date	10,000	50,000	75,000	10,000
Comments	See photo in textual portion of this report	Includes built-in graphic functions		

Source: Datapro Research Corp. survey

tics. They require more main memory to run (typically 128K bytes or more), but they can address almost unlimited amounts of memory. Many packages use virtual memory to accommodate one or more large models, and can compare and combine several models. Software Products International's ProCalc permits simultaneous viewing of four models.

The new packages also offer easier interaction with other applications. Spread-sheet data can be transferred back and forth between word-processing, data-

base-management and graphics programs, and spreadsheet vendors are beginning to build similar programs into their spread-sheet packages. Graphics are an especially popular extra feature. Context Management's MBA program was one of the first to offer graphic representations of spread-sheet-produced grids, and HP, Lotus Development, Desktop Computer Software and others now offer integrated spread-sheet graphics.

Two programs are emerging as leaders among second-generation spread sheets. Microsoft's Multiplan has quickly become the most popular. Some of its advanced features include sorting, global search and replace, menu prompts and an English-like language in

SPREAD-SHEET SOFTWARE GLOSSARY

Electronic spread sheets have brought a set of terms unique to the computer industry. Even the most experienced computer user may be hard pressed to decipher some of the terms and expressions that accompany these programs, and they're more than enough to baffle a novice. To make matters even more difficult, many vendors use different terminology to describe the same things.

- **Active block:** the cell on the matrix that is highlighted by the cursor. Information can be entered, altered or deleted by a user when the cell is active.

- **Active cell:** same as active block.

- **Average:** a function that computes the average of the values in a range or block of cells.

- **Blank:** a command that will erase the contents of a cell or a range of cells.

- **Cell:** a coordinate position on the display. The number of columns multiplied by the number of rows usually equals the total number of cells.

- **Columns:** horizontal divisions of the worksheet that are usually, but not always, identified with letters. Together with rows, columns serve to form the spread-sheet matrix.

- **Coordinate:** the intersection of two numbers and/or letters that uniquely identify the column and row or a cell.

- **Clear:** a command in many electronic spread-sheet programs that irretrievably erases all information on the worksheet.

- **DIF:** a format in VisiCalc that allows other unrelated programs to share stored VisiCalc files.

- **Edit mode:** available in many programs, the edit mode permits easy

modification of cell contents without rekeying the entire entry.

- **Entry:** the value or information contained with a specific cell.

- **Exponentiation:** a function that enables the user to calculate the power of a number. For example, the result of 8^6 can be calculated in a single step without multiplying $8 \times 8 \times 8$ etc.

- **Function:** a process through which values with dependence on other values are calculated.

- **Goto:** a command that permits the user to locate any cell immediately by specifying the coordinates.

- **Global symbols:** symbols that are designated to be displayed in every appropriate cell. Examples of global symbols include asterisks (*) for crude graphics displays, and dollar signs (\$) to denote finances.

- **Grid:** the display of a model composed of columns and rows.

- **Gridsheet:** same as grid, spread sheet, or worksheet.

- **Label:** the name or title of a column or row assigned by the user.

- **Lookup:** a function that compares a value with a block range and delivers corresponding values from adjacent cells.

- **Matrix:** same as a grid.

- **Model:** a grid that represents calculated and stored data created by the user to assess the interrelationship of variables.

- **Order:** a command found in most programs that permits the user to determine the order of calculation. For example, it may be necessary to calculate row-by-row across instead of column-by-column down or vice-versa.

- **Plansheet:** same as worksheet, spreadsheet.

- **Protect:** a command found in

some programs that permits the user to lock in the contents of a cell, column or row permanently so that the contents cannot be altered.

- **Protected cell:** an entry that has been locked in and cannot be changed. The unprotect statement frees this cell.

- **Range:** the identifying coordinates of a block of cells.

- **Replicate:** a command that allows a row, column or block to be duplicated and placed in another designated position of the model.

- **Rows:** vertical divisions of the worksheet that are usually, but not always, identified with numbers. Together with columns, rows serve to form the spread-sheet matrix.

- **Split screens:** two or more noncontiguous portions of one or more worksheets displayed on the screen and viewable at the same time.

- **Spread sheet:** the grid of columns and rows on the screen.

- **Sum:** a function that adds the values in all the cells of an entry range.

- **Template:** same as model.

- **Title:** same as label.

- **What if?:** the premise on which most spread-sheet programs operate. New values can be substituted to determine the resultant effect on the other values.

- **Window:** the view of the worksheet on the screen. This term is frequently used when the screen is split into two or more windows.

- **Worksheet:** same as spreadsheet.

- **VisiCalc:** the first and most popular electronic spreadsheet program. It stands for visible calculation.

- **Zap:** Same as clear.

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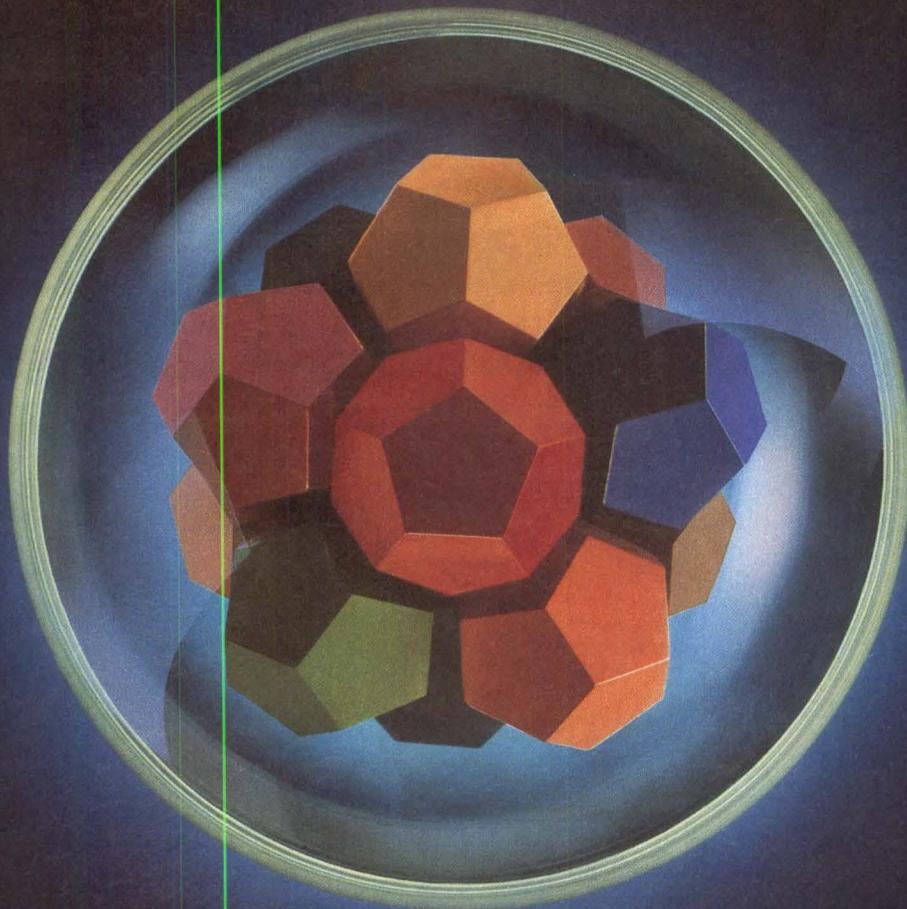
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lieu of formulas to facilitate user interaction with the program. Multiplan also permits as many as six noncontiguous parts of a model to be viewed simultaneously via window splitting. And, like most second-generation spread sheets, it is fully compatible with VisiCalc-produced files. Microsoft has marketed this program very aggressively through an OEM sales

department, and more than 50 word-processing, portable-computer and microcomputer manufacturers have licensed the program to offer with their products. In addition, Multiplan runs on virtually any microcomputer, with versions available for Apple, CP/M-80 and MS/DOS systems. IBM Corp. recently announced it had licensed Multiplan for its Personal Computer despite already offering VisiCalc.

The 1-2-3 program from Lotus, which runs on the IBM Personal Computer and compatible microcomputers, is one of the most complete spread sheets available,

Electronic Spreadsheet Vendors

Access Technology, Inc.
6 Pleasant St.
South Natick, Mass. 01760
(617) 655-9191
Circle 824

American Business Systems, Inc.
445 Union Blvd.
Lakewood, Col. 80228
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(302) 674-5500
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Businessoft International Corp.
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Monsey, N.Y. 10952
(914) 352-0021
Circle 828

Chang Laboratories, Inc.
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(408) 725-8088
Circle 829

Comshare
1935 Cliff Valley Way, Suite 200
Atlanta, Ga. 30329
(404) 634-9535
Circle 830

Context Management Systems
23864 Hawthorne Blvd., Suite 101
Torrance, Calif. 90505
(213) 378-8277
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Creative Software Concepts, Inc.
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Binghamton, N.Y. 13902
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H & A Computer Systems, Inc.
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(408) 725-8111
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(617) 492-7171
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MicroPro International Corp.
33 San Pablo Ave.
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Berkeley, Calif. 94710
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(312) 364-0752
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Software Arts, Inc.
27 Mica La.
Wellesley, Mass. 02139
(617) 237-4000
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Software Products International
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San Diego, Calif. 92121
(619) 450-1526
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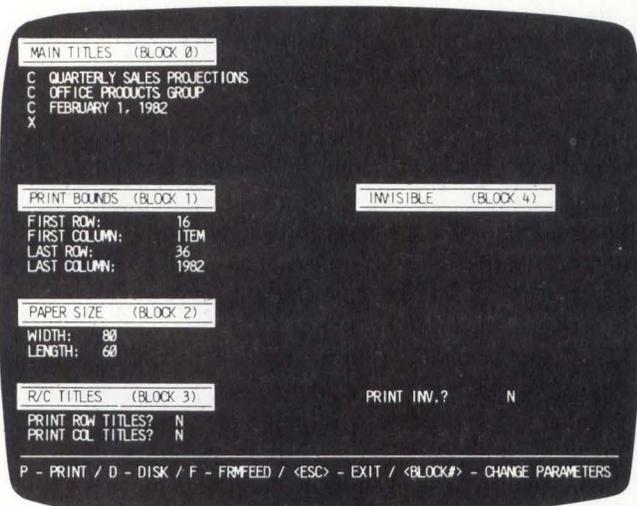
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requiring 128K bytes of memory. It too is VisiCalc file-compatible and even uses the same key sequences to initiate commands. Some of 1-2-3's distinguishing attributes include an excellent interactive, on-screen tutorial; very versatile cell editing; enriched help menus, a generous 255-column × 2048-row grid; and fast recalculation, on-screen sorting and graphic representation. 1-2-3 is priced at \$495, or twice the cost of Multiplan or VisiCalc. Computer manufacturers offering an MS/DOS-compatible product can turn to Lotus for licensing, but may be restricted unless their system supports graphics.



Report-generation capability is integrated into many spread-sheet programs. Vector Graphic's Execuplan II offers a print menu (above) that allows the user to format and customize spread-sheet output. Execuplan II output can be read and reformatted by the vendor's Memorite III word-processing software.

Although some of 1-2-3's graphics are quite crude and do not fully exploit the IBM PC's graphic capabilities, the fact that a spread-sheet array can be specified and quickly converted to color or monochrome bar charts signals an end to the days of reading eyestraining spread-sheet reports. Graphics capability is defining a new category of spread-sheet programs—decision-support spreadsheets. Standard spread sheets made it easier to generate ledger-style financial analyses, DSS spread-sheet programs will make it easier to understand them.

VisiCorp, once the runaway leader, now finds itself scrambling behind well-mobilized and powerful competitors. It is readying its VisiOn "operating environment" for delivery in December. VisiOn simultaneously supports multiple applications and allows them to be freely interchanged. Besides its spread-sheet capabilities,

#1	12	13	14	15	16	17	18	
Sales Forecast for 1982: Region 3								
#3	1	#4	14	15	16	17	18	
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total			
Sales	\$994.92	\$1,331.48	\$1,781.88	\$2,384.64	\$6,492.92			
Cost	\$686.50	\$918.72	\$1,229.50	\$1,645.40	\$4,480.11			
Gross Profit	\$308.43	\$412.76	\$552.38	\$739.24	\$2,012.80			
#2	2	3	4	5	#5	19	20	21
	Jan	Feb	Mar	Apr	Profit sharing for sales rep.			
	\$300.00	\$330.60	\$364.32	\$401.40				
	\$207.00	\$228.11	\$251.38	\$277.02				
	\$93.00	\$102.49	\$112.94	\$124.38	Profit Pool = \$281.28			

COMMAND: **F2** Blank Copy Delete Edit Format Goto Help Insert Lock Move
Name Options Print Quit Sect Transfer Value Window Xternal
Select option or type command letter
R2C12 86% Free Multiplan: FORECAST

Split-screen displays like this one from Microsoft's Multiplan program allow as many as eight noncontiguous portions of a model to be displayed simultaneously. Underneath the windows is a command menu that prompts the user to the next action. A true second-generation program, Multiplan integrates user-supplied labels instead of coordinates in its formulas, and sorts by both labels and numbers.

VisiOn supports word processing, database management and graphics. The user interface to VisiOn is a mouse that connects to the game-control adapter port on an IBM PC. Undoubtedly, VisiCorp will find itself not only competing with systems such as Apple's Lisa, but also with software companies such as Quarterdeck Software, Microsoft, Digital Research and other firms that will certainly introduce similar operating "environments."

The essence of an electronic spread sheet lies in its ability to assess the bottom-line effects of changes in components. But a few target- or goal-seeking spread sheets allow users to define a result and work backward to see how it could be achieved. The target is entered into the spread sheet, and the program holds it constant by changing or asking the user to change other variables.

Software Arts introduced the first dedicated "how-could" program optimized for target seeking in March. Although not a spread sheet, it employs several spread-sheet principles. Software Arts offers the program, TK!Solver, with a catalog of optional application-specific templates. Software Arts will sell the program directly to the public and through OEMs.

It is apparent that vendors of this new generation of integrated, extended-capability spread-sheet programs intend to break new ground. Next year, many will offer enhanced packages that will integrate word processing, database management and graphics so skillfully that it will render the current crop obsolete. First-generation and early second-generation spread-sheet programs are still not the complete personal-computer software environments their vendors promote, but they are among the most powerful microcomputer tools available.

Alan Hirsch is an associate managing editor at Dataproc Research Corp., Delran, N. J., specializing in the analysis of microcomputer hardware and software.

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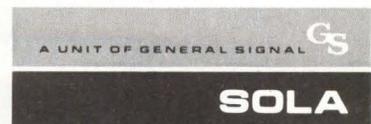
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			common-mode	transverse mode		
	momentary sharp voltage peaks or split-second power outages	short-term high or low voltages due to load start-up or shut-down	Unwanted voltages or frequencies due to bad grounding, switching, or radio-type interference	line-to-ground interference	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
Isolation Transformer	No	No	Yes	No	No	No
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Sola Mini-UPS	Yes	Yes	Yes	Yes	Yes	Yes

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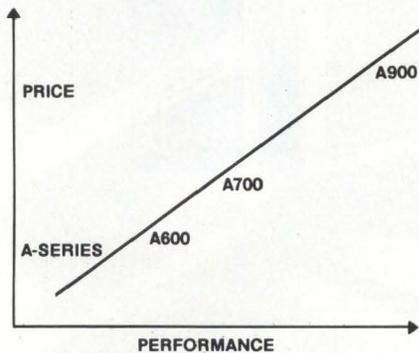


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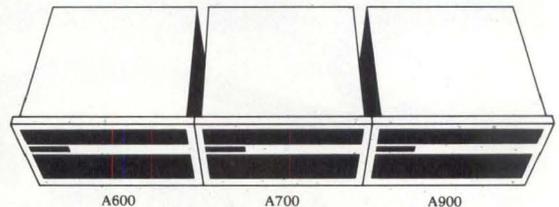
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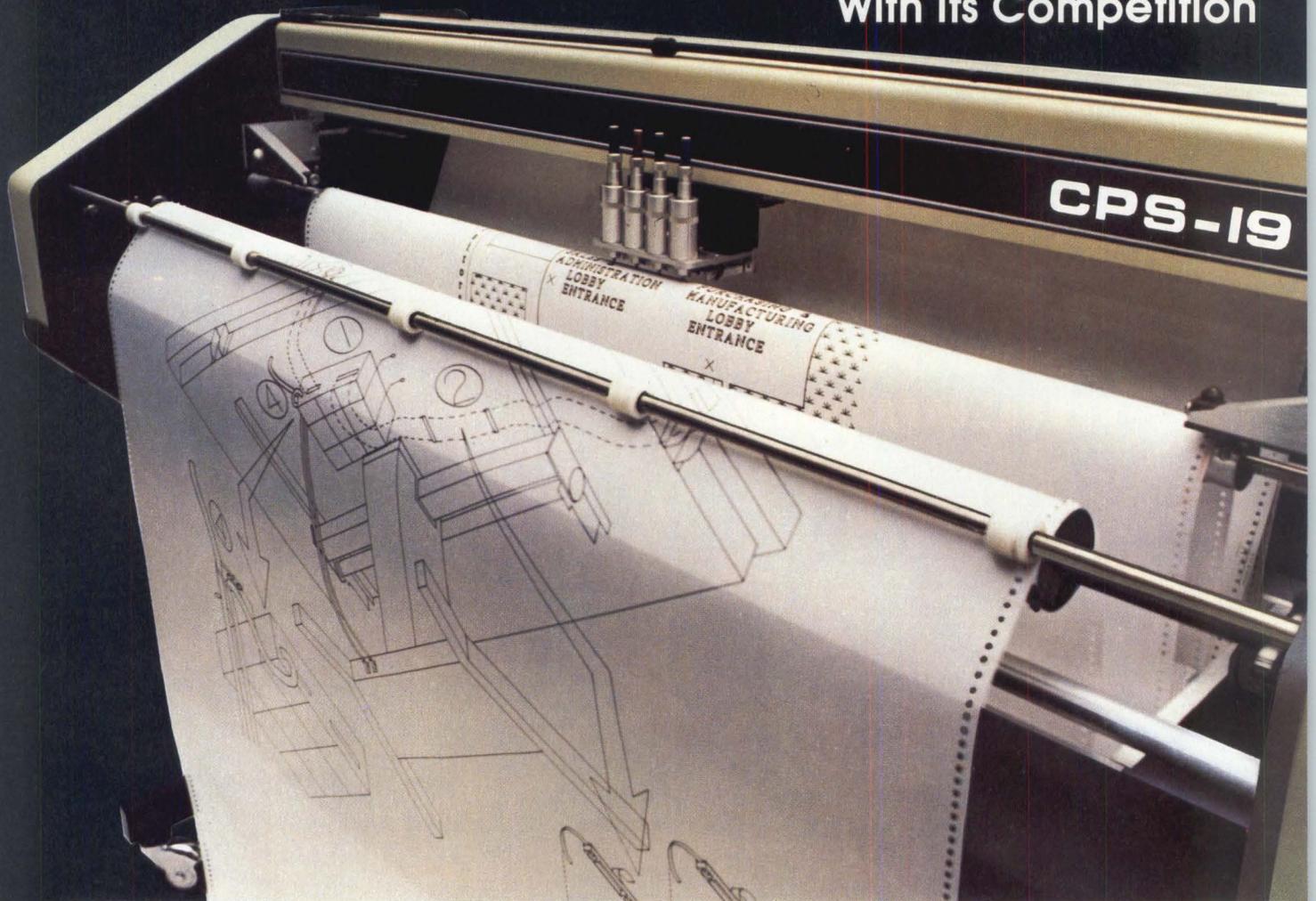
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Color non-impact printers hit the market

IAN H. MALLENDER, Advanced Technology Resources Corp.

Ink-jet and thermal printers add color graphics to their cost and speed advantages

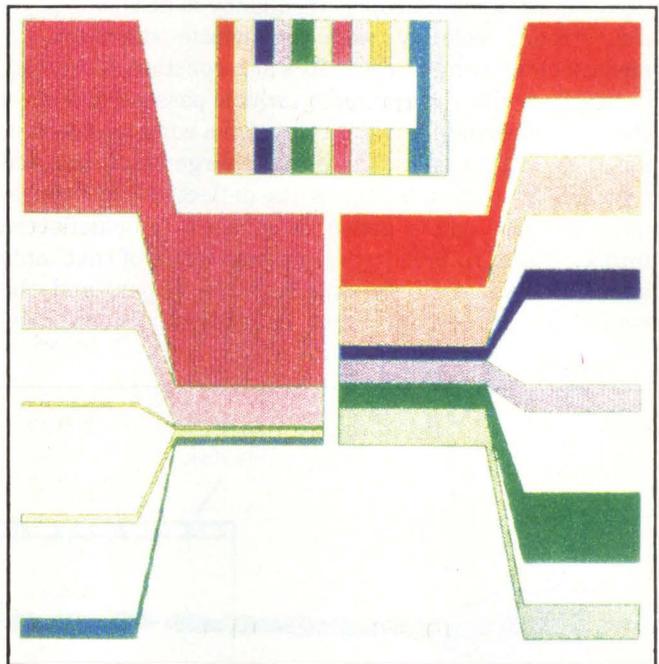
Ink-jet and thermal printers have always been the poor relations of the non-impact printing family. They competed against electrostatic, magnetic, laser and other electrophotographic printing techniques, both for market share and development dollars. Thanks to new color graphics capabilities, ink-jet and thermal printing techniques are gaining popularity. Japanese companies are in the technological vanguard, but U.S. small-system builders and users will benefit the most from the new machines.

Why non-impact and why now?

Ink-jet and thermal printers are gaining popularity because they can closely meet users' conflicting demands in printing.

The ideal text-output device for a small-business word-processing system would be a 1000-character-per-sec., letter-quality printer selling for less than \$3000 with reliability commensurate with other system elements. Daisy-wheel impact printers offer letter-quality output and convenient font flexibility, but are slow and expensive and have limited graphics capabilities. Impact matrix printers involve speed, quality and price trade-offs, and their output still falls short of letter-quality standards.

For these reasons, all the major printer manufacturers have been exploring other printing methods and are particularly interested in eliminating as many moving parts as possible. Expensive laser printers were attracting large amounts of development funding. In the meantime, the would-be developers of ink-jet products could not obtain sufficient funding, and some products that did reach the market proved too unreliable to survive into second or third generations of



Color thermal-transfer printer output from the \$11,000 Seiko CH 5201 was produced with three subtractive colors in about 1 min. with a resolution of 150 dots per in.

development. One major manufacturer, however, made a long-term commitment to both ink-jet and laser printing. Siemens, in West Germany, has used both technologies in a variety of products and applications.

In the meantime, other major manufacturers that were reluctant to bring ink-jet products to market were equally reluctant to give up on a basically sound and potentially lucrative technology. The high level of patent activity during the past three years indicates a

major research and development commitment to ink-jet technology.

The rapid proliferation of color terminals and the resultant demand for color hard copy has finally spurred many manufacturers to bring units out of the labs and into production.

The growth of Teletext systems is adding fuel to the fire, and it seems inevitable that low-cost color printers will become essential parts of every major printer manufacturer's product line. These new market demands provide a unique opportunity that both ink-jet and thermal-transfer technologies are uniquely positioned to exploit.

Ink-jet methods and manufacturers

Ink-jet printers use either continuous-stream or drop-on-demand print mechanisms. In continuous-stream systems (Fig. 1), drops are produced in rapid succession from a single nozzle and are either deposited on the paper or deflected away from it and reused. Continuous-stream droplet frequency is determined by the stream velocity and the nozzle diameter. A piezoelectric element resonates at a constant frequency to stabilize the drop stream, which passes through a charging electrode and then through a constant electrostatic deflection field. The initial charge level acquired by each droplet determines its deflection and consequent position on the paper, or causes it to be deflected into a gutter. In printing an average page of text, only about 2 percent of the ink hits the paper, and the remaining 98 percent must be caught, filtered, de-

gassed, pressurized and recirculated through the system.

In drop-on-demand systems (Fig. 2), an array of nozzles are used in the same manner as the styli in dot-matrix impact printers. Individual nozzles are actuated by piezoelectric element impulses, and drops are produced only when required. As a result, there is no recirculating system.

Color ink-jet systems require separate channels for each color component. This results in increased complexity of the ink-delivery system and requires accurate head positioning to ensure good color registration

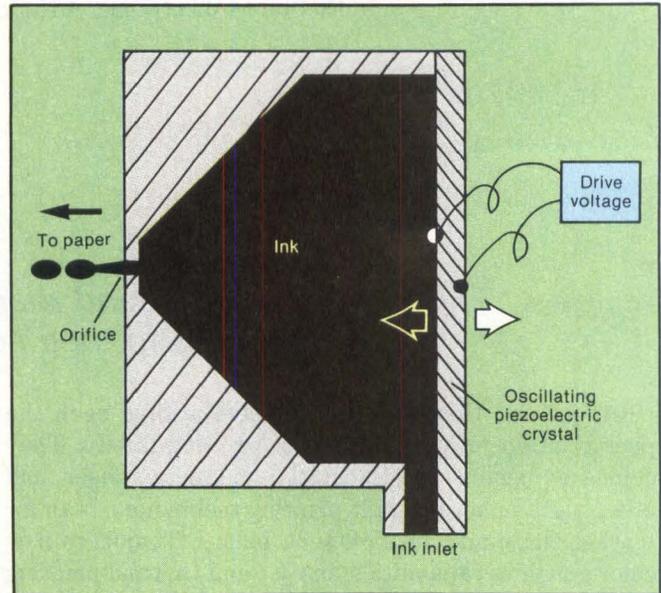


Fig. 2. Drop-on-demand ink-jet printers produce drops from a pressure pulse generated by the contraction of an ink chamber, usually under piezoelectric forces. Because drops are produced only when they are required on the page, an ink-recirculation system is not required.

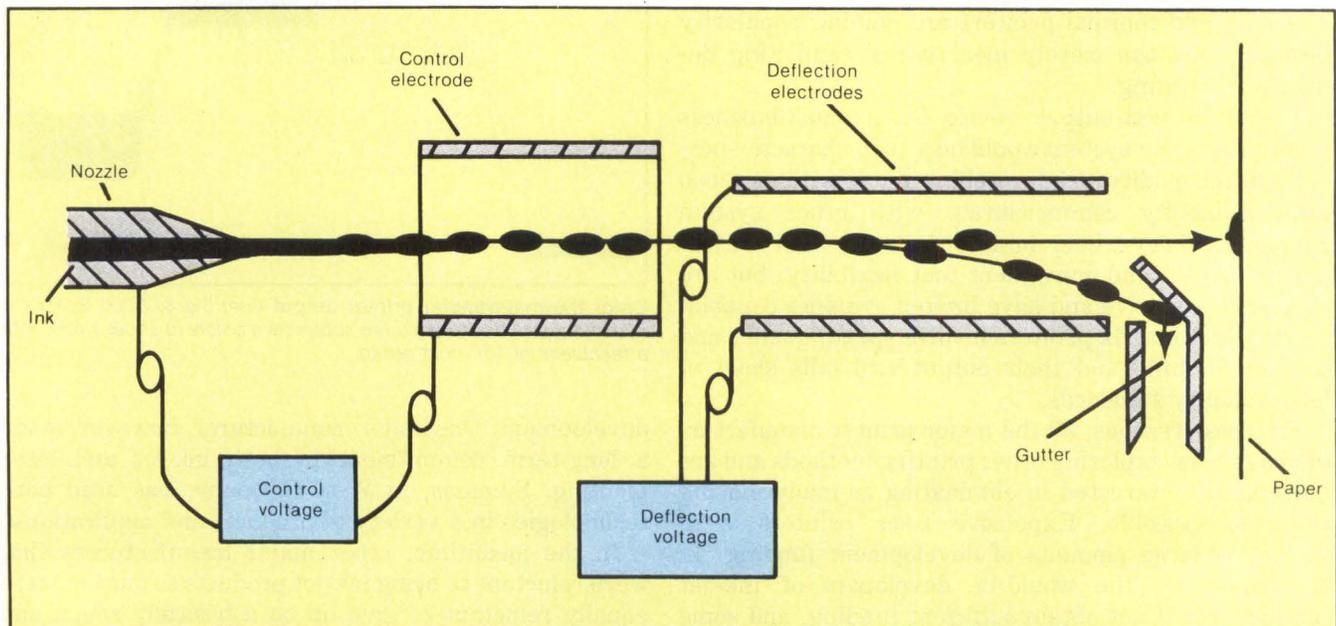
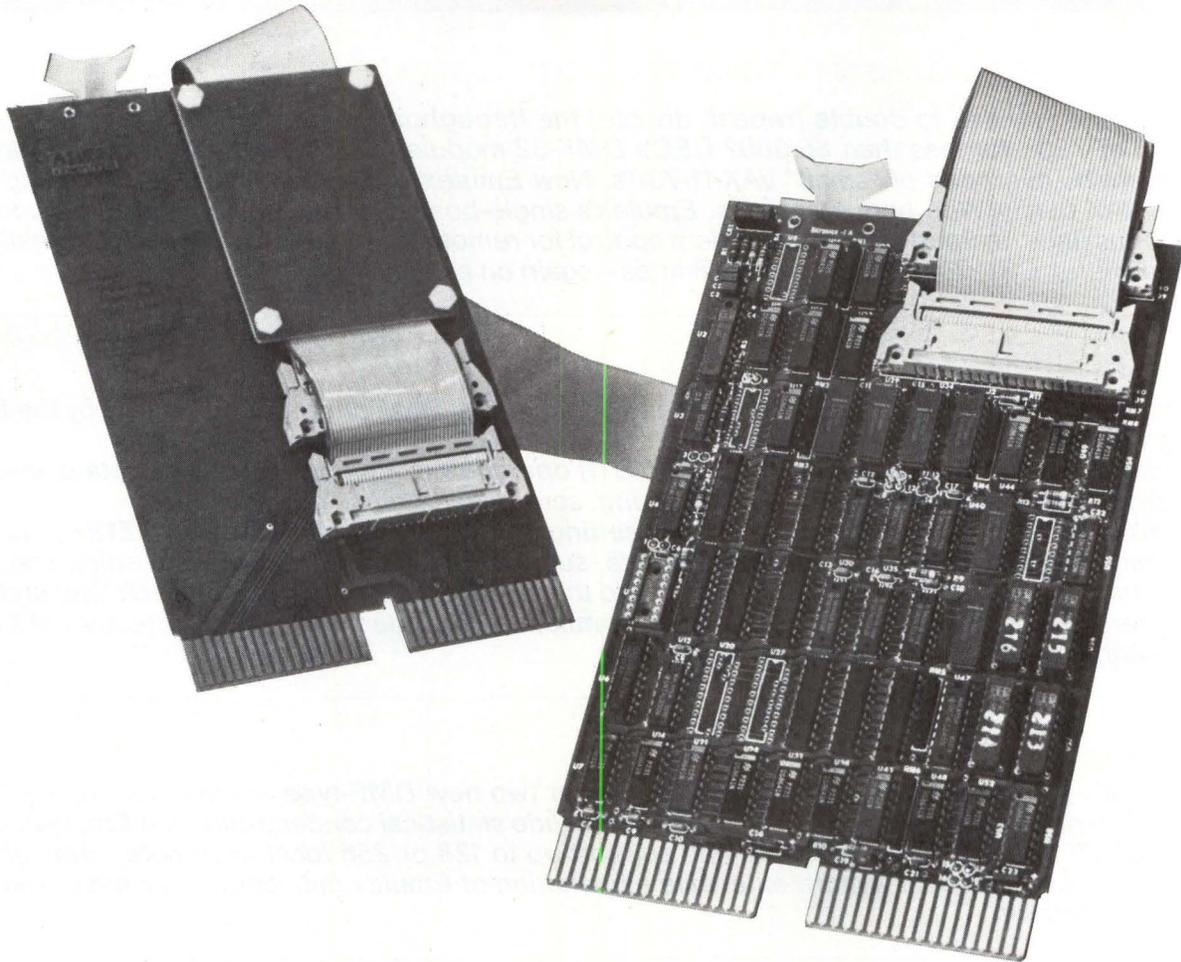


Fig. 1. Continuous-stream ink-jet printers form drops from the breakup of a continuous jet of liquid ink. The drops are selectively charged as they emerge from the nozzle and are either aimed at the page by deflection electrodes or allowed to fall into a gutter for recirculation.

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PRINTERS

of the composite image. Black printing can be achieved by superimposing the three subtractive color components (cyan, magenta and yellow) to create black or by adding a fourth (black) "channel."

Neither ink-jet method is better than the other. A drop-on-demand system suffers from the disadvantages of many nozzles and actuators with the attendant problems of multichannel maintenance, while a continuous system requires the maintenance of an ink-recirculation system.

Many variations of these two basic ink-jet schemes are possible, such as page-wide arrays of continuous jets and mechanical movement of a variety of head configurations. Among the more recent approaches are the Canon USA Inc. bubble jet, which uses a heat impulse to create air bubbles that expand and eject droplets, the Matsushita air-assisted jet, which uses an airstream to carry ink droplets out of the head and onto the paper, and the Olivetti Corp. dry ink-jet process, which uses a cartridge of carbon in a binder with explosive powder so that an electric arc causes a minor explosion and corresponding rise in pressure that ejects eroded carbon particles at the paper.

Ink-jet printers (below) range from expensive, high-resolution systems for large-page scientific applications to low-cost, home-computer, hard-copy devices. Developers of new printing technologies usually have the burden of bringing the technologies to the end-user market. Once a new technology begins to create demand, however, every system supplier wants to offer it either through captive, OEM or licensing channels. With many suppliers advertising a given technology, it's often difficult to determine the origins of a product. The following list shows what products printer manufacturers are developing.

Applicon Inc. was one of the first U.S. companies to put color ink-jet printing products on the commercial

market. The basic ink-jet technology Applicon employs was developed at the Lund Institute of Technology in Sweden and licensed in the U.S. through Arthur D. Little Inc. Applicon printers use a continuous jet that is modulated by varying ink flow from a very fine spray to a heavy stream and passing it through an aperture mask.

Three of these continuously variable jet modules are mounted around a rotating drum and moved along the length of the drum by a lead screw drive. The ability to control the density of each primary color component allows a wide range of color shading. Applicon systems are used primarily for seismic, satellite and other scientific applications in which large quantities of data must be presented in graphic form.

Advanced Color Technology Inc. and Printacolor Corp. both offer color ink-jet printers based on the single-color PT 80 printing module from Siemens. The PT 80 consists of a 12-nozzle, drop-on-demand head on a page-wide carriage that operates similarly to a dot-matrix serial impact printer. ACT and Printacolor modify the PT 80 ink-handling and -control systems to deliver cyan, magenta and yellow inks. Drop size is fixed, so color variation is limited.

Tektronix Inc.'s new 4691 ink-jet printer is based on technology licensed from Matsushita in Japan. The unit's drop-on-demand heads operate at higher than normal speeds because of an air jet that carries ink droplets out of the nozzle and onto the paper. Four ink-jet heads providing cyan, magenta, yellow and black are arranged around a drum in a similar manner to the Applicon system. Using a black channel instead of printing black by overprinting all the primaries saves ink and provides blacker copy. The unit is offered primarily as an output device for the Tektronix 4113A color terminal and produces A- and B-sized output.

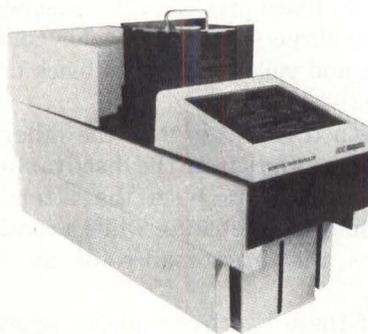
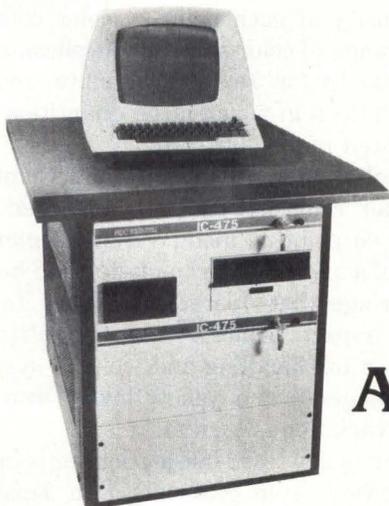
Canon's new ink-jet printer carries a \$795 recommended retail price. This aggressive pricing posture is based on high-volume estimates of the personal and home computer markets. Canon's drop-on-demand system uses a process that has been tested in a single-nozzle calculator recently introduced in Europe.

COLOR INK-JET PRINTERS

Manufacturer model	Speed (min. per page)	Resolution (dots per in.)	No. of jets	No. of inks	Continuous stream	Drop on-demand	Price
Advanced Color Technology, ACT-1	1.5	85 x 140	3	3	N	Y	\$9000
Applicon, IJP	2	125	3	3	Y	N	\$65,000*
Canon, A-1210	40 cps	80	4	4	N	Y	\$795
Hitachi, P JL-05C	44 cps	80	8	4	N	Y	N/A
OKI Electric, prototype	1	180	4	4	Y	N	N/A
Printacolor, GP1024	1.5	85 x 120	3	3	N	Y	\$5495
Ricoh, JP4100	1	240	4	4	Y	N	N/A
Sanyo, CJ2200	2	150	4	4	N	Y	N/A
Sharp, 10700	4	120	16	4	N	Y	N/A
Tektronix, 4691	2	150	4	4	N	Y	\$12,000

*Includes plotter and magnetic tape unit for off-line plotting
N/A: not announced

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Glass nozzles with piezoelectric constrictive actuators are attached by plastic hoses to collapsible ink sachets. The four color nozzles are arranged horizontally and transported across the page, minimizing local data-storage requirements and avoiding many paper-handling and color-registration problems. This process was developed by Gould Inc. and licensed to Canon.

Several Japanese companies are introducing color ink-jet printers and, although prices are not known, the products are aimed at low-end markets. All newer models use four colors, instead of three, indicating that they are intended to print straight textual matter as well as graphics.

Konishiroku and Exxon have also made recent announcements of black-and-white, ink-jet products aimed at word-processing markets. Several other manufacturers are demonstrating similar units.

Thermal transfer's time has come

In the past, thermal printers have been scorned as either cheap and mostly illegible or adequate only for point-of-sale terminals. Recent improvements in thermosensitive materials have bolstered thermal printer popularity and opened applications. As coated paper became less objectionable and expensive and images became clearer, thermal printing became acceptable for

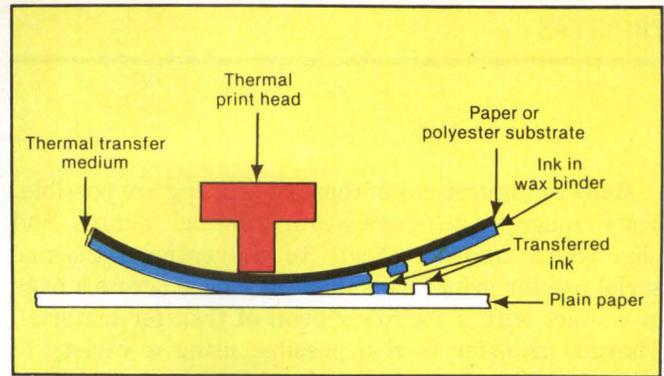
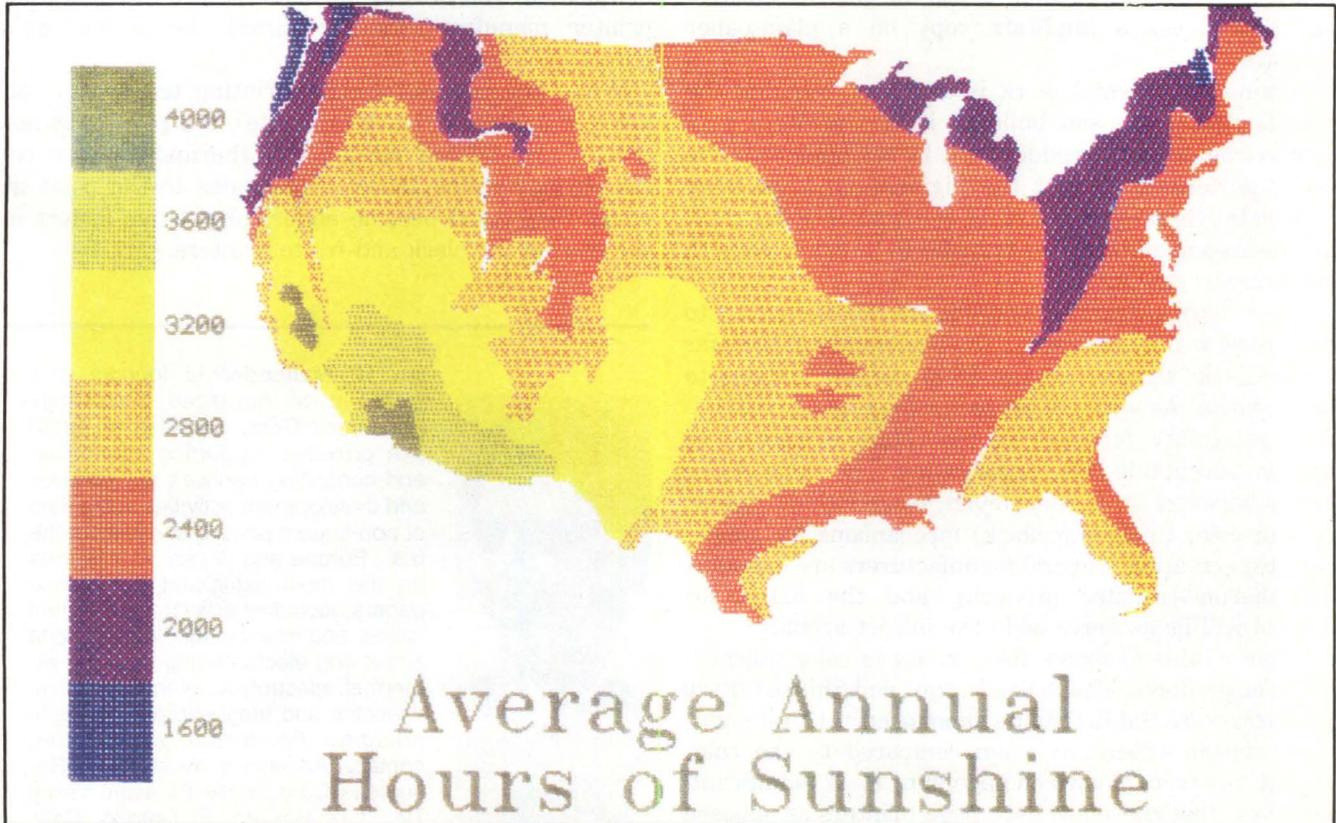


Fig. 3. Thermal-transfer print mechanism uses a thermal print head with a transfer medium and a plain-paper receptor sheet. The transfer medium usually consists of a pigment suspended in a wax binder and coated on a paper or polyester substrate. In operation, the thermal print head melts the wax binder, transferring the pigment to the receptor sheet. The transfer sheet or ribbon is then discarded.

facsimile output and other applications in which its low cost and simplicity proved important. The legibility of output from a modern cash register or printing calculator is testimony to advances in thermal printers and paper.

Japanese research into thermal printing for facsimile applications led to thermal printing on plain paper by means of a thermal transfer process (Fig. 3). Once the transfer process was proven, adaption to color was simple. The combination of a low-cost printing process with greatly improved quality and an almost unlimited color capability has elevated thermal-printing technology from near obscurity to the forefront of the industry.



Color ink-jet printer output from the \$5495 Printacolor GP 1024 was produced with three subtractive colors in about 1½ min. with a resolution of 85 × 120 dpi.

Many configurations of thermal printing are possible. They range from page-width thermal arrays and page-width transfer sheets to conventional thermal serial printer print heads that are moved across a page in contact with a narrow ribbon of transfer material. Thermal transfer is also possible using a variety of receptors. The Japanese National Railways uses thermal transfer to print on both plastic and cardboard commuter tickets that receive abuse from passengers and automatic turnstiles.

More than a dozen companies including Canon, Fuji-Xerox, Sony Corp., Toshiba Corp. and Pentel are offering new black-and-white printers, an indication of the potential low cost of thermal-transfer printers. Brother Industries of Japan recently introduced a portable unit weighing only 5 lbs. that produces 7 × 9 dot-matrix alphanumeric text at 11 cps for a retail price of \$199. The new Diablo Series 200 6-page-per-min. unit produces high-quality alphanumeric text and graphics at 200 points per in. at a recommended retail price of \$2500. If equipped with the appropriate multicolored ribbons, both of these units could produce color output. Such ribbons are available from Fuji Kagakushi Kogyo and The General Corp. of Japan.

The use of thermal-transfer ribbons rather than print

RECENT JAPANESE COLOR THERMAL TRANSFER ANNOUNCEMENTS

Manufacturer	Model	Speed	Resolution (dots per in.)	No. of colors	Price
Seiko	CH 5201	1 min./pg.	150	3	\$11,000 (Japan)
Shinko	CHC 30	45 sec./pg.	100	3	\$4500 (est.)
Toshiba	TN 5300	2 min./pg.	200	4	
Mitsubishi	(page)	30 sec./pg.	240	3	

Another version of the transfer process produces a duplicate copy of a conventional thermal original. A thermosensitive paper produces the first copy by normal means when the print-head elements exceed the paper's color-conversion temperature, and, simultaneously, a transfer layer underneath the thermosensitive paper produces a duplicate copy on a plain-paper receptor.

Other experimental work is aimed at reinking the transfer substrate and building it into printers as a captive component to reduce cost. Development work is being performed to coat the pigment on a resistive substrate, thereby eliminating the conventional thermal heads and allowing the transfer to be achieved with current-carrying styli.

Color thermal-transfer systems are relatively easy to configure, mainly because of the availability of transfer materials in shapes ranging from narrow ribbons to wide sheets. As with ink-jet technology, good positional repeatability for each of the colors is needed to achieve acceptable color registration. The same choice arises between three-color (cyan, magenta and yellow) or four-color (including black) mechanisms for single-pass text creation. Several manufacturers are introducing thermal-transfer products, and the battle for control will be as fierce as in the ink-jet arena.

Table 2 (above) shows the activity in color thermal-transfer products. The Seiko CH 5201 and Shinko CHC 30 products were the first to be announced. At first sight, they appear expensive when compared to the color ink-jet products shown on page 221. It is significant, however, that these are both page printers as opposed to the less complex serial-printer configurations that are expected to follow.

mechanisms is responsible for the sudden emergence of a large number of thermal-transfer products in both black-and-white and color configurations. Ribbon manufacturers, including Fuji Kagakushi Kogyo, were ahead of the game in offering the transfer material in a number of colors and formats before the thermal printer manufacturers recognized the technology's potential.

While any successful color printing technology can print in one color (black on white), the reverse is not true. Color-related ink-jet and thermal-transfer research may refine these technologies to the point at which they could become major competitive factors in the market for black-and-white printers. □



Ian H. Mallender is founder and president of Advanced Technology Resources Corp. Founded in 1979, ATR provides supporting information and consulting services for research and development activities in the field of non-impact printing to clients in the U.S., Europe and Japan. ATR reports on the most significant conference papers, technical articles, new patent issues and new product introductions employing electrophotographic, ink-jet, thermal, electrolytic, electrosensitive, dielectric and magnetic printing technologies. For further information, contact Advanced Technology Resources Corp., 6256 Pleasant Valley Rd., P.O. Box 80, El Dorado, Calif. 95623, (916) 626-4104.

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CIRCLE NO. 123 ON INQUIRY CARD

Processor matches text at high speeds

DAVID A. MORRIS, General Electric Co.

Array of specialized query processors sifts through 2 million characters per sec.

Most schemes for allowing a computer to retrieve and disseminate selected pieces of text require extensive text pre-processing to develop index terms. The technique of handling text by means of a sequential matching process has been largely unexploited because of the low speeds that result from even the simple matching requirements. Typical sequential matching speeds fall in the 2000- to 3000-character-per-sec. range, making processing even small text files time-consuming. The General Electric Co. GESCAN 2 high-speed text search and retrieval system addresses the speed problem of sequential search processes through a text array processor (TAP) that can increase matching speed to as much as 2 million characters per sec. The TAP simultaneously matches many terms and conditions against a given text string, resulting in more than 40 billion comparisons per sec. The TAP is specifically designed to perform the match function, with no general-purpose processing capability, and is configured as a peripheral device to a general-purpose host.

TAP configuration and operation

A typical TAP system configuration (Fig. 1) consists of a general-purpose CPU, mass storage, a user terminal, the TAP and an input device such as an optical character reader, a word processor or a magnetic-tape drive. The CPU accepts user requests for text and transmits them to the TAP, where the requests are stored for processing. Information to be searched can be retrieved from mass storage by the CPU and written to the TAP or routed directly from the input device to the TAP where the information is stored in preparation for search.

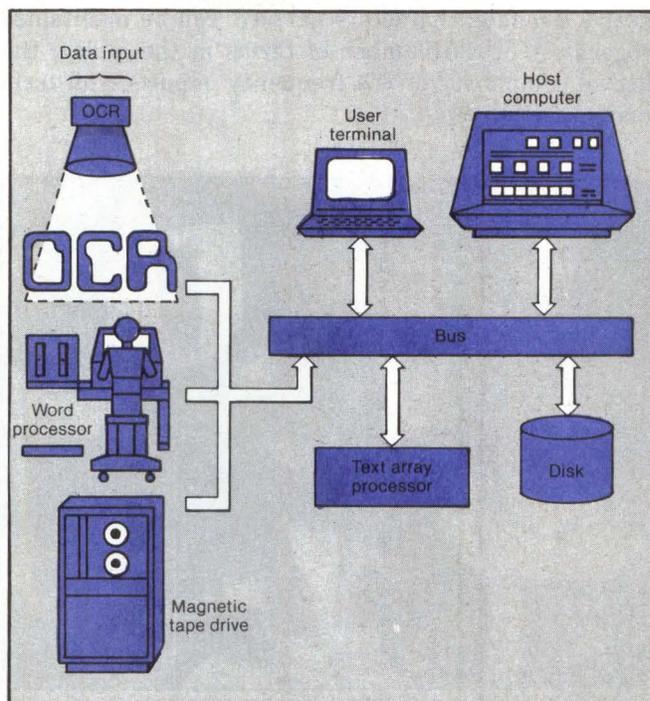


Fig. 1. Text array processor (TAP) configuration typically includes host computer, workstation, disk storage and input device such as OCR, word-processing station or magnetic-tape drive. TAP is configured as a peripheral device, with no general-purpose processing capabilities.

The TAP (Fig. 2) consists of a 128K-byte cache memory and an array of four to 128 query processors (see "How the query processor works," p. 230). Text to be searched is loaded, 128K bytes at a time, into the cache memory, and queries are loaded into the query processors. On command from the CPU, the contents of

the cache are passed through all query processors simultaneously at about 2 million cps, where queries are compared to the text and matches are resolved. Each query processor stores results in the form of record identification numbers, which are later read and processed by the CPU. At the conclusion of a search, new queries can be loaded for processing against the same cache memory data, or the next 128K bytes of information can be loaded for search. The 128K-byte cache size does not limit record length to 128K bytes. A record can span one or more 128K-byte blocks, with the query processors suspending processing until the next 128K-byte block is loaded.

Each query processor is independent and can be loaded at any time with a new query without disrupting the functioning of other query processors. A query processor performs all term matching and query resolution for a complete query, which may consist of multiple terms interrelated through various logical operators. Because no microprocessor or software is used in the query processor, a fixed search speed of nearly 2 million characters per sec. can be maintained regardless of the number of terms in the query, the logical complexity or the frequency of successful term matches.



GESCAN 2 high-speed text search and retrieval system processes multiple queries simultaneously at speeds as high as 2 million characters per sec.

Query construct capabilities

A user can employ any of several constructs to formulate a query. Constructs include:

- **Exact term match:** a term is defined as a word or phrase comprising alphanumerics, spaces or punctuation characters. The given term is matched as long as it

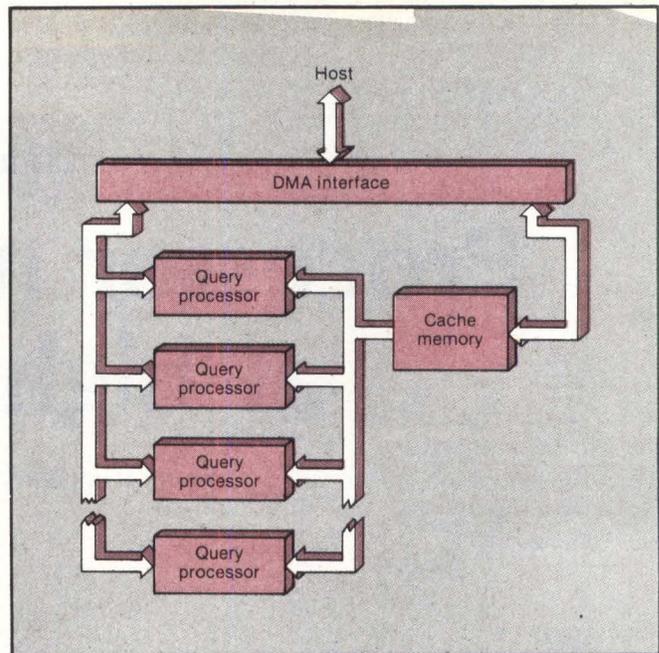


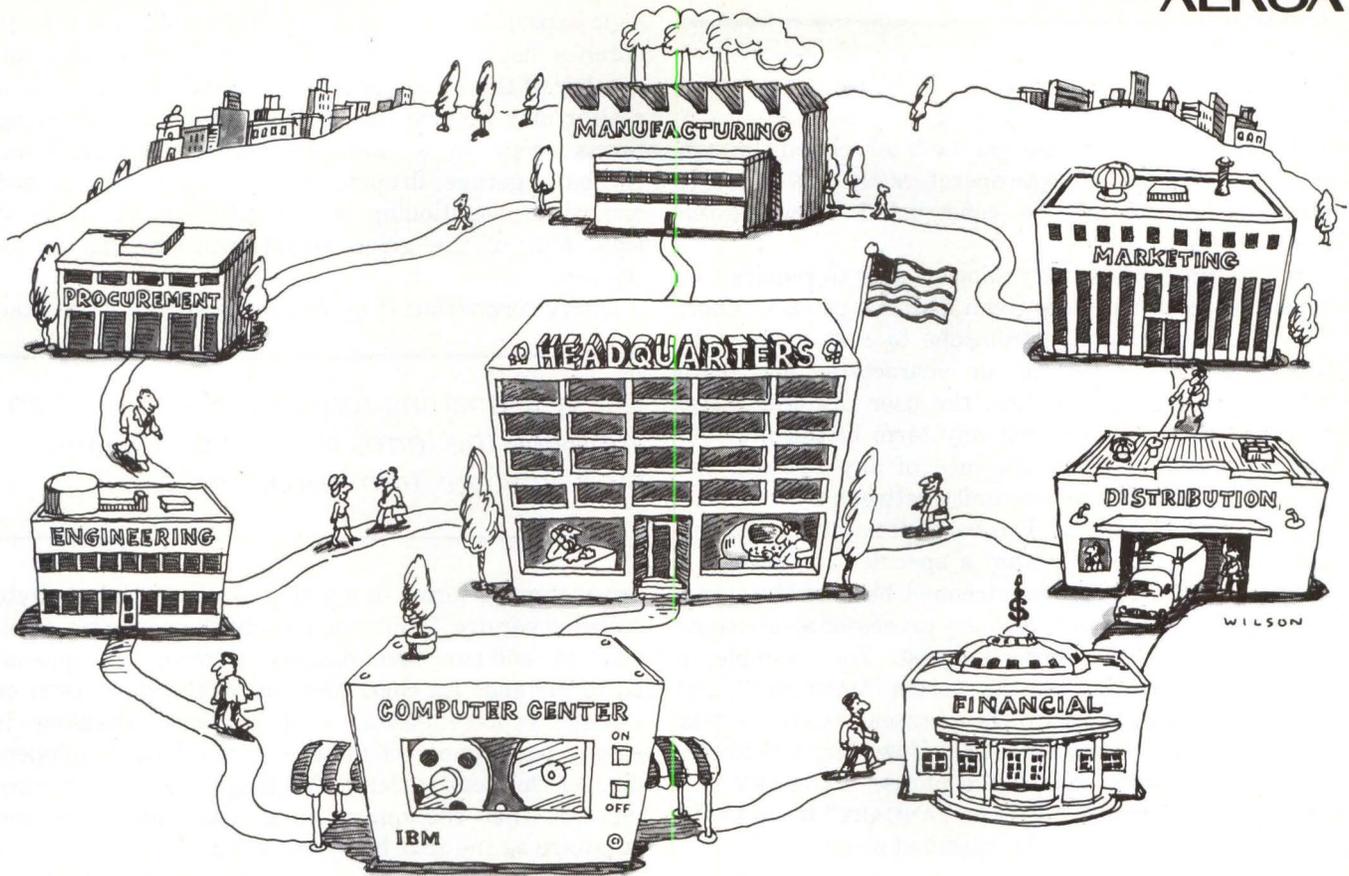
Fig. 2. TAP architecture consists of interface, cache memory and query processors. Identical text strings are loaded into query processors from cache, and are simultaneously compared to each processor's individual query. Results are then sent to host.

appears in the text bounded by spaces or punctuation characters. For example, the term "ATE" matches only the word "ATE" and does not match with "GREATER."

- **Fixed length don't care:** a term can contain one or more FLDC characters, represented by "!" which matches any single alphanumeric character. For example, "!ATE" matches "FATE," "DATE" or "GATE," but does not match "CREATE."

- **Variable length don't care:** the VLDC, represented by "?," can match any single alphanumeric character, group of characters or no character. For example, "?ATE" matches "ATE," "FATE," "CREATE" or "CONCATENATE." VLDC and FLDC characters can be placed at the beginning, middle or end of a term. They can be used to handle spelling uncertainties and to pick up a word regardless of its beginning or ending, such as locating all chemical names that end with "OXIDE."

- **Fields:** each record of the database can be subdivided into as many as 256 fields. A field is usually a data item of the record. In message traffic, for instance, a message can be subdivided into source, destination, date and text, each constituting a field of the message record. As the user enters the terms of a query, each term can be given a field specification requiring the term to appear in any of a list of fields. For example, requiring "Washington, D.C.," to appear in the source, "San Diego" in the destination and "January" in the date would retrieve all messages sent from Washington to San Diego during January. This specification would eliminate messages that simply mention Washington or San Diego in the text. All fields are considered to be of variable length and can appear in any order.



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- **Boolean logic:** terms can be interrelated through the use of the Boolean logic operators AND, OR and NOT, and expressions can be constructed using nested parentheses.

- **Proximity:** proximity allows a user to require two terms to occur within a given distance of each other. The distance can range from one to 1024 units, with units specified as words or characters. For more complex proximity searches, the user can create two lists of terms and ask that any term in the first list appear within a given distance of any term in the second list. This allows proximity between two terms or any of their synonyms. The basic proximity requiring two terms to appear within a specified distance is a bidirectional proximity requirement because the terms can appear in any order. A query processor also accepts a unidirectional proximity request. For example, a bidirectional search on the terms "JANUARY" and "10TH" would match with the phrases "JANUARY THE 10TH" and "10TH OF JANUARY." However, a unidirectional search would match the phrase "JANUARY THE 10TH" and not match "10TH OF JANUARY" because the terms do not appear in the specified order.

- **Near-term match:** to simplify many of the Boolean logic expressions, the query processor allows a user to enter a list of terms and then require a minimum number of them to appear in a record. For example, a realtor may require that at least four of the following terms occur in a database record: four-bedroom, two-bath, garage, fireplace, electric, full basement and central air-conditioning. Any house that can satisfy at least four of the given requirements would be retrieved.

Query formatting (Fig. 3) requires little more than

Query formatting requires little more than arranging the terms in a string separated by a one-byte 'term separator.'

arranging the terms in a string separated by a 1-byte "term separator." Information about proximity, Boolean logic and near-term match requirements is appended to the end. All characters are left in their ASCII or EBCDIC representation, as the query processor is simply performing bit matches. Searching is independent of character codes or language; the only requirement is that the query be in the same code and language as the text being searched.

HOW THE QUERY PROCESSOR WORKS

A query processor is a special-purpose processor designed to accept a user's character-string specifications, sequentially scan information and identify records that satisfy the specifications. It is constructed specifically for this function, and does not contain a microprocessor or software. Processing of a user's request is divided into two sub-processes: matching the given words or phrases (term match) and resolution of the Boolean logic, proximity and near-term match requirements.

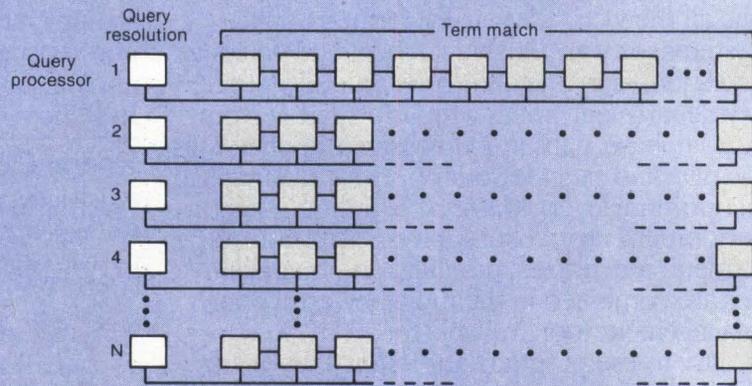
Term matching is performed by a series of character cells, each containing one character of the query. As information streams past, each character cell looks for the character that matches its stored character. A string of character cells is implemented on an LSI chip, permitting long strings of these cells by connecting several chips in series. When a word or phrase of the query has been matched, a signal is sent to the resolution sub-process.

The resolution sub-process is also implemented on an LSI chip to keep pace with the term-match sub-process and avoid a bottleneck during search. Only one such chip is required per query processor, regardless of the

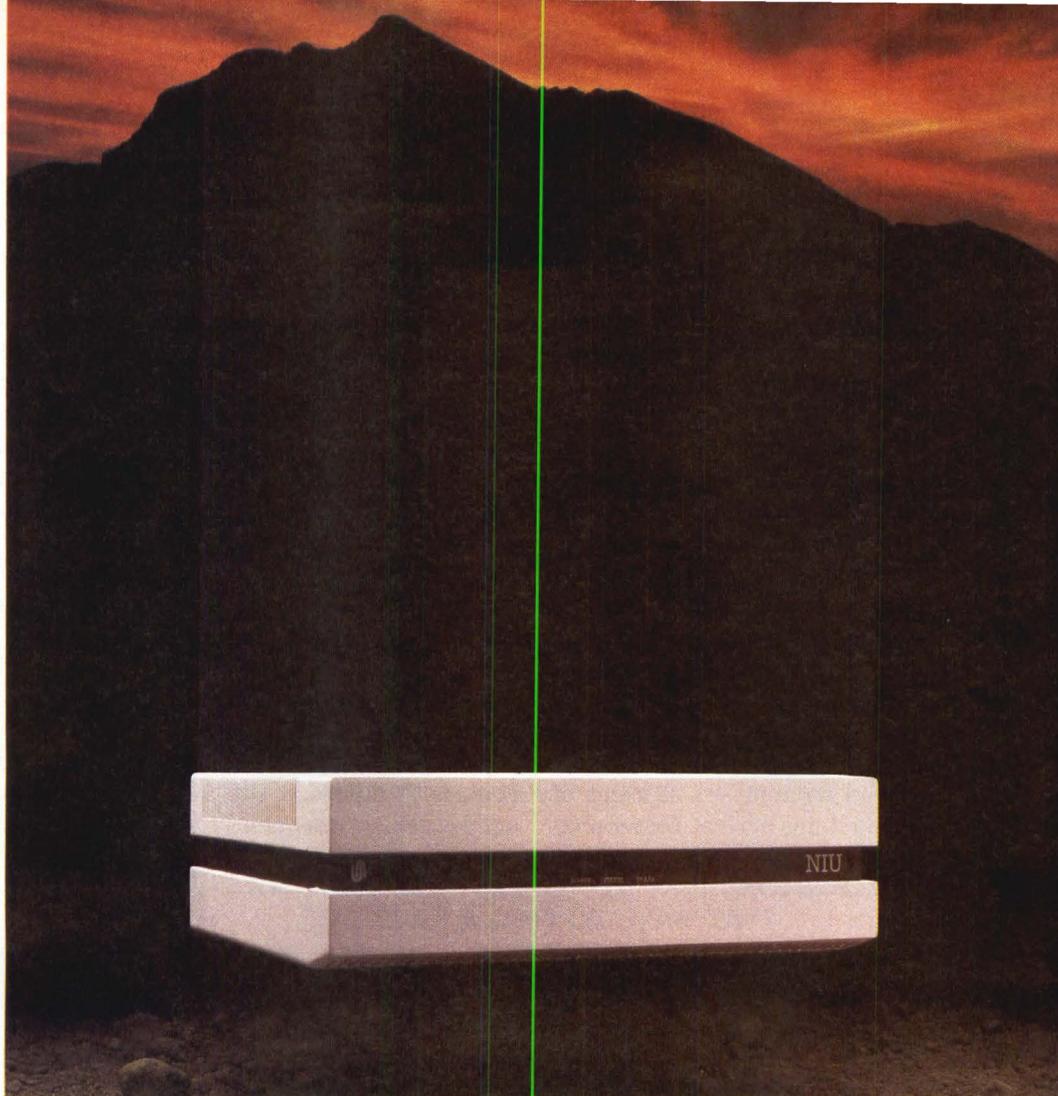
number of term-match chips that are strung together. As terms are located, the match signal is received by the resolution chip, which then evaluates the Boolean logic, near-term match and proximity requirements of the user's query. If the request is satisfied, the record identification number is stored in an output buffer for return to the host.

The text array processor uses

these chips in a matrix arrangement (figure). Each row of the matrix is a query processor, in which the first chip performs the query resolution, while the remaining chips match query terms. The length of a row dictates the maximum number of characters in a query, while the number of rows determines the number of queries that can be processed simultaneously.



Query processor structure consists of strings of character cells, each string with a resolution cell. Character cell strings are used to match text to the user-specified string, while the resolution cell determines if term relationship specifications are satisfied. Each row represents a separate query, and all queries are processed simultaneously.



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Applications

Sequential text searches are often avoided because they are slow. Many alternative schemes have been developed that sacrifice capabilities that are possible only by means of a sequential search. Now, many applications can be reevaluated, with the sequential-search process considered viable.

Indexed systems generally are the means to provide text retrieval, but it is impractical to index everything appearing in large volumes of text, especially if items are seldom accessed. With a TAP, data can be archived without indexes and still provide a user with a means of retrieving information quickly when needed. Because the TAP does not rely on a hierarchical structure and does not compress or encode the data it searches, the TAP can monitor incoming communications to match interest profiles of users against information as soon as it is received. Users then can be apprised of items of special interest as soon as the items arrive. Dissemina-

tion is thus based on the content of the message rather than on an address attached to the front of the message.

The TAP can also be used in text editing and indexing applications. Text-editing systems usually perform a software sequential search of text files to locate such items as names, references, part numbers and regulations that must be updated or changed. When the documents requiring updates are lengthy, locating the areas of change can be time-consuming. Using a TAP, references can be located quickly, and updates can be made sooner. In some applications, an indexed system can be assisted by a TAP by using thesaurus terms or stop words as queries run against documents added to the database. The TAP acts as a filter, identifying the stop words and locating those words under which the document should be indexed. If the database administrator determines that a new term should be added to the thesaurus, then the TAP can be used to search the existing database. This procedure updates the index as if the terms had been a part of the thesaurus for several months.

Because the TAP is considered a peripheral device, it does not require a different configuration for each application. Consequently, several applications can be

TWO WAYS TO FIND A LAZY DOG

The GSCAN 2 text-retrieval system uses a hardware sequential search technique to find pieces of text containing words. Because sequential searching—examining every character in order from the beginning of the database until the word or words are found—is slow without special hardware, other methods of text retrieval have been developed. One such alternative is the inverted-list technique.

The inverted-list technique places every nontrivial word of the database into a separate alphabetical list along

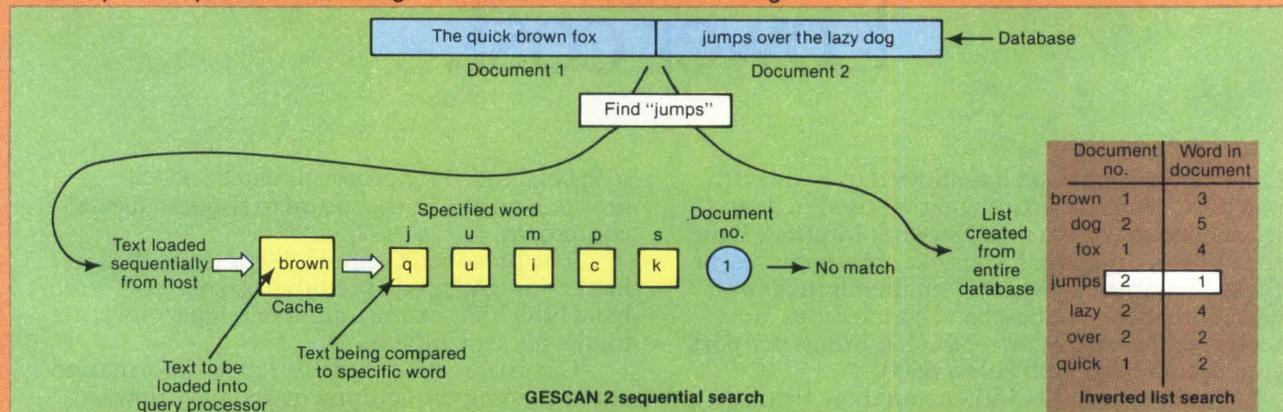
with its location in the main text; the list is created when the database is loaded into the system. This technique is generally implemented in software on a general-purpose computer. Text-retrieval software from Emanuel Data Systems, New Rochelle, N.Y., for example, works on most UNIX-based minicomputers and microcomputers.

Like the GSCAN 2, the inverted-list technique requires only that the database be divided into smaller units, or documents. But while the GSCAN 2 searches through the

documents for the specified words, an inverted-list system scans only the alphabetical list, finding the associated document number and word position within the document (figure). This information is then used to retrieve the appropriate block of text.

To the user, the two techniques accept the same types of requests and produce similar results—although any system is likely to be hard pressed to match the speed of the GSCAN 2.

—DHF



Two methods of text retrieval include GSCAN 2 hardware sequential search and inverted-list search, usually in software. In this highly simplified example, the database to be searched consists of the sentence, "The quick brown fox jumps over the lazy dog," and the word to be searched for is "jumps." The GSCAN 2 finds the word by sequentially loading blocks of text into its query processor (in general, many such processors work in parallel), which compares the loaded text to the specified word. When a match occurs, the accompanying document number is returned to the host. The inverted-list system scans an alphabetical list of all nontrivial words (hence "the" is excluded from the list in this example) to find the specified word. This word is stored in the list with the document number and the location of the word in the document.



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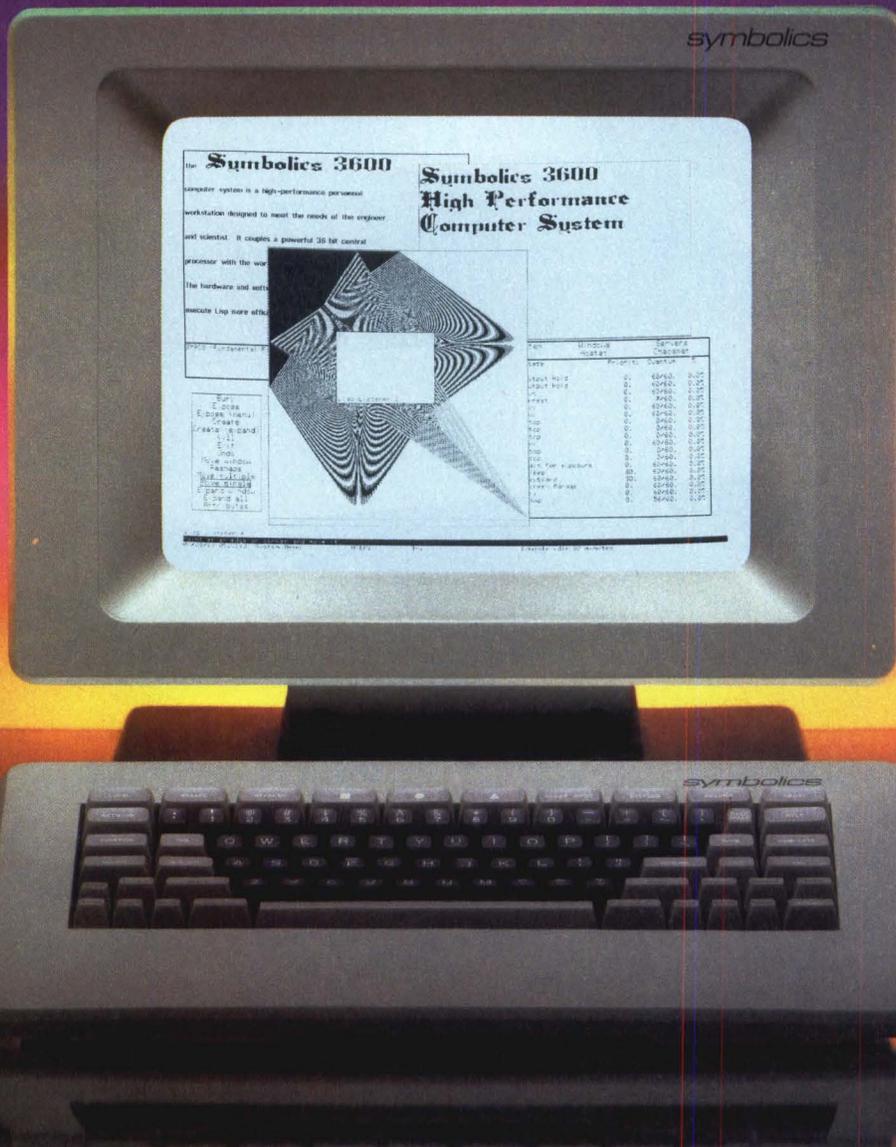


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in progress at once when using the TAP in a time-sharing mode. For example, message dissemination on

Because the TAP is considered a peripheral device, it does not require a different configuration for each application.

an incoming communication line can occur while other users are retrieving archived data. The host computer meanwhile is available for general-purpose applications.

The retrieval process is independent of the database architecture. It is not necessary to determine search strategies before database construction because the TAP requires boundary markers only at the beginning and end of a record and between its fields. This independence from database structure allows new information to be brought on-line quickly. New records can be appended to the end of the database, and are immediately available for retrieval. Indexing can still be used, but is not required at the word level. Instead,

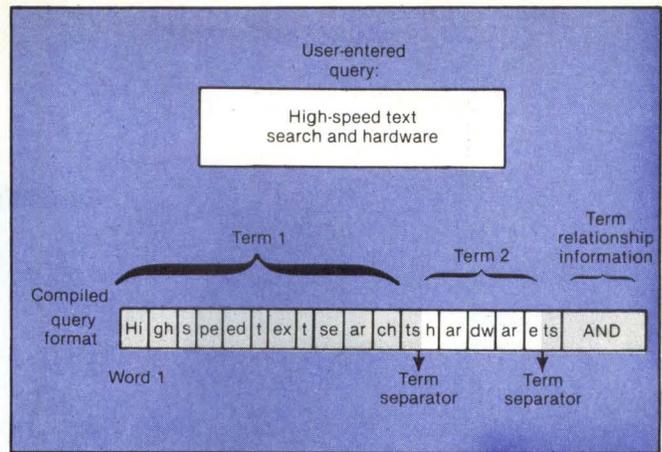


Fig. 3. Query structure involves specifying desired character string, with term separators between each term, and term relationship information at the end. Individual characters are grouped into two-character words, with spaces counting as a character. In this example, the TAP identifies all records containing both the terms "High-speed text search" and "hardware."

indexing can be performed at a higher level, such as by topic, thereby reducing the size of the index and speeding indexing without sacrificing the ability to perform fine-grained retrievals. □

David A. Morris is manager of advanced information systems and technology at General Electric Co., Arlington, Va.

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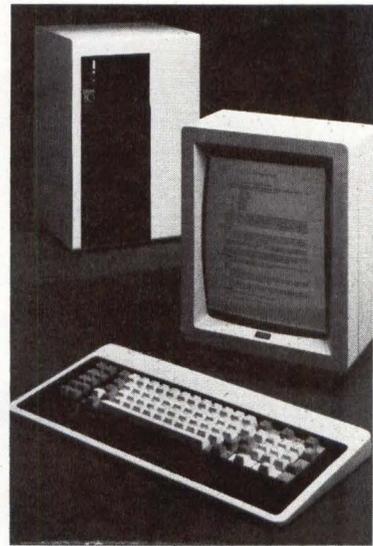
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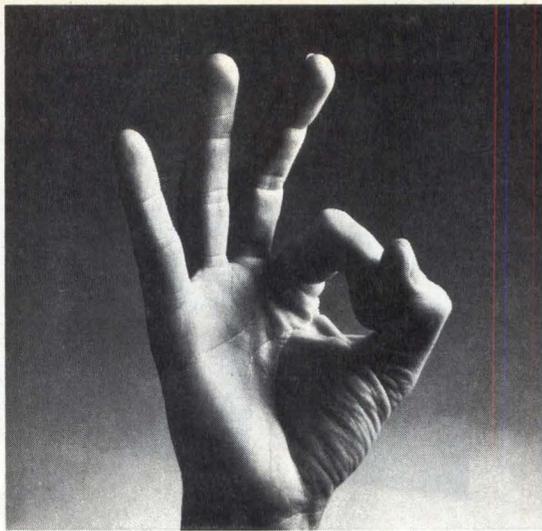
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MINI-MICRO SYSTEMS/June 1983

Bar-code and voice recognition ease data-entry problems

DAVID H. FREEDMAN and ROY FRIEDMAN, Associate Editors

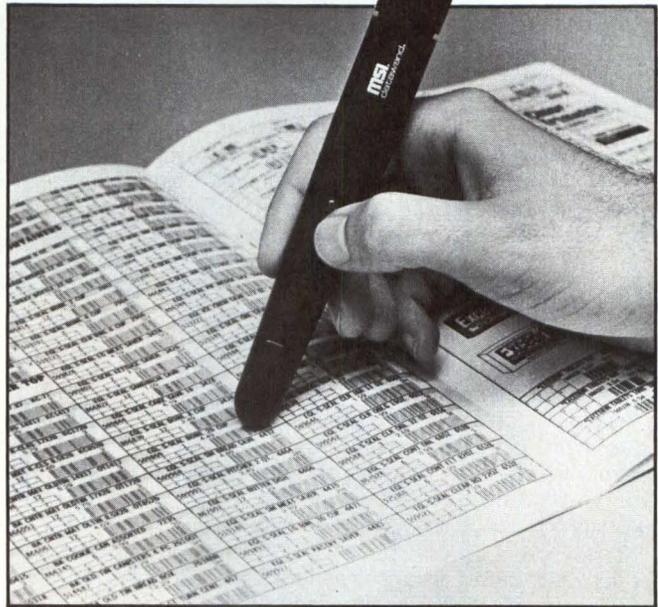
New technologies and applications could help wands and microphones rival keyboards in some markets

Data entry has long been one of the weakest links in the data-processing chain. The availability of more computing power at low cost has only emphasized the need to get data into systems quickly, inexpensively and conveniently. The introduction of low-cost optical-character-recognition systems offers a possible solution to office-automation bottlenecks (MMS, May, p.211), and now, two other automated data-entry schemes promise to extend the solution to retail, industrial and consumer areas. Bar-code reading is a proven technology finding increasing demand, and voice recognition is a much-demanded capability enjoying recent technological improvements.

The push for bar codes

The ubiquitous line patterns familiar to consumers throughout much of the world are the most visible element of an industry that has grown from less than \$1 million in the 1960s to more than \$100 million today. Bar-code-scanning systems are making deep inroads into the retail market, and government and industrial uses promise to push the bar-code industry to higher growth in the years to come.

Supermarket point-of-sale applications account for about two-thirds of the bar-code-reader market. Systems from IBM Corp., NCR Corp., Sweda and others, typically selling for \$4000 per station, are installed in more than 8000 stores in the U.S., checking out more than 30 percent of the items bought in supermarkets. Bar-code systems are expected to penetrate much of the rest of the retail industry in the next five years. Department stores such as J.C. Penney and Sears Roebuck & Co. have experimented with OCR, but high



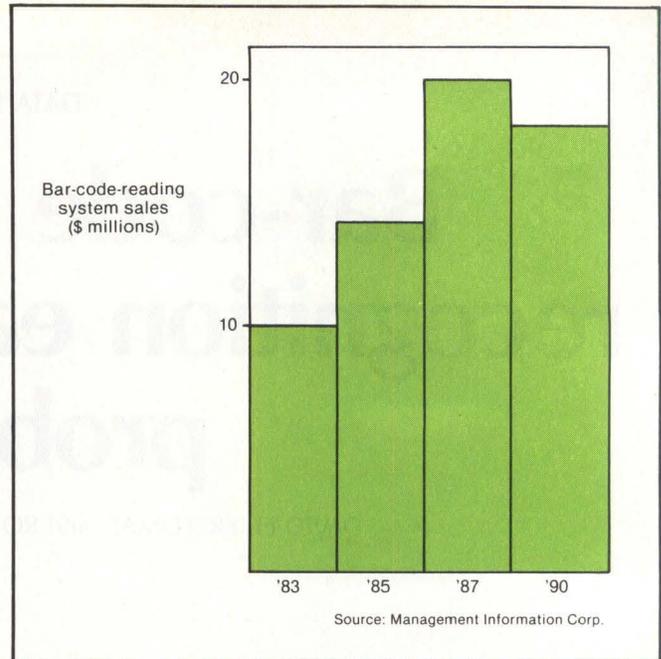
MSI Data's Datawand reads and stores data without a larger, separate unit required by most hand-held wand scanners. The Datawand incorporates a battery, a microprocessor and RAM and is recharged in a unit the size of a coffee mug that also serves as an RS232C interface.

OCR error rates (as much as 1000 times higher than bar code) and a lack of pre-coded items limit the success of these programs. Bar codes have fared much better. While only 10 percent of all department-store items are bar-coded (compared to 90 percent of all supermarket items), this figure is expected to grow dramatically after a few large chains including K-Mart implement bar-code systems.

Manufacturing and distribution account for most of the remaining third of the bar-code market. Raw materials and parts in factories can be labeled or laser-etched with bar codes that are tracked by scanners mounted near conveyer belts throughout the manufacturing process. The Automotive Industry Action Group, representing GM Corp., Ford Motor Co., Chrysler, American Motors Corp. and Volkswagen of America, has successfully pushed for standards that allow manufacturers to track components such as engine blocks from casting through warranty repairs.

Hand-held scanners in warehouses capture inventory data on items as they are placed on or removed from

The manufacturing and distribution market for bar-code technology may eventually overtake the retail market.



Annual bar-code-system sales will double over the next five years as more retail chains and manufacturing operations turn to bar code. After 1987, sales could decline slightly as bar-code-system prices drop and reliable OCR point-of-sale systems become available.

PUTTING DATA BEHIND BARS

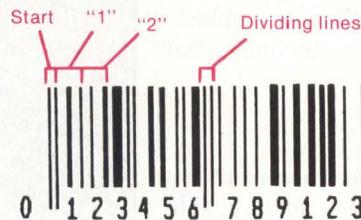
There are three basic types of bar-code readers: wand, fixed beam and moving beam. Each works in the same way, bouncing a light beam off of a bar-code pattern and measuring the reflected light.

Pen-like wand readers, used primarily in inventory applications, are manually pressed against a bar code and pulled across the code at speeds as high as 30 in. per sec. MSI Data Corp. offers a completely self-contained wand reader, but most wands must be connected by cable to a signal-conditioning and -digitizing unit. Fixed-beam readers, popular in manufacturing work-in-progress tracking, use a laser source to scan code on objects passing on a conveyer belt at distances as far as 16 in. Supermarkets use moving-beam readers, incorporating a laser beam that sweeps across the code as many as 400 times per sec. The line of the sweep can be rotated automatically, so that objects to be scanned can be held at any orientation as long as the code is facing the reader. Intermec recently introduced a hand-held, moving-beam, laser scanner for inventory applications in which the contact required with wand readers is impractical.

There are about a dozen bar-code standards in use. The schemes vary in the number of characters repre-

sented, the number of bars and spaces required to specify a character, the relative width of thick bars to thin bars and error-detection provisions. The Universal Product Code used in retail applications, for

example, is a fixed-length, numeric-only code in which each character is composed of two spaces and two bars. Code 39, popular for industrial applications, is a variable-length, alphanumeric code using five bars



3 widths of bars and spaces
2 bars and 2 spaces per character
totaling 7 unit widths



Two widths of bars and spaces
Five bars or five spaces per character, interleaved
Two wide bars or spaces per character

Different bar codes may look alike to the untrained eye, but differ in significant ways. UPC, used in retail point-of-sale and inventory, represents a character with a combination of four bars and spaces of three widths. Interleaved 2 of 5, a popular industrial code, uses five bars or five spaces of two widths to represent a character; if a given character is described by bars, the next character is described by the spaces between these bars. The above enlarged samples were originally printed by a Dataproducts M-100L matrix printer.

shelves. One furniture manufacturer claims that bar-coding its warehouse operations led to a tripling in space from consolidation, a 70-percent drop in labor costs and a 50-percent reduction in inventory. Bar-coded shipping labels allow gate-controlled conveyor belts to sort products automatically, and some distribution and trucking companies rely on scanner-equipped systems to maximize route consolidation. One of the biggest boosters of bar coding inventory operations is the U.S. Department of Defense. The DOD estimates that military standard 1189, issued last year to define bar-code requirements to the 50,000 U.S. manufacturers with which it deals, will save \$114 million in inventory costs.

An untapped market

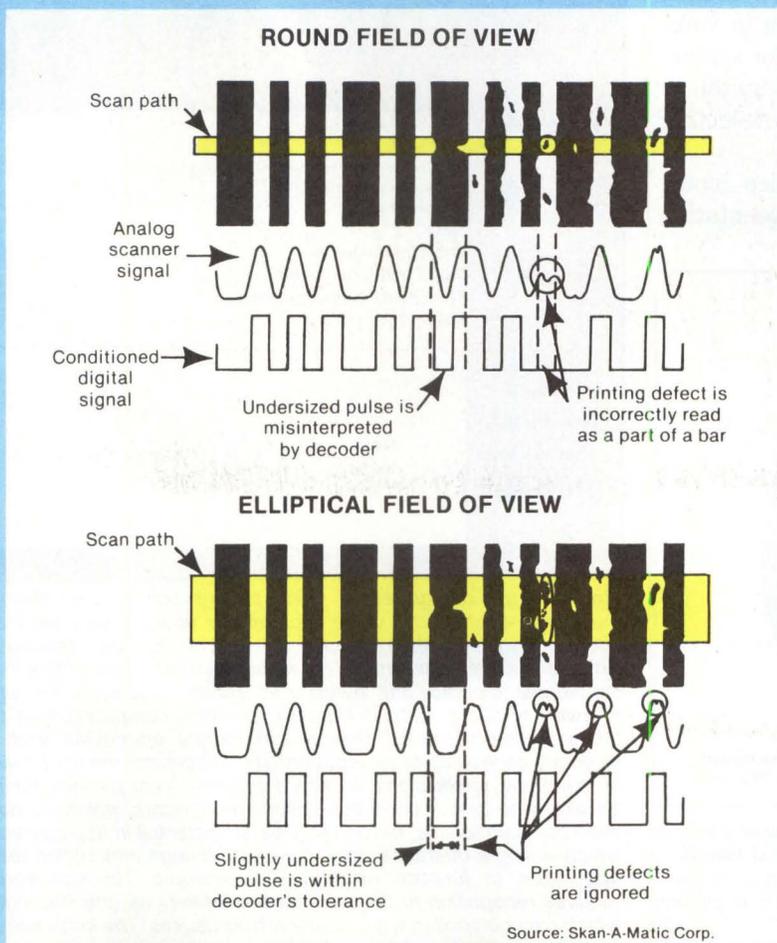
Some industry observers think the manufacturing and distribution market for bar-code technology will eventually overtake the retail market. "Only about 1 percent of the industrial market has been tapped," says Bill Hakanson of Automatic Identification Manufacturers, a bar-code industry trade association. While the retail bar-code system industry is dominated by data-processing giants like IBM and NCR, the nonretail

segment is made up primarily of privately held companies with sales of less than \$10 million per year. But the industrial bar-code market is predicted to grow 20 to 60 percent over each of the next five years, and a number of larger vendors are eyeing the market. MSI Data Corp., Costa Mesa, Calif., has shifted its product split from all keypad terminals to more than 50 percent bar-code-reader sales, while Intermec Corp., Lynwood,

Raw materials can be laser-etched with bar codes tracked by scanners throughout the manufacturing process.

Wash., has moved from a 50:50 retail/industrial reader sales split to 80 percent industrial. Hewlett-Packard Co. and NCR are also said to be readying their entries into the industrial bar-code-scanner market.

While point-of-sale and industrial applications comprise most of the bar-code-scanner market, bar-code technology has been put to limited but promising use in



and four spaces per character. Other codes include Interleaved 2 of 5, used in industry, and Codabar, popular for library-circulation and medical applications such as blood inventory.

Bar-code-reader reliability is limited more by bar-code print quality than by reader capabilities. With high-quality printing, most readers can correctly scan a code on the first try more than 99 percent of the time, with error rates of 1 in tens of million of characters. In actual applications, bar-code samples are made less readable by ink spreading, voids in bars, spots in spaces and uneven bar edges. The effects of low-quality code can sometimes be minimized by adjusting the size and shape of the scanning beam, but results can still be less than satisfactory: one Western university library manually affixed 300,000 bar code labels to its books before discovering the code was unreadable.

Defects in bar-code printing are more likely to produce read errors if the reader's field of view is small compared to the size of spots and voids. A round field of view, however, cannot be made wider than the narrowest bar, or bars and spaces will appear to overlap. One solution is to use an elliptical field of view, increasing the field of view area without enlarging its width.

other fields. In consumer electronics, hand-held wands skim across bar-coded booklets with Casio electronic organs, Texas Instruments Inc. talking books for children and HP programmable calculators. Traffic-management applications include train-yard scheduling and track switching, in which trackside scanners read labels on passing trains, and toll-plaza operations, in which windshield bar-code stickers replace commuter passes. Bar codes have also appeared in one application that would otherwise seem to defy automation: runners in the New York Marathon sport bar-coded identification bibs to aid in compiling results at the crowded finish line.

The growing voice-recognition market

"Dream products" such as voice-activated typewriters probably will not appear in the next decade. But for many microcomputer and minicomputer applications, voice recognition will become an increasingly important feature. "The marriage of affordable hardware and sophisticated recognition technology has led to a 75-percent reduction in high-end cost over the last two years," says Janet Baker, president of Dragon Systems, a research and development firm specializing in voice recognition. The potential rewards are large for system designers who focus on the applications best suited to voice recognition and avoid the pitfalls in selecting voice-recognition products.

Voice recognition is a special case of voice input. Voice input converts voice to a digital representation

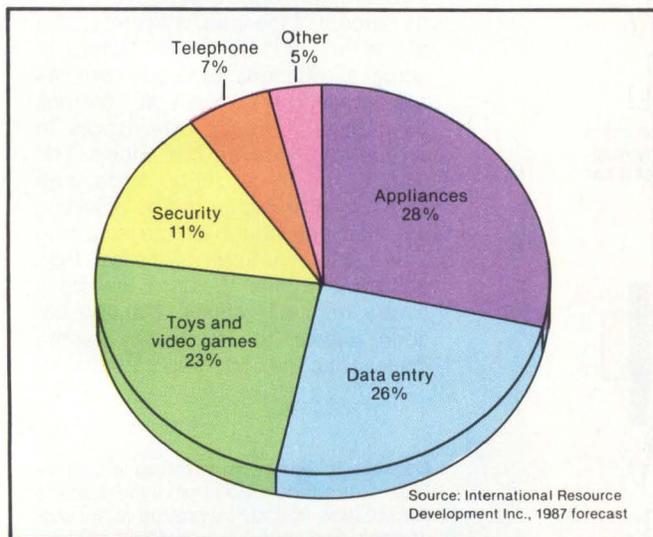


Fig. 1. Applications of voice recognition do not necessarily involve advanced technology. Although data-entry, security and telephone applications may require improved recognition techniques to reach market projections, appliances, toys and video games need only simple voice commands such as "on," "off," "left," "right," "fire" and "kill." For these applications, low cost and user acceptance of voice recognition are the keys to market growth.

for computer storage or processing. Voice recognition involves making a decision based on what a speaker says.

The market for voice-recognition equipment, approximately \$40 million in 1982, will grow to \$100 million in 1986 and \$180 million in 1990, according to Management Information Corp., a Cherry Hill, N.J., consulting firm. Major segments of the projected market are appliances, data-entry devices (including personal computers, office workstations and manufacturing systems), toys and video games, security systems and telephone systems (Fig. 1).

There are three categories of voice-recognition systems: speaker dependent, isolated word; speaker independent; and continuous speech (Fig. 2).

Speaker-dependent, isolated-word systems recognize one word at a time for a single speaker and must be "trained" to the speaking style of that speaker. Products in the speaker-dependent, isolated-word category include chips, boards, front-end processors and stand-alone systems. Prices range from less than \$10 each for low-end chips to more than \$10,000 for

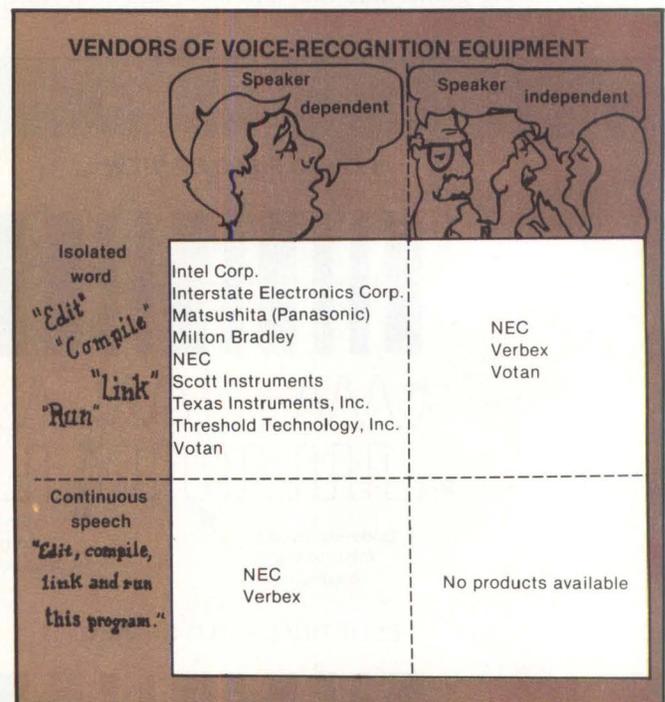
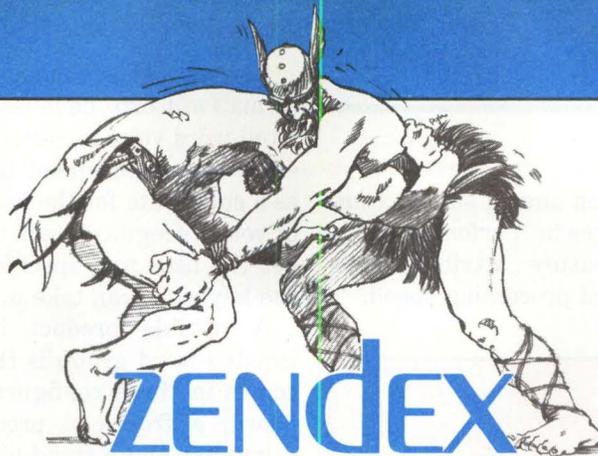


Fig. 2. Three categories of voice recognizers can be defined, based on whether the voice recognizers handle more than one speaker and more than one word at a time. Speaker-dependent, isolated-word recognizers are the most prevalent because they have the highest accuracy and lowest cost. These recognizers are suited to a variety of applications including personal computing, toys and games, computer-aided design and factory operations such as inventory control. Speaker-independent recognizers are used mainly in telephone applications, in which systems must perform for any speaker who calls. Continuous-speech recognizers, which are not in wide commercial use, have their greatest potential in applications in which a single utterance does not carry enough information for an application to function properly. For example, zip-code sorting requires recognition to five consecutive utterances (the five digits), which may be spoken without intervening pauses. The large number of zip codes makes it impractical to create a one-to-one mapping between the zip codes and a set of single-word commands.



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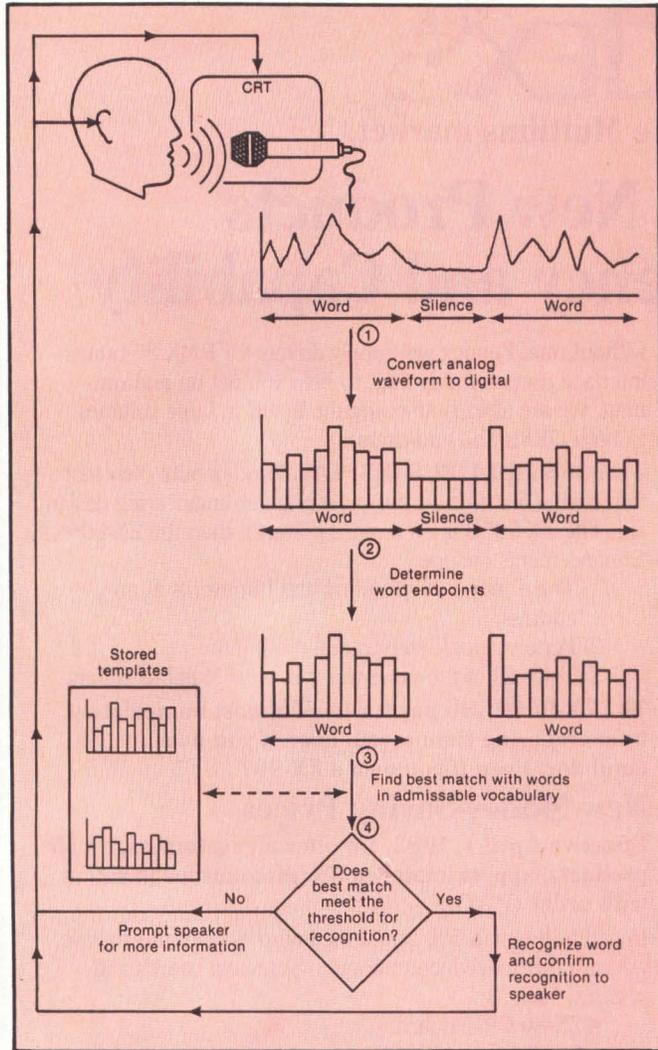


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complete systems. Price variation among similar components is explained by differences in "performance," a loosely defined, difficult-to-measure attribute that includes recognition accuracy and processing speed.



The voice-recognition process consists of four basic steps. To convert voice input from analog to digital representation (1), the analog waveform is sampled thousands of times per sec. in various segments of the sound frequency spectrum. In isolated-word recognition, word endpoints are determined by the periods of silence (2), which typically must last at least 200 msec. In continuous-speech recognition, word endpoints may be ambiguous (e.g., "porous" versus "pour us"), but endpoint determination can be aided by knowledge of the language syntax. Finding the best match between the input word and the admissible vocabulary (3) involves extensive statistical analysis, so fast numerical processors and sophisticated algorithms are required for real-time applications. Processing time in this step is proportional to the vocabulary size of the application. After finding the best match, the system decides if the input word is close enough to the best match to justify a "recognition" (4). If so, confirmation is sent to the speaker by voice synthesis or CRT display. If not, the system can prompt the speaker for more information to clarify the situation. Increasing the system's threshold for recognition reduces system throughput (by generating more requests for follow-up information from the speaker) but reduces the number of errors from "recognizing" the incorrect word.

Lawrence Feidelman, president of Management Information Corp., believes that speaker-dependent, isolated-word voice recognition will be used widely in data entry as a complement to keyboard input, rather than as a substitute for the keyboard. "The greatest benefit of voice recognition will be in sifting through menus to get the user to a specific application program, where the keyboard can take over," says Feidelman.

A notable product in the speaker-independent, isolated-word group is the Votan v5000. This product comes in three configurations: a Multibus-compatible board, a front-end processor for the IBM Personal Computer and a stand-alone system based on the 8086 microprocessor. The v5000 is one of the few products that integrates voice recognition and voice output. This is a desirable feature because "hands-busy, eyes-busy" applications cannot fully exploit voice recognition if system prompts and input verification are made by CRT.

A vocabulary of just two words would be difficult to recognize if the two words were "seem" and "seen."

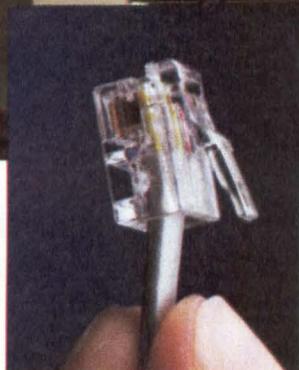
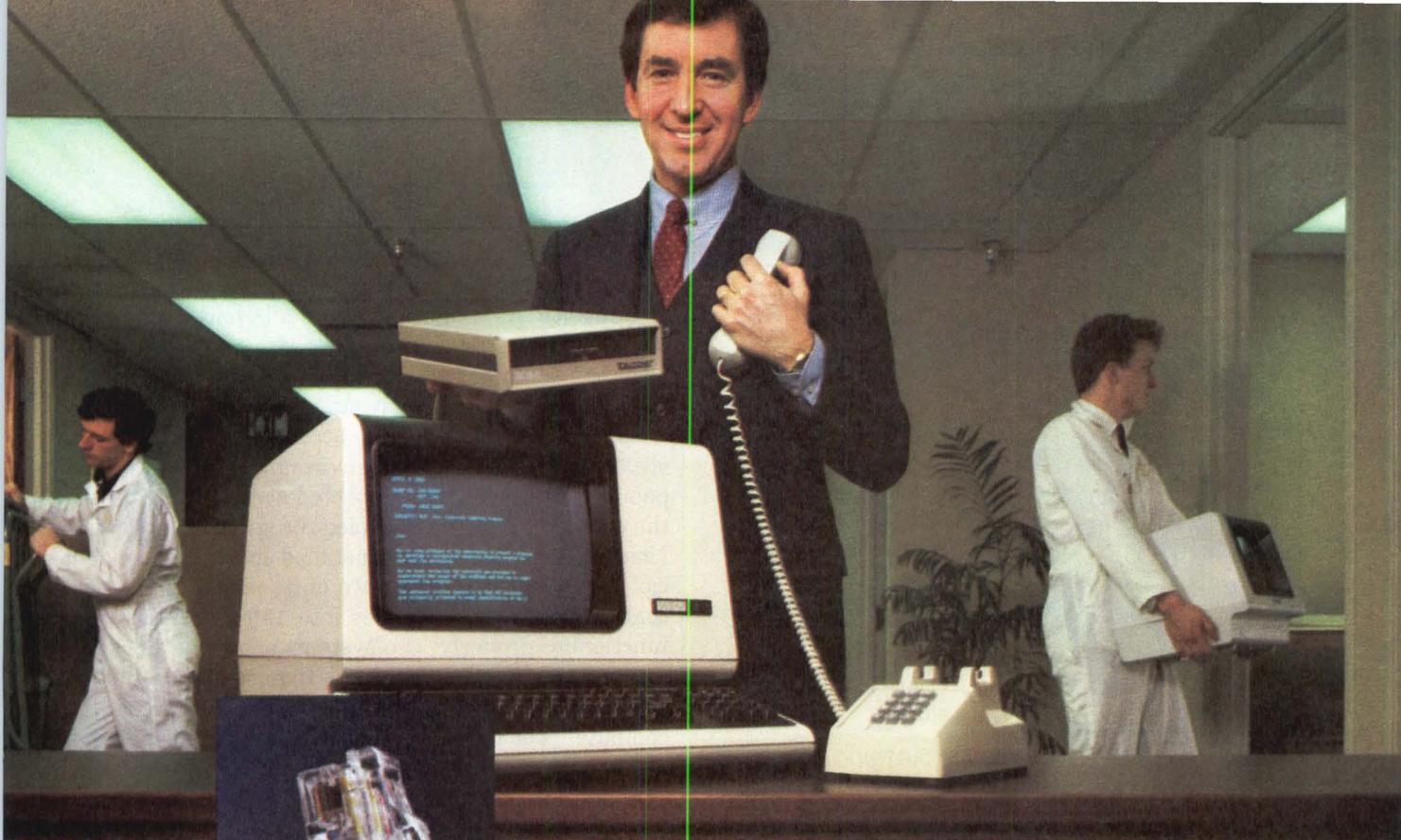
Personal-computer compatibility plays a significant role in the speaker-independent, isolated-word market. Aside from the Votan-IBM match-up, Scott Instruments has board-level products compatible with the Apple II and TRS-80 models 1 and 3, and NEC Information Systems Inc. markets a voice-recognition attachment for its Astra line of personal computers.

Speaker-independent systems recognize one word at a time, but are not limited to a single speaker. Verbex Corp. is the acknowledged technological leader in this market, although it has installed just 14 systems. The principal deterrent to market growth is high cost. A typical speaker-independent system to recognize the digits 0 through 9 and a few control words sells for about \$45,000. At that price, speaker independence is a feature that can be justified only in applications in which it is essential, such as telephone systems.

Continuous-speech systems recognize more than one word at a time for a single speaker. This market, still in its infancy, is now receiving attention because of a new product announcement by Verbex. But despite recent improvements in cost and performance, Feidelman does not believe users are ready for continuous-speech systems. "The continuous-speech companies are making the same mistake that was made with the OCR Omnifont. Instead of hitting a specific application, companies are producing products that are technologically excellent but at too high a price." Feidelman does not expect continuous-speech recognizers to be commercially successful until the 1990s.

Potential problems

Pitfalls in designing voice-recognition applications



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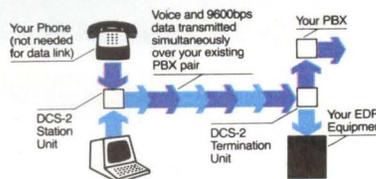
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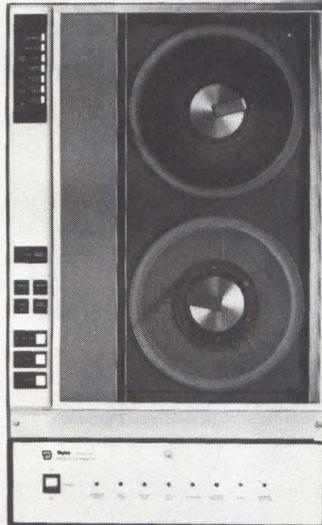
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DATA ENTRY

are low accuracy, small usable vocabularies and inadequate attention to end-user concerns.

Assessing the accuracy of a voice-recognition system is difficult. Although virtually all voice-recognition products are advertised as having a 99 percent accuracy, the accuracy of products in actual use can be much lower. There is no standard way to measure accuracy that takes into account an application's vocabulary, its installation environment and its speaker population. Lower than expected accuracy can destroy the economic benefit of a voice-recognition application. United Parcel Service has installed speaker-dependent, isolated-word systems at two of its plants to use voice commands to sort packages into 15 categories. When functioning properly, the systems allow one worker to perform jobs that previously required two. But the systems are not reliable. "If our man has a cold, the computer won't recognize his command and the whole system goes down," says Dan Buckley of UPS.

Voice recognition will be used widely in data entry as a complement to keyboard input, rather than as a substitute for the keyboard.

An issue closely related to accuracy is vocabulary size. Speaker-dependent, isolated-word systems typically advertise vocabularies of 40 to 250 words, depending on the amount of available RAM. Although a vocabulary size in the low end of this range is adequate for most applications, an advertised vocabulary size may be unattainable because the system cannot distinguish the words in the vocabulary from one another. For example, a vocabulary of just two words would be difficult to recognize if the two words were "seem" and "seen." To avoid this problem, the words in the vocabulary must be selected carefully to assure that they are acoustically dissimilar.

Another important consideration is end-user acceptance of voice-recognition equipment. To increase accuracy, many voice recognizers employ a headset microphone that increases signal-to-noise ratio. George Gagliardi, a consultant with Arthur D. Little Inc., believes that headsets will be an impediment to the use of voice recognition in offices. "It's hard enough to get managers to use computer keyboards. With headsets, you've really got a problem," says Gagliardi. But Steve Weissman of International Resource Development Inc. disagrees, feeling that the headset issue has been resolved by the widespread acceptance of devices such as the Sony Walkman.

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Coaxial-cable multiplexers solve a big LAN problem

WALTER A. LEVY, Contributing Editor

IBM-compatible multiplexers can provide major reductions in network cost

There are more than 2 million IBM Corp. 3270 display terminals in data centers in the U.S. Connecting these terminals to their host computers is today's largest local-area-networking problem. The standard IBM coaxial cabling system for 3270 terminals, developed more than 15 years ago, is obsolete. The cables are costly, bulky and inconvenient to install and to relocate. The cost of installing or moving a terminal can exceed the cost of the terminal itself.

The solution to this problem is multiplexing. Several companies have introduced coaxial-cable multiplexers that are compatible with networks of IBM 3270 terminals. These multiplexers can reduce network cost by eliminating many cable runs, and the multiplexers themselves are relatively inexpensive. Coaxial-cable multiplexers eventually may be used in as many as 50,000 U.S. installations.

Coaxial-cable multiplexers

Standard IBM 3270 coaxial-cable installations use an

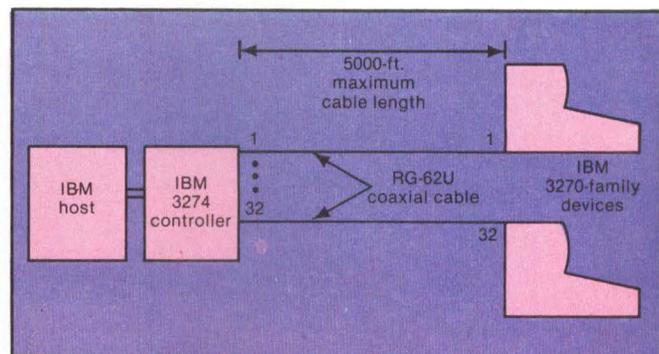


Fig. 1. The standard IBM coaxial-cable installation provides little configuration flexibility. Each device must have a separate cable to the controller.

IBM 3274 controller (Fig. 1). The controller polls each device and exchanges data by a sequence of commands lasting about 20 to 40 μ sec. An entire service cycle for 32 devices takes roughly 1 msec.

SUPPLIERS OF COAXIAL-CABLE MULTIPLEXER SYSTEMS

Company	Product
Astrocom Corp. 120 W. Plato Blvd. St. Paul, Minn. 55107	3274 Squeezplexor
Fibronics International Inc. 218 W. Main St. Hyannis, Mass. 02601	FM-1674 CX series FM-1670 FO series
Interactive Systems Business Communications Products, Division/3M 3920 Varsity Dr. Ann Arbor, Mich. 48104	Model 6600 series IBM attach multiplexers
Ungermann-Bass Inc. 2560 Mission College Blvd. Santa Clara, Calif. 95050	CMX cable multiplexer

MULTIPLEXERS

The controller's polling technique can be time-division multiplexed if the technique is enhanced so that each device can be addressed. Coaxial-cable multiplexers (Fig. 2) make this enhancement by adding a device address to each data packet transferred on the cable between multiplexers. The device address is removed before transferring the data packet to an IBM device, to assure that the multiplexers are transparent to IBM devices in the network.

Economic benefits

The installed cost of a typical coaxial-cable run varies from \$500 to \$2000, depending on length, cost of labor and the complexity of the building. Coaxial cable once

The installed cost of a typical cable run varies from \$500 to \$2000, depending on length, the cost of labor and the complexity of the building.

No. of ports on multiplexer	List price	Price per pair of ports
8	\$2700	\$675
16	\$3200	\$400
24	\$3700	\$308
32	\$4200	\$263

Table 1. Typical multiplexer prices are low in comparison to the cost of installing several coaxial-cable runs. For example, a 32-port multiplexer is priced at about the same amount as two to eight cable runs.

sold for less than 10¢ per ft., but the National Electric Code now requires Teflon-insulated cable, priced at as much as \$1 per ft. wherever the cable runs in an enclosed air-carrying plenum.

Users planning several new cable runs, five or 10 at a time, for example, should easily be able to reduce network cost by employing multiplexers (Table 1). Users planning one-at-a-time cable additions should consider the potential savings from multiplexers, even if multiplexers cannot be justified from the standpoint of initial cost.

Coaxial-cable multiplexers are relatively new products. New features are being announced rapidly as the products gain acceptance, so potential users should consult the multiplexer suppliers for the latest product and pricing information. □

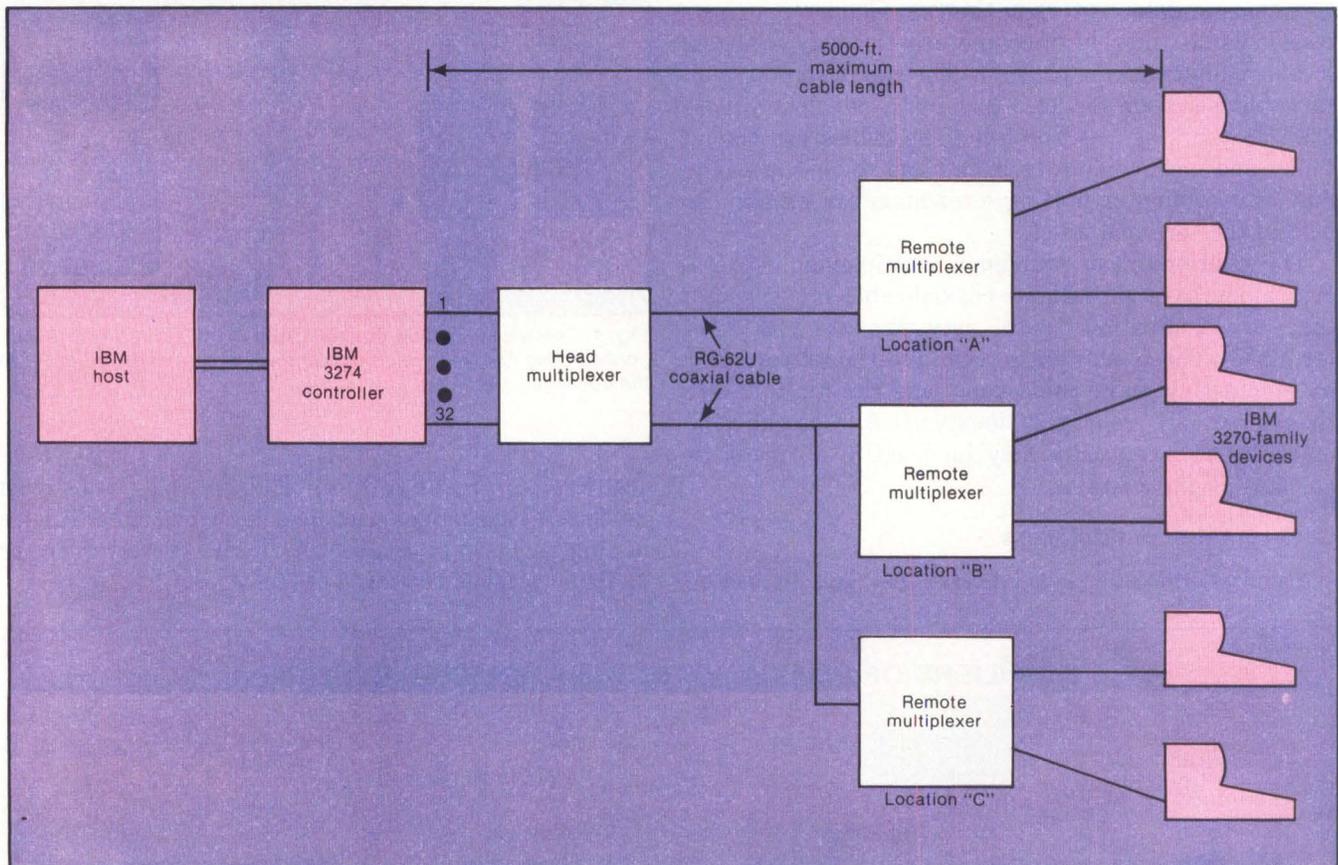
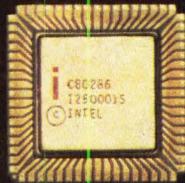


Fig. 2. Coaxial-cable multiplexers allow end-use devices to be configured in a variety of ways. The representative configuration shown employs several network designs: point-to-point service between remote multiplexers and end-use devices, multidrop service between remote multiplexers at locations "B" and "C" and star service between head and remote multiplexers. Also possible but not shown is service in which two IBM controllers share one head multiplexer.

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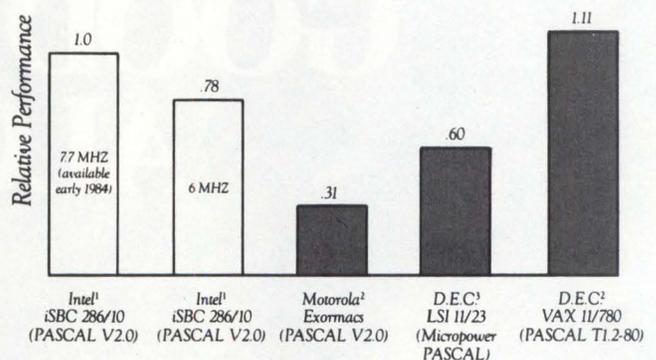
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Performance Comparisons



¹Based on Eratosthenes Sieve Benchmark in PASCAL. Details available from Intel's "Eratosthenes Sieve Prime Number Benchmark on the iSBC 286/10 Board," literature order number 210984. ²"Eratosthenes Revisited," BYTE, Jan., 1983.

³"A System/Architecture Approach to Microcomputer Benchmarking," Digital Equipment Corporation, Sept., 1982.

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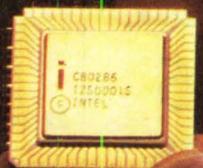
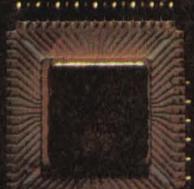
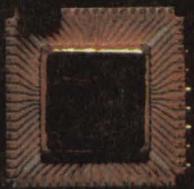
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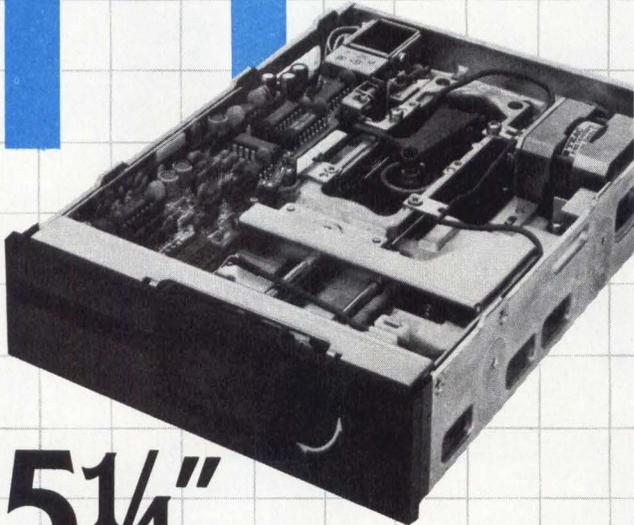
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JUNE

- 13-15 "An Introduction to PADL-2" Course**, Rochester, N.Y., sponsored by the University of Rochester. Contact: Arlene Rosenberg, Administrative Assistant, Production Automation Project, The University of Rochester, Rochester, N.Y. 14627, (716) 275-3106.
- 13-16 Syntopican XI**, San Francisco, sponsored by the International Information/Word Processing Association. Contact: IWP Conference Planning Department, 1015 N. York Rd., Willow Grove, Pa. 19090, (215) 657-6300.
- 15-17 "Computed Imaging" Course**, Columbia, Md., sponsored by the Continuing Education Institute. Contact: Continuing Education Institute, Oliver's Carriage House, 5410 Leaf Treader Way, Columbia, Md. 21044, (301) 596-0111. Also to be held July 27-29 in Los Angeles, (213) 824-9545.
- 16-17 "Introductory NC for Graduate Engineers" Course**, Rochester, N.Y., sponsored by the University of Rochester. Contact: Arlene Rosenberg, Administrative Assistant, Production Automation Project, The University of Rochester, Rochester, N.Y. 14627, (716) 275-3106.
- 16-17 Computer Showcase Expo**, Milwaukee, sponsored by the Interface Group. Contact: The Interface Group, 160 Speen St., P.O. Box 927, Framingham, Mass. 01701, (617) 879-4502 or (800) 225-4620.
- 22-24 "Machine Vision/Image Understanding" Course**, Los Angeles, sponsored by the Continuing Education Institute. Contact: Continuing Education Institute, (213) 924-9545. Also to be held July 13-15 in Columbia, Md. (Oliver's Carriage House, 5410 Leaf Treader Way, Columbia, Md. 21044, (301) 596-0111).
- 23 22nd Annual Technical Symposium**, Washington, D.C., sponsored by the Washington, D.C., Chapter of the Association for Computing Machinery. Contact: Lorraine Lynch Nagy, (202) 676-0037.
- 23-26 U.S. Computer Show**, Cologne, Germany, sponsored by the U.S. Commerce Foreign Commercial Service. Contact: Kenneth D. Blum, Counselor of Embassy of the United States of America, Deichmanns Ave., 5300 Bonn 2, Germany, (0228) 339-2047. Also to be held June 29-July 2, Vienna, Austria.
- 26-30 NCGA '83**, Chicago, sponsored by the National Computer Graphics Association. Contact: Nancy Lefebvre, NCGA, 8401 Arlington Blvd., Fairfax, Va. 22031, (703) 698-9600.
- 27-29 Third International Conference on Decision Support Systems**, Boston, sponsored by The Institute for the Advancement of Decision Support Systems. Contact: Pat Van Cleve, DSS-83, P.O. Box 10001, Austin, Texas 78766, (512) 345-7948.

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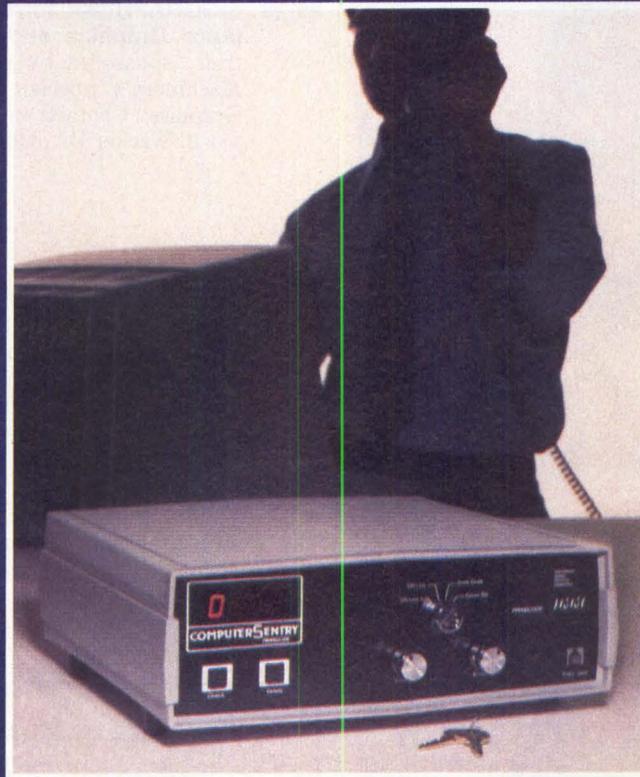
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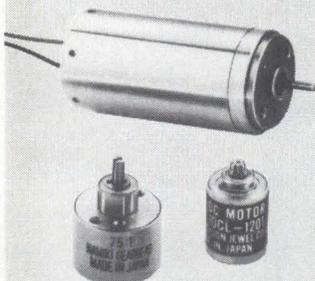
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Calendar

JULY

25-29 SIGGRAPH '83, 10th Annual Conference on Computer Graphics and Interactive Techniques, Detroit, sponsored by the Association for Computing Machinery's Special Interest Group on Computer Graphics. Contact: SIGGRAPH '83 Conference Office, 111 E. Wacker Dr., Chicago, Ill. 60601, (312) 644-6610.

AUGUST

8-12 Eighth International Joint Conference on Artificial Intelligence, Karlsruhe, West Germany, hosted by the Federal Republic of Germany. Contact: Institut für Informatik I, Universität Karlsruhe, Postfach 6380, D-7500 Karlsruhe, West Germany, (0721) 608-3975.

AUGUST 31 - SEPTEMBER 2

Eurographics '83 Conference, Zagreb, Yugoslavia, sponsored by the European Association for Computer Graphics. Contact: ATLAS, Congress Department, P.O. Box 17, YU-41001, Zagreb, Yugoslavia, Telex: 22413 yu altcon.

NEXT MONTH IN MMS

July's spotlight is computer graphics and MMS will feature two product focus articles. One will cover a wall size graphic projection system designed for mass viewing of CRT-generated color images. A second article highlights a computer terminal for measuring 3D objects. July will also feature a product profile of low-end graphic workstations for distributed graphics environments.

Other articles will cover:

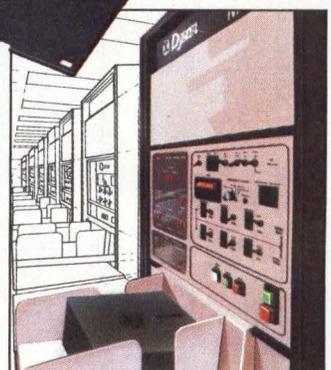
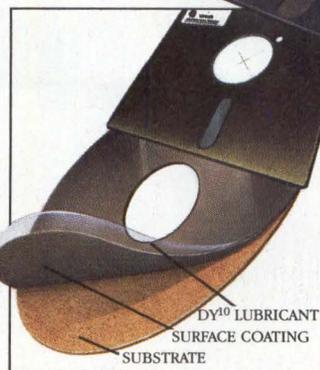
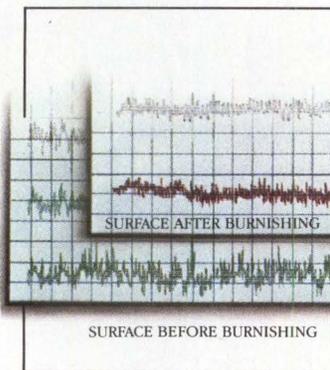
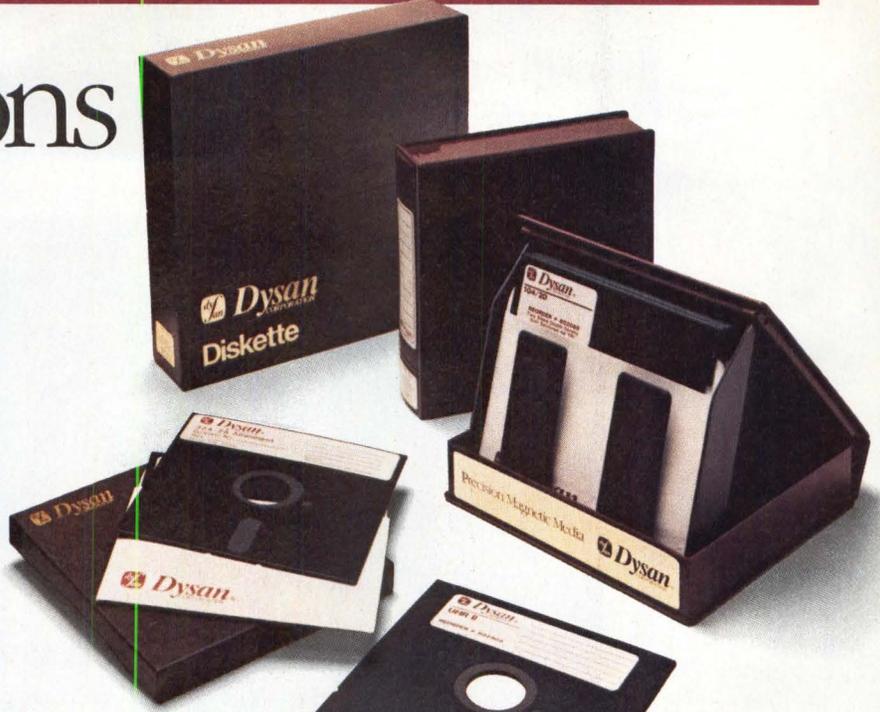
- Fiber optics for local area networks.
- Graphics hardware compatibility.
- A desk-design station with multi-mode graphics.

LOOKING AHEAD IN MMS

Be sure to watch for these editorial highlights in coming issues of Mini-Micro Systems:

- Micros will be profiled in the August issue.
- Software packages will be studied in MMS's September issue.

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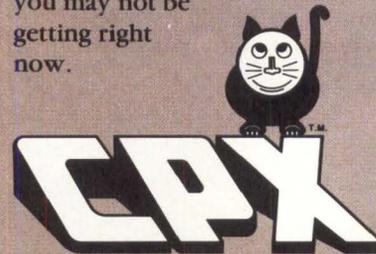
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CIRCLE NO. 145 ON INQUIRY CARD

New Products

SYSTEMS

High-performance minicomputers use two 16K-byte cache memories

The Concept 32/67 product line, a mid-range offering in the vendor's Concept/32 family of 32-bit minicomputers, features a 32K-byte, two-way set associative cache memory with separate 16K-byte banks for data and instructions. This type of cache organization contributes to the Concept 32/67's 2-MIPS performance rating. The Concept 32/67 also features an alterable control store, a writable control store and 16M-byte task addressing in a base register mode.

The Concept 32/67 product line consists of three products. The low-level Concept 32/6705 includes a 32-bit CPU implemented with high-speed transistor-to-transistor logic that operates at a 150-nsec. machine cycle time, an I/O processor, 1M byte of MOS memory and a single cabinet with 24½ in. of vertical rack space near the top of the cabinet for optional peripherals such as disk or tape drives.

The intermediate-level Concept 32/6750 is similar to the 32/6705 except that it uses the rack space at the top of the cabinet for a SelBUS (a high-speed synchronous bus that has a transfer rate of 26.67M bytes per sec.) expansion chassis. In this configuration, more SelBUS slots are available for memory and expansion. The 32/6750 can also be field-upgraded to include an optional internal processing unit that increases the system's performance. During operations, the CPU and IPU can execute different tasks in parallel. The IPU handles compute-bound tasks, and the CPU handles all interrupts and I/O processing.

The top-level Concept 32/6780 includes the CPU and IPU, each with its own cache memory, and 2M bytes of main memory. Like the other 32/67 computers, it is packaged in a single cabinet and is controlled from a console CRT.

Options for the Concept 32/67 product line include a floating-point accelerator that can be attached to both the CPU and the IPU, a diagnostic processor, an IPU console device and upgrade kits for 32/6705 and 32/6750 computers.

All Concept/32 computers are supported by the vendor's proprietary real-time



The Gould Concept 32/67 computers provide 2-MIPS performance in a compact package.

MPX-32 mapped programming executive and UNIX.

Base prices for the 32/6705, 32/6750 and 32/6780 are \$120,500, \$130,000 and \$170,000, respectively. **Gould Inc.**,

S.E.L. Computer Systems Division, 6901 W. Sunrise Blvd., P.O. BOX 9148, Fort Lauderdale, Fla. 33310.

Circle No 300

Superminicomputer offers UNIX operating system

A low-cost packaged superminicomputer system built around the vendor's model 3210 32-bit superminicomputer features the Edition VII workbench version of the UNIX operating system. Typical applications of Edition VII workbench include generalized software development, word processing, time sharing, software-configuration management, networking and application development and testing. The packaged system includes a model 3210 processor, 512K bytes of memory, a 64M-byte disk drive, eight communications lines, a model 550B console terminal and an eight-port Edition VII workbench license. Options include expansion to a 96M-byte disk drive, substitution of 1M byte or 2M bytes of main memory in



place of the 512K bytes offered and eight-port expansion. Single-unit price is \$49,950. **Perkin Elmer Corp., Data Systems Group**, 2 Crescent Place, Oceanport, N.J. 07757. Circle No 301

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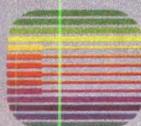
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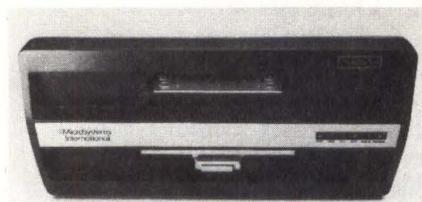
New Products

SYSTEMS



STD bus microcomputer is CP/M compatible

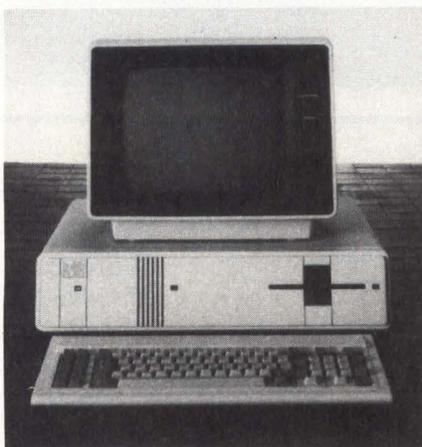
The model ABL-1 general-purpose, CP/M-compatible STD bus system contains a 4-MHz Z80A CPU or a 6.144-MHz 8085 CPU, 64K bytes of static RAM, two slimline, 8-in. floppy disk drives with a total storage capacity of 3.2M bytes, two RS232C ports and a single-density controller that supports as many as four 8- or 5¼-in., single- or double-sided floppy disk drives. The vendor's Auto-BIOS firmware allows any single-density CP/M 2.2 8-in. floppy disk to work with the ABL-1's STD bus hardware. Other features include a bootstrap routine and hardware self-test programs. The all-metal ABL-1 is available in a RETMA 19- × 7-in. rack-mountable package that contains a 13-slot STD bus card rack, a 4V switching power supply and a bus terminator card with a reset switch and a power indicator. Price is \$6295. **Pro-Log Corp.**, 2411 Garden Rd., Monterey, Calif. 93940. **Circle No 302**



Multi-user system is aimed at the business community

MultiNet is a multi-user, multiprocessor, IEEE 696 standard S-100 bus computer system. MultiNet accommodates as many as eight users, each with his own processor and memory. It allows the intermixing and simultaneous operation of 8-bit (Z80) and 16-bit (8086/8087) user processors within a single system. A basic two-user system includes a master processor, two user processors, a 5¼-in., ST-506-compatible, 20M-byte Winchester disk, a 13.4M-byte cartridge-tape drive, a

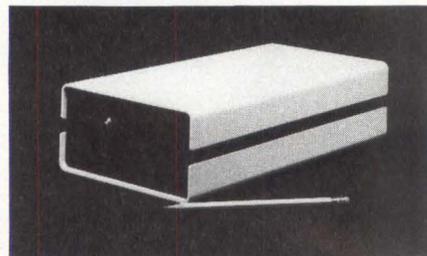
1.2M-byte industry-standard 8-in. floppy disk drive, a distributed-processing operating system and CP/M. As many as 16 MultiNet systems can be linked in a local network to share programs and data. A master processor includes a 4-MHz Z80A CPU with 64K bytes of RAM. Each user processor includes a Z80 CPU with as much as 128K bytes of memory or an 8086 CPU with as much as 1M byte of memory and an optional 8087 arithmetic-processing chip. Price of the basic two-user system is \$9995. **Micro-Systems International Corp.**, 12 Mercer Rd., Natick, Mass. 01760. **Circle No 303**



Business computer runs 8-, 16-bit CP/M and MP/M

Aimed at business and professional users, the desk-top Rair Business Computer supports as many as four user workstations, 1M byte of main memory and 8- and 16-bit microprocessors. Each user workstation includes an ergonomic, low-profile, detachable keyboard and a high-resolution, eight-color video display. The Business Computer's multitasking operating system is compatible with PC-DOS and with 8- and 16-bit versions of CP/M and MP/M. Electronic spread-sheet, word-processing, database-management and communications packages are supported as well as 16-bit implementations of BASIC, COBOL and Pascal. An entry-level, single-user system, configured with a 19M-byte Winchester disk drive, a 1M-byte floppy disk drive and 256K bytes of RAM, is priced at \$8500. Memory upgrades are priced at \$1500 in 256K-byte increments. User workstations are priced at \$1500 each. Quantity and OEM discounts are

available. **Rair Computer Corp.**, 4101 Burton, Dr., Santa Clara, Calif. 95050. **Circle No 304**



Single-board computer is convection-cooled

The model DSB-4/6 single-board computer is now available in a compact, convection-cooled enclosure that measures 3½ × 7 × 14 in. The new model, called the DS1-4/6, is a Z80-based microcomputer featuring 64K bytes of RAM, boot ROM, a parallel printer port, a hard disk port, as many as four RS232 ports (including one configured for a modem) and a disk controller. The controller interfaces with 5¼- and 8-in. drives in single- or double-density recording format. The DS1 series is available with a 4-MHz Z80A or a 6-MHz Z80B microprocessor. In single-unit quantities, the DS1 series is priced between \$920 and \$1220, depending on CPU and number of I/O ports. Quantity discounts are available. **Davidge Corp.**, 1951 Colony St., Suite x, Mountain View, Calif. 94043. **Circle No 305**

Microcomputer features mass-storage options

The Diskstor-Q, a microcomputer system based on Digital Equipment Corp.'s 11/23 Q-bus technology, is available with many combinations of built-in mass storage (8-in. floppy disk drives, 18M- and 36M-byte Winchester disk drives and ¼-in. cartridge-tape drives). It features a KDF11 CPU with memory management, 128K bytes of RAM, a clock, two serial communication channels, push/pull forced air cooling, a 200W switching power supply and a Q-bus card cage. Front access to the boards and chassis assembly is possible without unmounting the shell. High-level languages including BASIC, FORTRAN and Pascal are available. Single-unit price is approximately \$7485. **Comark Corp.**, 257 Crescent St., Waltham, Mass. 02154. **Circle No 306**

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New Products

SYSTEMS



Multi-user system features networking capability

The model 586 five-user microcomputer system, which can be upgraded to eight users, offers Ethernet and Altos-Net networking capability. It features a 16-bit 8086 microprocessor with 256K or 512K bytes of RAM, expandable to 1M byte. The system supports the XENIX/UNIX, ABS/86 business software package, MS/DOS, Pick, CP/M-86, MP/M-86 and OASIS-16 operating systems and the BASIC, COBOL, FORTRAN, Pascal and C programming languages. The model 586-10, which includes a 10M-byte, 5¼-in. hard disk drive with floppy disk backup, is priced at \$7990 in single-unit quantities. **Altos Computer Systems**, 2360 Bering Dr., San Jose, Calif. 95131. **Circle No 307**

CPU board features DMA

The model GMX III 6809 CPU board is intended for use with multi-user, multitasking operating systems. The CPU board features high-speed memory-to-memory DMA transfers and automatic task switching on interrupts and operating system calls. Also featured are a time-of-day clock with year and automatic leap-year/daylight-savings-time correction and a 2K-byte scratchpad RAM, both with battery backup. To prevent system crashes caused by errors in user programs, the system has protected user modes with illegal instruction and out-of-range memory reference trapping and write protection. The board's single EPROM socket accepts 2K-, 4K- and 8K-byte EPROMs with a maximum of 4K bytes mapped into the system address space at once. The GMX III 6809 CPU board is available with the OS-9 GMX III operating system for a package price of \$1698.01. **Gimix Inc.**, 1337 W. 37th Place, Chicago, Ill. 60609. **Circle No 308**

Packaged microcomputer includes software

The Unisystem, a fully assembled microcomputer system with floppy or Winchester disk drives contained in a single housing, features a 4-MHz Z80



microprocessor, 64K bytes of RAM, one user serial port and one Centronics-compatible parallel port or optional serial printer port. The Unisystem operates under CP/M. Single-unit price of the Unisystem starts at \$1595 including 1M byte of floppy disk storage and CP/M 2.2, Word Editor, an electronic spread sheet, communications and automatic program-load software. **International Systems Marketing Inc.**, 932 Hungerford Dr., Jackson Place S., Suite 6, Rockville, Md. 20850. **Circle No 309**



Compact micro has half-height floppies

The compact Sage II microcomputer now includes half-height floppy disk drives and measures 3.9 × 12.5 × 16.7 in. The low-profile Sage II features a 16-bit 68000 microprocessor that operates at 8 MHz, 128K bytes of RAM, expandable to 512K bytes in 128K-byte increments, one built-in, half-height, 640K-byte floppy disk drive, and room for a second disk drive. A Sage II with one floppy disk drive, 128K bytes of RAM and the p-System operating system is priced at less than \$3600. CP/M-68K is optional. **Sage Computer Technology**, 35 N. Edison Way, Suite 4, Reno, Nev. 89502. **Circle No 310**

Multibus-compatible computer features 68000

The Multibus-compatible ModulasTen M68K10 68000-based single-board computer features 128K bytes of on-board

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INCREASED VAX THROUGHPUT.



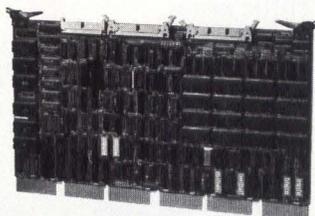
ABLE VMZ/32[™]
16-line DMF/32 subset

Here's an asynchronous microcontroller with programmable DMA, fully transparent to VAX/VMS as two 8-line DMF 32's and contained on a single board. Priced

below the DZ11-E, it outperforms DZ or DH devices under VMS v.3, has interrupt-driven modem control on every line, and includes an output throttle which lets peripheral devices optimize their own data rate.

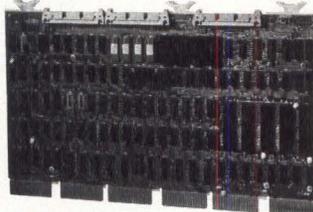
#1 UNIBUS DMA.

Then there's our DH/DM, the original multiplexer which puts 16 lines with modem control on a single board. This popular device meets UNIX VAX system needs for DMA communications requirements, serves UNIBUS systems equally well, and beats them all for MTBF, throughput and



ABLE DH/DM[™]
16-line combination DH11 & DM11 replacement

price. Other features include on-board diagnostics, modem control on all lines, superior on-board silo depth and variable prom-set. **SYNC/ASYNCH FLEXIBILITY.**



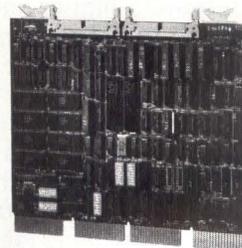
ABLE DV/16
16-line DV11 replacement

A controller for the PDP-11 user, the DV/16 contributes microprocessor-derived flexibility, which permits mixing of sync and async lines in combinations

of 4 or 8 lines with modem control and full system software compatibility. It takes less than half the space of a DV11 and uses word transfer instead of byte DMA to gain a 2 to 1 speed advantage or permit operation in half the bandwidth required for data transfers.

Q-BUS DMA.

The Q/DH is an asynchronous controller which makes DH-class performance possible on PDP-11/23 and LSI-11/23 Q-BUS systems. It connects the standard Q-BUS to as many as 16 async lines with DMA output capabilities and allows optimum Q-BUS utilization. Features include software compatibility with RSTS/E and RSX operating systems, large input silo, modem control on all lines.



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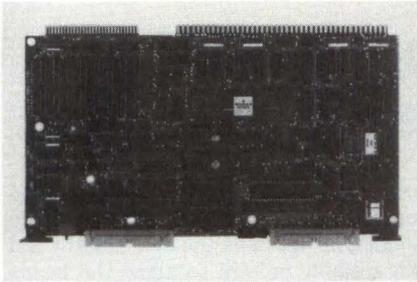
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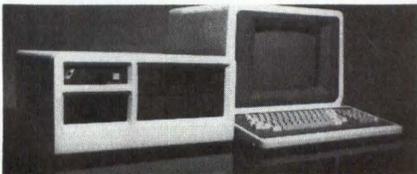
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New Products

SYSTEMS



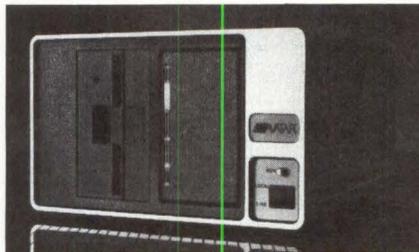
RAM (expandable to 256K bytes via a piggyback memory module), Multimodule capability, multiprotocol serial communications and parallel control. The M68K10 runs at 10 MHz with no wait states. Dual-ported memory enables other masters on the Multibus to share on-board dynamic RAM. Two 8-bit ISBX Multimodule I/O connectors permit customization of on-board I/O for process control, data analysis, laboratory and medical or ATE applications. With 24-bit addressing capability, the ModulasTen computer can access 16M bytes of system address space. The M68K10 has 24-bit parallel I/O (8255) with iSBC-compatible header pin assignments. Other on-board features include an 8274 multiprotocol serial I/O controller supporting two independent full-duplex channels in asynchronous, bisynchronous, SDLC and HDLC protocols; jumpered/programmed baud-rate selection for individual channels; 8253 triple counter/timer functioning at 3 MHz; and eight software-controlled fault-isolation LEDs. Four 28-pin sockets are available for byte-wide memory. The M68K10 is supported by several software systems including Regulus, a real-time UNIX-like operating system, VRIX, a real-time executive in PROM, and CP/M 68K. Single-unit price is \$1995. **SBE Inc.**, 4700 San Pablo Ave., Emeryville, Calif. 94608. **Circle No 311**



Desk-top computer is based on S100 bus

The SDS-100 line of desk-top micro-computer systems is based on the IEEE 696-, S-100 bus-compatible model SBC-100 single-board computer. On board the SBC-100 are a Z80A micro-processor, 64K bytes of RAM, 4K to 16K

bytes of EPROM, two RS232 channels, two parallel channels, four counter timers, a floppy disk controller and a hard disk interface. Any of the desk-top units can be configured with as many as four double-sided, double-density, Shugart-compatible, 5¼- or 8-in. floppy disk drives, a Micropolis 8-in. Winchester disk drive or ST-506-compatible 5¼-in. hard disk drives. The desk-top enclosures feature a filtered power supply, filtered forced-air circulation, an LED display, a momentary reset switch, a key-lock power switch and a 12-slot IEEE motherboard. The systems operate under CP/M or TurboDOS. Prices vary according to configuration, quantity and peripherals supplied. **Sierra Data Sciences, Product Support Group**, 21162 Lorain Ave., Fairview Park, Ohio 44126. **Circle No 312**

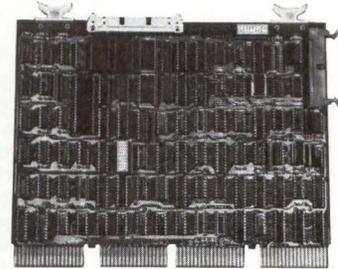


Terminal converter has Z80A processor

The Avatar universal terminal converter family of microprocessor-based systems converts dumb terminals into intelligent workstations. They allow users to operate any CP/M-based application from any vendor on any Avatar-supported video terminal. The Avatar TC10 system includes a Z80A microprocessor, three asynchronous serial ports, a Centronics-type parallel printer interface, a floppy disk drive and a Winchester disk subsystem. The integral 5¼-in. Winchester disk system is available in 5m-, 10m- and 20m-byte capacities. The 5¼-in., double-sided floppy disk drive is available in double- or quad-density configurations with storage capacities of 410K and 820K bytes, respectively. Also included in the system are the CP/M operating system, WordStar and CalcStar application programs and CBASIC development software. Price of the Avatar TC10 system ranges from \$1995 to \$6095, with quantity discounts available. **3R Computers**, 18 Lyman St., Westboro, Mass. 01581. **Circle No 313**

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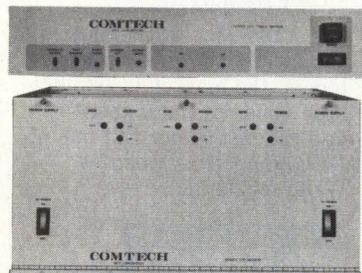
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New Products

DISK/TAPE

High-capacity floppy disk drives provide height savings

Three very thin, high-capacity 5¼-in. floppy disk drives have been introduced by the Peripherals Division of Canon U.S.A. Inc. The model MDD 221 is a 96-tpi, double-sided, double-density, single-disk drive with a 1M-byte capacity. It measures only 33.5 mm. high, an 18 percent saving in height over a 41-mm., half-height drive. For installation in existing designs, the MDD 221 is available with a 41-mm. panel. The drive features a 250K-bit-per-sec. data-transfer rate and a 95-msec. average access time.

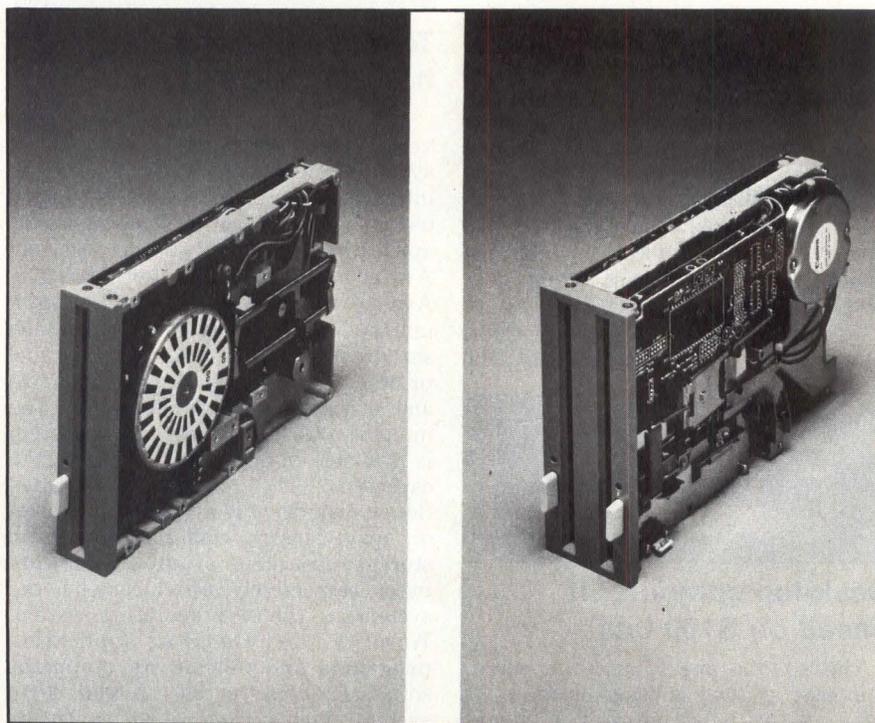
The models MDD 422 and MDD 423 are 96-tpi, double-density, double-sided, dual-drive units with an unformatted capacity of 1M byte per diskette. Both models measure 57.5 mm. high and are approximately two-thirds the height of one standard drive. They feature the same data-transfer rate and average access time as the model MDD 221. The model MDD 422 uses one motor to drive

both disks and one stepper motor to position the heads for both disks. The model MDD 423 uses one drive motor and two stepper motors to allow the heads for the two drives to seek independently.

All three models feature single-push-button media locking and ejection and an anti-crunch mechanism to prevent damage to improperly inserted media. For compactness, many electrical parts, transistors, resistors, capacitors, TTL ICs and analog ICs are incorporated into two hybrid ICs. The electronics of all three drives are compatible with standard interfaces.

In 1000-unit quantities, the models MDD 221, MDD 422 and MDD 423 are priced at \$250, \$335 and \$370, respectively. **Canon U.S.A. Inc., Peripherals Division, One Canon Plaza, Lake Success, N.Y. 11042.**

Circle No 314



Canon U.S.A.'s model MDD 221 (left) and model MDD 422 single- and dual-drive 5¼-in. floppy disk units store 1M byte and 2M bytes, respectively, in packages measuring only 33.5 and 57.5 mm. high, respectively.

Large System Tape Performance In A Small System Design

A 6250 bpi tape subsystem at traditional 1600 bpi prices.

Storage Technology's new 2920 OEM Magnetic Tape Subsystem provides large system GCR tape performance at prices in tune with today's small systems.

Whether you're **off-loading** a disk drive or performing a **sort/merge**, the 2920 performs equally well without special software modifications or time consuming repositioning.

Microprocessor adaptive controls eliminate the need for routine maintenance. Further cost-of-ownership savings accrue from a **5000 hour MTBF**.

System throughput is assured by the 2920's full **start/stop** capability and its very fast **5.0 millisecond** nominal start time.

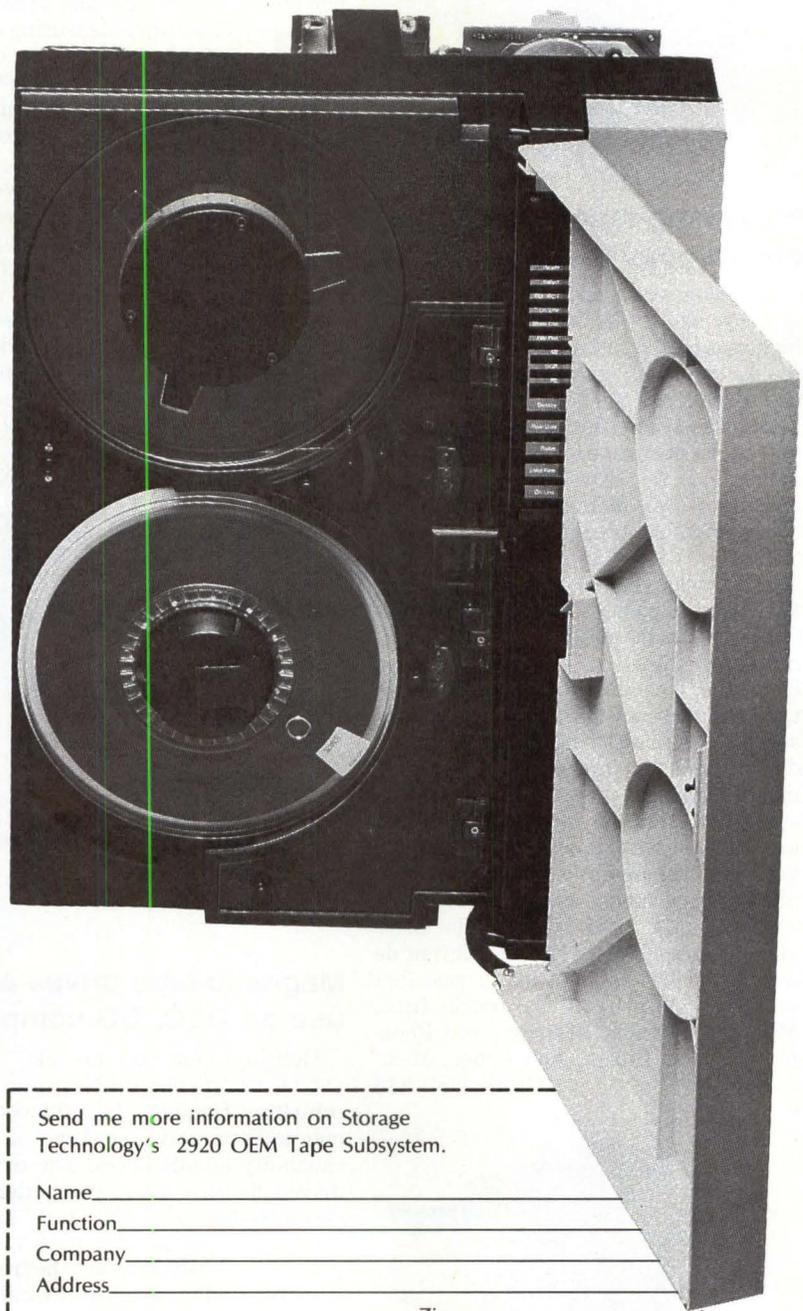
Using 6250 bpi (GCR) format, a tape library can be reduced in size by up to 70% while dramatically improving **data reliability**.

Mixed format libraries can easily be accommodated by the 2920's standard **dual-density** features (both 1600 bpi PE and GCR).

Automatic tape threading provides ease of operation, saves time and extends tape life.

An innovative mechanical design, extensive LSI and an **integrated formatter/controller** are the component parts that make the 2920 what it is—a low cost, start/stop, high-performance tape subsystem. **Priced at \$6779***—the 2920 can perform for you. For additional information, call us at (303) 673-4066 or mail the following:

*OEM quantity 100 over 24 months.



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New Products

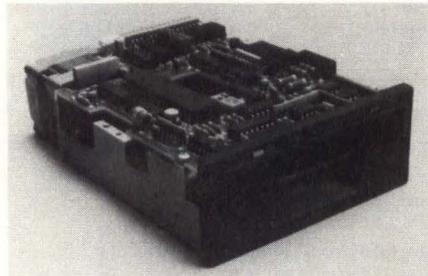
DISK/TAPE



Streaming-tape drive fits microfloppy footprint

Designed to provide backup in systems using the new generations of high-capacity Winchester disk drives, a family of 5/4-in. streaming cartridge-tape drives has the same form factor as a standard 5/4-in. floppy disk drive. The drives can provide backup for 78M bytes of data in 15 min. The drives' serpentine streaming-tape motion, coupled with a two-channel read-after-write head positioned by a high-resolution positioning system, achieves 60M to 100M bytes of formatted capacity on 12 data tracks. Capacity can be matched to the system needs by use of the appropriate cartridge. Upon insertion, the cartridge type (450 or 600 ft.) is automatically sensed, and write-head current, bit density and tape speed are adjusted to maintain media compatibility and constant data-transfer rates. The drives are offered in basic and intelligent versions. Intelligent versions are pin-, plug-, signal- and command-compatible with the QIC standard, while basic versions are compatible with current de facto basic drive standards. Prices start at \$600. **Northern Telecom Inc., Memory Systems Division, 100 Phoenix Dr., P.O. Box D, Ann Arbor, Mich. 48106.**

Circle No 315

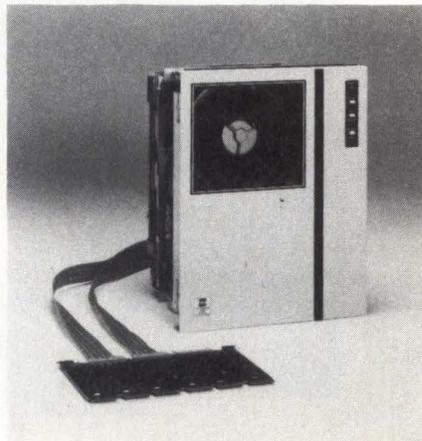


Single-sided microfloppy uses 3 1/4-in. flexible disks

The model TC 500 Drivette single-sided microfloppy disk drive uses a

3 1/4-in. version of a flexible disk in a soft vinyl jacket. The drive offers a 500K-byte storage capacity, a 250K-bit-per-sec. transfer rate and a 282-msec. average access time. Measuring 1.625 x 4 x 5.5 in. and weighing 26 oz., the drive is suitable for use in desk-top and portable computer systems, programmable instrumentation and computer games. With its standard 5/4-in. interface, the TC 500 Drivette is plug-compatible with 5/4-in. drives. In addition, the media format—140 tpi, 80 tracks per side—makes the drive data compatible with 5/4-in. drives as well. Other features include a direct-drive spindle motor, custom read/write electronics, LSI control logic and a patented head-actuator mechanism. Single-unit price is \$315. **Tabor Corp., Lyberty Way, Westford, Mass. 01886.**

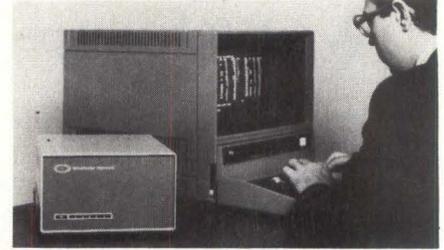
Circle No 316



Magnetic-tape drives are for use on DEC, DG computers

Designed for use on DEC PDP-11, LSI-11, VAX-11 and DG Nova and Eclipse computer families, the DMT3000 series magnetic-tape drives have a backup capability of 80M bytes. The nine-track drives feature a recording density of 800/1600 bpi, a 45-ips tape speed, a data-transfer rate of 36K or 72K bytes per sec., depending on the recording density, and a 160-ips rewind speed. They can accept 3600-ft. x 1/2-in. magnetic tape on a maximum reel size of 10 1/2 in. For tape interchangeability, the drive accommodates ISO, ANSI, ECMA and IBM standards. The rack-mountable tape drives are priced at \$7500 including controller. **Unitronix Corp., 197 Meister Ave., Somerville, N.J. 08876.**

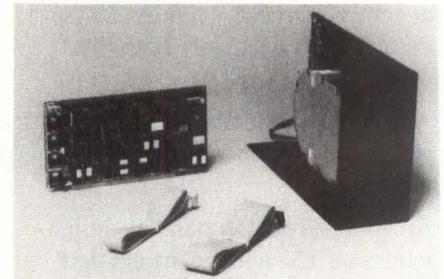
Circle No 317



Winchester subsystem keeps data secure

The DataSafe-8 is an ISIS-II-compatible, 5/4-in. Winchester disk subsystem for users of Intel Series II and III and MDS-800 development systems. The unit runs all Intel-supplied software and utilities without modification. It provides 5M bytes of formatted storage partitioned as two directories. Each directory has a maximum of 992 files. Performance features include a 625K-byte-per-sec. data-transfer rate and a 68-msec. average access time. Data are protected from power failures because the DataSafe-8 requires no special power-down sequence. The unit can be moved safely without mechanical interlocks or other special precautions. Price is \$4995. **Winchester Systems Inc., 14 Laurel Hill, Winchester, Mass. 01890.**

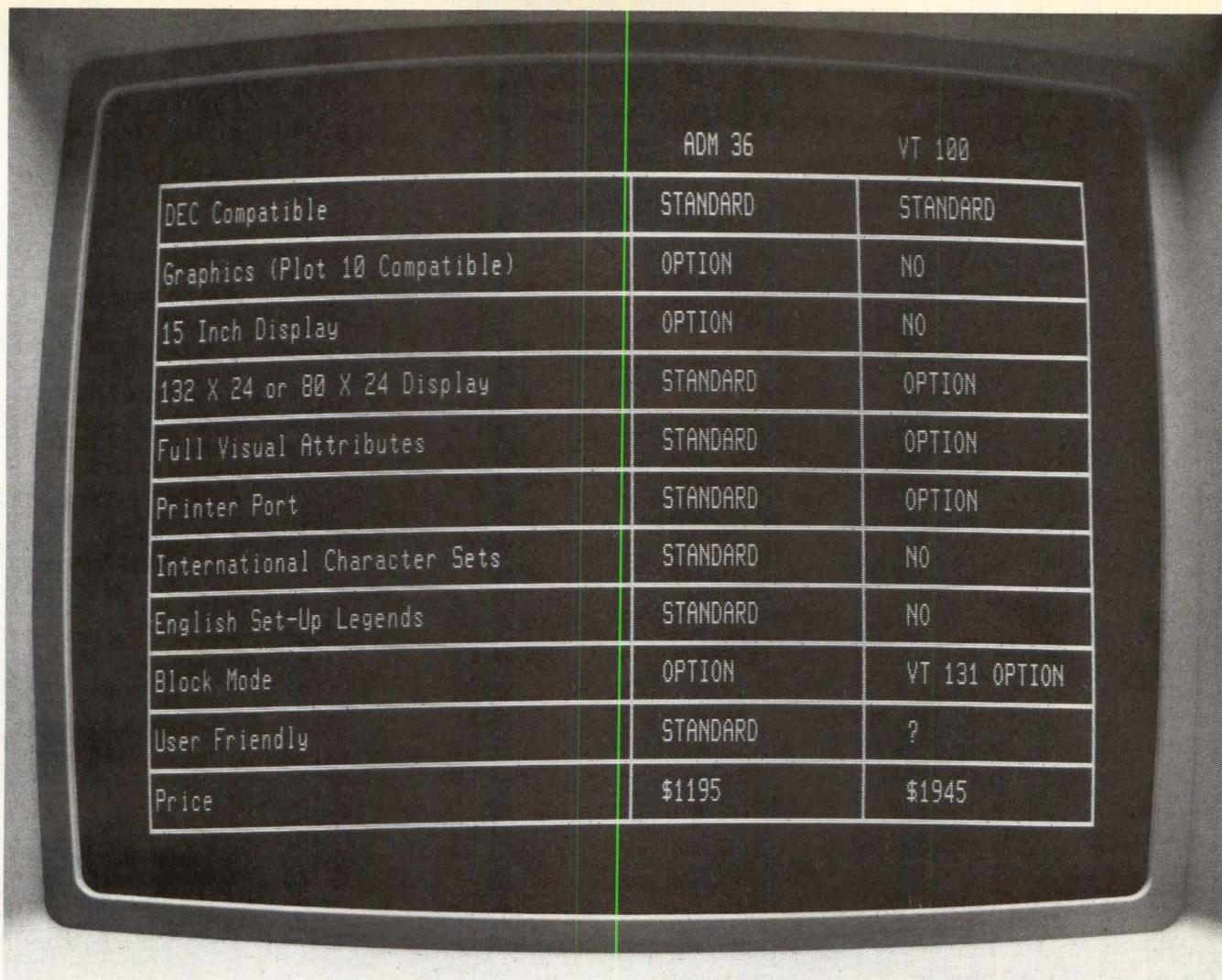
Circle No 318



Hard disk systems store 16M bytes

A line of 5-in. hard disk systems features 5M-, 10M- and 16M-byte formatted capacities. Each system includes a 5-in. disk drive, an 8-in. metal frame with 5V and 12V regulators, a hard disk controller and cable, CP/M 2.2 and documentation. Performance features include a 5M-bit-per-sec. data-transfer rate and a 120-msec. average seek time. Prices range from \$2095 to \$2375 in single-unit quantities. **Tarbell Electronics, 950 Dovlen Place., Suite B, Carson, Calif. 90746.**

Circle No 319



THE VT100™ SIMPLY DOESN'T MEET LEAR SIEGLER'S STANDARDS.

We not only engineer our terminals to the highest standards. We give you more standards. (See chart.)

Our ADM 36 DEC™ compatible video display terminal has more standard features. More operator conveniences. Performs faster. And costs less.

Not only that, we give you options DEC doesn't even offer. Like the full point-plotting and vector-drawing capabilities of our sophisticated graphics package. English setup legends. Reduced intensity and protected fields. And a 15-inch display that can come in very handy when you're in the 132 column mode.

On theirs you pay extra for a 132 column by 24-line display. Extra for



non-embedded attributes like bold, blink, and underline. Extra for printer port. But all these features are ADM 36 standards.

ADM 36. Another innovative implementation of state-of-the-art technology from LSI, the world's favorite manufacturer of reliable, high quality terminals. It's backed by the broadest network of full service centers anywhere, with walk-in Express Depot™ service, on-site service and extended warranty service in 3,000 cities nationwide. No wonder we're the standard others copy.

So before you buy another DEC VT100 terminal, consider the options. Or the absence thereof.

Our easy-to-operate ADM 36 is your logical alternative. Thanks to our standard approach.

Call 800-LEAR-DPD or 714-774-1010 for more information and the name of your nearest distributor.

Please send me further information about the ADM 36.

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New Products

PRINTERS



Low-noise printer features paper-handling capabilities

The Canon model PW-180 impact dot-matrix printer features 120-cps bidirectional printing, 16- × 16-dot high-resolution characters, graphics printing at 480 or 960 dots per line and a less-than-60-dB operating noise level. The printer prints a 128-character ASCII set and condensed and enlarged characters. It handles single-sheet, pin-fed and roll paper and three-part forms. Single-unit price is \$595, with OEM quantity discounts available. **Canon U.S.A. Inc.**, One Canon Plaza, Lake Success, N.Y. 11045.

Circle No 320

Color ink-jet printer is IBM 3279 compatible

The ACT-1 color ink-jet printer for IBM 3279 terminals produces an 8½- × 11-in. image on plain paper in 1.5 min. The printer uses yellow, cyan and magenta inks supplied in a single cartridge to produce 125 shades including seven solid colors. The printer's vertical resolution is 85 dpi, and its horizontal resolution is 140 dpi. No software is required to drive the ACT-1 from the IBM 3279 terminal. Single-unit price is \$8795, with quantity discounts available. **Advanced Color Technology**, 21 Alpha Rd., Chelmsford, Mass. 01824.

Circle No 321

Band printer prints at 1000 lpm

The model 3101 band printer offers a print speed of 1000 lpm using a 64-character band. Standard features include an acoustic cabinet, casters, a spool-to-spool ribbon, a rear control panel and diagnostics. Options include an eight-/12-channel vertical forms unit, a forms-length selector switch, format load, a paper puller, an elapsed-time meter and a digital line counter.

Single-unit price is less than \$11,000. **Data Printer Corp.**, 99 Middlesex St., Malden, Mass. 02148. **Circle No 322**

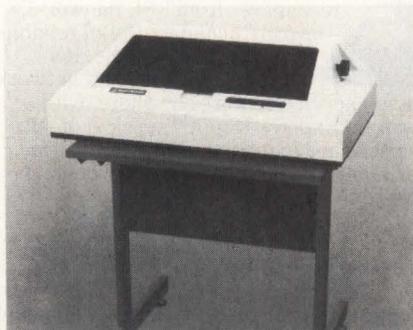
Plotter adds graphics hard copy to personal computers

The model 100 Sweet-P graphics plotter adds high-resolution, hard-copy graphics capability to Apple, IBM and other personal and small-business computers. This portable unit can draw on paper or overhead transparency material, has an addressable plotting



area of 7½ × 118 in. and accepts paper from 8½ × 11 in. to 8½ × 120 in. The maximum plotting speed is 6 ips, and the plotting resolution is 250 line segments per in. Menu-driven software permits users to draw pie charts, bar graphs, line graphs and technical illustrations. Provision is made for color fill, and digitizing allows a user to scale and draw images traced from photographs, illustrations or printed material. In addition to software-driven commands, nine functions related to pen movement and instrument setup are controlled from the plotter's front-panel keyboard. Single-unit price is \$795. **Enter Computer Inc.**, 6867 Nancy Ridge Dr., San Diego, Calif. 92121.

Circle No 323

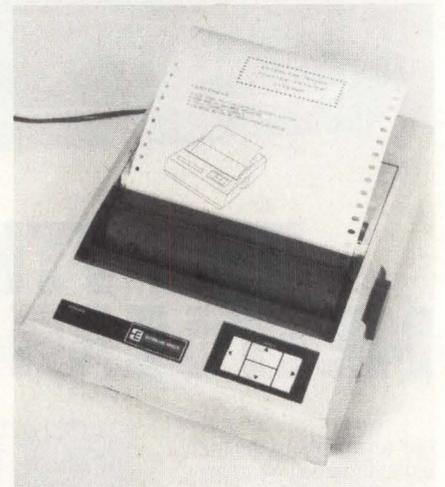


Multi-mode printer features faster NLQ-mode printing

The enhanced model DP-9625A multi-

mode printer, which originally offered print speeds of 50 cps at 10 cpi in near-letter-quality mode, 100 to 150 cps in correspondence-quality mode and 200 cps in data-processing mode, now offers two new near-letter-quality-mode options including 60-cps printing at 12 cpi and 50- to 60-cps printing with proportional spacing. Also added is condensed printing of 15 and 16.4 cpi at 150 and 164 cps, respectively. Other enhanced features of the DP-9625A include Swedish, Danish-Norwegian, German, French, Spanish and Italian character sets in addition to standard USASCII; left, right and full justification; title centering, positive half-line feed; in-line font changes; and RAM expandable to 12.5K bytes in 4K-byte increments. Single-unit price is \$1995. **Anadex Inc.**, 9825 De Soto Ave., Chatsworth, Calif. 91311.

Circle No 324



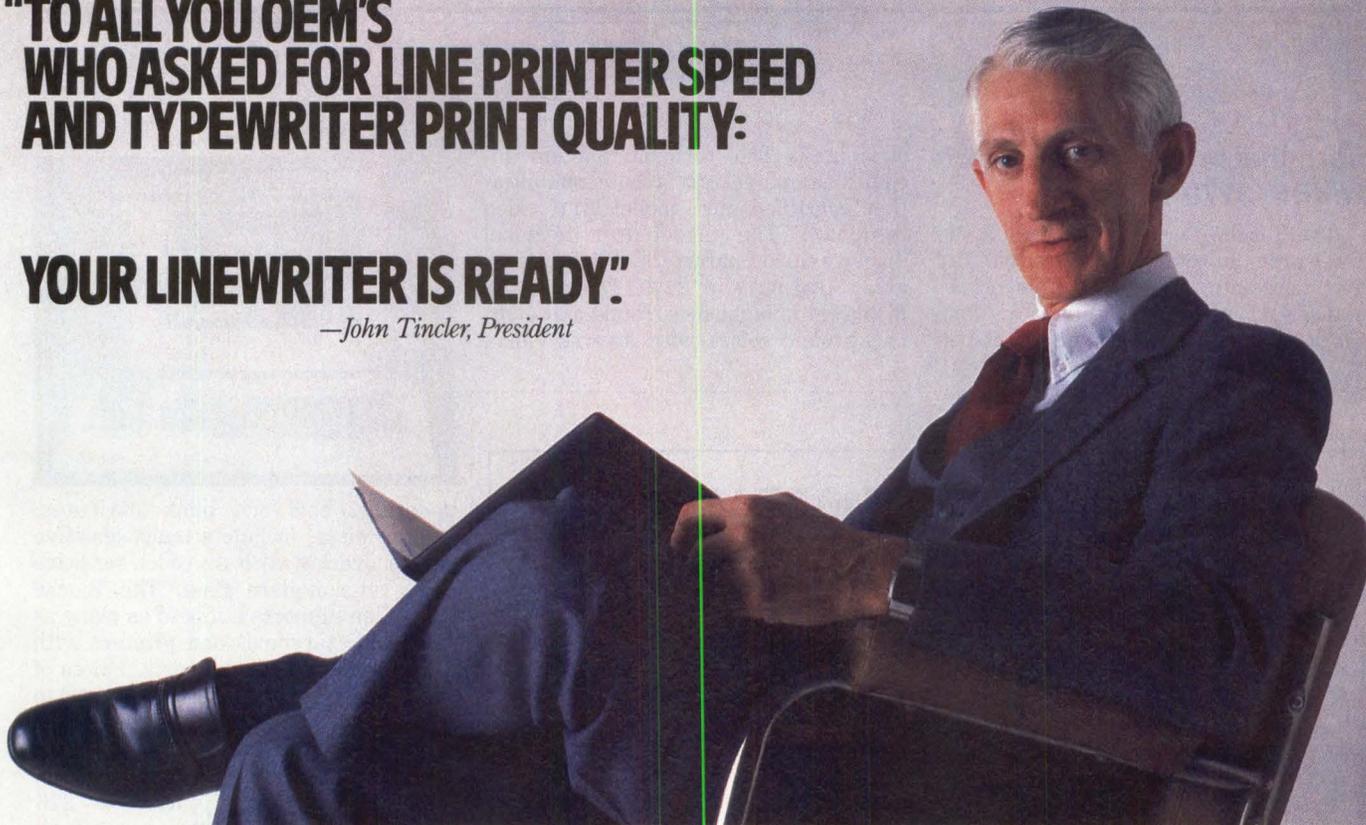
Plotter/printer is suited for OEM applications

The S-201GP plotter/printer can annotate plots and print alphanumeric data on 8½-in.-wide paper. Bidirectional movement of the print head and chart drive enables an operator to perform real-time plotting and overplotting of interrelated variables on one coordinate axis. Plotting speeds of 6.25 ips horizontally and 2 ips vertically provide graphic output with 160-dpi resolution. Available interfaces include Centronics, RS232 and IEEE-488. Single-unit price is approximately \$1600, with quantity discounts available. **Esterline Angus Instrument Corp.**, Box 24000, Indianapolis, Ind. 46224. **Circle No 325**

"TO ALL YOU OEM'S WHO ASKED FOR LINE PRINTER SPEED AND TYPEWRITER PRINT QUALITY:

YOUR LINEWRITER IS READY"

—John Tincler, President



Recently we asked what you wanted most from the next generation of line printers. You told us in no uncertain terms: typewriter quality print at line printer speed; more reliability and less need for service.

So we built it—a printer that embodies everything you want and eliminates everything you don't want.

We built *your* line printer. The Centronics Linewriter 400.

We can't describe the superior print quality—so we'll let you judge for yourself. Just look at the unbelievable difference between the Linewriter 400 and standard band printer samples.

<=>?@ ABCDEF GHIJKLMN OP

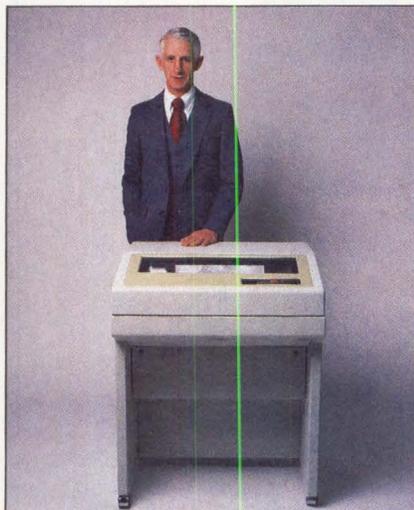
Sample of Linewriter 400 quality.*

#&. ABECDTFGOHIJ1KL2MN

Sample of standard band printer quality.*

On top of that, the Linewriter is smaller, quieter, easier to operate and maintain, with the lowest cost of ownership of any 300-500 LPM line printer ever made.

To build the Linewriter, we developed some proprietary innovations that redefine established line printer technology.



These include true linear free-flight hammers to eliminate character clipping (especially on multi-part forms); and slower, clockwise band rotation to reduce character smudging.

For reliability—LSI and VLSI electronics and up to 15 KV ESD immunity throughout. To improve throughput we included statistical printbands and early end of print. Then we finished it off with human-engineering features: extensive self-diagnostics and an alphanumeric display to pinpoint specific problems; resonating ribbon cassette that doubles ribbon life; 2860 hr. MTBF; 0.5 hr. MTTR and *no scheduled preventive maintenance*, plus a 55 dBa (optional) sound level.

The result is the Linewriter 400—the line printer that makes every other 300-500 LPM printer obsolete.

Which is no less than you should expect in a line printer you had such a large part in specifying. And one it took Centronics technology to build.

To find out more about the Linewriter 400 call our Line Printer Division (313) 651-8810, Ext. 342. Or write to us for more information and free print samples to Centronics Data Computer Corp., Dept. A, One Wall Street, Hudson, NH 03051.

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CENTRONICS® PRINTERS

CIRCLE NO. 156 ON INQUIRY CARD

New Products

TERMINALS

Terminal brings color, touch to IBM 3270 networks

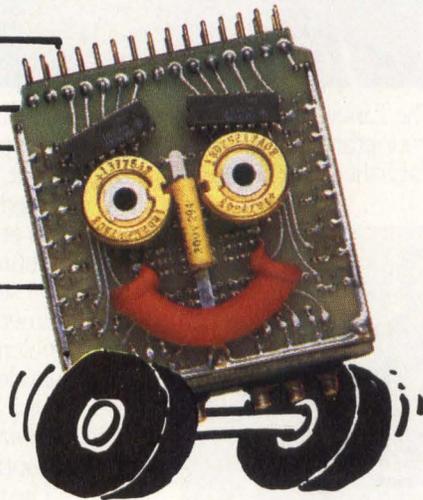
The Touché Series 1000 permits the integration of color touch-sensitive CRT terminals into an IBM 3270 bisynchronous/SDLC-SNA communications network using standard 3270 and light-pen

attributes. The terminal system includes the model ETC-1000 communication controller and model ETT video terminals. The model ETT terminal displays 1920 characters and functions as an IBM 3278 or 3279. Data can be displayed in eight foreground and eight background colors with inverse video,



underline, bold and blink attributes. ETT terminals include a touch-sensitive screen overlay with 32 touch-sensitive areas on non-glare glass. The Touché controller supports a mix of as many as four video terminals and printers with four optional additional ports. Prices of the Touché terminal range from \$3500 to \$3900. Prices for the controller unit range from \$5650 to \$6350. **Emutec Inc.**, 908 Concord St., Framingham, Mass., 01701. **Circle No 326**

**WHEN YOUR COMPUTER'S
DOWN AND OUT,
WE'LL GET IT UP
AND RUNNING. FAST.**



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800/328-3980**

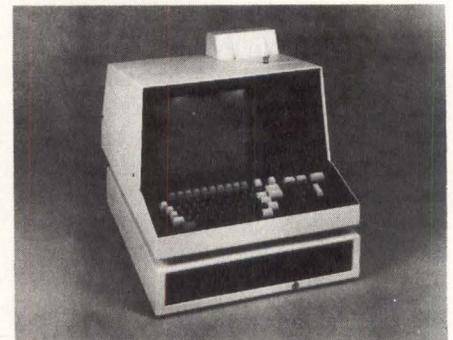
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CIRCLE NO. 174 ON INQUIRY CARD



Peripheral device combines cash-register, video

The model 9460 video register terminal is designed for use by system integrators and sophisticated end users requiring a terminal to implement the cash-register/point-of-sale function while providing a video terminal interface to an on-line computer system for real-time, interactive inventory control and other point-of-sale accounting functions. Programmer access to all of the model 9460 VRT's internal functions allows simple configurations for various requirements. Communications with the host computer via industry-standard RS232/422 line protocols permit interfacing the model 9460 VRT with many processors. An auxiliary RS232 port permits connection of various peripheral devices such as a ticket-validating printer or a coin

Five definitions of the word quality.



 Quality: over 15 years' experience producing disk drives, total vertical integration of manufacturing, and a caliber of product support you can measure by the loyalty of our customers. Quality that is a Fujitsu exclusive. Find it in our complete line of Winchester disk drives.

	a. 5 1/4-INCH			b. 8-INCH			
MODEL	M2231	M2233	M2234	M2301B	M2302B	M2302BE	M2303BE
CAPACITY (M Bytes)	6.7	13.3	20.0	11.7	23.4	23.7	47.5
AVG. POSITIONING TIME (ms)	95	95	95	70	70	70	70
TRANSFER RATE (K Bytes/s)	625	625	625	593	593	1,200	1,200
INTERFACE	ST506/SA4000			SA4000			
POSITIONING METHOD	Buffered Stepper			Buffered Stepper			

	c. 8-INCH		d. 14-INCH			e. 10 1/2-INCH
MODEL	M2311K	M2312K	M2280K/N	M2284K/N	M2294K/N	M2351
CAPACITY (M Bytes)	48.3	84.4	84.3	169	335	474
AVG. POSITIONING TIME (ms)	20	20	27	27	27	18
TRANSFER RATE (K Bytes/s)	1,229	1,229	1,012	1,012	1,012	1,859
INTERFACE	SMD		SMD			Modified SMD
POSITIONING METHOD	Rotary Voice-Coil		Rotary Voice-Coil			Rotary Voice-Coil

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QUALITY LIVES

CIRCLE NO. 157 ON INQUIRY CARD

New Products

TERMINALS

changer. Other features include a 12-in., green screen that displays 24 rows of 80 characters each and an 81-key keyboard with numeric keypad and 10 special-function keys. The model 9460 VRT includes one or two cash drawers and is priced at \$2995 in OEM single-unit quantities. **Perry Data Systems Inc.**,

3401 Spring Forest Rd., Raleigh, N.C. 27604. **Circle No 327**

Graphics terminal is Tektronix 4010 compatible

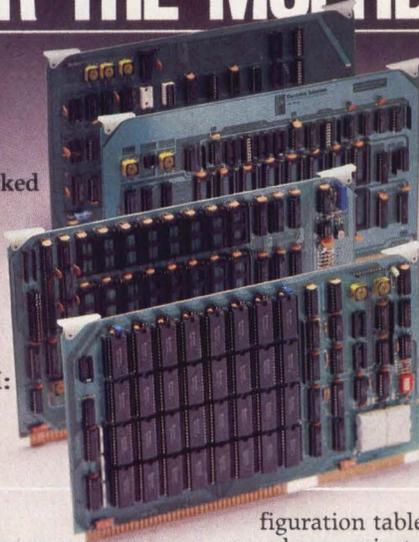
The Tektronix 4010-compatible Concept GVT graphics display terminal

offers vector and character erasure or write over, block fill, memory dump and load, dotted and dashed lines and graphics memory dim. The Concept GVT can also produce graphics hard copy via connection of a low-cost printer to the terminal's printer port. In addition to its graphics capabilities, the terminal features ANSI X3.64 functionality, DEC software compatibility and a switchable 80-/132-column compatibility. Other standard features include four pages of

NON-VOLATILE MEMORY FOR THE MULTIBUS

64K Battery-backed CMOS RAM:
\$680 (1's)
\$520 (100's)

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\$275 (1's)
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Electronic Solutions has non-volatile system memory cards in sizes and prices just right for your system. Take a look at this sample of memory cards—all designed specifically for the Multibus:

CMOS RAM: Make use of low-power CMOS RAM with the RAM-C series. Choose from 8K up to 64K bytes with 170 hrs. of NiCd battery backup on board. All have 8/16 bit data paths and 20 bit addressing. The unpopulated board price is only \$295 (singles) or \$225 in 100's.

EEPROM: There's a new application idea every day for these versatile components. Program development or downloading, con-

figuration tables and security access logs are just a few. For the 5V X2816A type, Electronic Solutions RAM-S series has a 64K board on which you can intermix EEPROM, CMOS/static RAM and EPROM. For other types, the EEPROM-32 has on-board V_{pp} for up to 32K of EEPROM or 2716 EPROM.

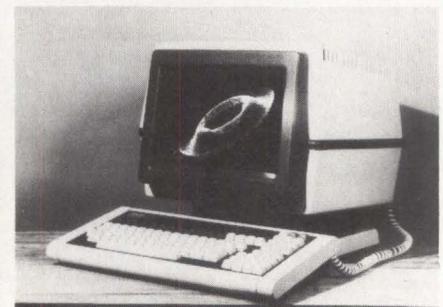
PROM/EPROM Use the new 27128's for up to 256K on the PROM-64/256, with 24-bit (16Mb) addressing. It holds either 28-pin or 24-pin chips. Or choose from 3 other models with less capacity.

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memory, 43 programmable functions, windowing and multiple computer capabilities. The terminal also offers 128 uppercase and lowercase ASCII characters and as many as four user-selectable character sets including 32 VT100 graphics characters, continuous-curve approximation, forms drawing, 32 math symbols and 32 communications-control symbols. Ergonomic features include an amber screen with etched faceplate for glare reduction and a detached keyboard. Single-unit price is \$1895. **Human Designed Systems Inc.**, 3440 Market St., Philadelphia, Pa. 19104.

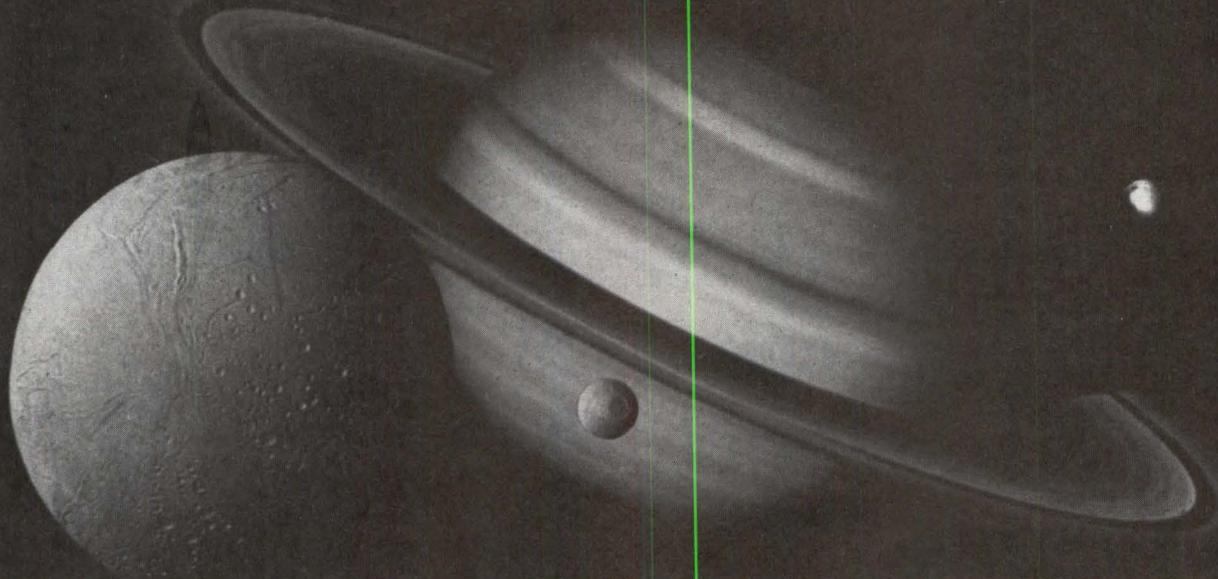
Circle No 328

Terminal features two pages of memory

The Ergo 301 terminal emulates the DEC VT100 terminal with advanced video option, 132-column display and printer port features. The Ergo 301 has a tilt-adjustable, 12-in., non-glare green screen and a detached keyboard with an integral palm rest, user-programmable function keys and seven LEDs to indicated terminal status. Other features include two pages of memory, plain-English setups, a transparency mode and Xoff indication. The monitor module can accept as many as four expansion boards for graphics and other uses. Single-unit price is \$895. **Micro-Term Inc.**, 1314 Hanley Industrial Court, St. Louis, Mo. 63144.

Circle No 329

EXPAND YOUR MULTIBUS SYSTEM'S OUTER LIMITS.



XYLOGICS HAS SOLD MORE HIGH PERFORMANCE MULTIBUS PERIPHERAL CONTROLLERS TO MORE MAJOR OEMS THAN ANYONE.

That's a fact. But it's sometimes obscured by the breadth and popularity of Xylogics' full range of peripheral controllers for mini and micro computers.

Yet for Multibus™ systems employing 68000, 8086 or Z8000 class microprocessors with large capacity disk and tape drives, no other Multibus controllers offer better performance or more advanced features.

NEW 450 AND 472 CONTROLLERS JOIN POPULAR XYLOGICS 440.

For the past three years, the Xylogics 440 peripheral controller—the industry's first Multibus SMD controller—has offered the highest peripheral control performance in Multibus benchmark tests and customer installations.

Now Xylogics has developed two new advances in Multibus periph-

eral control: the 450 and 472. Together, they set the standard for price, performance and size for IEEE-796 Multibus applications.

The new Xylogics 450 peripheral controller provides even more performance for Multibus disk control applications. The 450 can address up to 16MB of memory and control up to four SMD disk drives at data rates of up to 1.8 MB/sec. non-interleaved.

The new Xylogics 472 is a high performance, single-board tape controller for streaming and start-stop tape drives. It can address up to 16MB of memory and control up to four tape drives—running at speeds from 12.5 ips to 125 ips and at densities of 800 bpi NRZI, 1600 bpi PE, 3200 bpi, or 6250 bpi GCR.

The 440, 450 and 472 feature advanced channel control tech-

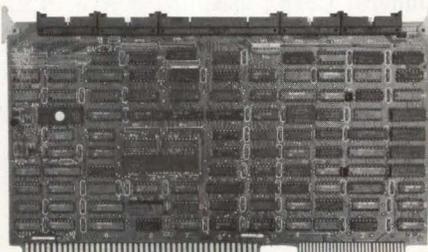
niques and are designed to work together for system optimization. For Multibus users, this means low bus usage, non-interleaved disk operation and true high-speed streaming with no repositioning. All three work with any 16, 20 or 24 bit address Multibus system.

Xylogics. The leader in high performance Multibus peripheral control.

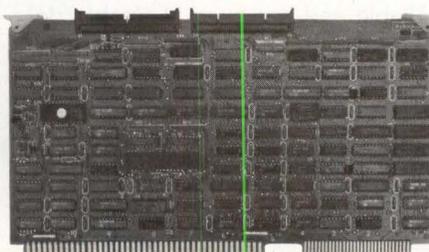
™ Multibus is a registered trademark of Intel Corp.



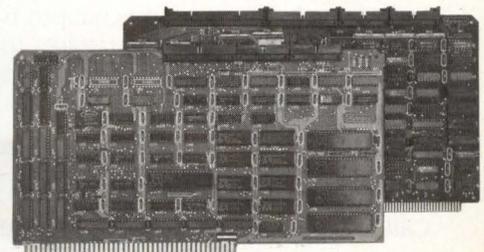
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Tel: (0753) 78921 Telex: (851) 847978
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Xylogics 450 Multibus Disk Peripheral Controller.



Xylogics 472 Multibus Tape Peripheral Controller.



Xylogics 440 Multibus Disk Peripheral Controller.

New Products

DATACOMM

Multidrop concentrator supports 16 terminals

The Micro900/2 multidrop concentrator provides polled terminal support for as many as 16 dumb asynchronous terminals in as many as 16 sites served by one telephone line. A master

Micro900/2 at the minicomputer site handles polling, and node Micro900/2s provide add-on intelligence to the terminals, enabling them to respond to their polls. The Micro900/2 provides a command port for changing channel operating parameters, gathering statistics and performing diagnostics from



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Alpha Merics' two plotters are the best value in the field: Alphaplot II (24 x 34") at \$5590 and Alphaplot I (18 x 30") at \$4590.

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They're the only plotters on the market that provide an 8000 character communications buffer which allows your computer to quickly download the drawing commands to the plotter. The plotter then works independently, freeing the host computer for other tasks.

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These large, open-bed plotters can be used for larger than C or D size drawings... they can be used with any size or type of media.

Precision and Quality

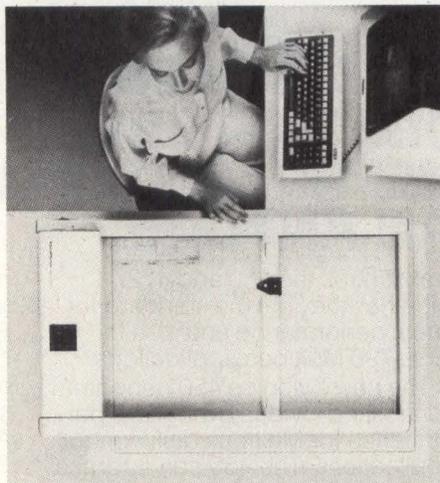
The Alphaplot's unique mechanism is reliable and has been in worldwide use for over four years. Alphaplots use wet ink drawing pens as well as felt tip markers and fiber tips. Drawing quality, repeatability and resolution are all excellent.

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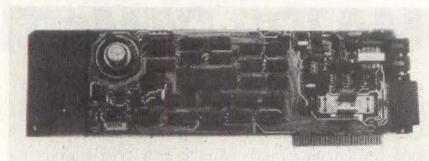
Alpha Merics Corporation

20931 Nordhoff Street, Chatsworth, California 91311
(213) 709-1155, Telex 182314



the central site. Other features include dynamic channel-priority assignment, four selectable response-time optimizations and automatic retransmission on error. Micro900/2 master units are available with four, eight or 16 channels, starting at \$2050 for the four-channel version. Node units are available in one-, two-, four- and eight-channel models, starting at \$900. **Micom Systems Inc.**, 20151 Nordhoff St., Chatsworth, Calif. 91311.

Circle No 330



Telecommunications card works with an IBM PC

The PConnection plug-in telecommunications card for use with an IBM Personal Computer features a direct-connect modem, a real-time clock and a serial I/O port. All components are mounted on a single board with gold-plated edge connector fingers to plug into the PC. Only the direct-connect cord to the telephone line is external to the PC cabinet. The modem on the PConnection is Bell 103-/113-compatible and provides auto dial (touch tone or pulse dialing) and auto answer in both answer and originate modes. The modem has an automatic disconnect circuit in case of failure or carrier loss. Single-unit price is \$375. **The Microperipheral Corp.**, 2565 152nd Ave. N.E., Redmond, Wash. 98052.

Circle No 331

Protocol converter emulates many protocols

Series 720 protocol converters support a wide variety of protocol-conversion tasks by combining standard or custom hardware and software modules to implement the required

The Clear Advantage™ of TAB's multi-user computer system

With the new TAB Multifunction Workstation you'll never suffer from computer congestion.

Desk top computers are supposed to make working time more productive. However, a lot of stand alone systems can't go beyond standing alone. They can't grow with your demands. The new TAB Multifunction Workstation not only upgrades with your needs, it has multi-user capability, unequalled communications flexibility, and can tie in with an existing computer network.

Single user 8 bit to multi-user 16 bit. You can start with the TAB System 830 as an entry level, single user station. Then, as your requirements expand, you simply replace its 8 bit processor board with a 16 bit board, and the same workstation becomes a multi-user System 1650. This system can support up to six TAB Terminals and a printer... plus communicate with a central corporate computer.

Maximum memory capacity from the start. The large integrated disk memory of TAB Workstations handles 5 million bytes of information and can be expanded. In addition, an IBM compatible 8" floppy disk provides 256KB to 1.2MB of capacity for data input, output and file backup. And they're both contained in the same space saving cabinet with a large 15-inch display screen.

Total communications capability and the top operating system. TAB Workstations utilize industry standard communications for convenient interface to a host computer—Async, IBM Bisync, and SNA/SDLC. Additional capabilities include ASCII to EBCDIC and Async to IBM Bisync conversions.

By employing the universally popular family of CP/M® and MP/M® operating systems, TAB Multifunction Workstations can access the largest base of applications



packages and programming languages in the world.

So, before you invest in a desk top computer for a small business, or expand the corporate system, compare the Clear Advantage of the TAB Multifunction Workstation. Call or write: **TAB Products**, 1451 California Avenue, Palo Alto, CA 94304, (415) 858-2500 Inside Calif.; 800-672-3109 Outside Calif.

In Europe: **TAB Products Europa B.V.** Ellermanstraat 5, 1099 BW Amsterdam, The Netherlands. Phone: 020-681691. Telex: 15329

In Canada: **TAB Products** 550 McNicoll Ave., Willowdale, Ontario M2H 2E1. Phone: (416) 494-0077

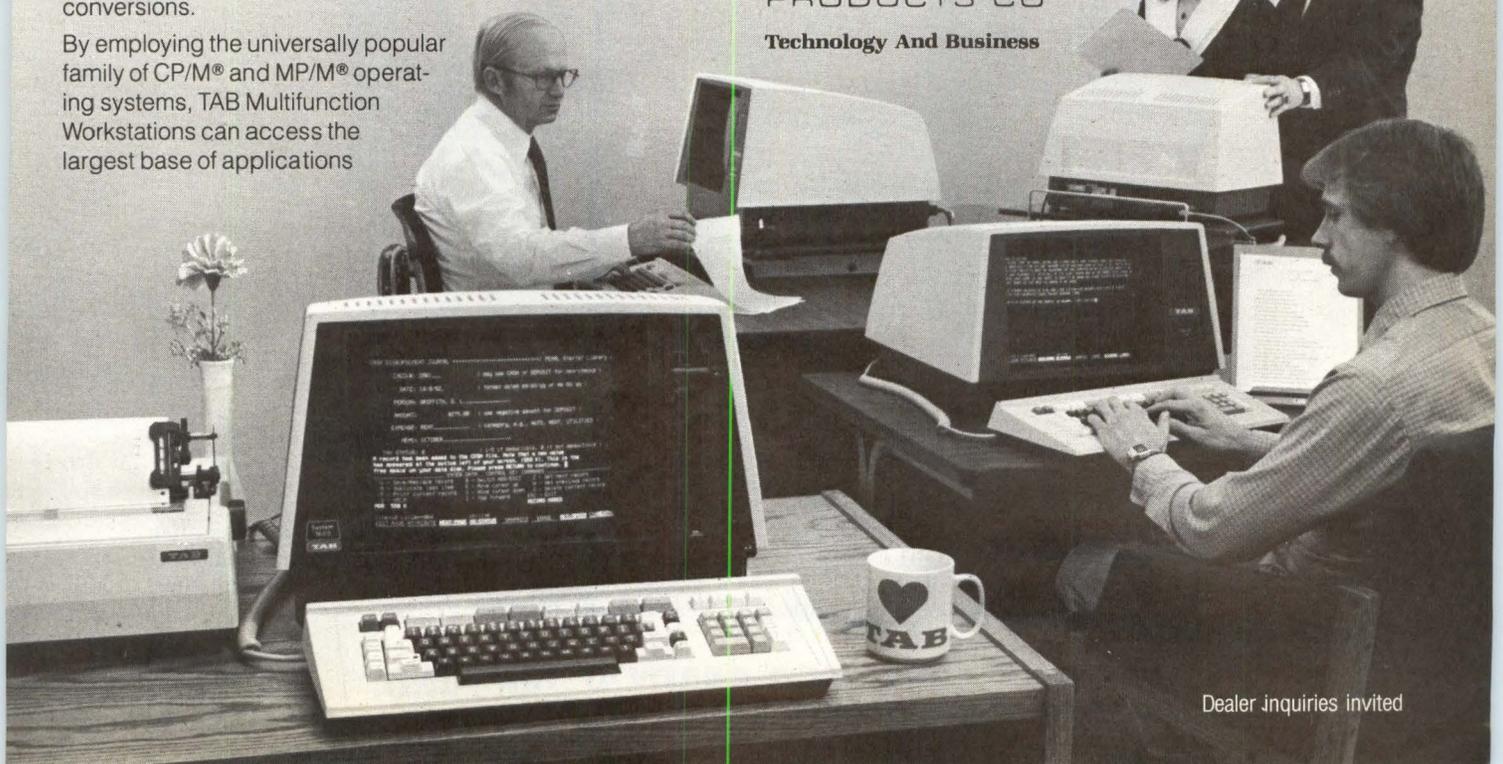
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CIRCLE NO. 161 ON INQUIRY CARD

TAB

PRODUCTS CO

Technology And Business

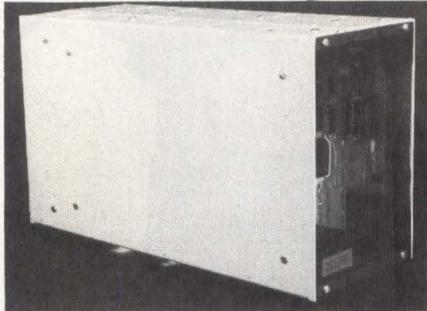


Dealer inquiries invited

New Products

DATA COMM

functions. The system is based on a CP720 communications processor board featuring a Z80 CPU, 2K to 16K bytes each of ROM and static RAM, optional



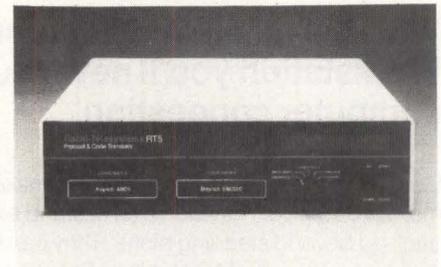
DMA and buffered CPU bus interface, four counter-timer channels, two 8-bit parallel ports with handshake and as many as three full-duplex serial channels with RS232C interface that support asynchronous and both character-oriented (bisynchronous, X3.28) and bit-oriented (SDLC, HDLC) synchronous communications. Modular software con-

figures the ports to the application and emulates higher protocol levels (IBM 2780, 3270, 3780, CCITT and X.25). The series 720 protocol converters are available in stand-alone and multi-line rack-mount versions. The A720 stand-alone consists of a 7- x 5- x 12-in. enclosure/power supply with one CP720 board. The R720 rack-mount version consists of a 7- x 19-in. rack-mount card file/power supply that can mount as many as 21 cards. Price is approximately \$1650, with quantity discounts available. **Nu Data Corp.**, 32 Fairview Ave., Box 125, Little Silver, N.J. 07739.

Circle No 332

Protocol-conversion product for DP applications

The model RT5 protocol and code translator converts asynchronous protocol to bisynchronous protocol and ASCII code to EBCDIC code, allowing communications between normally incompatible terminals or printers and computer



ports. With the RT5, an asynchronous ASCII terminal can communicate with a bisynchronous computer that uses EBCDIC code. The asynchronous-to-bisynchronous translation provides compatibility with data-processing equipment that uses the 2770, 2780 and 3780 bisynchronous protocols. Standard features include a user-selectable translation direction at data rates from 50 to 9.6K baud, built-in self-diagnostics and an eight-digit display screen. Single-unit price is \$1595. **Racal-Telesystems Inc.**, 410 N. Michigan Ave., Chicago, Ill. 60611.

Circle No 333

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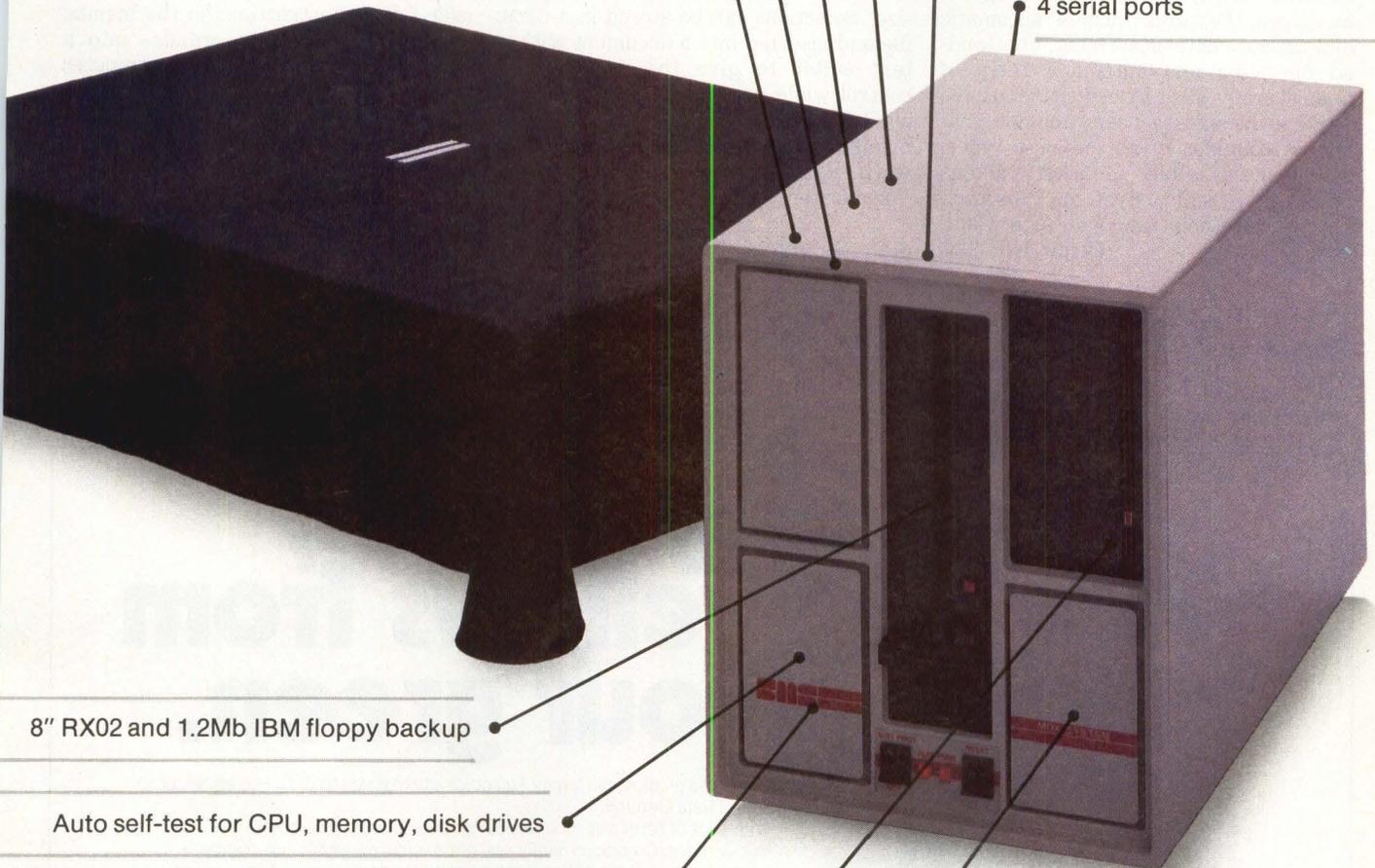
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New Products

SOFTWARE

Microcomputer becomes a Telex terminal

With MicroTLX, any microcomputer running under the CP/M or MP/M operating system can be connected to the Western Union network, replacing a Telex or TWX terminal for sending and receiving Telex, TWX, Mailgram, International Telex, Cable and Telegram messages. Features include automatic dialing, automatic answering, unattended operation and automatic retry of unanswered calls. Priced at \$150, the package includes a user's manual that shows examples of all message types, sample message files on diskette and an on-line help facility. **Systems Plus Inc.**, 1120 San Antonio Rd., Palo Alto, Calif. 94303. **Circle No 334**

Program controls Paper Tiger printers

The IDS Printer Control Program, running on microcomputers under the

CP/M or MP/M operating system, facilitates software control of Integral Data Systems' Prism, Microprism and Paper Tiger printers. The menu-driven package allows a user to select character density, including normal and enhanced widths, in draft or correspondence format; fixed or proportional spacing; justification; horizontal and vertical tabs; line spacing; margins; and page size. Selections can be stored in a CP/M file and inserted into a document with a text editor to give the user on-line control while printing. The program is available on an 8-in. diskette with user's manual for \$36.95. **Information Network Systems Inc.**, P.O. Box 2011, Warminster, Pa. 18974. **Circle No 335**

Routine sorts numeric quantities

The SpredSort routine for sorting on electronic spread sheets includes a user's manual that gives step-by-step instructions and theory of operation for

a template to sort numeric quantities in spread-sheet cells. Any number of cells can be included, limited only by available memory. Formulas are given for VisiCalc and SuperCalc; users can adapt the template to similar packages. The routine can be incorporated into existing templates or installed in a stand-alone template and invoked as needed. Diskettes are not included; the user follows instructions in the manual to enter the sorting formulas into a spread sheet through the computer keyboard. Price is \$5.98. **Selfix Corp.**, P.O. Box 1044, Lowell, Mass. 01853. **Circle No 336**

Encryption program runs on CP/M-based micros

ComCrypt, running on microcomputers under the CP/M operating system, uses a proprietary encryption/decryption technique to protect transmission of sensitive information between computers, directly or over

How to get reds, blues and yellows from your green.



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Eagle clears the air on what it takes to buy a computer.

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Eagle productivity organizes your business. The Eagle PC is available at a base system price of \$1995. Complete, turnkey systems for under \$3000 include operating systems, word processing, and financial planning software at no additional charge. For those needing greater disk storage, the Eagle PC-XL, with 10 megabytes of hard disk storage, starts at \$4495. High resolution graphics are standard.

Designed for the first-time computer user, the Eagle PC keeps pace with your growth. It is

expandable, so you can add memory, additional disk storage, peripherals, and other options to build a system that will expand with your needs.

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New Products

SOFTWARE

telephone lines. In "encrypted chat" mode, two ComCrypt users can communicate privately via a time-sharing service such as The Source. Features include two-way communication with or without encryption and decryption and error detection and correction. A terminal with a 24-line ×

80-column display, a clear-screen command and an addressable cursor is required. Price is \$250. **Century Systems Inc.**, 12872 Valley View Ave., Garden Grove, Calif. 92645.

Circle No 337

Procedure processor runs on IBM Series/1

Proc/Mach 1, running on the IBM Series/1 computer under the EDX operating system, provides interactive mode responses to execute sequences of batch utility and application programs without operator intervention. Intended for production of lengthy reports or backup operations, it stores and repeats any conversational procedure that an operator executes once. It monitors operations to ensure that the correct tape is mounted, the correct diskette is available or the printer is active. The operator can enter variables such as dates before invoking a process. A log of each executed procedure can be displayed or printed. Price is \$850. **Data Index Inc.**, 4390 Alpha Rd., Dallas, Texas 75234.

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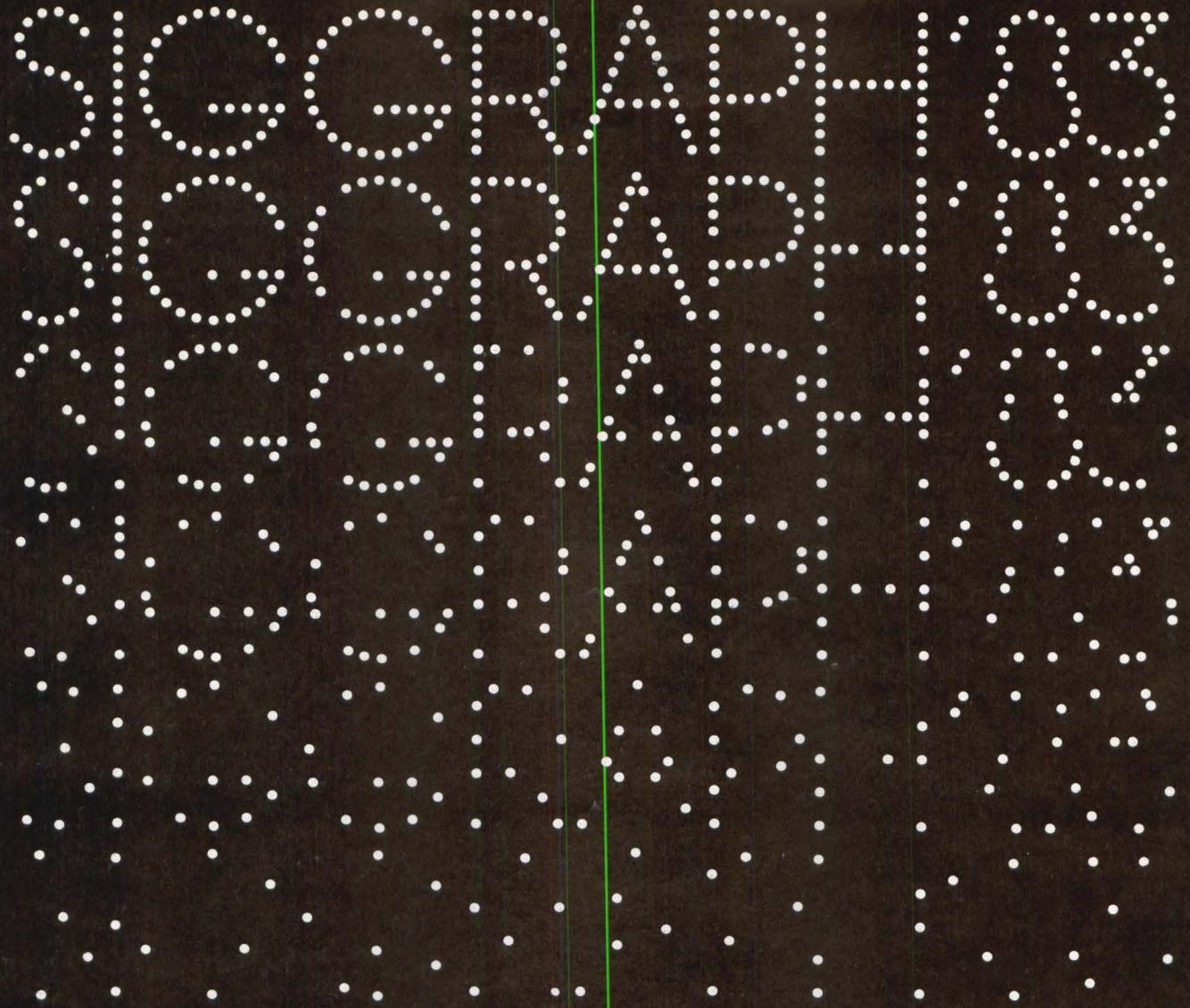
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CIRCLE NO. 166 ON INQUIRY CARD

68000 cross assembler uses Motorola mnemonics

A software package that enables users to develop application programs for 68000-based microcomputer systems includes the ASM-68000 structured macro cross assembler and the LINK-68000 relocating linkage editor. The ASM-68000 translates assembly-language source statements into relocatable object code for the LINK-68000 linker, which in turn combines them into an absolute load module. The assembler provides a printed listing containing the source-language input and assembler object code using Motorola-compatible mnemonics, addressing modes and expression syntax. With the LINK-68000 linker, the user can specify as many as four memory segments, providing the ability for the ROM code to be contained in a segment from the RAM data. As many as 16 relocatable sections, plus absolute and named common sections can be allocated among the segments. The package is supplied on DOS-11 formatted magnetic tape (800 bpi) in compiled object form, ready to link and run on Digital Equipment Corp.'s PDP-11 computer under the RSX-11M operating system, or on the VAX computer under the VMS operating system in the compatibility mode. The package is priced at \$3000, and a software license agreement is required. **Mostek Corp.**, 1215 W. Crosby Rd., Carrollton, Texas 75006.

Circle No 339



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acm



New Products

LITERATURE

Array processor described in brochure

The AP500 series floating-point array processor is described in a 16-page, color brochure. Illustrated with photos, diagrams and charts, the brochure contains sections on hardware/software

design concepts, configuring a system, application versatility and specifications. The test also explains the three operational modes of the AP500: attached, independent and co-processor.

Analogic Corp., Audubon Rd., Wakefield, Mass., 01880. **Circle No 340**

Disk drive enclosure includes S-100 card cage

The model MFE-100 mainframe enclosure is described in an illustrated, two-page, black-and-white brochure. The brochure details the MFE-100, which is designed to package two slimline disk drive units, a power supply and as many as six S100 boards. The brochure also describes a six-slot S-100 card cage that is available separately.

The Buckeye Stamping Co., 555 Marion Rd., Columbus, Ohio 43207.

Circle No 341

Application note discusses bar-code data-entry system

An application note provides readers with information for the design and implementation of a bar-code data-entry system. *Elements of a Bar-Code System* contains a section on fundamental system design, which covers data storage and retrieval and system performance evaluation. A section on bar-code symbology discusses the attributes of various types of bar codes and provides a code-selection summary. The section on symbol generation describes media and printing. The section on data entry presents information on scanners, optical parameters, electrical characteristics, resolution and decodability. A glossary of terms and an appendix on bar-code standardization are included.

Hewlett-Packard Co., 1820 Embarcadero Rd., Palo Alto, Calif. 94303.

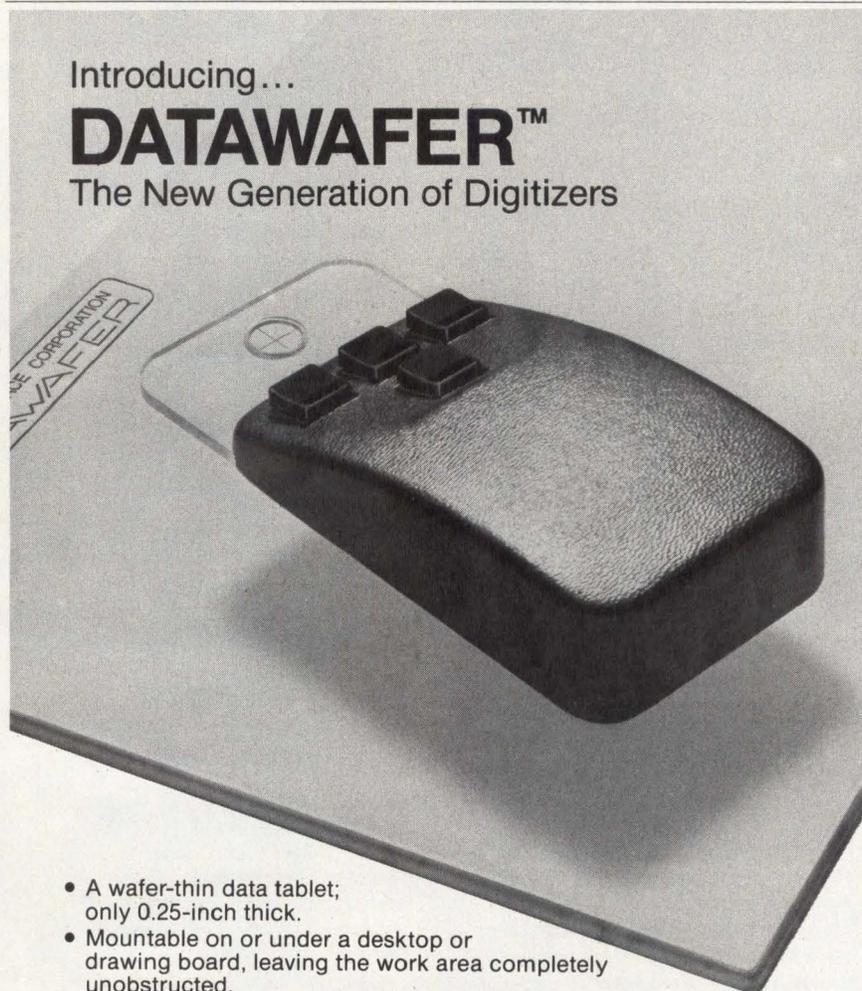
Circle No 342

Computer forms catalog covers 200 products

more than 200 new products including continuous forms for miniprinters, carbonless computer business forms and forms for word processors are described in an 84-page catalog. Also described in the illustrated, color catalog are several products sold exclusively by the vendor including a computer-room care kit and two-color computer business forms. The catalog also details the company's technical product-assistance service that offers computer users free technical assistance over the telephone.

Moore Business Center, Catalog Group, Department 302311, 1400 S. Wolf Rd., Suite 300, Wheeling, Ill. 60090.

Circle No 343



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CIRCLE NO. 167 ON INQUIRY CARD

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Sure, the specs were great: the basic MultiNet system has a master microprocessor and two user micro's, 20 megabytes of 5¼ Winchester disk, 13.4 megabyte cartridge tape drive, 1.2 megabyte 8" floppy disk, distributed processing operating system, CP/M—all in one table-top unit and all for only \$9,995.

More importantly, however, the specs translated into a number of extremely practical user benefits, business benefits, that lead us to call it "the serious business solution."

For example, high disk capacity obviously means plenty of high-speed, fast access storage. The integrated cartridge drive lets you back-up the disk to protect critical data, or simply to store data. It runs concurrently without interruption to other work in progress. The 8" floppy offers convenient program loading and data storage. No need to convert existing programs to 5¼" formats. The distributed processing operating system lets each user have a dedicated processor (for far faster response) while sharing expensive common devices like disk, tape and printers. And the use of the industry standard CP/M operating system means you can use any of thousands of inexpensive programs on the market for accounts receivable and payable, general ledger, data base management, etc. Just load and go.

MultiNet can handle up to 8 users, with intermixing and simultaneous operation of both 8- and 16-bit programs, so you get a lot of flexibility and plenty of room to expand your operations. Install MultiNet for today's 8-bit programs and it will be ready for tomorrow's 16-bit programs.

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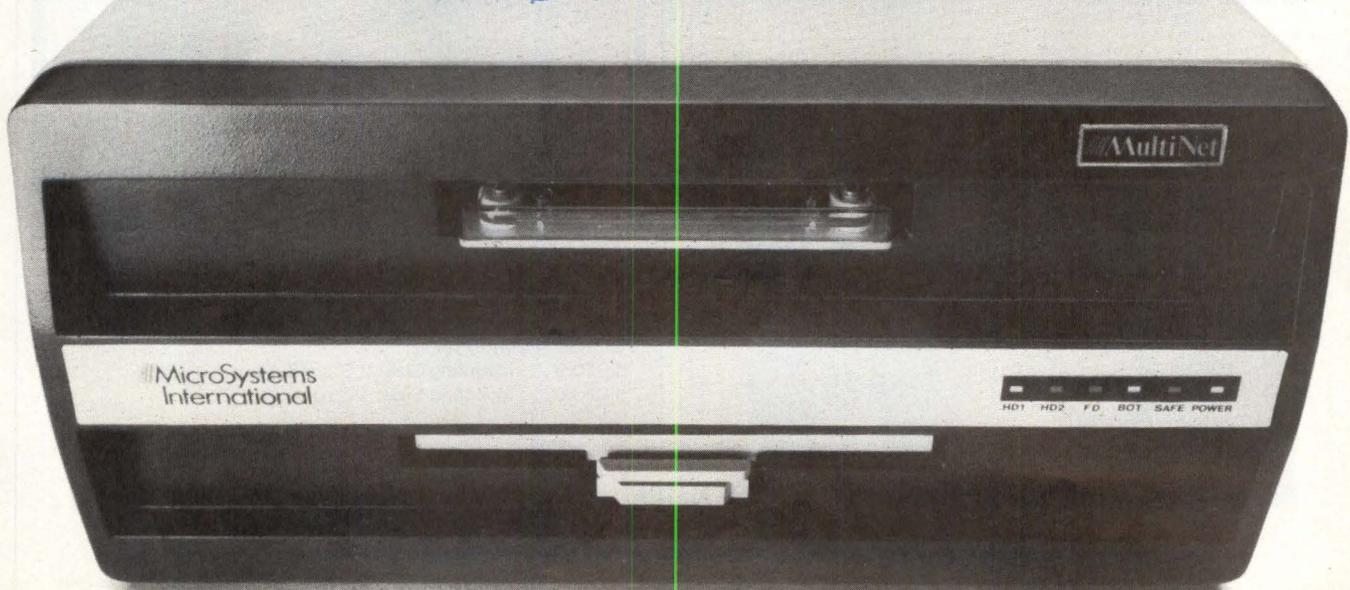
In summary, MultiNet gives you more efficient performance, higher storage capacity, backup for critical data, convenience, economical use of common devices, flexibility, growth and protection against downtime.

Now that's serious. The "serious business solution": MultiNet.

We're ready to demonstrate that we deserve your business. Call us now at (617) 655-9595. Or write Customer Information Services, MicroSystems International, 12 Mercer Road, Natick, MA 01760.

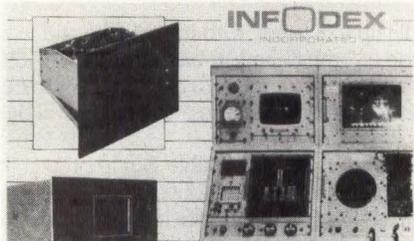
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New Products

LITERATURE



Brochure features OEM, mil-spec CRT displays

A line of OEM CRT displays is described in a six-page brochure. The brochure describes standard models and customized designs that meet the requirements of builders of military, industrial and medical equipment. Precision x-y CRT displays for high-performance applications are also described. The brochure provides technical specifications for several representative models and includes product photos. **Infodex Inc.**, 395 W. Main St., Waterbury, Conn. 06702.

Circle No 344

LITERATURE THAT COSTS

Fifth-generation systems explored in book

The 287-page *Fifth Generation Computer Systems*, edited by Tohru Moto-oka, contains the proceedings of the International Conference on Fifth-Generation Computer Systems held in Tokyo, Japan, in October, 1981. An introductory chapter covers the background and significance of the development program for fifth-generation computers, the impacts and effects of the computers on society and areas for research and development. The book also covers knowledge-based information processing and architecture. Price is \$49.

Elsevier North-Holland, 52 Vanderbilt Ave., New York, N.Y. 10017.

Circle No 345

Personal computer guides provide quick references

These *Quick Reference Guides* to the Apple II, Atari 800 and the IBM Personal Computer give owners of these computers instant access to their microcomputers' programming symbols and statements, commands and controls. The reference cards are designed to be kept beside the computer, measure 6 x 12 in. and open to four panels. Compiled by Gilbert Held, the guides list and define BASIC statements, system controls, input/output processing statements, memory statements, error messages, video and graphic controls, basic functions and arithmetic operation symbols. Each guide is priced at \$2.95. **John Wiley & Sons Inc.**, 605 Third Ave., New York, N.Y. 10158.

Circle No 346

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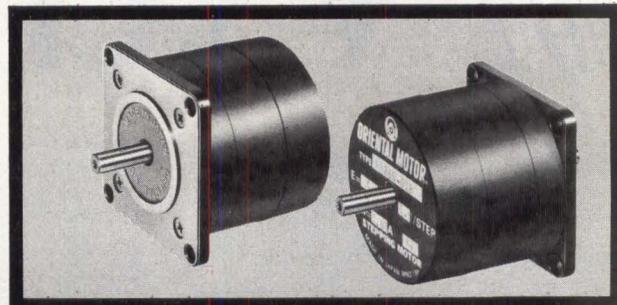


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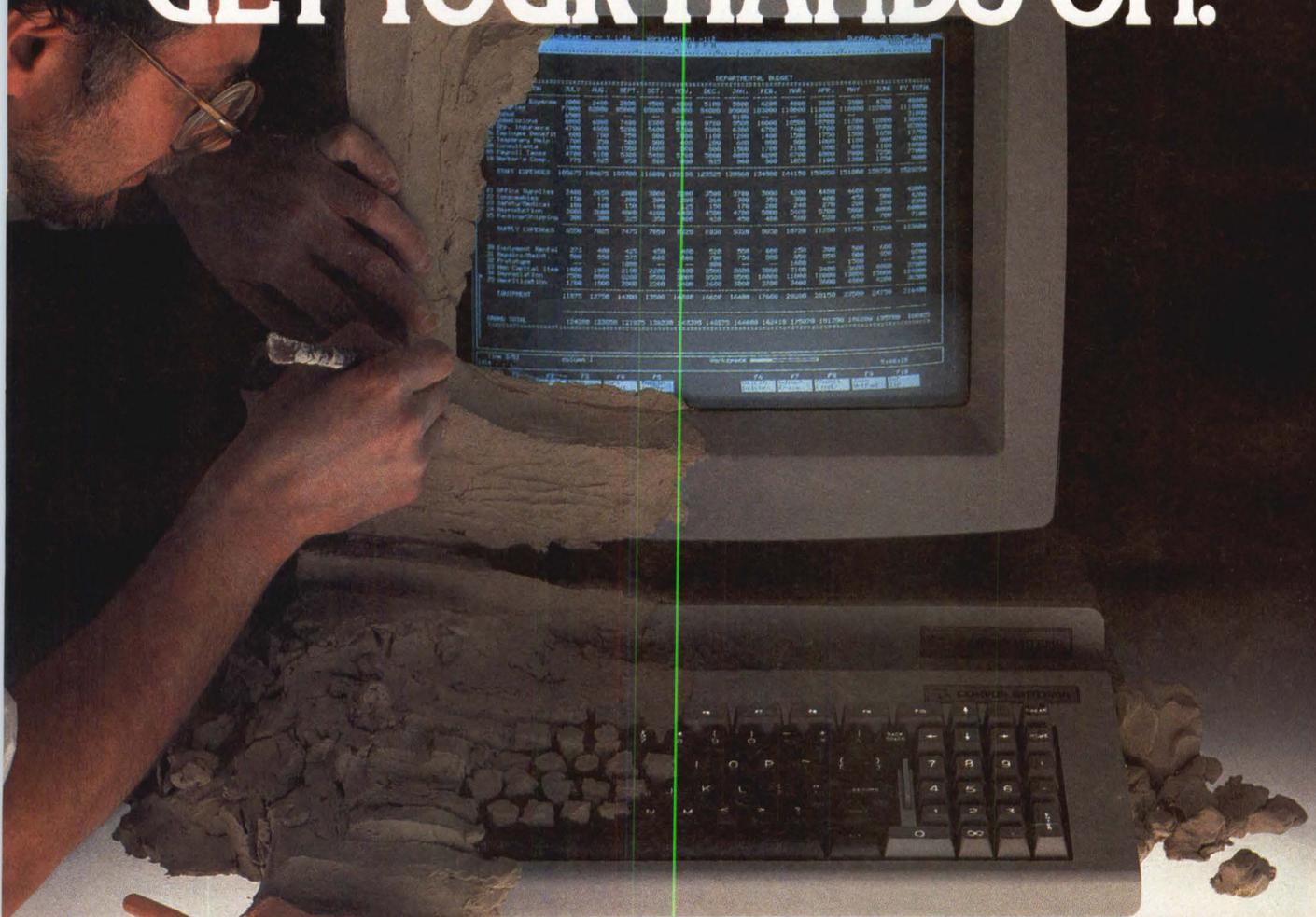
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CIRCLE NO. 170 ON INQUIRY CARD

MINI-MICRO SYSTEMS/June 1983

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MOLDED TO FIT RIGHT
INTO YOUR APPLICATION.**

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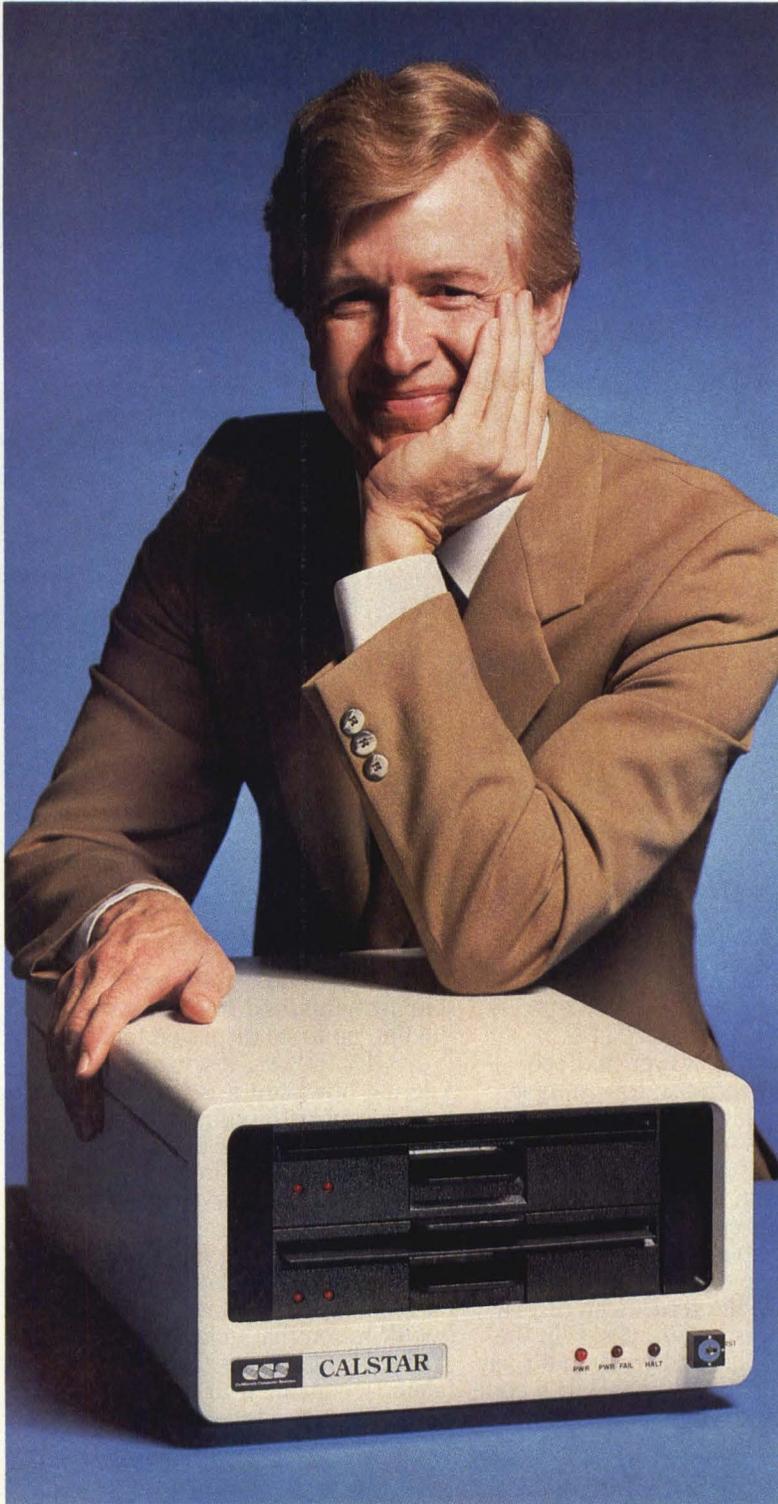
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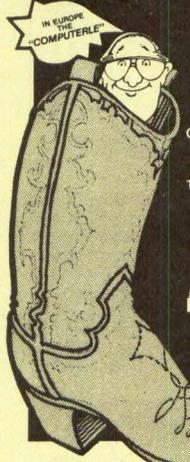
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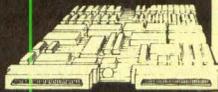
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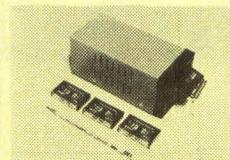
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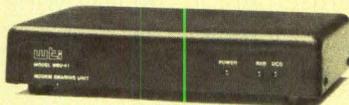
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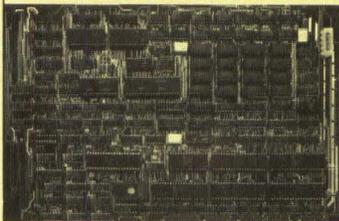
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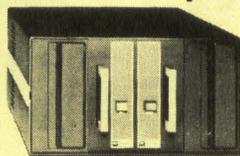
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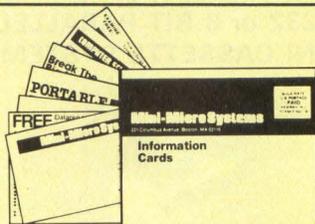
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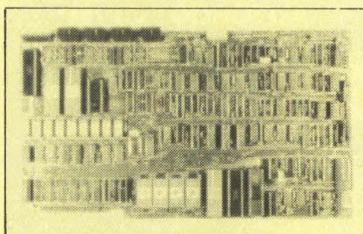


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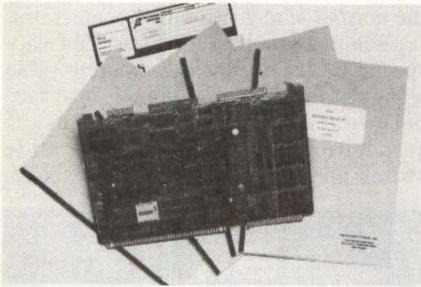
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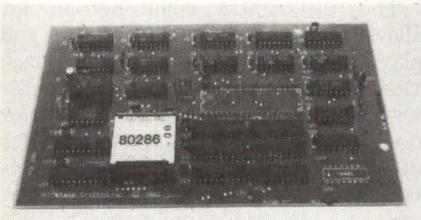
SUBASSEMBLIES



80286 software vehicle works with CP/M-80

The model DV286 80286 software-development vehicle works with CP/M-80- and CP/M-86-based development systems or Intel development systems running the 8086 assembler. The DV286 includes the execution vehicle, a single Multibus board featuring the Intel 80286 microprocessor and 128K bytes of on-board memory expandable to 16M bytes; DEBUG286, a PROM-based 80286 debugger that provides single-instruction execution, breakpoint setting, memory disassembly and examine/modify of memory, I/O and registers; and MACRO286, a set of 80286 instruction macros. After installing the execution vehicle and MACRO286 on a host development system, users can develop software on the host system and then load the software via an RS232 port to the execution vehicle for execution, testing and debugging with DEBUG286. Single-unit price is \$2495. **Microbar Systems Inc.**, 1120 San Antonio Rd., Palo Alto, Calif. 94303.

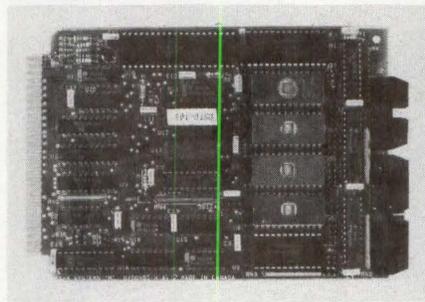
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80286 upgrade plugs into 8086-based systems

The model MX286 plug-in module for 8086-based systems increases 8086 system performance and gives virtual-memory capability via Intel's 80286 microprocessor. The MX286 provides 80286 capability with 8-MHz operation, as much as 16M bytes of physical address space, 1G byte of virtual space, built-in memory management and virtual-

memory support. The MX286 operates in both 8086 compatibility mode and virtual-address mode. The virtual-address mode requires using virtual-memory instructions of the 80286 microprocessor. Software development for the MX286 can be performed on any CP/M-80, CP/M-86 system using the 8086 assembler or compilers and a set of macros for the iAPX 286 instructions provided by the vendor. Price is \$695 each in 100-unit quantities. **Microbar Systems Inc.**, 1120 San Antonio Rd., Palo Alto, Calif. 94303. Circle No 348



Slave processor offers multiprocessing capabilities

The DSTD-103 intelligent Z80 slave processor with parallel I/O offers multiprocessing capabilities on the STD-Z80 bus. This capability is implemented by using the DMA request-control lines. As many as four DSTD-103s can be used per backplane for 4-MHz systems. The card provides the ability to access all external RAM and I/O on the STD bus. The DSTD-103's four programmable counter-timer channels are buffered to an external connector. The two 8-bit parallel I/O ports can be configured for TTL or open-collector outputs. The five byte-wide sockets can support EPROM, RAM and EEPROM byte-wide devices, allowing for a variety of memory configurations. The DSTD-103 receives its system clock from the STD bus backplane. Single-unit prices range from \$249 to \$272. **dy-4 Systems Inc.**, 888 Lady Ellen Place, Ottawa, Ontario K1Z 5M1.

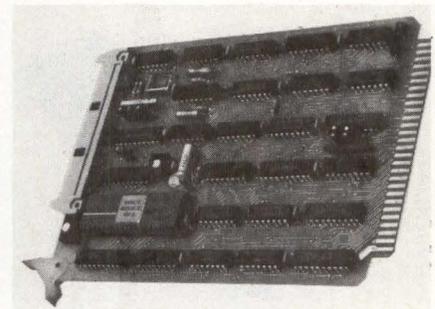
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Board for TI Professional runs CP/M programs

The Baby Tex co-processor board for the Texas Instruments Professional Computer enables the computer to run CP/M software application programs under the MS/DOS operating system. The

Baby Tex board features a Z80B microprocessor and includes 64K bytes of additional system memory, which is accessible to a user even when Baby Tex is not in use. The Convert program supplied on a 5¼-in. floppy disk with the Baby Tex hardware adds a special header to a user's CP/M program and formats his disk for MS/DOS. When a user runs a converted CP/M program, the header instructs the Professional Computer's 8088 processor to load his CP/M program into Baby Tex and then stand by to handle all keyboard, screen and disk drive functions. Baby Tex's processor then executes the CP/M program and delegates all I/O functions to the Professional Computer's 8088 processor. The result is that both processors execute simultaneously under a single operating system. In single-unit quantities, Baby Tex is priced at \$600. Baby Tex is also available bundled with the WordStar, MailMerge, Personal Pearl and WonderCalc programs for \$995. **Xedex Corp.**, 222 Route 59 Suffern, N.Y. 10901.

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Floppy disk controller interfaces to STD bus

The model FLP-380 floppy disk controller card interfaces as many as four 5¼- or 8-in. floppy disk drives to the STD bus. No restrictions are placed on the CPU type, provided it supports I/O functions on the STD bus. All read, write and format functions are software configurable, giving a user the ability to mix and match drive types and formats in one system. The FLP-380 accommodates single- or double-sided and single- or double-density operation. Full DMA or polled interfacing is available, along with adjustable write precompensation. Software support includes BIOS for CP/M 2.2 and MP/M. Single-unit price is \$275. **Computer Dynamics Inc.**, 105 S. Main St., Greer, S.C. 29651. Circle No 351

New Products

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Printer buffers increase home computer efficiency

The MicroSpooler and SooperSpooler are printer buffers for use between a home computer terminal and a printer. A basic MicroSpooler features 16K bytes of memory, factory- or user-expandable to 32K or 64K bytes; a multiple-copy function; pause capability; an internal power supply; and independently selectable baud rates for serial applications. Interfacing configurations include serial to serial, serial to parallel, parallel to parallel or parallel to serial. The units are priced at \$199 and \$349, respectively. **Consolink Corp.**, 1840 Industrial Circle, Longmont, Colo. 80501. **Circle No 352**

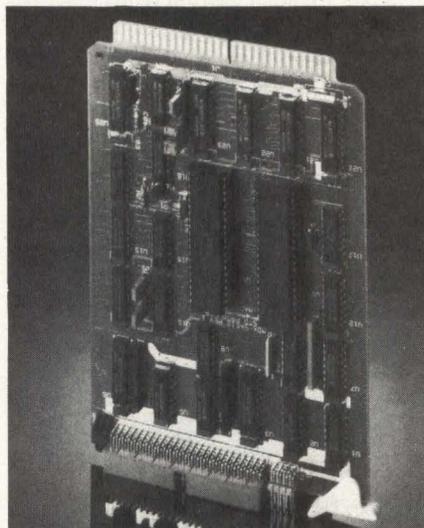


Floppy disk interface features Z80A

The model Z2800 single-card floppy disk interface features a Z80A microprocessor with 2K bytes of RAM and 4K bytes of ROM, a floppy disk port and an RS232C port. It includes firmware to duplicate the DEC TU-58 cassette drive protocol and a jumper-selectable executive program that enables users to develop their own custom interfaces. The Z2800's memory is expandable to 40K bytes of combined RAM/ROM, and a second RS232C port is available. Baud rates and stop bits for the RS232C port are selectable. The disk port can accommodate single- or double-sided, single- or double-density floppy disk drives from Shugart Associates and other manufacturers. IBM 3740 and IBM

40 formats are standard. Floppy disks, power supplies and self-contained or rack-mount enclosures are optional. Single-quantity price is \$195. **Greco Systems**, 10020 Prospect Ave., Suite A15, Santee, Calif. 92071.

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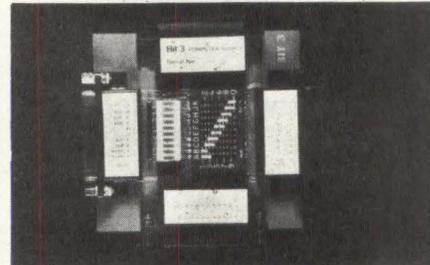
Host adapter for systems is STD bus compatible

The model MDX-SASI2 STD bus host adapter board for a hard disk controller allows OEMs to upgrade, mix and interchange peripherals without affecting the host microcomputer interface or the host software. Featuring 4-MHz operation, the board has a maximum transfer rate of 1 byte per 5 μ sec. The 5V card has Mode 2 interrupt capability and occupies eight I/O port addresses. This block of eight contiguous addresses can be any of 32 or 64 I/O addresses using I/O expansion capabilities. A user can select the port block addressing via jumpers on the board. The data bus is 8 bits bidirectional, while the address bus is 16 bits plus optional I/O expansion. The MDX-SASI2 card also features a DMA controller and contains an external Ready output that can be used with an external DMA board. The board also has a diagnostic LED for debugging hardware and software. Single-unit price is \$249. **Mostek Corp.**, 1215 W. Crosby Rd., Carrollton, Texas 75006. **Circle No 354**

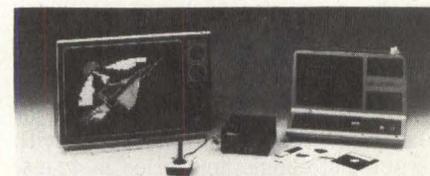
Universal device mates RS232 connectors

This RS232 connector matrix permits

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Peripheral device adds color to Radio Shack computers

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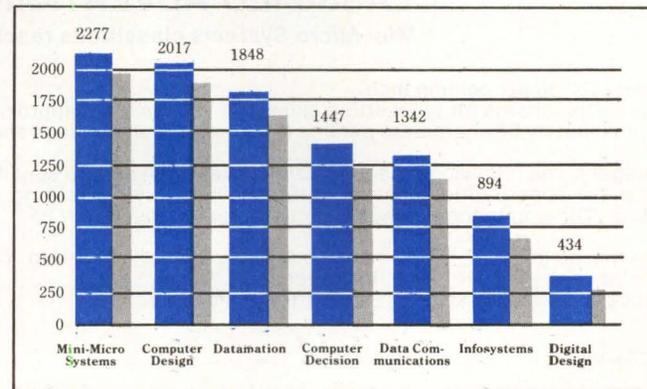
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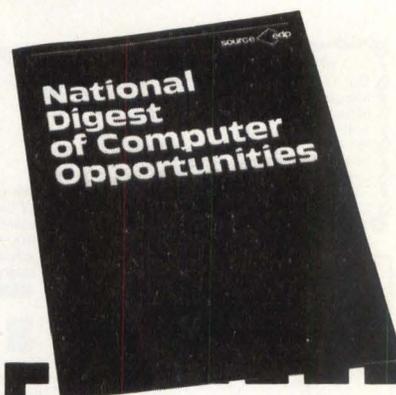
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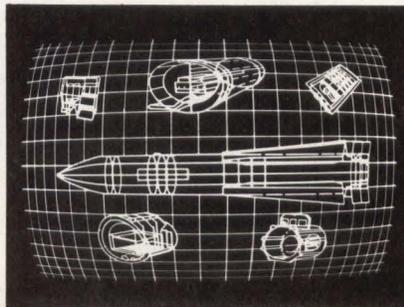
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Advertisers Index

Able Computer	219, 268, 269	Eagle Computer	285	Okidata Corp.	162
Adaptec, Inc.	182-183	Electronic Processors Inc. (EPI)	161	Onyx Systems	179
Advanced Color Technology	171	Electronic Solutions	278	Oriental Motor USA	290
Alpha Merics Corp.	280	Elsevier Science Publishing Co.	290	Persyst	164-165
Alpha Micro Systems	122-123	Emulex Corp.	137, 220	Pixel (Instrumentation Laboratory)	236-237
Altos Computer Systems	265	Envision	126	Plexus Computers	104-105
Amlyn Corp.	31	Esprit Systems, Hazeltine Terminals Div.	204	Priam	68-69
Ampex Corp., Memory Products Div.	196	Everest Electronic Equipment	76	Printek Corp.	191
Anadex, Inc.	86	Fujitsu America Inc.	277	Printronic Inc.	106
Ann Arbor Terminals Inc.	97	General Electric Co.	36	Quadram Corp.	40-41
Applied Data Communications (ADC)	222	Genstar REI Sales	18	Quantum Corp.	78-79
Archive Corp.	42-43	Glasgal Communications	64	Rabbit Software Corp.	209
Britton Lee Inc.	75	Gould Inc., S.E.L. Computer Systems Div.	5	Rexon Business Machines Corp.	153
Burr-Brown Corp.	181	Hewlett-Packard	134, 214-215	Rosscorp Corp.	61
C. Itoh Electronics	13	Houston Instrument Div. of Bausch & Lomb	216	Scientific Micro Systems	283
Calay Systems Inc.	115	IBC/Integrated Business Computers	144	Seagate Technology	84-85
CalComp	35, 37, 39	IBM Corp.	65, 193-195	Seiko Instruments USA	83
California Computer Systems	292	Illbruck/USA	4	Shugart Corp.	20-21, 226
Canon U.S.A.	89	Imagen Corp.	267	Siggraph '83	287
Centronics Data Computer Corp.	275	Infotron Systems Corp.	16	SoftTech Microsystems	238
Charles River Data Systems	80	Intecorp Corp., an Intelligent Systems Co.	121	Sola Electric	213
CIE Systems	47	Integral Data Systems	225	Storage Technology Corp.	271
CIE Terminals	Cover 3	Intel Corp.	251-253	Symbolics Inc.	234
Cipher Data Products Inc.	203	International Mobile Machine	255	Sydis	56-57
Columbia Data Products	148-149	Intertec Data Systems Corp.	29	Tab Products Co.	281
Compaq Computer Corp.	1	Iomega	248	Tandon Corp.	14-15
CompuPro	187	Ithaca InterSystems Inc.	110	TEAC Corp. of America	254
Computer Automation	99	Jefferson Electric Co.	74	Tecstor	73
Computer Resources Inc.	53	Kennedy Co.	6	TeleVideo Systems Inc.	108-109, 166-167
Computer Technology Group	286	Kimtron	112	Teltone Corp.	245
Comtech Data	270	Leading Edge Products	10	3R Computer Corp.	90
Conrac Corp.	260-261	Lear Siegler Inc.	273	Trac Line Software	51
Control Data Corp.—Engineering Services	276	Lexidata Corp.	139	Ungermann-Bass	231
Control Data Corp.—MSD	169	Liberty Electronics USA	55	Unitronix	38
Control Data Corp.—OEM	247	MAI/Basic Four	19	U.S. Design Corp.	77
Convergent Technologies	124-125	Maxtor Corp.	116-117	Ven-Tel	22
Corvus Systems Inc.	291	MCG Electronics	138	Versatec Inc., A Xerox Co.	44
CPX	258	MDB Systems Inc.	34	Vertex Peripherals	92-93
Cromenco Inc.	130-131	Megatek Corp.	9	Visual Technology Inc.	70
Data I/O	88	Memorex—OEM (A Burroughs Co.)	177	Wangtek	185
Datamedia	284	Micom Systems Inc.	Cover 4	Western Digital	62, 63, 174-175
Dataram	Cover 2	Microcom	48-49	Whitesmiths, Ltd.	158
Data Systems Design Inc.	100-101, 188-189	Micro Peripherals Inc. (MPI, Calif.)	150	Wyse Technology	142-143
Data Technology Corp. (DTC)	102	Micropolis Corp.	132-133	Xerox Corp. (Computer Services)	229
Datavue, An Intelligent Systems Co.	66-67	Microscience International	289	Xylogics Inc.	279
Davidge Corp.	246	3M Co.	173	Zendex	243
Delta Airlines	282	Momentum Computer Systems	146-147	Zentec	262-263
Digital Engineering	157	MPI (Utah)	233	Zilog Inc.	94
Digital Equipment Corp.	58, 140-141	Mupac Corp.	256		
Direct Inc.	118	Namiki Precision Jewel Co.	256		
Display Interface Corp.	288	National Instruments	235		
DriveTec	210	NCR, OEM Marketing Div.	154		
Dual Systems	4	NEC Information Systems Inc.	33		
Dylon Corp.	246	North Star Computers	129		
Dysan Corp.	257	Northwest Digital Systems	202		

See pp. 297-303 for Career Opportunity advertisers
See p. 303 for Computer Consultants Corner
See pp. 293-294 for Mini-Micro Marketplace

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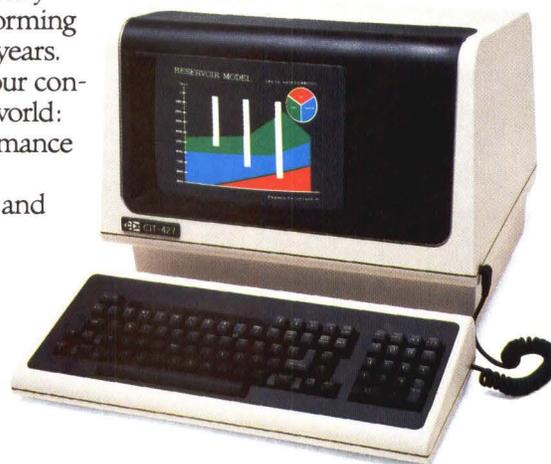
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