MAY 1987

Mini-Micro Systems

THE MAGAZINE FOR COMPUTER SYSTEMS INTEGRATION

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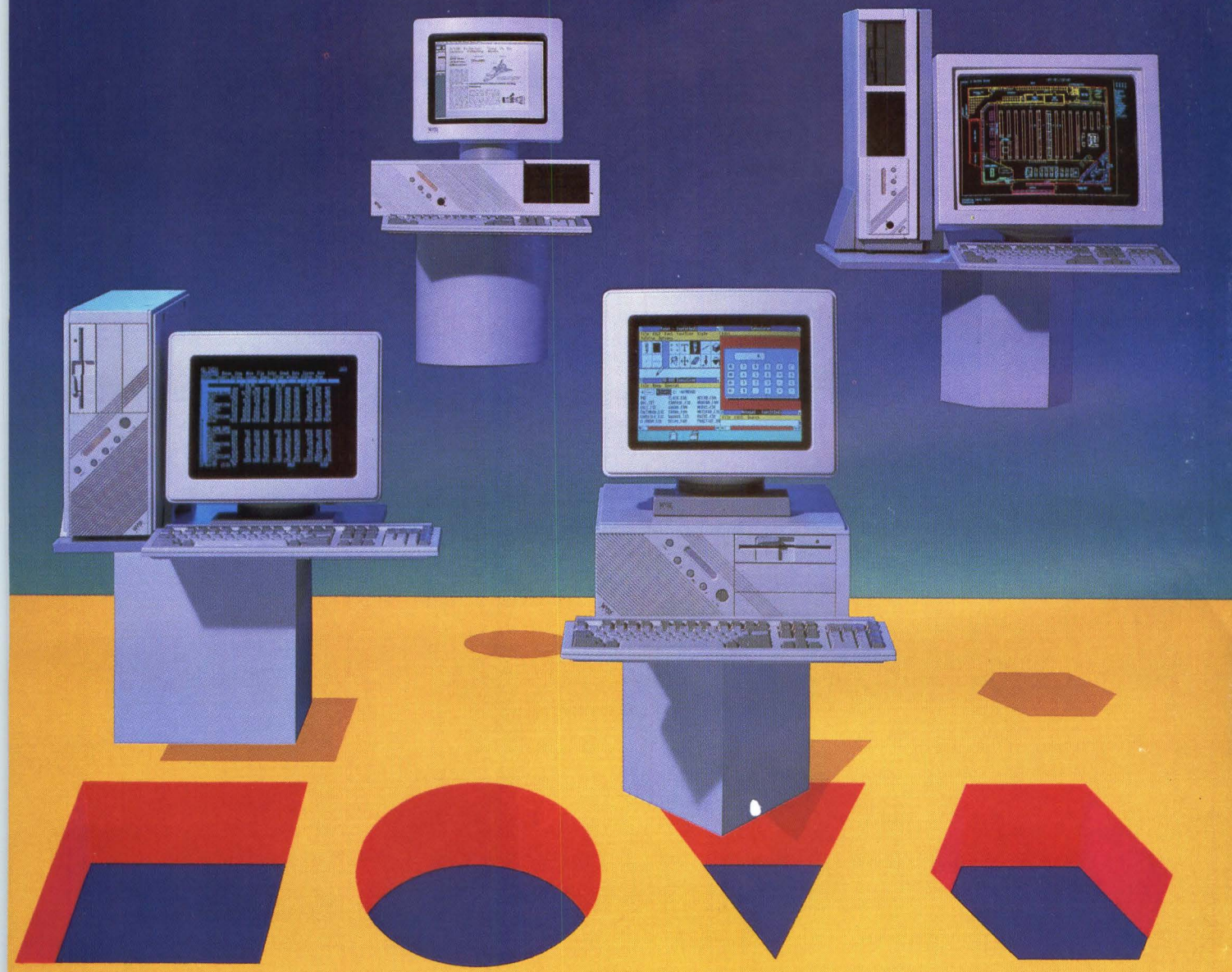

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- Database development tool evaluation
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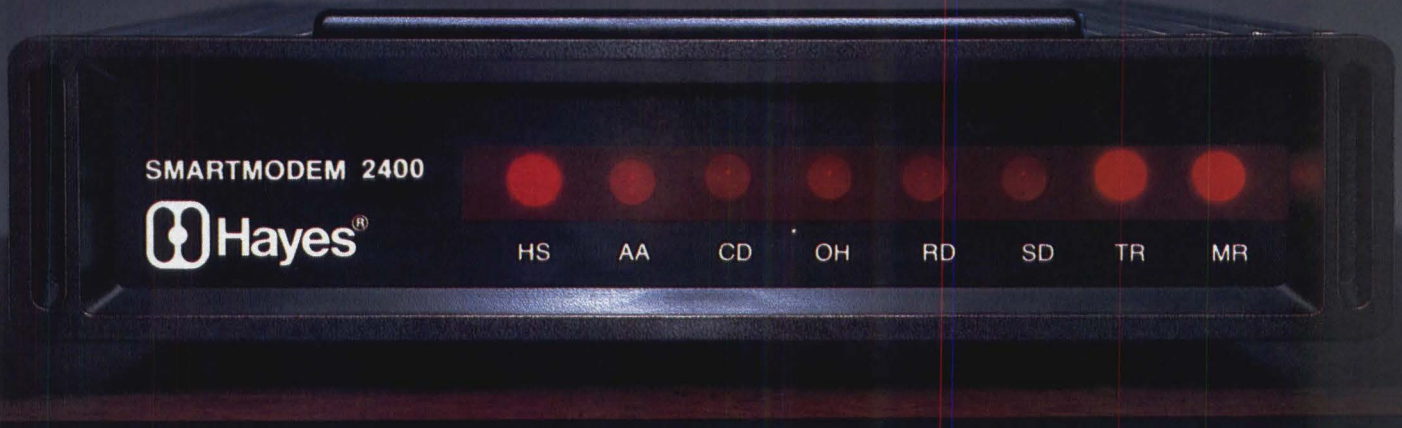
- Multiprocessors



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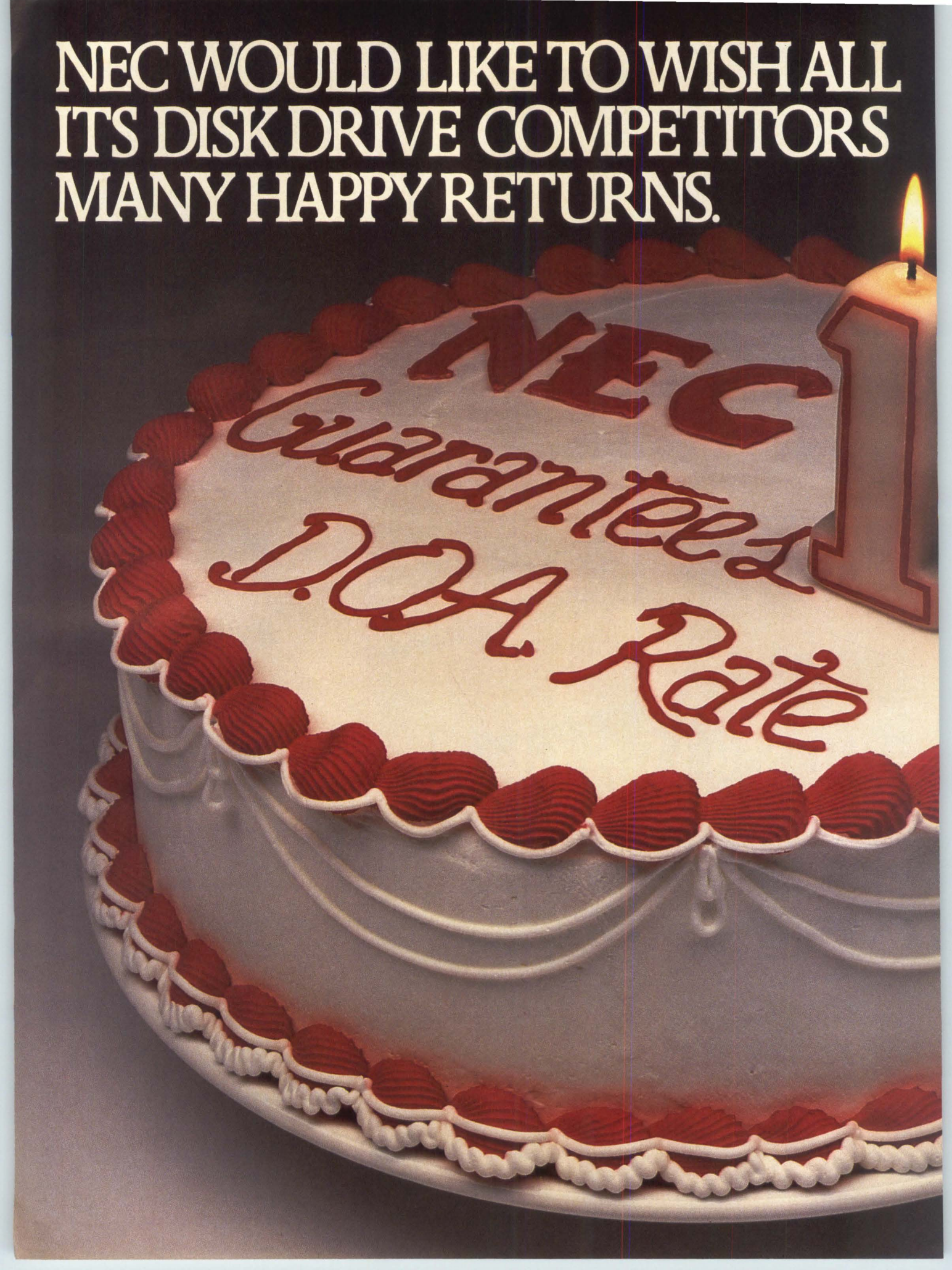

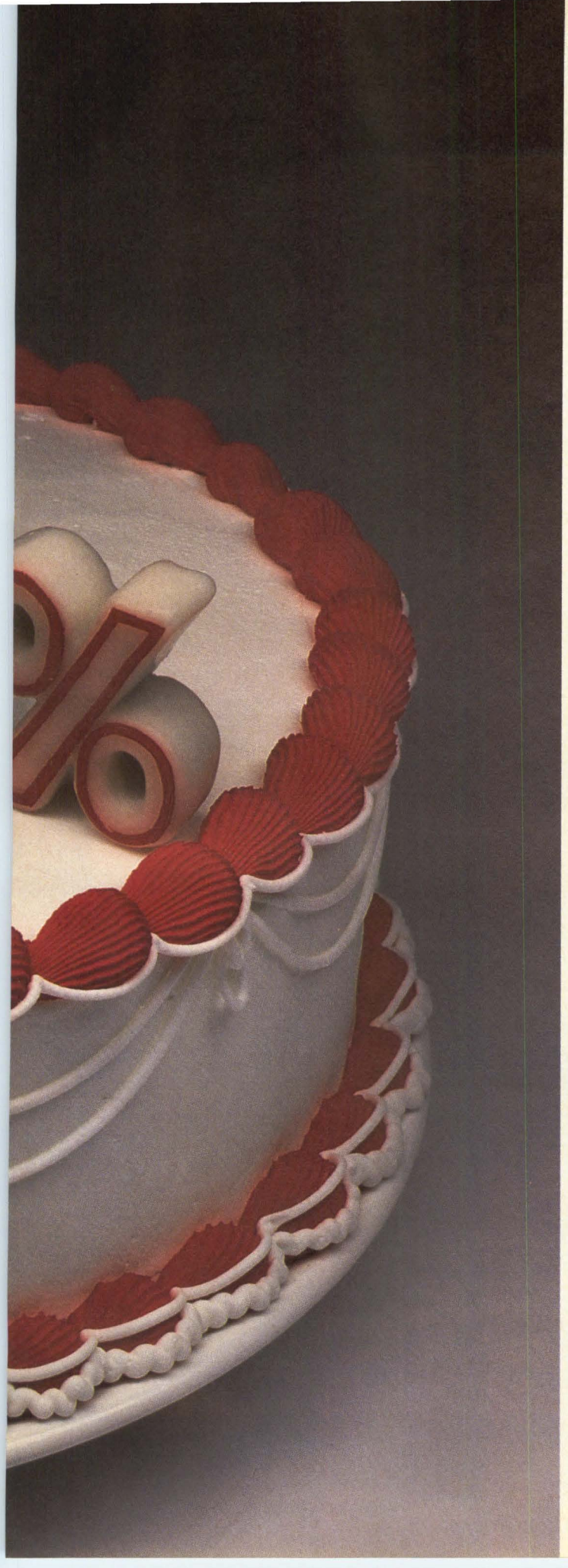

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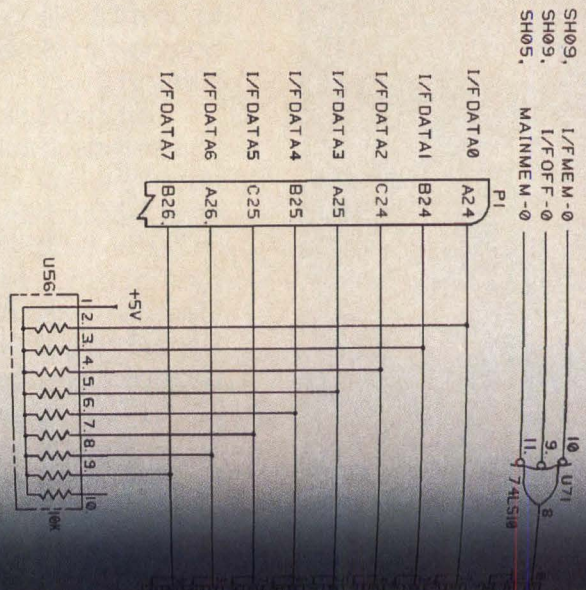

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MAY 1987

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Cahners Publishing Company • A Division of Reed Publishing USA • Specialized Business Magazines for Building and Construction • Computer/Technology • Electronics • Food/Packaging • Manufacturing Industries • Medical, Design & Publishing
MINI-MICRO SYSTEMS® (ISSN 0364-9342) is published monthly with additional issues in May and November by Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington St., Newton, MA 02158. William M. Platt, President; Terrence M. McDermott, Executive Vice President; Jerry D. Neth, Vice President of Publishing Operations; J.J. Walsh, Financial Vice President/Magazine Division; Thomas J. Dellamaria, Vice President Production and Manufacturing; Frank Sibley, Group Vice President.

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Circulation records are maintained at Cahners Publishing Co., 270 St. Paul St., Denver, CO 80206. Second class postage paid at Denver, CO 80202 and additional mailing offices. Postmaster: Send address changes to MINI-MICRO SYSTEMS®, 270 St. Paul St., Denver, CO 80206. MINI-MICRO SYSTEMS® is circulated without charge by name and title to U.S.- and Western European-based corporate and technical management, systems engineers and other personnel who meet qualification procedures. Available to others at the rate of $65 per year in the United States; $80 in Canada and Mexico; $105 surface mail in all other countries; air mail surcharge, $45 (14 issues). Special HANDBOOK issues, $15. Single issues, $6 in the United States; $8 in Canada and Mexico; $10 in all other countries.

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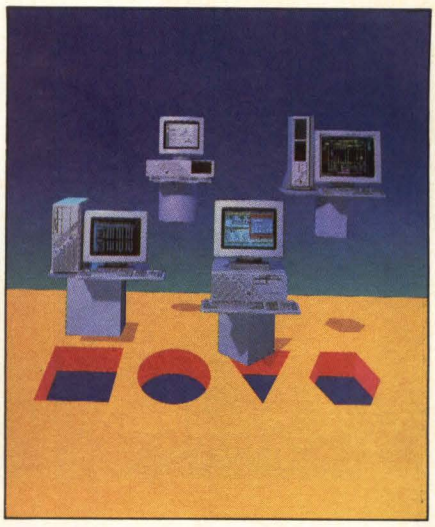

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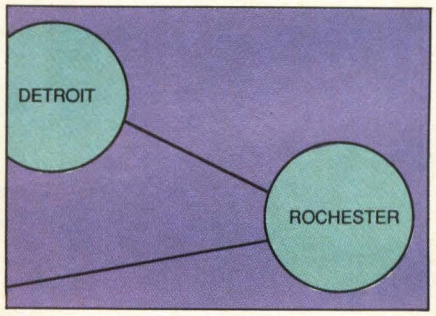

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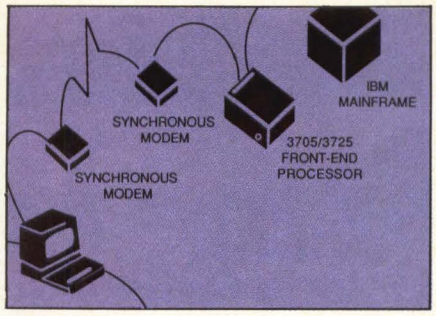

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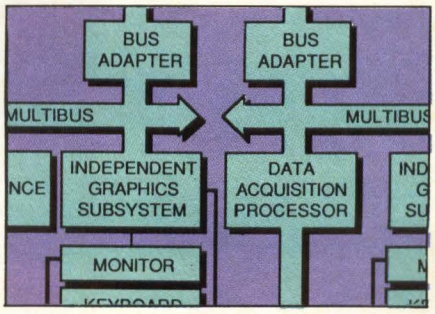

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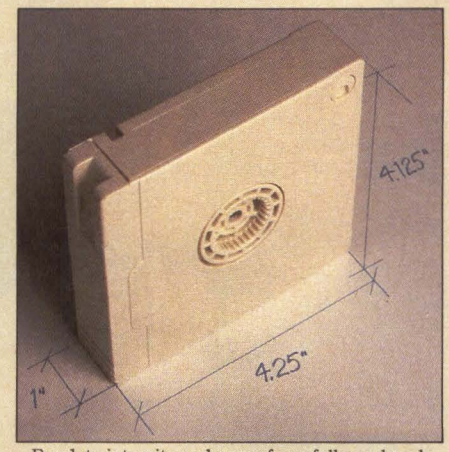

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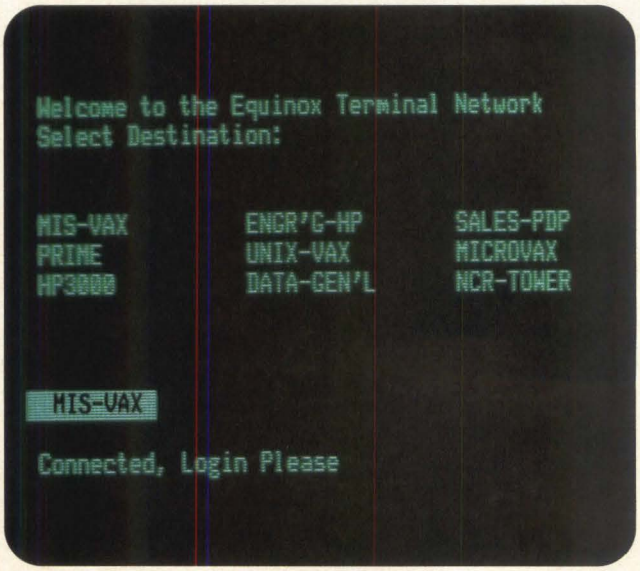

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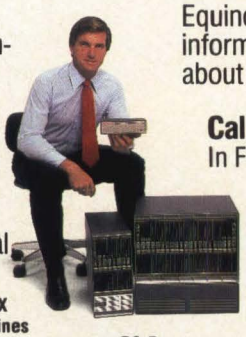

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EDITORIAL

R&D: A MANDATORY INVESTMENT

Research and development (R&D) has attained new meaning this year as computer companies search for new technology and products to improve their competitive edge—and, just maybe, ensure their sheer survival. To combat the influx of foreign competition that burst onto the computer scene in 1986, U.S. companies are closely examining their R&D programs to make sure that they hold the promise of innovative, useful and quality products.

To support R&D, U.S. industrial research spending has steadily increased over the past decade at a robust 13 percent average each year. In 1987, though, R&D budgets will drop, say two recent surveys. In one, Battelle Memorial Institute, Columbus, Ohio, estimates an increase in R&D spending of only 7.2 percent. In the other, the National Science Foundation forecasts a rise of just 5 percent.

Both studies conclude that the dollar downturn results from inaccurate sales projections, concern over short-term profits and budget slashes due to corporate mergers and acquisitions. To overcome these financial problems, many companies have opted to drastically reduce their long-term R&D efforts.

In 1986, private industry accounted for 50 percent of the estimated $116 billion in R&D expenditures. The government spent about 47 percent of these dollars; the remaining funds were doled out by universities and non-profit institutions.

In obtaining R&D services computer companies have relearned the merits of working with the academic community.

A prime example of advanced technology transfers from campus laboratories to industrial centers involves the CMU Robotics institute at Carnegie-Mellon University. Described as the world's largest industry-financed center for research on robots, the Institute serves some 30 companies with progressive technical information. These companies contribute heavily to cover the Institute's $7.2 million annual budget. But, in return, they gain the skills of about 200 scientific and engineering experts in artifical intelligence, computer vision and robotics.

Even with this renewed company-college collaboration, some age-old problems still persist. For example, college professors are eternally vigilant against industry corrupting the pure-research and teaching processes. And companies constantly worry that basic research will absorb precious short-term funds and might not mature into practical products and profits.

More important, though, universities appear eager to participate in R&D partnerships. For one key reason, they must rebuild their outdated scientific facilities. *Business Week* estimates that about 240 of the United States' 290 engineering schools are operating with outmoded equipment, and that more than $30 billion is needed to refurbish these facilities.

In addition, many teaching professors at important scientific schools have not kept pace with technology. What's more, the number of graduate engineering and scientific students has decreased markedly over the past few years.

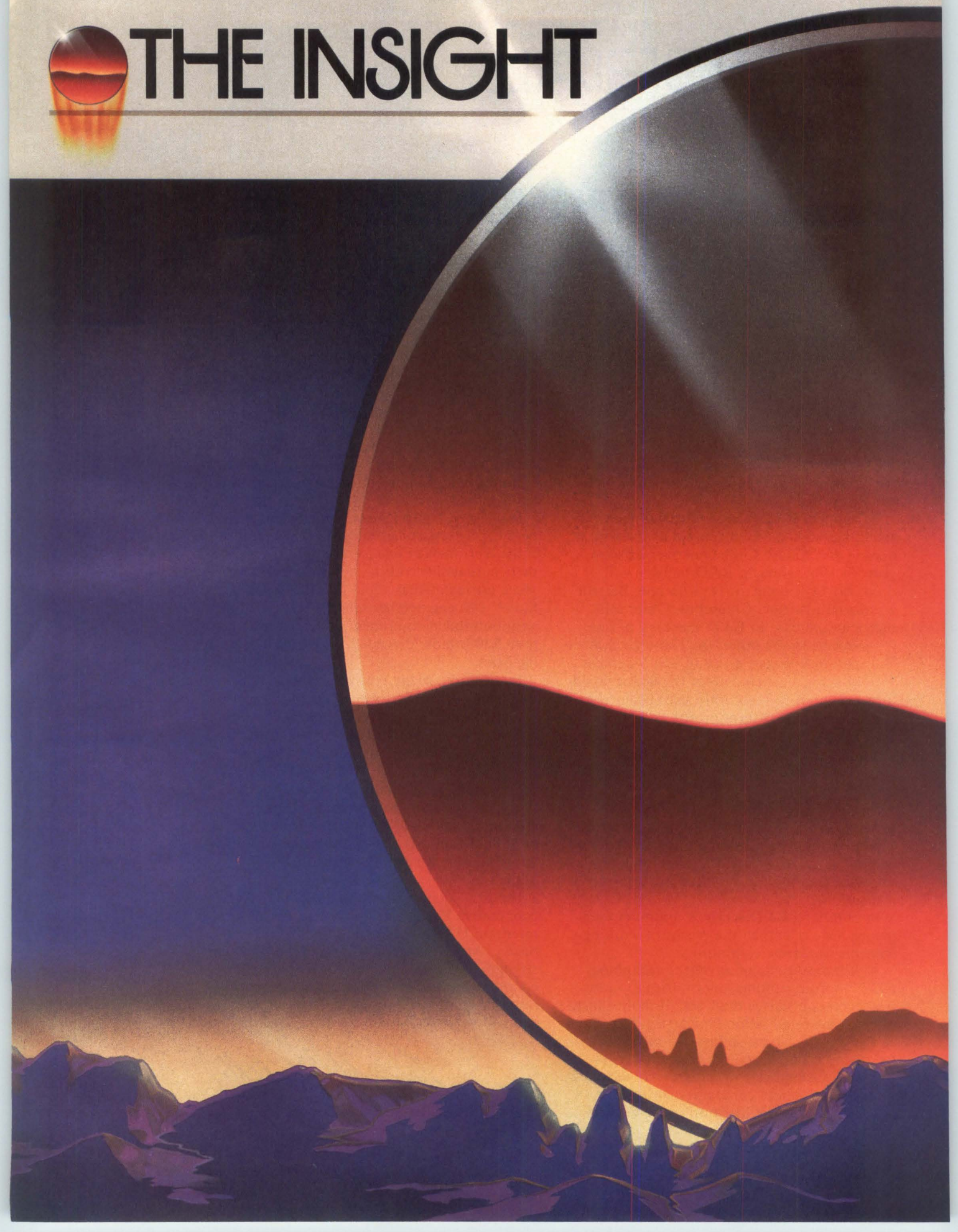
Fortunately, help is on the way. For one thing, the federal government is issuing equipment grants to universities to the tune of $50 million this year. For another, computer companies are also donating millions of dollars in new systems.

Industry analysts agree unanimously that cooperative R&D ventures are necessary to maintain U.S. supremacy in the computer industry. And the company-college link must be strengthened even further. For its part, the computer industry must resolutely increase its investment in R&D programs. The industry's survival depends on it.

George V. Kotelly

George V. Kotelly
Chief Editor

THE INSIGHT



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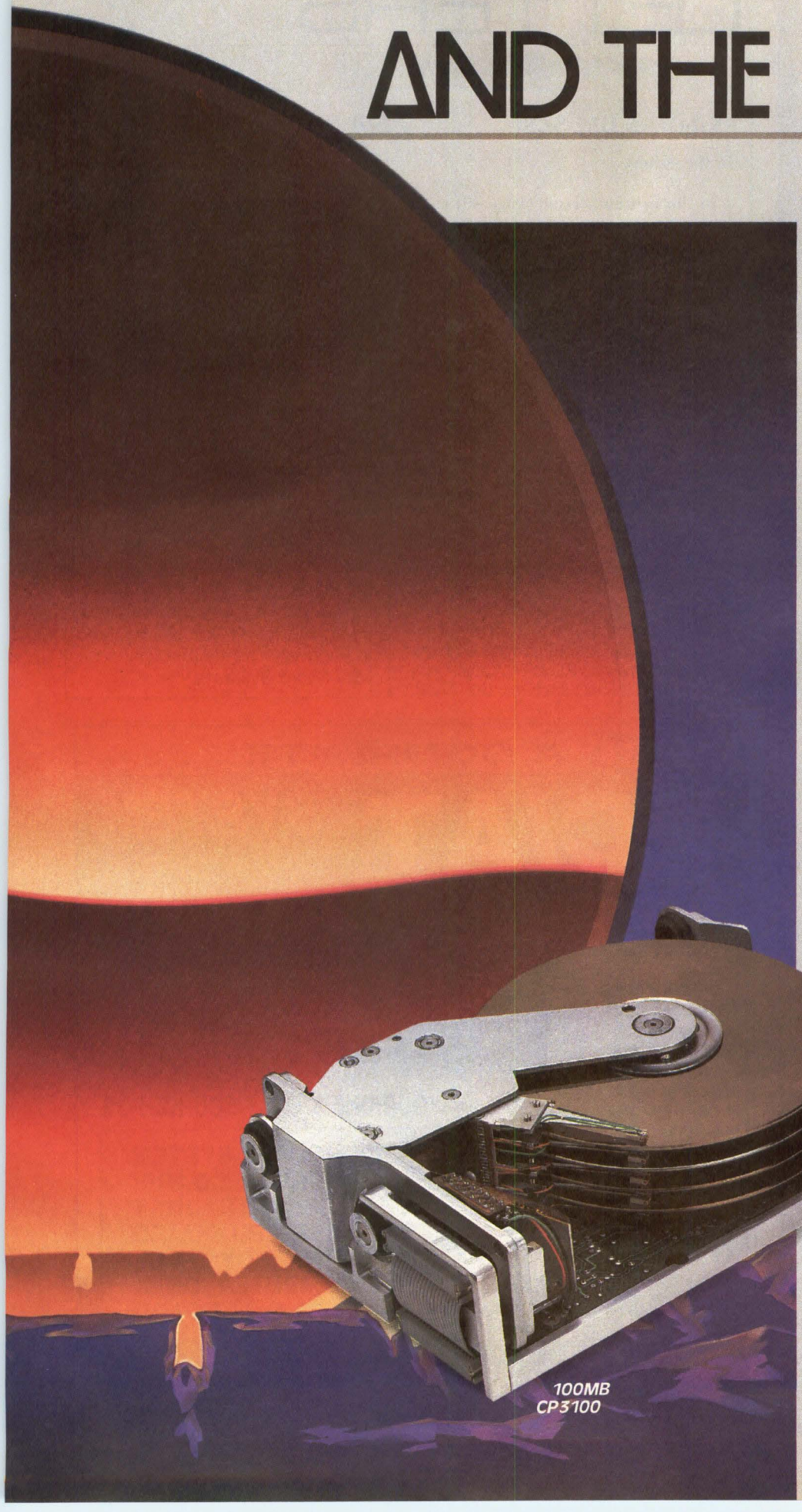

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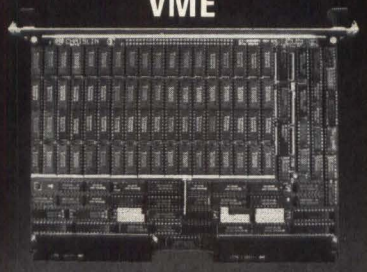

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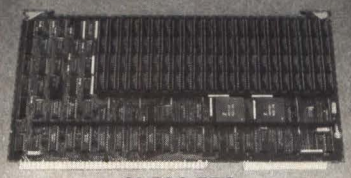

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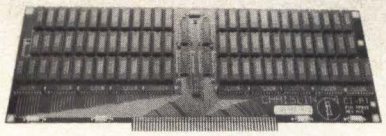

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PRINTERS USE SCSI

To the editor:

In the February issue (Page 49) is an article on the small computer systems interface entitled "SCSI extends beyond data storage devices." It seems to raise the question, "Will printers use SCSI?"

Printers already use SCSI and NCR [Corp.] offers that product. Our NCR ADP-60 is a SCSI-to-Dataproducts type of long-line printer-interface adapter that allows one or more hosts to share one or two high-speed printers. The baud rates are printer-dependent, but this controller can operate two 2,000-line-per-minute printers simultaneously. NCR is also considering the development of a low-cost SCSI-to-Centronics type of interface.

In our opinion, printer manufacturers will follow the lead of disk and tape manufacturers in providing embedded SCSI ability within the printer. Value-added manufacturers and system integrators will use bridge-type printer interfaces, such as the NCR ADP-60.

SCSI printer commands allow the sharing of printer resources by more than one host. The command also allows a SCSI copy operation (such as disk to printer) to be managed by the printer, thus freeing the host from managing this opeation.

The SCSI bus can provide the bandwidth necessary to accommodate the non-impact printer marketplace. Printer manufacturers are probably looking at this as the interface of choice.

John Ast
OEM Products Marketing Manager
NCR Corp. OEM Division
Wichita, Kan. 67226

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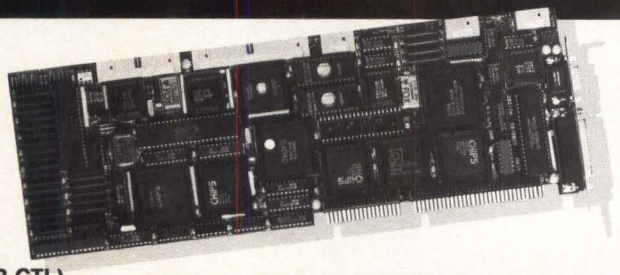

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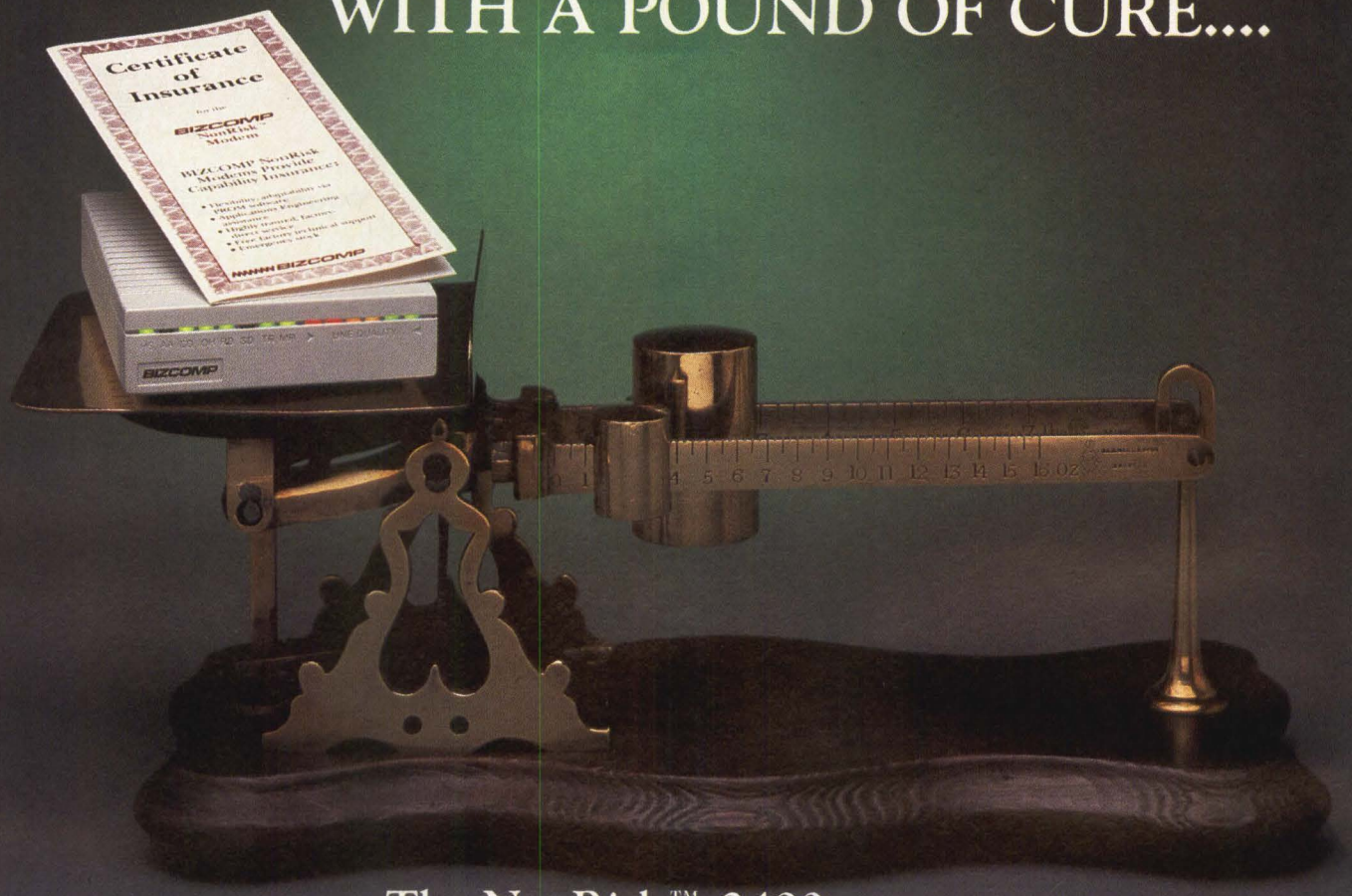

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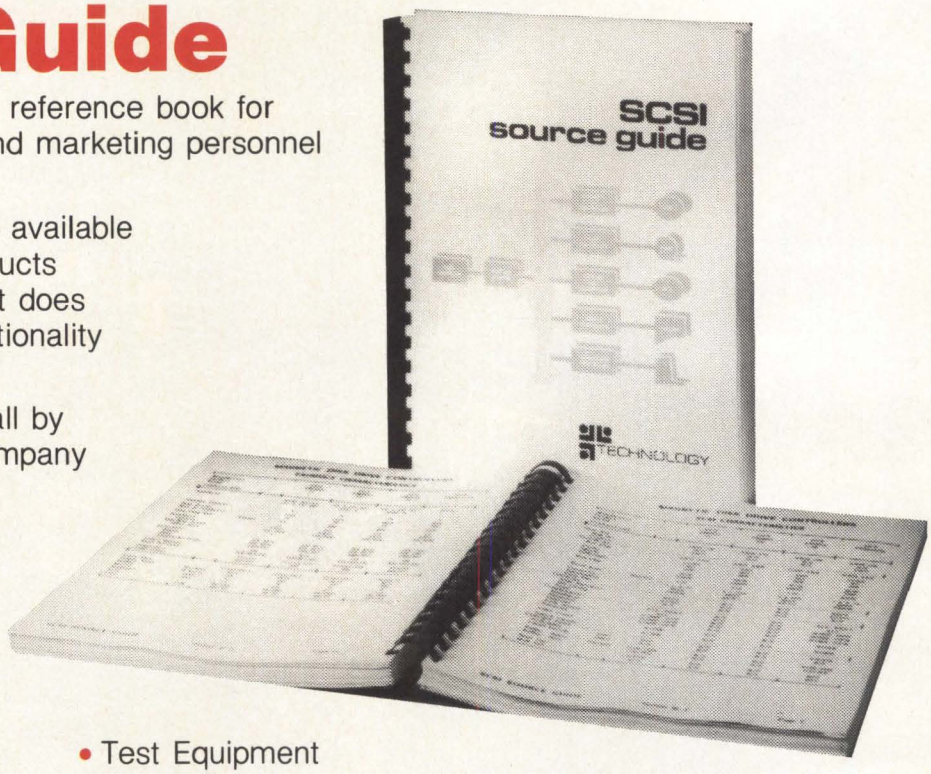

Published in the Spring and Fall by Technology Forums — the company who also brings you the SCSI Forum and the SCSI Market Study — The SCSI Source Guide includes the following SCSI product categories:

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- Subsystems
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Examples of product listings for intelligent disk drives are found on the reverse side of this data sheet (Courtesy of Seagate and Micropolis).

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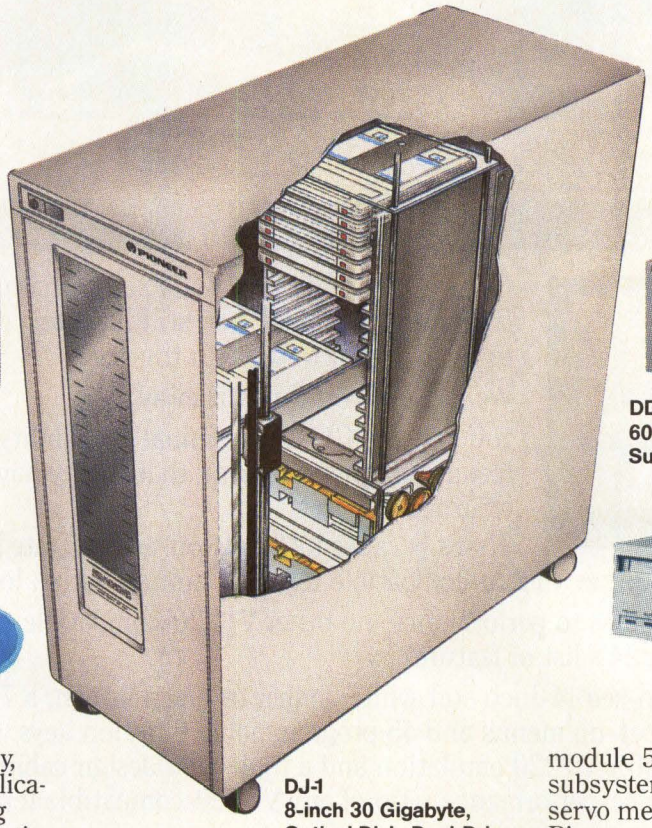

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"PC" Optical
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Advanced Pioneer technology, along with the world's first application of an organic dye recording media make possible the introduction of a new series of highly efficient, low cost, write once (W.O.R.M.) optical disk subsystems from the leader in optical technology... Pioneer.

Featured in this new product line is Pioneer's DJ-1 eight-inch Optical Disk Dual Drive Autochanger Jukebox. This high-speed optical disk jukebox provides for up to 30 gigabytes of data storage capacity (20 two-sided removable cartridges) with an End-User price of $40,000 per unit... **that's less than a $1.35 per megabyte of storage capacity.**

The 8-inch drive which is incorporated in the autochanger, is also available in a stand-alone configuration. The DD-8001 eight-inch stand-alone subsystem combined with the DC-801/DC-802 optical disk media represents the ideal, compact disk drive. (1.5 gigabytes on two sides). The DD-8001 is equipped with the SCSI high-speed parallel computer interface and is available with MS-DOS operating software. With an End-User price of $13,000 per unit, this front-loading, high-speed drive is ideal for any type of desk top system configuration.

In addition to this outstanding 8-inch technology, Pioneer is also pleased to introduce the DD-U5001 stand-alone and DD-S5001 "PC" module 5.25-inch optical disk drive subsystems. A new, light-weight servo mechanism developed by Pioneer provides incredibly quick random access to any information on the disk. At an End-User price of between $2,800 (DD-U5001) to $3,500 (DD-S5001), the 5.25-inch subsystems are provided with the SCSI interface and full MS-DOS operating software will be available Each double-sided DC-502 optical disk offers 600 megabytes of storage capacity (300 megabytes per side).

Pioneer's unique 8-inch and 5.25-inch low cost organic dye optical disk media ensure a data storage life of greater than 15 years.

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And when it comes to performance, no other VT220-compatible terminal stacks up to the CIT224's list of features.

Like an easy-to-see 14-inch soft white, amber or green screen, a 7 x 15 character matrix, 11 set-up menus and 45 programmable function keys. Couple this with proven 100% VT220 emulation and a high-tech design cabinet, and you've got the best price-performance ratio of any VT220-compatible terminal on the market.

Improve your bottom line with the CIT224 terminal. And throw away the box.

For more information on the CIT224, contact CIE Terminals, a C.Itoh company, 2505 McCabe Way, Irvine, CA 92714; or call (714) 660-1421 or our toll-free number (800) 624-2516.

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CIRCLE NO. 12 ON INQUIRY CARD

BREAKPOINTS

KIMTRON BEEFS UP PC-COMPATIBLE NETWORKED TERMINALS

Kimtron Corp. will launch a new line of Satellite PC-compatible terminals next month at Comdex/Spring in Atlanta. The SAT10 and SAT20 come with IBM Corp. PC/AT-style keyboards, serial and parallel ports, three 8-bit expansion slots and built-in color and monochrome graphics adapters and monitors. Both are priced at $995 (monochrome) and $1,395 (color) and come with an add-in board to connect them to other PCs. Four SAT10s can run single-user DOS applications off the host PC using Kimtron's $99 Knet software. Ten SAT20s running IBM's PCNet software can operate multiuser programs off the host PC. By year's end the San Jose company plans to support Arcnet, Ethernet and token-ring networks on other Satellite products.—*Mike Seither*

NEW AT&T PRODUCTS EMPHASIZE CONNECTIVITY

While IBM Corp. prepared its recent product barrage, rival AT&T Co. fired a few salvos of its own. It announced a set of communications products that helps its 3B2 line of minicomputers connect with the machines of other vendors, including IBM, Digital Equipment Corp. and Wang Laboratories Inc. AT&T also brought out two new servers for its 1M-bps Starlan local area network, and enhancements to its packet-switching Information Systems Network (ISN). One of the ISN enhancements is software, scheduled to be available in July for $5,000, which permits IBM 3270 terminals to communicate with DEC host/terminal networks. Other key announcements: support for IBM's LU 6.2 protocols and software that permits the 3B2 computers to exchange documents in the IBM office environment.—*Jim Donohue*

LAN VENDORS OFFER THEIR OWN PC WORKSTATIONS

Three local area network vendors have announced competing IBM Corp. PC-compatible workstations designed specifically for LANs. They are 3Com Corp. of Santa Clara and Nestar Systems Inc. of Mountain View, Calif., and Novell Inc. of Orem, Utah. 3Com's $1,895 3Station is an 80286 system with four integrated graphics adapters, Ethernet and 1M byte of memory. Nestar goes to market with three PC workstations, two based on the 8088 and the third on the 80286. The Nestar products all run either on Datapoint Corp.'s ARCnet or token ring and cost from $895 to $1,695. Novell's offering is a $699 diskless network PC. All three companies bank on LAN customers wanting total systems, not pieces.—*Mike Seither*

UNISYS INTRODUCES 80386 WORKSTATION

Unisys Corp. has joined the ranks of workstation vendors offering products powered by the Intel Corp. 80386 microprocessor. The B38 Universal Workstation operates at 16 MHz and runs under BTOS, a multiuser, multitasking operating system from Burroughs Corp., the company now merged with Sperry Corp. to form Unisys. You can cluster up to 11 B38s in a shared-resources environment (disks, printers, communications devices), or you can cluster up to 10 IBM Corp. PCs with one B38 acting as the controller. But you must buy

$475 Clustershare RS422 interface boards from Unisys for each PC in the cluster. Unisys places a price tag of $8,375 on a basic B38 workstation, which includes 1M byte of memory and a 20M-byte rigid disk drive.—*Jim Donohue*

FUJITSU UNLEASES SALVO OF HIGH-END PERIPHERALS

Fujitsu America Inc. will introduce a host of peripherals by mid-May, including its first scanner for OEMs in the United States. The M3094A, priced at $3,090, scans at 200, 240, 300 and 400 dots per inch. It produces 64 shades of gray and, with an optional $610 circuit, detects subtle variations. And, the San Jose company will unveil a 5¼-inch, 389M-byte Winchester disk drive with an ESDI interface and an access time of 18 msec that pits Fujitsu against Maxtor Corp., Micropolis Corp., Miniscribe Corp. and Priam Corp. for drives in that range. Also coming: a 3½-inch, 77M-byte Winchester with run-length limited encoding; a 10M-bps intelligent peripheral interface (IPI); a 5¼-inch, 218M-byte half-inch cartridge tape drive; and four 3½-inch flexible drives. —*Mike Seither*

APOLLO BRIDGES DOMAIN, ETHERNET

Augmenting its own token-ring network products, Apollo Computer Inc., Chelmsford, Mass., recently announced Ethernet support for its Domain workstation computing environment. The 802.3 Network Controller-AT, which plugs into the company's Domain Series 3000 workstations, enables direct connection to Ethernet networks. That means system integrators can link up to a variety of other vendors' systems, including Digital Equipment Corp. VAX/VMS and a variety of UNIX machines. The price of a Series 3000 workstation includes either the 802.3 Network Controller-AT or Apollo's original Token Ring Network Controller-AT. If purchased as an add-on, each controller costs $2,000. —*Dave Simpson*

COMMUNICATIONS A FAX OF LIFE FOR EMULEX

Although a player in data communications only since early this year, Emulex Corp., Costa Mesa, Calif., will begin shipping its third set of modems next month—this time targeting the growing facsimile market. The $355 HF144 and $255 HF96 operate over either dedicated telephone lines or general switched telephone networks at 14,400 and 9,600 bps, respectively. The modems will also be marketed to OEMs and VARs in Japan in an effort to crack the Japanese fax market where Rockwell International Corp. is presently the sole U.S. supplier of modem boards. Marketing manager Roger Free says Emulex will compete on the basis of lower power consumption, smaller size and surface-mount technology.—*Tim Scannell*

IBM BLESSES OPTICAL DISK DRIVES—AT LAST

IBM Corp. has ended its long holdout and entered the optical storage business with the 3362, an external, 200M-byte WORM optical disk drive. "It gives IBM a way to learn what the optical market is all about," says industry analyst Bob Katzive of Disk/Trend Inc., Los Altos, Calif. The 3363, which carries a price tag of $2,950, is built for IBM by Matsushita of Japan. With attachments, says IBM, it can hold 1.6G bytes of data. The drive will be available in the second quarter. Meanwhile, IBM is working on an optical disk

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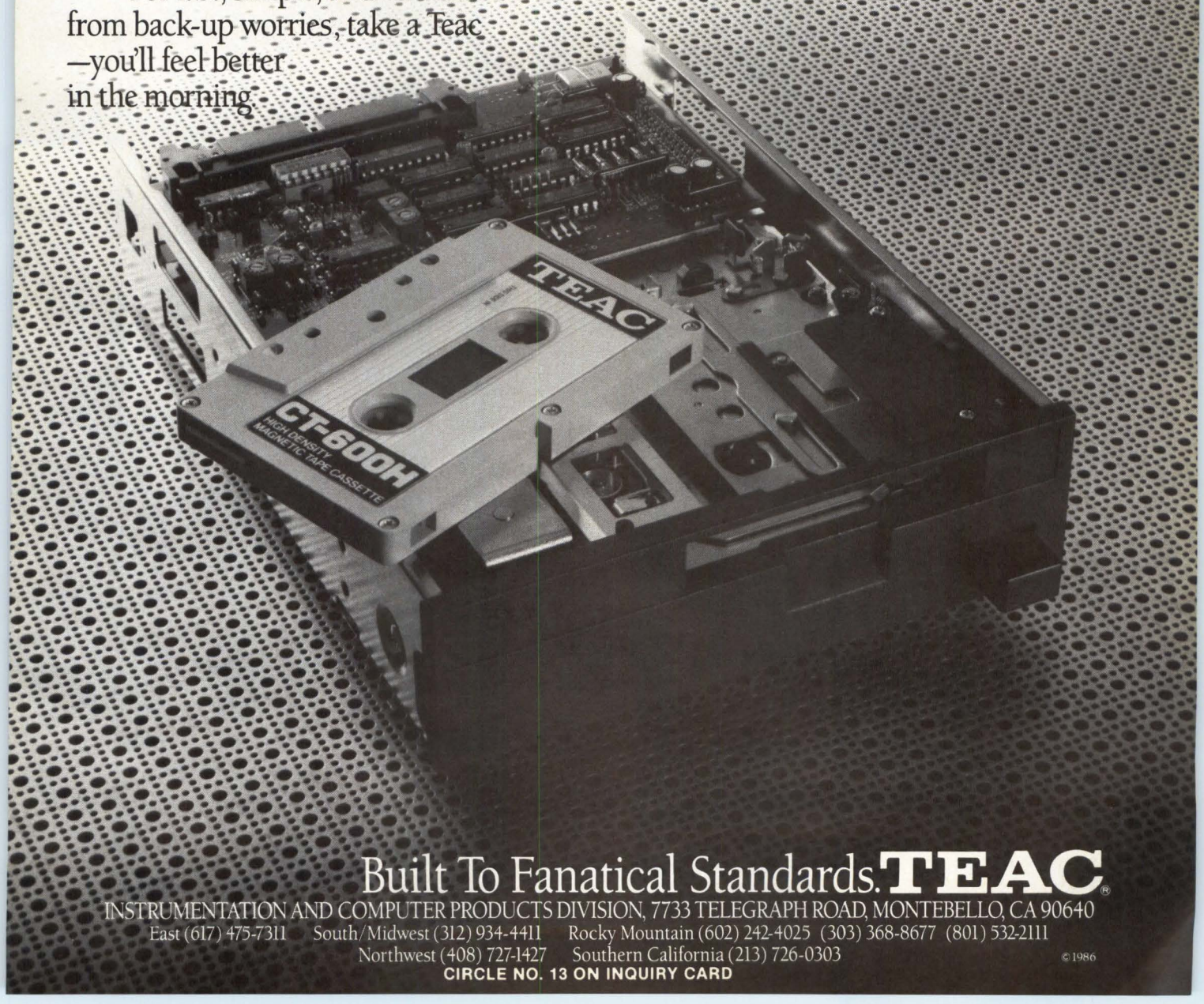

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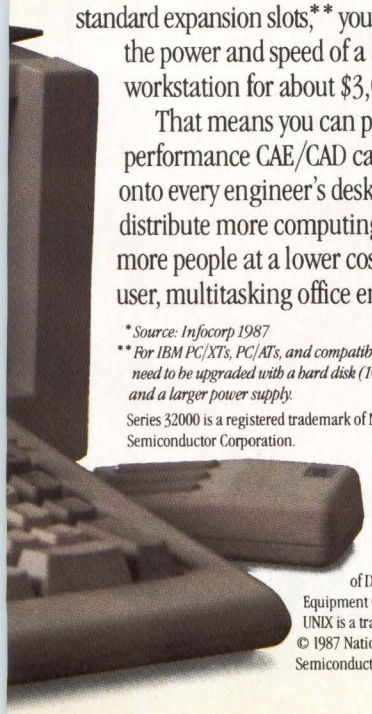

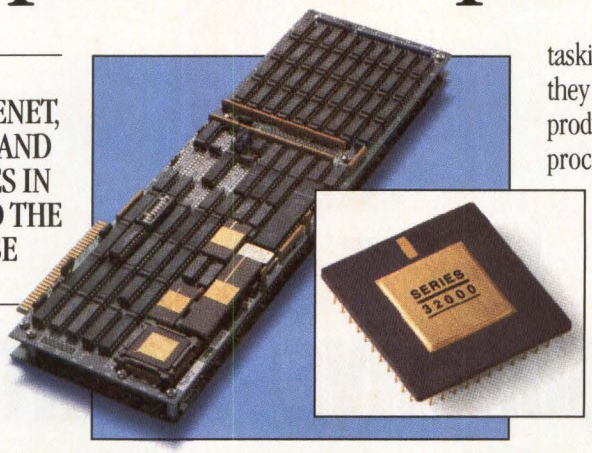

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PLUG INTO THE MARKET *NOW*

Obviously, the potential of the PC add-in market is enormous. And it's already being tapped with Series 32000-based boards being manufactured by a number of OEMs. If you're a systems integrator, VAR or VAD, contact one of these companies about their products.

Or if you're a board-level OEM yourself, follow their lead by contacting National Semiconductor about how you can design the Series 32000 into your own product.

PC ADD-IN COMPANIES USING SERIES 32000

Selected OEMs

Aeon Technologies, Vail, CO (303) 986-3599
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Definicon Systems, CA (818) 889-1646
DFE Electronic Data Systems, CA (415) 829-3925
Hightec EDV Systems, Saarbrücken, Germany
Matrox Electronic Systems, Quebec, (514) 685-2630
Opus Systems, Cupertino, CA (408) 446-2110
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Either way, the PC add-in market represents one of the most significant business opportunities in years. With over 10,000,000 prospective customers. And the Series 32000 can help you reach every one of them.

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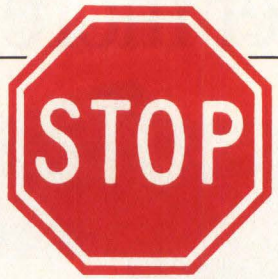
PDP 11/34
PDP 11/04
PDP 11/24
PDP 11/40
PDP 11/60



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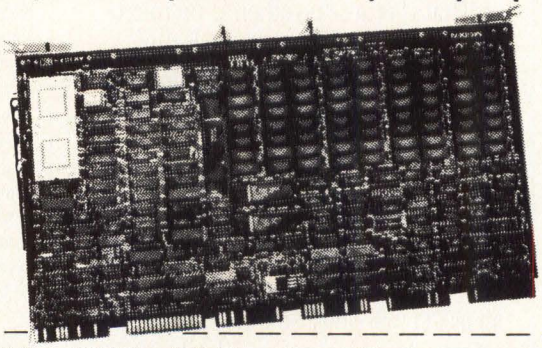

**N1100 has been so designated by* Digital Review *September 1985.*
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CIRCLE NO. 15 ON INQUIRY CARD

drive of its own design. That work is underway in Tuscon, Ariz. Says one official with optical drive competitor Maxtor Corp., "The significance [of the 3363] is that IBM has finally blessed WORM technology. It's something we've all been waiting for."—*Mike Seither*

MULTIFUNCTION OPTICAL DRIVES DUE THIS YEAR

Optimem Inc., Sunnyvale, Calif., says it will have multifunction optical disks and drives in the 5¼-inch form factor in beta test this summer and expects to ship the product in volume in the fourth quarter. At least one other company —Maxtor Corp., San Jose,—says it is looking into multifunction drives with the idea of having a product on the market in 1988. Larry Fujitani, director of marketing for Optimem, says his company's drives will combine WORM and CDROM technologies with the newly developed erasable technology. 3M of St. Paul, Minn., will supply the recording media and the disks.—*Jim Donohue*

COMMITTEE GOES BOTH WAYS ON OPTICAL FORMATTING STANDARD

Following the lead taken earlier this year by the Japanese, the ANSI X3B11 committee has voted to pursue two competing standards for formatting write-once 130-mm optical disk drives. But that decision, some members think, could be reversed by another vote when the committee meets again this month. One camp favors the composite/continuous method, which interlaces servo information with data. The other group leans toward the sample servo technique, which physically separates servo information from data on the disk. The committee decided on the twin-standard approach after being unable to reach a consensus on the issue for more than a year.—*Mike Seither*

DO MEGA-MEMORY CHIPS THREATEN TO REPLACE MAGNETIC MEDIA?

"DRAM (dynamic RAM) chips always go to $2." That's been a constant economic law for solid-state memory. Prices start much higher and then fall as manufacturers achieve economics of scale and control over the chip-making process, according to San Francisco's *California Technology Stock Letter,* quoted above. Noting IBM Corp.'s recent announcement of a 4M-bit DRAM chip—and hints at 16M-bit, 64M-bit and 256M-bit chips—the newsletter editors believe solid-state memory will soon be a cost-effective replacement for magnetic disk drives. By 1991 semiconductor memory prices will be about $10 per megabyte, vs. $15 per megabyte for 14-inch Winchester disks and $10 for 8-inch Winchesters. That, the editors say, will be low enough for IBM Corp. to announce "solid state replacement products for their largest computers as soon as 1988 or early 1989."—*Mike Seither*

ISDN KEEPS COMMUNICATIONS IN THE CHIPS

Systems integrators should keep abreast of developments in integrated services digital networks (ISDN). For one thing, Advanced Micro Devices Inc. of Sunnyvale, Calif., one of the five top U.S. chip suppliers, will start shipping toward the end of this year an ISDN protocol controller designed to easily connect terminal equipment with digital PABXes. The device should increase ISDN's real-time capabilities, and that is what communications integration is all about. For another thing, the ISDN market is expected to mushroom from about $500 million this year to more than $3 billion by 1995, says AMD Group vice president John East.—*Tim Scannell*

INTEGRATORS VENT MASS-STORAGE BEEFS

"Every storage device or controller we use has shut down our production line at least once," complains Jon Garman, director of I/O engineering for Sun Microsystems Inc., Mountain View, Calif. Garman spoke out as one of a panel on "Insights from Storage Device Integrators" at Dataquest Inc.'s April storage-industry conference in San Jose. Garman asserted that drives and controllers are often not compatible "though advertised as such." Gripes from other panelists: non-standard "standards" like the ESDI interface, which has several different transfer rates.—*Mike Seither*

PLUS PRODUCES 40M-BYTE HARDCARD

Plus Development Corp., the Milpitas, Calif., company that started the drive-on-a-card business two years ago with a 10M-byte device, began shipments in early May of its 40M-byte HardCard. Unlike many competing drive cards that require one and a half personal computer expansion slots, Plus Development has retained its original sleek design and still takes up only a single slot. The HardCard 40, which uses run-length limited encoding, retails for $1,195. Plus claims it has shipped a total of 200,000 10M-byte and 20M-byte HardCards. — *Mike Seither*

BREAKING THE LISP LANGUAGE BARRIER WITH COBOL

Citing an "academic bias" toward LISP in the area of artificial intelligence applications, Cullinet Software Inc., Westwood, Mass., has taken the wraps off a series of expert-system programs based on the COBOL programming language. It marks the company's first entry into AI applications since it acquired Distribution Management Systems (DMS) of Lexington, Mass. OrderEXL, SalesEXL, VoiceEXL and the DMS Application Expert all support COBOL and SQL file conventions. As a result, they can more easily integrate with commercial applications. Their framework also eliminates the need for dedicated hardware and complicated compilers. Besides, if the application is successful, "the underlying language becomes somewhat irrelevent," claims John Landry, former DMS CEO and now an executive vice president at Cullinet.—*Tim Scannell*

HAND-HELD SCANNER AIMS AT SPREADSHEET USERS

Typical scanners load a complete page of type into a computer. Now Saba Technologies, Beaverton, Ore., is bringing out an optical character reader that selectively enters information into popular spreadsheet, word processing and database programs. About the size of a mouse, the $695 device, called the Hand Scan, can be used to read small bits of information, such as a group of numbers, and enter them into a spreadsheet's cell or a word processing file. The reader connects to an IBM PC Corp. or compatible through a full-size add-in card. Among other programs, it supports Lotus 1-2-3, WordStar, WordPerfect and MultiMate.—*Mike Seither*

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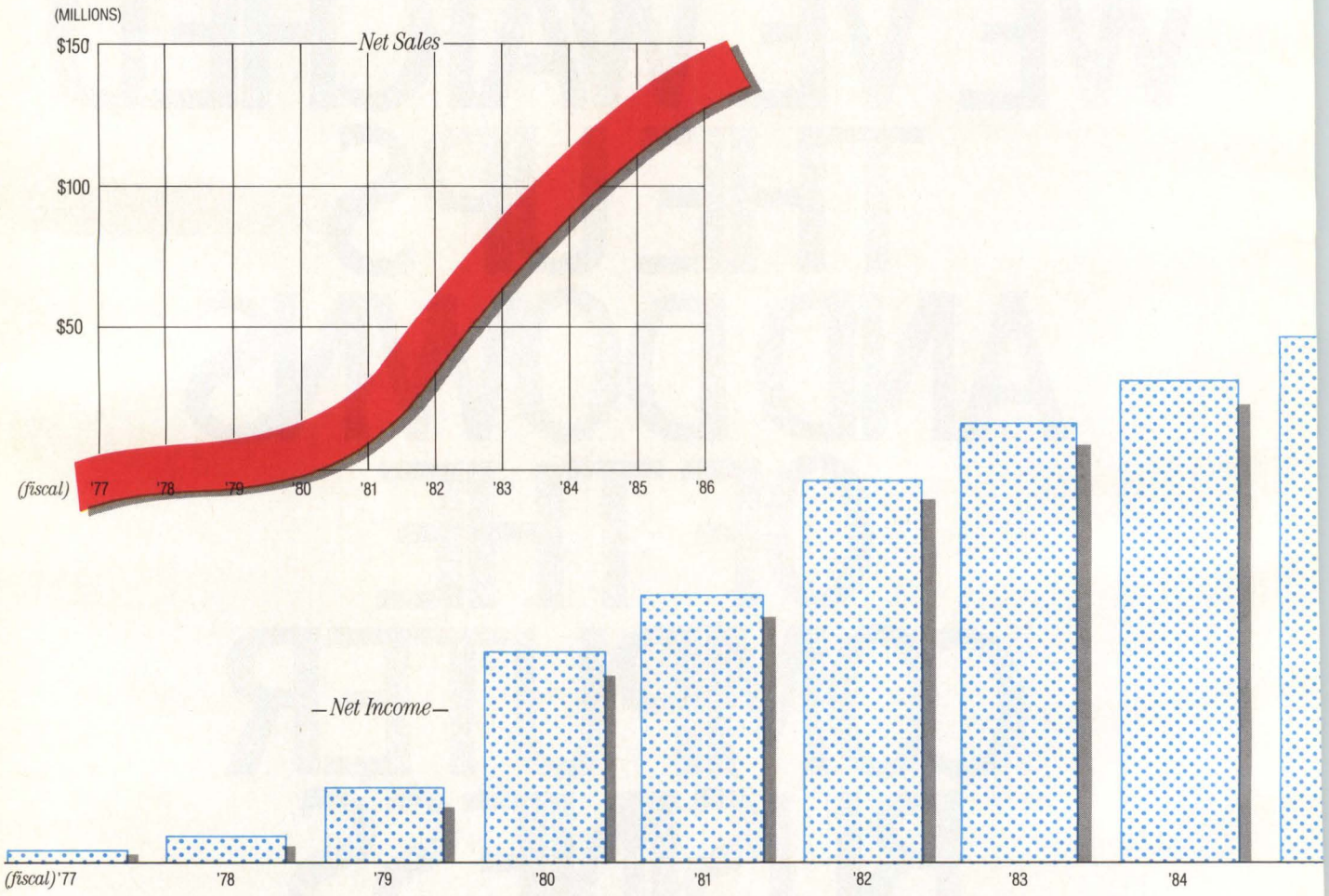

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*Includes gain on sale of investment in affiliated company.

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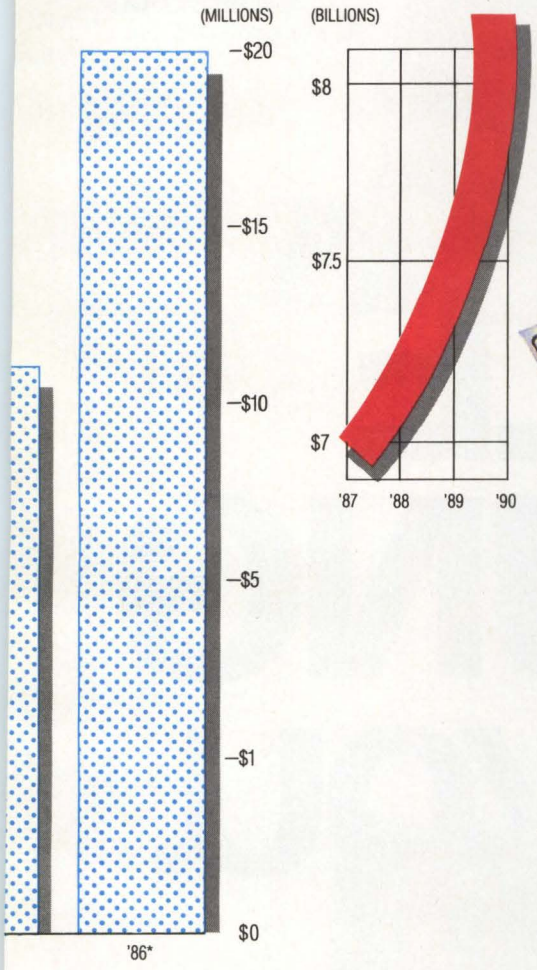

Projected World Growth in Multi-user Systems.$25,000 - $50,000
(Source: Dataquest)

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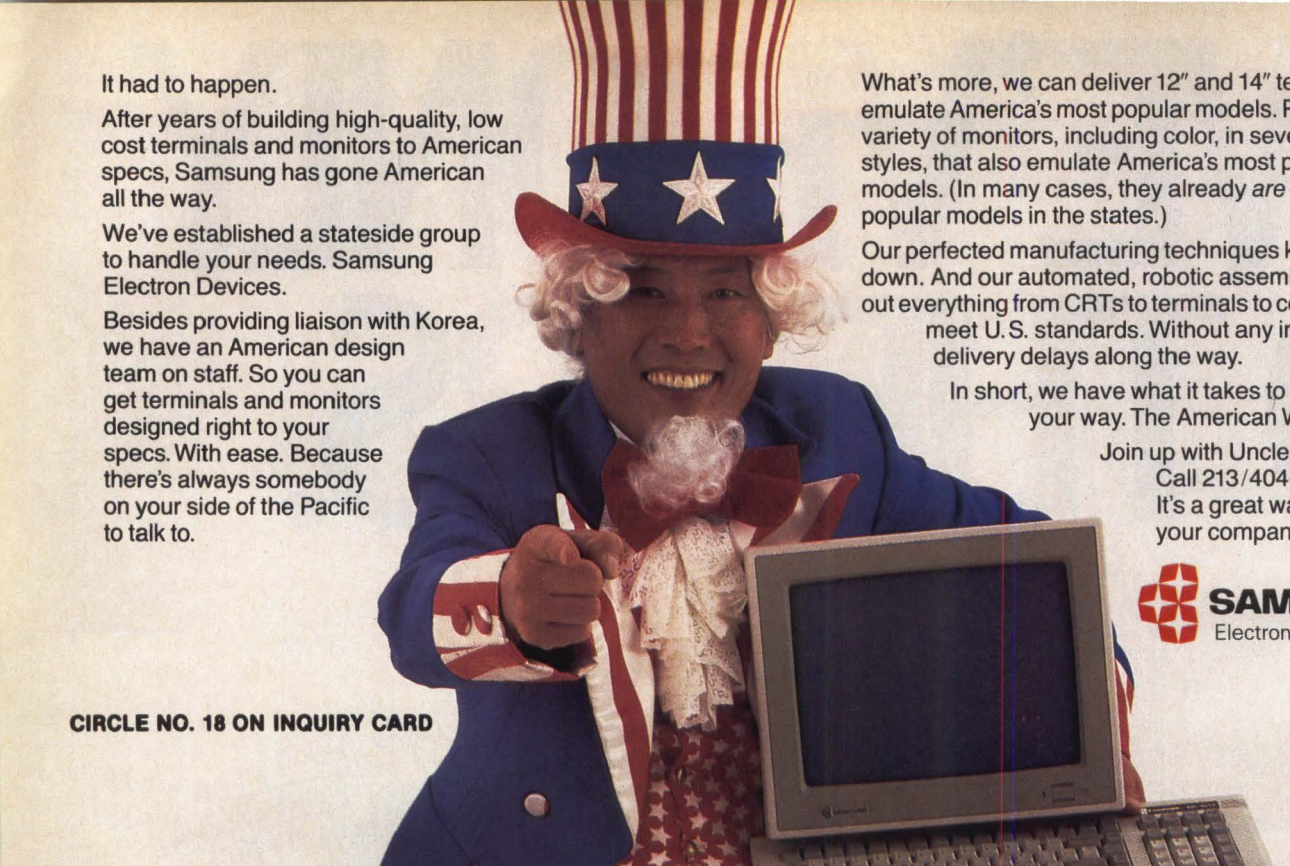

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COVER STORY

Passive backplane proves active strategy at Wyse

Mike Seither, Senior Editor

Terminals and monitors have been the backbone of business at Wyse Technology ever since the company was founded six years ago. But IBM Corp.-compatible personal computers are now becoming an increasingly important part of the company's product mix.

Last year, for example, personal computers—the Intel Corp. 8088-based WYSEpc+ and the PC/AT-class WYSEpc 286—accounted for almost one-quarter of the San Jose company's $200 million in revenues. What's more, personal computer-related income is expected to reach nearly $60 million this year and close to $95 million in 1988, according to Hambrecht & Quist Inc., a San Francisco investment banking concern.

This month Wyse moves whole hog into the personal computer arena with a full line of highly flexible products for system integrators, OEMs and value added resellers. Unlike its previous machines, which were built around a typical motherboard that held the main processor and its related logic, Wyse has switched to a new design called "modular system architecture." It's akin to the approach taken by vendors of minicomputers and industrial systems that use single-board processors, and that control memory and video characteristics by way of secondary CPUs on separate add-in boards.

In Wyse's case, those secondary CPU boards, home to a variety of processors running at different clock rates, slip into standard 8-bit or 16-bit expansion slots. Wyse plans to market modular personal computers that can be configured with Intel's 80286 and 80386 microprocessors. The basic systems—the WY-2108, WY-2112, WY-2214 and WY-3216—are available immediately and range in price from $1,900 to $3,500.

Wyse Technology *has outfitted its WY-2112 personal computer with programmable liquid crystal displays for indicating time and date, test and configuration information and messages for networked users.*

Wyse believes the simple design will appeal greatly to system integrators, who can choose the processing unit best suited to individual needs. Moreover, those customers can also pick a chassis with the desired amount of space for more add-in boards and mass storage devices, yet still mix and match processor boards. The only differences are in the size of the chassis and the length of backplane.

"The architecture has value for OEMs, users, service organizations and us," says Steven Holzman, director of product marketing at Wyse. "It's a lot more efficient and cost-effective." The reason: Add-in cards can be swapped easily. On the other hand, fixing or upgrading a motherboard usually means taking the whole system apart, thereby adding time and cost to the work. The systems' modular design also means less training and on-site work is required of field technicians—a fact Wyse believes will attract a lot of OEMs.

Adding punch when needed

Finally, OEMs can order a tailor-made system but not be locked into purchasing a whole new machine when their customers need more processing power. Instead, they can add processor boards for more punch, as necessary.

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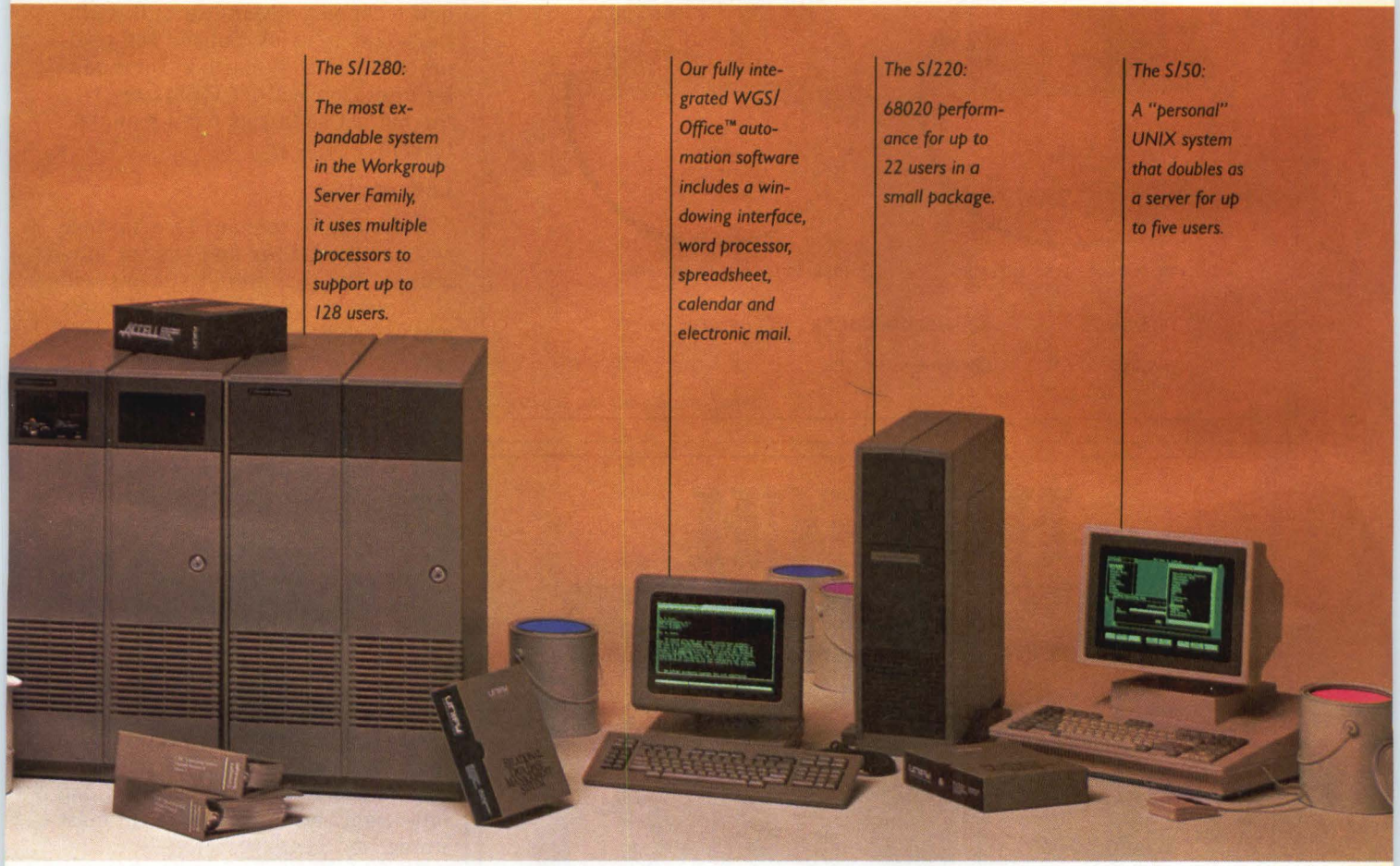

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Technology	10 MHz 68010 CPU	12.5 MHz 68020 CPU	12.5 MHz 68020 CPU	12.5 MHz 68020 CPU	25 MHz 68020 CPU	4x16.67 MHz 68020 CPU
MIPS	.75	2.0	2.0	2.0	4.25	8.8

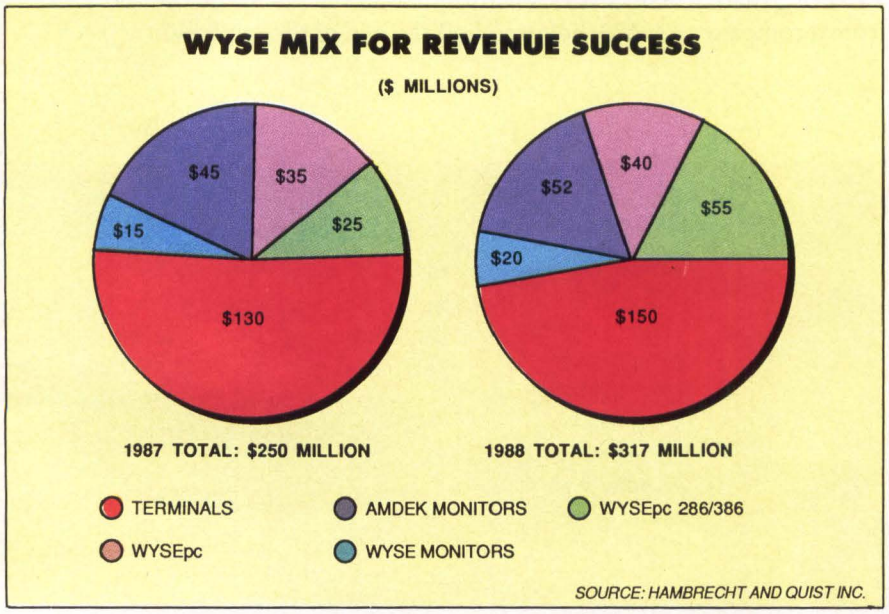
*storage listed in unformatted capacities

Convergent

When great ideas converge, great products emerge.

COVER STORY

Some industry observers say that the time has come for a strategy like Wyse's. "I don't know why they [personal computer vendors] have waited so long before moving toward a passive backplane," says a bemused John Lemons, president of Faraday Electronics. Faraday, Sunnyvale, Calif., has made a business of manufacturing single-board personal computers for industrial applications. "It's a much quicker way to get technology to market," claims Lemons.



Indeed, time-to-market was a major consideration in opting for the backplane approach, says Christopher Kryzan, the Wyse product manager in charge of the modular personal computer line. "Instead of redesigning a complete system, we'll change only the boards. It will allow us to respond to market trends much faster. OEMs typically take a long time to get into new technology. Many are still selecting 80286 systems, but the 386 revolution has already started. Our modular approach will let OEMs react to the market as fast as retail manufacturers."

Lots of slots

Although Wyse plans to customize systems for OEMs and system integrators, the four initial systems will be aimed at so-called "niche" users and will share many common features (see Table). For instance, all of the systems are configured with 8-MHz and 12.5-MHz versions of the 80286 16-bit chip or with the 16-MHz, 32-bit 80386. Base prices include a single 5¼-inch flexible disk drive. However, Wyse is offering system integrators wide latitude in choosing peripherals. Flexible disk drives are available in capacities of 360K bytes, 760K bytes (in a 3½-inch form factor) or 1.2M bytes; rigid disk drives come in 20M-byte, 40M-byte and 70M-byte capacities. Systems with the smaller, seven-slot, chassis can accomodate three half-height devices. The larger chassis has nine slots and holds one full-height and three half-height mass storage devices.

Standard onboard main memory on the 80286 CPU cards is half a megabyte, expandable to 1M byte. The top-of-the-line 80386 machine, the model 3216, can have up to 24M bytes of static RAM. That system utilizes a dedicated 32-bit memory bus so that additional memory cards can reside in any slot in the system. To ensure hardware compatibility with other add-in boards on the market, Wyse uses an 8-MHz PC/AT-compatible system on all the new systems. Switchable modes allow timing-sensitive applications to run compatibly. In addition, Wyse has

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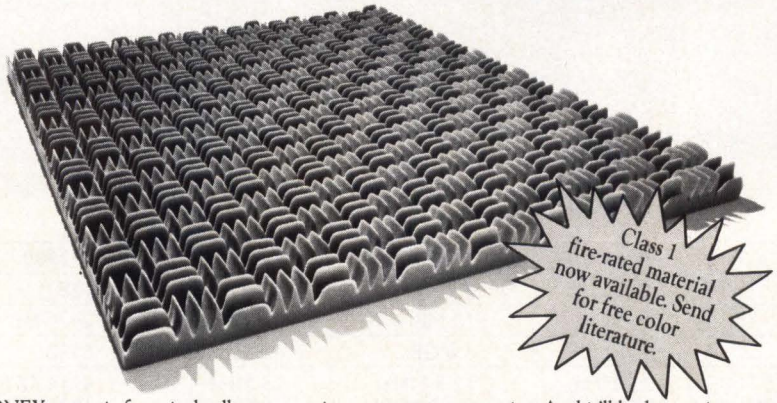

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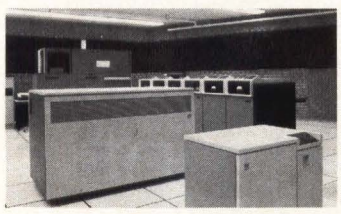

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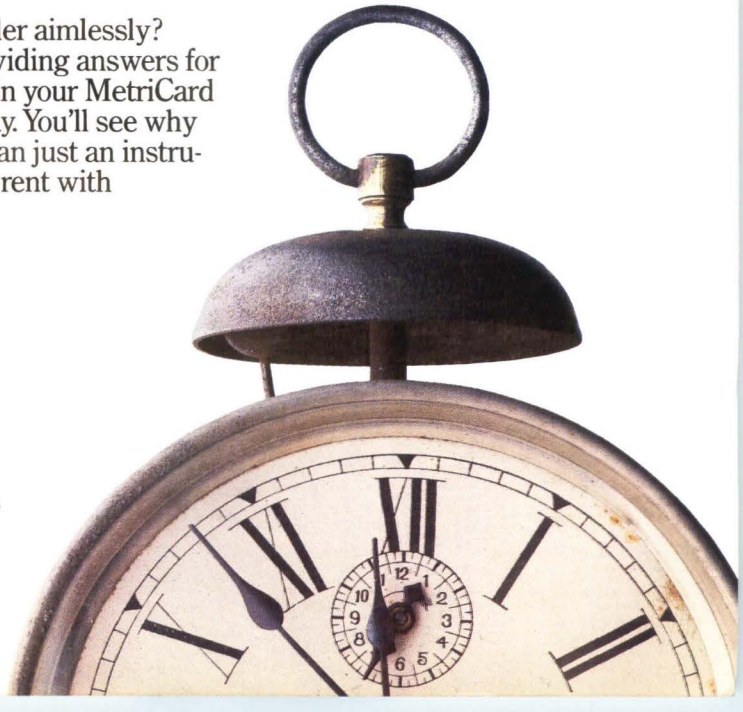

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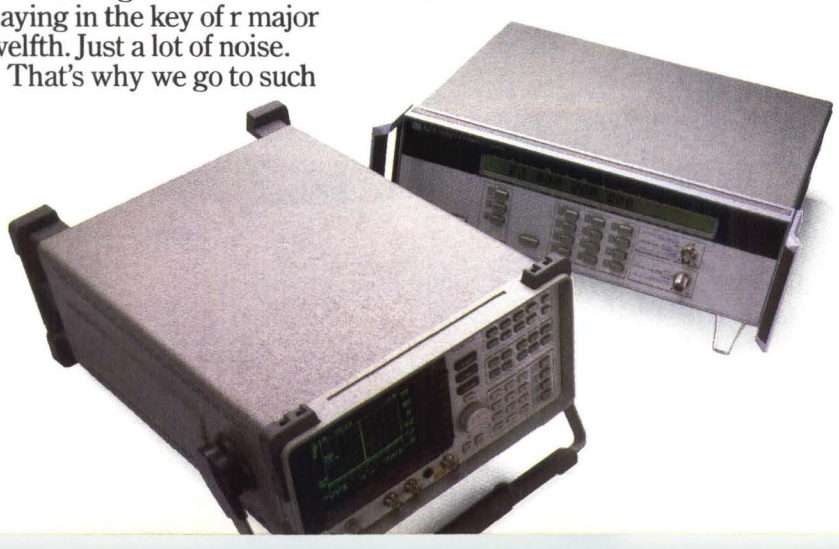

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COVER STORY

bundled in software utilities so users can configure memory above 640K bytes, in accordance with the Lotus/Intel/Microsoft and AST Research, Inc. expanded memory specifications (EMS).

Wyse is bundling into all its modular systems a number of features that are otherwise available for personal computer users piecemeal from a variety of third-party vendors. For example, a standard part of the system software is a disk-caching utility that the company claims speeds up disk operation by 40 percent to 50 percent by mirroring the most frequently used areas of the drive in main memory.

Version 3.2 of the MS-DOS operating system, as well as GW BASIC, come with all Wyse personal computers. But Wyse has enhanced MS-DOS with an on-line Help menu that lists command parameters, gives examples of their uses and tells why each command is necessary or useful.

To further distinguish itself within the herd of personal computer vendors, Wyse has added a dash of spice to the outward appearance of its latest systems. All four come with a liquid crystal display on the front panel that can be programmed for a number of uses. The LCD can display the date and time of day, as well as the operating speed of the processor, the disk drive performance and other system activities. Among other things, Wyse is pitching the LCD at system integrators as a way to configure a system without having to attach a monitor.

Putting up a good front

Wyse is also offering a $30 style kit with which OEMs and VARs can customize the appearance of the systems. The kit includes a cable covering for the back panel, a platform for mounting the chassis in a tower configuration and a choice of red, yellow or blue buttons and jacks. Wyse is also providing two packaging schemes that change the chassis color, louver design and LCD position in order to differentiate the systems sold through distributors.

Wyse officials say the modular personal computers will allow the company to address a broad set of customers. The smaller WY-2108 and WY-2112 will be aimed at the general office-automation market, which Wyse says will reach $19 billion this year. The more powerful WY-2214 and WY-3216 will go to OEMs who provide platforms for such applications as CAD/CAM, file servers and multiuser systems.

To help resellers reach those latter users, Wyse is introducing with the personal computers a $799 add-in board with eight intelligent serial ports. The WY-995 board takes up a single slot and has eight RJ-11 connectors on the back. It comes with all the cabling and DB-25 adapters necessary to attach data terminals or other serial peripherals, such as modems and printers. Continuous data can be transferred over all channels at 38.4K baud or in a burst mode over a single channel at 76.8K baud.

The WY-995 comes with 48K bytes of dual-ported static RAM as well as MS-DOS diagnostics and device drivers for the XENIX multiuser operating system.

With this onrush of equipment, say industry analysts, Wyse is positioning itself well for its next spurt of growth. Indeed, some contend the company has no choice but to diversify its product line.

"It's a great move and one they have to make," says Bruce Lupatkin, an analyst with Hambrecht & Quist, "The market is sleepy for terminals. PCs are where the action will be."

Wyse's diversification in personal computers will allow it to use the same successful mix of distribution channels that it does for terminals, according to analyst Dan Reeve of Cowen & Co., a Boston investment service. Along with that, Reeve says, the company's acquisition last year of Amdek Corp., a leading retail supplier of PC-compatible monitors, will allow Wyse to leverage its way into the retail business without making a big marketing investment in brand awareness. Although Wyse officials have not yet said so, a line of Amdek personal computers built around the modular architecture is sure to follow its OEM machines. □

LOOKING AT WYSE'S MODULAR APPROACH TO PCs

Feature	WY-2108	WY-2112	WY-2214	WY-3216
CPU/speed	80286	80286	80286	80386
Speed (MHz)/wait states	8/1	12.5/1	12.5/0	16/0
Maximum RAM on CPU (M bytes)	1	1	1	24
Expansion slots				
8-bit	2	2	3(2 half-slot)	3(1 half-slot)
16-bit	5	5	6	6
Mass storage slots				
half-height	3	3	3	3
full-height			1	1
Power supply (watts)	190	190	220	300
Base price ($)	1,900	2,300	2,800	3,500

FACT FILE

Wyse Modular System Architecture

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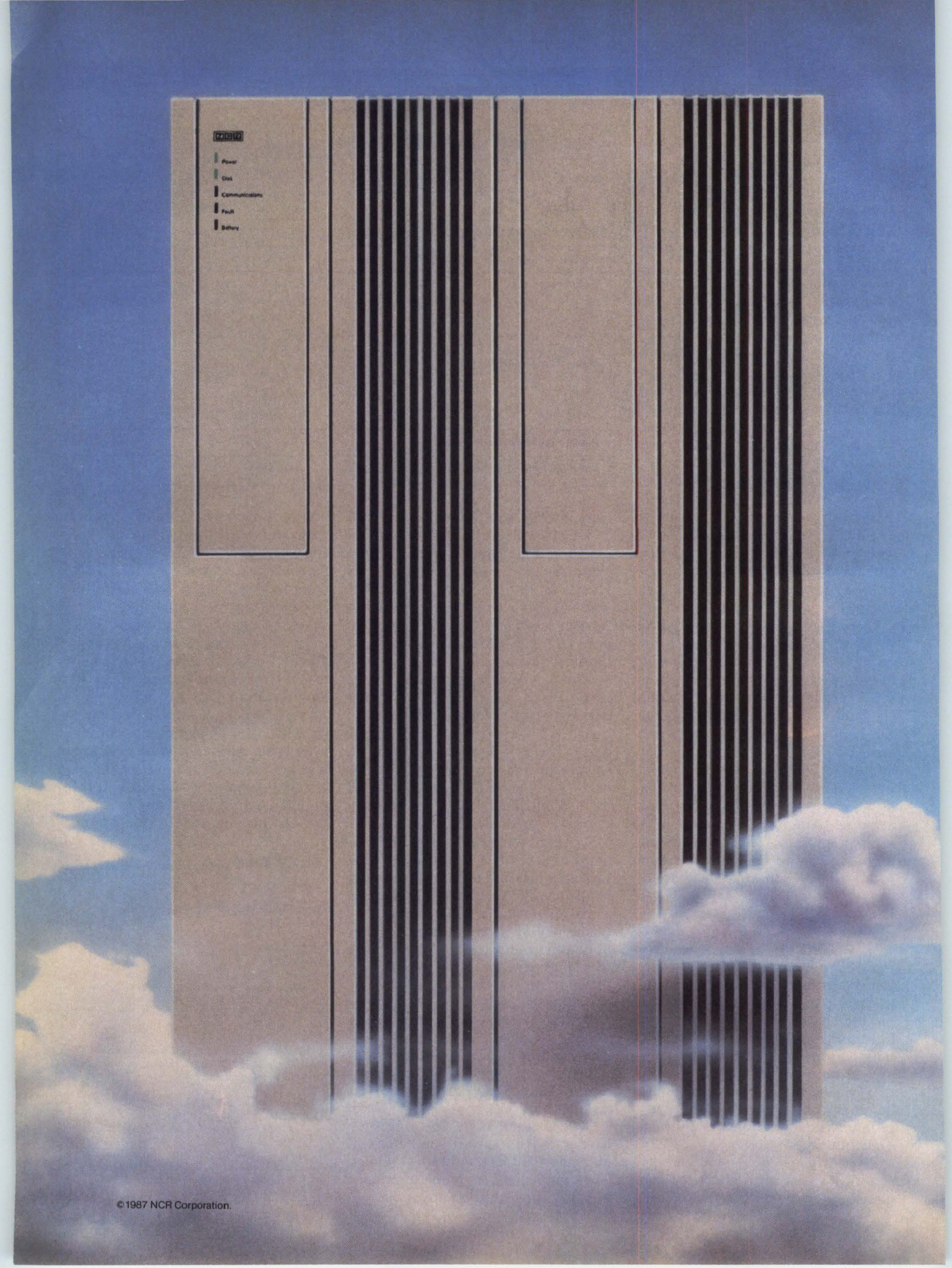
Circle 474

**Line of IBM Corp.-compatible personal computers that can be configured with either Intel Corp. 80286 or 80386 processors at various clock speeds.

**Systems feature passive backplane architecture. CPUs reside on add-in boards to maximize configuration options.

**Backplane accepts combinations of standard 8-bit and 16-bit add-in boards. Chassis available with either seven or nine expansion slots.

**Optional Wyse WY-995 interface card allows up to eight terminals or other serial devices to be attached via a single expansion slot.



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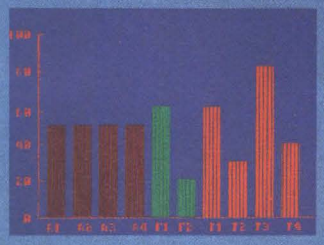

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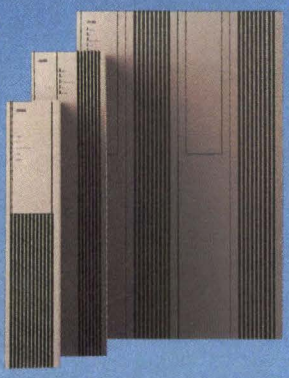

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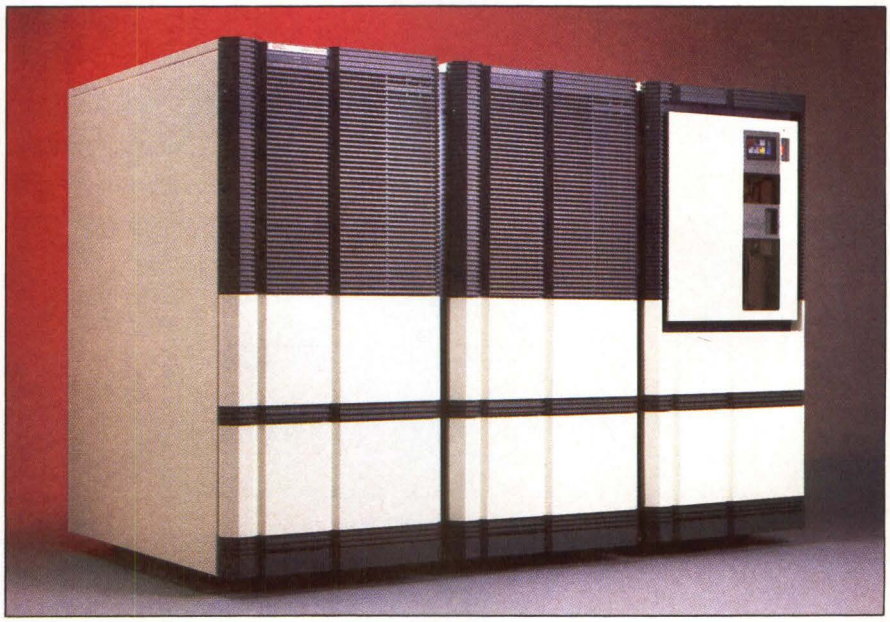
PRODUCT SPOTLIGHT

Pyramid's RISC-based superminis afford a multiprocessor approach

Mike Seither, Senior Editor



Pyramid Technology's *Series 9000 superminicomputers now come in three- and four-processor versions and are object-code compatible with all previous Pyramid systems.*

Pyramid Technology Corp. has this month doubled the punch of its Series 9000 superminicomputers with its most powerful systems yet—three- and four-processor models that can operate at between 19 and 25 million instructions per second (MIPS).

Along with the introduction of models 9830 and 9840, Pyramid also has expanded its communications horizons by offering access to IBM Corp.'s 3270 SNA (Systems Network Architecture) environment. At the same time, the Mountain View, Calif., company has brought out an ANSI 85 COBOL compiler, optimized for its reduced instruction set computer (RISC) architecture. With those offerings, Pyramid hopes to bolster its growing presence in the commercial marketplace, especially for large database applications.

According to analyst George Weiss of The Gartner Group Inc., a Stamford, Conn., market research outfit, Pyramid is repositioning itself between two ends of the data-processing world. "Their niche will be to act as a file server for workstations and as an extractor of databases tied to mainframes," says Weiss. "It's going to be important for them to talk about connection between those two tiers and to provide tools like SQL (structured query language) interfaces to bring data into their environment."

The new SNA connectivity goes hand-in-hand with a recent announcement that Pyramid will couple its superminicomputers with workstations manufactured by Sun Microsystems Inc., a Mountain View neighbor.

Pyramid has had some success selling into the commercial marketplace since it first introduced systems in 1983. But many of Pyramid's installed base of 550 computers have been used for software development. One reason for that is the company's OSX operating system, a dual port that allows users to easily switch between both AT&T Co.'s UNIX System V and the Berkeley UNIX Version 4.2.

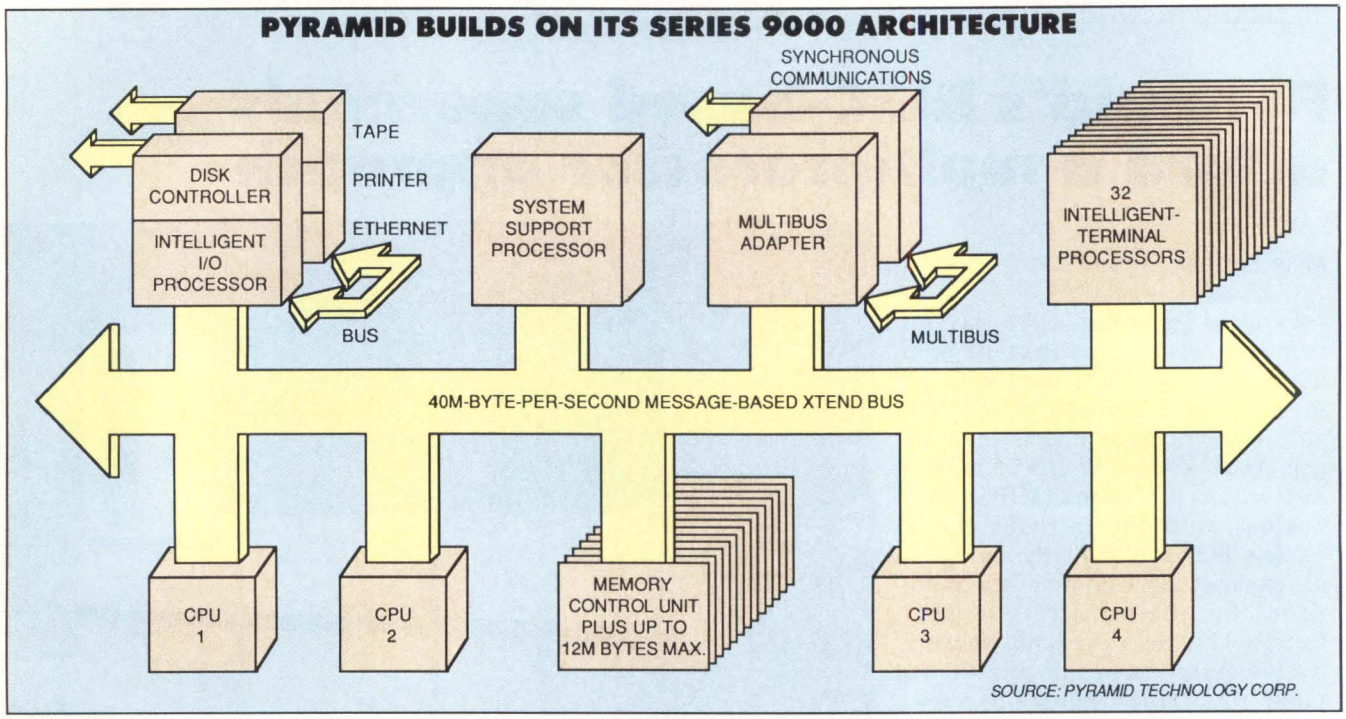
Pyramid's latest offerings round out the Series 9000 line. Last November the company brought out the one-processor 9810 and the two-processor 9820. Now, the 9830, with three CPUs, and the 9840, with four CPUs, establish the high end of the series. Using Digital Equipment Corp.'s VAX-11/780 as a 1-MIP baseline for comparison, the Series 9000 offers incremental performance increases of 7 MIPS, 13 MIPS, 19 MIPS and 25 MIPS, according to Pyramid product manager Tom Stuart. Moreover, all of the company's computers, including the earlier 90X, 98X and 98XE, are object-code-compatible, allowing applications written for any system to run on all others, without a compiler.

A 9830 in a standard configuration sells for about $400,000. A similarly configured 9840 costs $490,000. For that, buyers get a three- or four-CPU system with 32M bytes of main memory, 32 RS232 ports, a 470M-byte disk drive, a half-inch tape drive, a system console, a built-in Ethernet, an OSX 32-user operating system license and a one-year warranty.

More mass to store

Besides adding more CPUs, Pyramid has also doubled both the user support and the mass storage of the entire Series 9000 line. Users can now attain a maximum 512 attached terminals by adding 16-port intelligent-terminal processors, up to a limit of 32. Total disk-drive capacity now stands at 29G bytes, up from 15G bytes on earlier systems. Main memory, available in 4M-byte or 16M-byte modules, still tops out at 128M bytes.

In the Series 9000, Pyramid has somewhat refined its original RISC architecture. RISC uses transistor to transitor logic, placing 528 overlapping 32-bit registers inside the proprietary CPUs. The intensive use of reg-



Pyramid's UNIX-based *9840 superminicomputer features four RISC processors. Multiple intelligent terminal processors can support up 512 users. Disk capacity for all Series 9000 systems has doubled to a maximum of 29G bytes.*

isters and a simplified set of 128 instructions allow the CPUs to execute most pipelined instructions in a single clock cycle. To further increase the number of single-cycle executions, Pyramid has installed prefetch and branch-prediction features.

In addition, Pyramid has doubled the instruction and data caches to 32K bytes and 64K bytes, respectively. "Database applications that, before, just exceeded the cache limits now have an extra margin," explains Pyramid's Stuart.

Databases are a key to Pyramid's marketing strategy. The Series 9000 supports most major databases, including those from Britton Lee Inc.,

Third-party resellers critical to Pyramid's success

Concentration on database applications is only one part of Pyramid's strategy to broaden the appeal of its RISC (reduced instruction set computer) machines. In March, the company entered the Pick System world by signing an agreement with VMark Computer, Natick, Mass. Pyramid will license VMark's Pick-based Universe operating system, which runs under Pyramid's OSX. That will give Pyramid users access to applications that were previously unavailable to them, like distribution and manufacturing.

Pyramid also plans to step up its activity in the reseller channel. Now, about 40 percent of the company's sales come from reseller and OEM agreements, while the majority are direct. Richard Luccier, who has recently joined the company as president, wants to reverse those figures. To get there, Pyramid has launched a program to identify resellers who want to run their vertical-market applications on more powerful machines. Luccier expects to have at least two dozen resellers on board before the year's end. Says Kathleen Hurley, an analyst with Dataquest Inc., San Jose, "Alliances with third-party software vendors are critical for Pyramid. Without them they won't sell many products."

Pyramid also has its work cut out for it elsewhere. In its last fiscal year, ending September 1986, the company posted a $2 million loss on sales of $38.6 million. Luccier attributes the losses to bloated inventories and a poor market. However, he believes the company is now breaking even because of internal cost-cutting measures. Cost cutting's being done, he adds, without reducing the number of employees or cutting back on the company's $10 million research and development budget.

How well Pyramid spends its R&D funds may have a large impact on its future, says analyst Geroge Weiss of market researcher The Gartner Group of Stamford, Conn. He notes that Pyramid was slow in bringing its three- and four-processor system to market. "The mid-range of the mini market was once a golden egg," he says. "But now, the competitive pressure is intense, and product life cycles are shrinking."

Los Gatos, Calif.; Oracle Corp., Belmont, Calif.; Relational Technology Inc., Alameda, Calif.; Informix Software Inc., Menlo Park, Calif.; and Unify Corp., Lake Osewego, Ore. To maintain its position in that market, Pyramid is trying to ensure that its systems have the muscle to access large amounts of data.

To that end, Pyramid recently brought out a virtual disk facility which resides in the operating systems and allows mapping between logical and physical disk volumes—something IBM and vendors of other large systems have been doing for some time. With a virtual disk, data can be split over several disks as one logical file. A logical database can also reside on several drives. By splitting up the database, and allowing the information to be reorganized, the virtual disk can help reduce bottlenecks caused by "hot spots," or areas of the disk holding information that is frequently accessed. Hot spots can also be assigned their own spindles and heads, thereby further reducing the possibility of information logjams, says William Gimple, Pyramid's vice president for systems technology.

Pyramid claims it is the only UNIX vendor to thus far offer the capabilities of a virtual disk. □

FACT FILE

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(415) 965-7200
Circle 473

**The 9830 and 9840, three- and four-processor superminicomputers, respectively, based on Pyramid's RISC architecture.

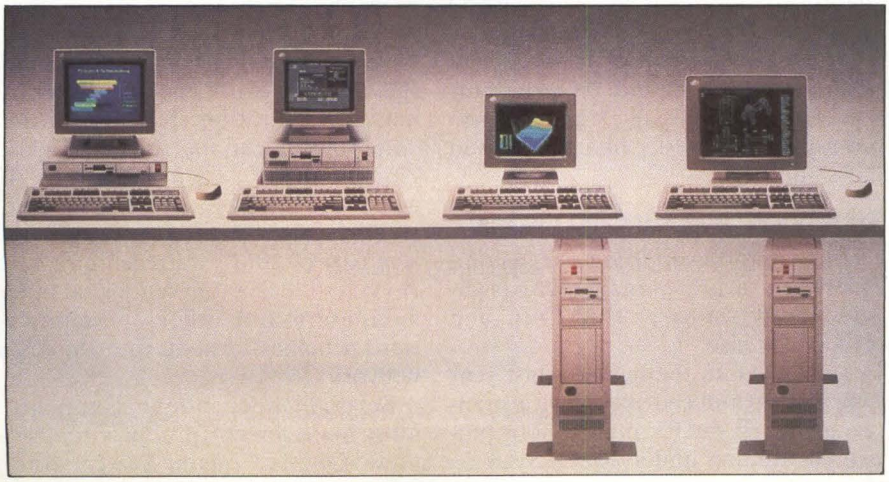
**Maximum configuration supports 512 terminals and 29G bytes of mass storage capacity.

**Systems operate under Pyramid's OSX operating system, a dual port of AT&T Co.'s System V Release 3 and Berkeley UNIX Version 4.2.

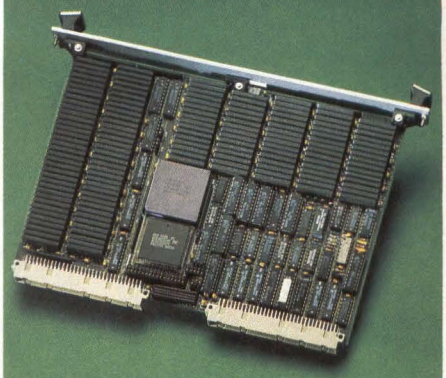
**Optimized ANSI 85 COBOL compiler, and IBM Corp. communications via 3270 SNA, now available with Series 9000 systems.

FAMILY PORTRAIT

IBM'S new Personal System/2 series consists of (from left) models 30, 50, 60 and 80. The $1,695 model 30 incorporates Intel's 8086; models 50 ($3,595) and 60 ($5,295), the 80286; and model 80 ($6,995), the 80386. Model 30 boasts twice the performance of the PC/XT; models 50 and 60, twice the performance of the PC/AT; and model 80, more than triple the performance of the PC/AT. All models will run under the new OS/2 operating system due in the fourth quarter. Starting next month, *Mini-Micro Systems* will run a multiple-article series on the PS/2 family, quoting analysts, VARs, system integrators and vendors.



16 MB VMERAM



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NETWORKS

System integrators jump into network management

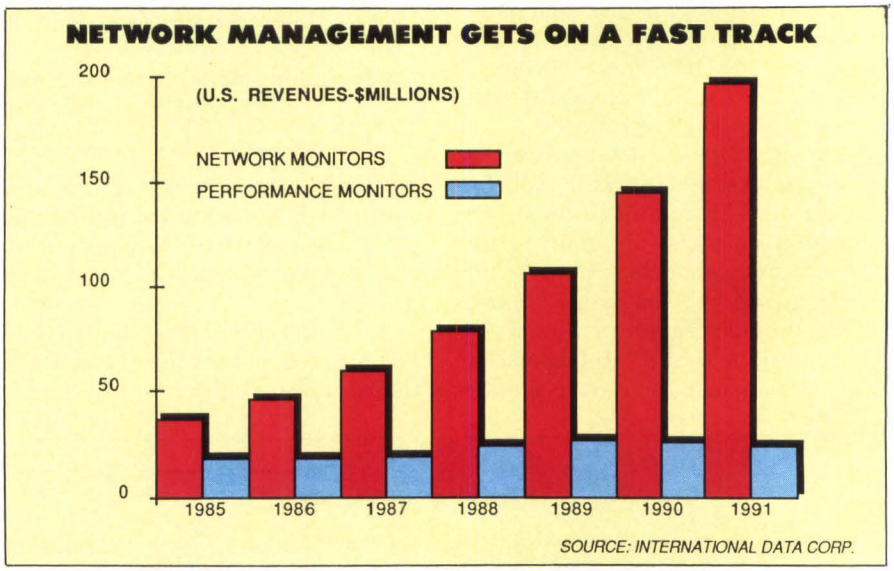
James F. Donohue
Managing Editor

It should come as no surprise, but system integrators have discovered there's money to be made in network management. The reason: Money, or the saving of it when setting up and operating a network, is the chief worry among most communications customers.

"It's a very hot topic with telecomm users," says Don Wallace, project manager for Teknekron Infoswitch Corp., a system integrator and consultant in Richardson, Texas. "A telecomm network is very expensive, and users have no way to stay on top of the costs. Everything is manual, so they review the costs on very long intervals, typically a year," Wallace points out. "They want to do better than that."

Christopher A. Walker, account manager for Omega Datum Corp., a system integrator in Towson, Md., says, "Networking can solve a lot of problems, and certainly we're going to be involved with it." Vendors of network management equipment have a long way to go, he observes. "Most of the things out there are no more than file-swap mechanisms. We'd like to see things operate at a little more elevated level."

Computer networks are growing fast (about 35 percent a year) and have become hugely expensive (taking up to 60 percent of many computing budgets). Yet, selecting and implementing a network management system is not easy, because vendors offer so many incompatible products and so many conflicting protocols. "There's a mishmash of tools out there, but nobody seems to have it integrated to make the whole process run very smoothly," Wallace says.



Revenue growth *for performance monitors will slow because vendors increasingly will include that function in network monitors. Approximately one-third of revenues comes from upgrades of existing equipment.*

Despite this confusion, vendors and system integrators agree on what they want network management products to do. The products ought to monitor who's using the network and when, and where the data is going; they should collect and display alarm signals; diagnose and fix problems (intelligently if possible); and perform administrative tasks like billing and cost allocation.

Network history: IBM and the rest

Like almost everything else in computers, network management is divided into two parts: IBM Corp. and everybody else.

IBM got into the business last year when it introduced Netview, a management scheme for multivendor networks running under IBM's Systems Network Architecture (SNA). Later, IBM came up with an enhancement, Netview/PC.

Netview brought under one roof several of Big Blue's alphabet soup of network protocols: Network Communication Control Facility (NCCF), Network Logical Data Manager (NLDM), Network Problem Determination Application (NPDA), Virtual Telecommunications Access Method Node Control Application (VNCA) and Network Management Productivity Facility (NMPF). Netview/PC was part of IBM's outreach program: It makes it easier for vendors of other computers and other communications schemes to hook into the SNA network.

Several independent companies offer management products for Netview. One is Cincom Systems Inc.,

Cincinnati, with Net/Master Management Component. A software solution to monitoring and control, Net/Master checks error messages, captures statistics and prioritizes alerts for network managers. Another company with products for Netview is Timeplex Inc., Woodcliff Lake, N.J. Specializing in monitoring the physical aspects of networks, Timeplex supports a software product called Link/View with which it ports many of its systems to run on Netview.

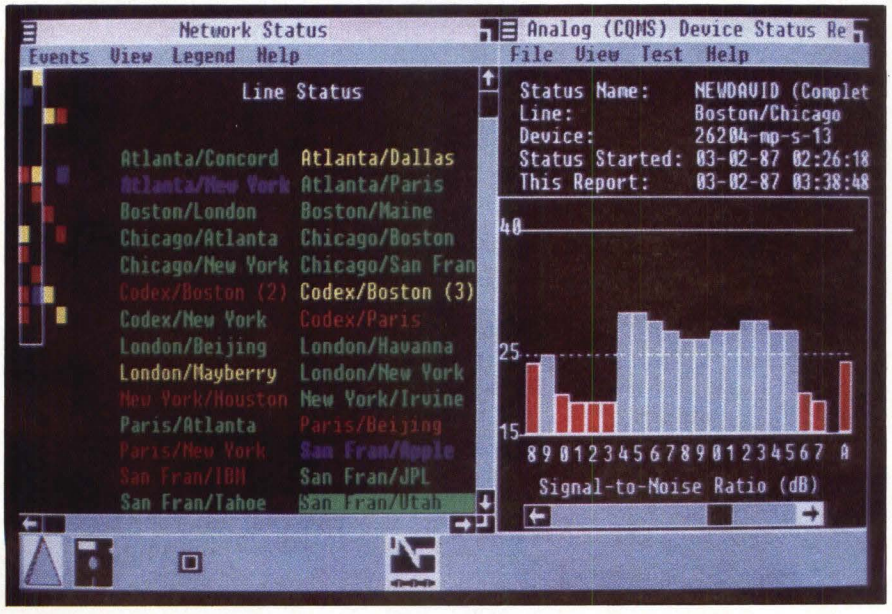
Two segments of product

In the IBM world, as well as in the non-IBM world, vendors tend to divide their products into two segments. These are: (1.) products that monitor the network's physical aspects—multiplexers and modems (what Victoria Duckworth, product manager at Cincom, calls the "wires and pliers end;")—and (2.) products that monitor the performance of the network, i.e. the movement of data over the wires.

Computer network monitoring makes up a small industry now, about $83 million in U.S. sales, according to International Data Corp. (IDC), the marketing information concern in Framingham, Mass. But forecasts are for rapid growth, almost threefold to $224 million in 1991.

Price cuts spurred by competition are behind much of this growth, says Katheryn Korostoff, senior market analyst at IDC. "Three years ago you could buy a good network management system for $250,000 to $350,000," she says. "Today, it will cost you about $150,000, and you can probably get one for less."

One such system that costs a lot less is offered by Codex Corp., Canton, Mass. Called the 9300 Series, it targets smaller networks (up to 400



Line-status monitoring *gets color coding in Codex's 9300 Series network management system: green for normal conditions; yellow, degrading conditions; red, serious alarms; blue, acknoweledged alarms. Windowing permits operators to handle several jobs at once.*

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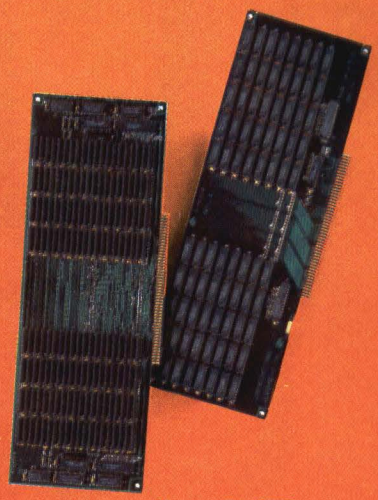

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CIRCLE NO. 26 ON INQUIRY CARD

NETWORKS

nodes) and starts at $11,500. The user is prompted on line status through color coding and can monitor several jobs simultaneously via windows.

The companies selling products that monitor the physical part of the network have the biggest share of sales: $61.5 million this year. These include Codex; Timeplex; AT&T Co.; Case Communications Inc., Columbia, Md.; General DataComm Inc., Middlebury, Conn.; Infinet Inc., North Andover, Mass.; Infotron Systems Corp., Cherry Hill, N.J.; Paradyne Corp., Largo, Fla.; and Racal-Milgo Information Systems Corp., Fort Lauderdale, Fla.

Checking with 'sidebands'

Typically, these companies sell products that do their monitoring over "secondary" channels, or "sidebands," which use a frequency (usually 150 Hz) that differs from the frequency of the channels carrying the main network traffic. That way, the monitoring doesn't interfere with the work traffic.

However, this technique presents problems. The vendors use their own very private conventions for the sidebands. "Everybody has a proprietary protocol, which they protect under the threat of death," says Stephen Mank, manager of product marketing at Codex. "That's how we differentiate ourselves from our competitors."

A result is that a vendor's monitoring product works only with that vendor's modems and other network gear. To accommodate customers with foreign equipment, vendors sell "wrap" or "wrap-around" devices that plug into the network control ports of the foreign devices.

But even the vendors admit these wrap products don't work well. "They can't read the analog portion of the devices," Mank explains. They miss such conditions as jitters, distortions and dropouts, which are key heralds of trouble coming on a line.

System integrators say they have no efficient way to deal with this incompatibility problem. If protocols can't monitor what's happening to certain devices, the system integrator often is reduced to using primitive manual methods to fix a failure. When a modem fails at the University of Maryland at Baltimore, for example, Bill Reynolds, director of computer operations, tries to figure out what device has failed and fix it with a spare. Often, he says, "We can't find the problem by analysis and have to swap out components to try to isolate what's wrong."

One system integrator in California notes that the way he knows that a modem has failed is "when one of our customers calls up and screams."

Incompatibility of monitors and foreign devices on the network is an issue system integrators say vendors must address quickly. "That's one of the issues that's been an inhibitor to effective network management," says Omega Datum's Walker.

Tops among performance watchers

The second segment of the network management business—companies that sell products that check on the performance of the networks—is led by Avant-Garde Computing Inc., Mount Laurel, N.J., and Tesdata Systems Corp., Herndon, Va. IDC says these two share more than half of this market segment's $21 million in 1987 sales. Other vendors include Cincom; Dynatech Packet Technology Inc., Alexandria, Va.; Ocean Data Systems, Inc., Rockville, Md.; and T-Bar Inc., Wilton, Conn.

Increasingly, vendors are combining the monitoring of the physical and performance aspects of networks. Infinet monitors both functions and integrates them in a relational database that supports administrative functions. Infotron does the same with its Integrated Network Manager.

Customers have begun to demand higher levels of sophistication in network management. They no longer are satisfied with products that "fix" problems by predefined (preprogrammed) means: for example, by rerouting traffic around a failed

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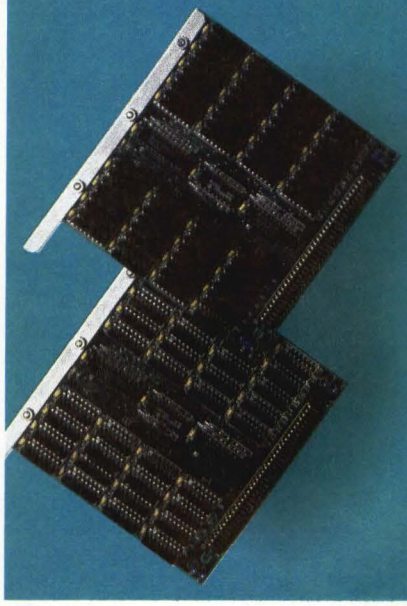

■ Apollo DN3000

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NETWORKS

Will IBM junk SNA?

Are you kidding? There's not a chance in the world, says just about anybody you ask.

First, there's all that money IBM Corp.'s already spent on SNA—Systems Network Architecture, Big Blue's hierarchical network operating system. Michael D. Zisman, chairman, Soft-Switch Inc., King of Prussia, Pa., says IBM has had 15,000 people working on SNA in one form or another for 15 years at its research operation in Raleigh, N.C. That's an investment which by now runs into the billions of dollars in just salaries and facilities costs.

And then there's all those customers worldwide who own IBM mainframe computers and use SNA to network them with other IBM computers. IBM has 85 percent of worldwide mainframe installations, says The Yankee Group, a Boston think tank. As far as IBM is concerned, SNA both makes these customers happy and locks them into the color blue. "SNA is the single most important strategy IBM has today," says Howard Anderson, managing director of The Yankee Group.

Nevertheless, in the past couple of years, IBM found itself slipping between SNA and a hard place.

On one side was that enormous investment. On the other were all those blue-tinted customers who, suddenly, had become restless. They began telling IBM they wanted ways to connect into other people's computers and computer networks, especially into Digital Equipment Corp.'s computers and into its DECnet network system.

At about the same time, IBM's European customers said they wanted their computer networks to operate under a framework called Open Systems Interconnection (OSI), established by the International Standards Organization (ISO). To compound matters, DEC said it supported OSI and moved to make DECnet a subset of it.

If these customers didn't get what they wanted, says Anderson, they threatened "to consider other options, including OPC—Other People's Computers."

About this time, insiders say, IBM considered junking—or substantially revising, or "turning"—SNA. Better to lose a network operating system than the world's largest customer base.

Then IBM found a way off the horns of its dilemma. It formalized the Open Communication Architecture (OCA) it had been discussing with customers for years. With OCA, IBM allowed customers to attach the computers of companies like DEC, Hewlett-Packard Co. and Wang Laboratories Inc. to the IBM/SNA network—with a catch. You had to do it IBM's way.

"IBM specifies the rules by which you connect to their system," explains Dr. Kenneth Thurber, president of system integrator Architecture Technology Corp., Minneapolis.

It was a clever scheme. IBM clung to SNA, but made it easier for anybody to connect almost anything into it—while maintaining tight control over how users made the connections. In the process, says Soft-Switch's Zisman, SNA changed meaning from "Shall Not Attach" to "Shall Not Abandon."

Insiders say IBM is reconciled to a belief that, eventually, the world will be divided into SNA and OSI. And IBM understands that these two worlds will connect. More than that, IBM plans to use OSI as part of its sales strategy. "IBM sees OSI as an Esperanto, the gateway into non-IBM environments," says Victoria Duckworth, product manager, Cincom Systems Inc., Cincinnati, Ohio.

Says Thurber, "IBM's strategy is that SNA will become the de facto standard" for IBM networks. Then, he says, "IBM will build gateways to OSI."

modem in a way determined in advance by a programmer. Instead, they want systems with enough intelligence to figure out solutions for themselves.

"Networks have become too complicated for anybody to determine in advance what to do in every instance of a problem," says Mac Lewis, president of Computer Network Technology Corp., New Hope, Minn., a communications vendor specializing in moving data among mainframe computers. "When you connect 10 to 20 Ethernets, how can you predefine how to fix everything?"

Easier said than done

To meet this demand, vendors are turning to one of the computer industry's most maligned product categories: artificial intelligence. Several companies are working on AI for network management—including Avant-Garde, Case Communications and IBM. But, incorporating AI into network management is presently more talk than actual technology. Effective products, like expert systems that can replace human beings and make decisions as the need arises are seen to be years away. "It seems that there is an opportunity for artificial intelligence to be applied to this technology," Lewis says. "But I've not seen any of it implemented at this time." □

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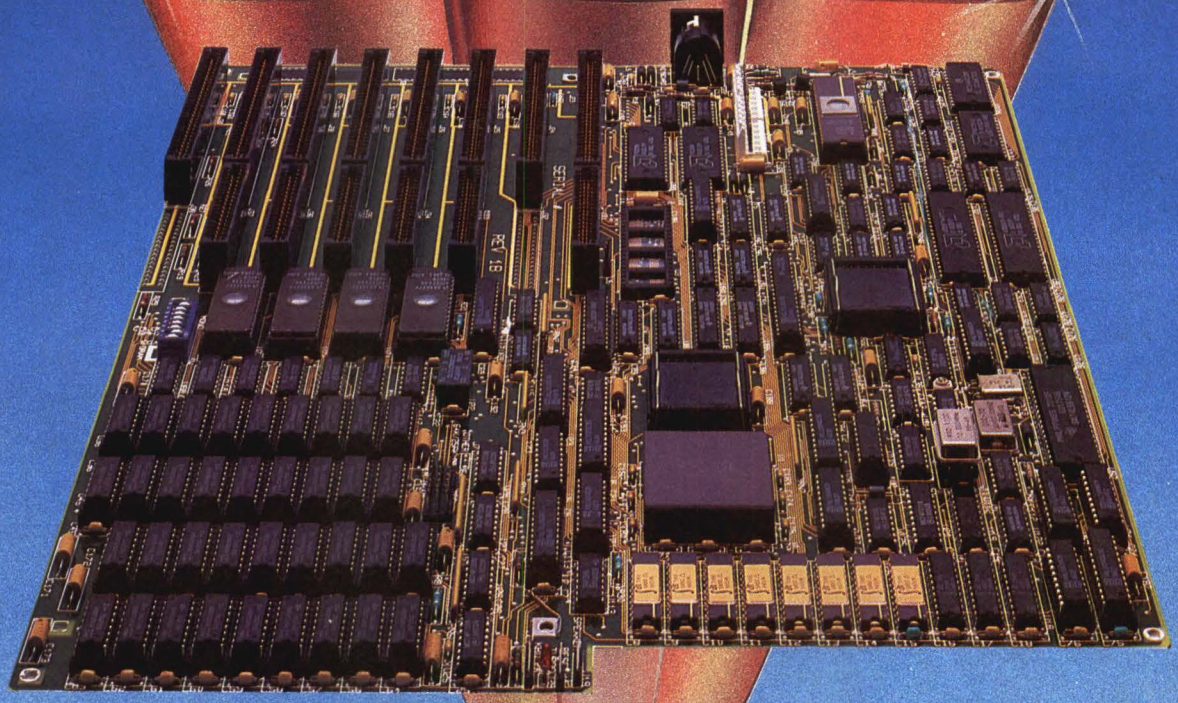

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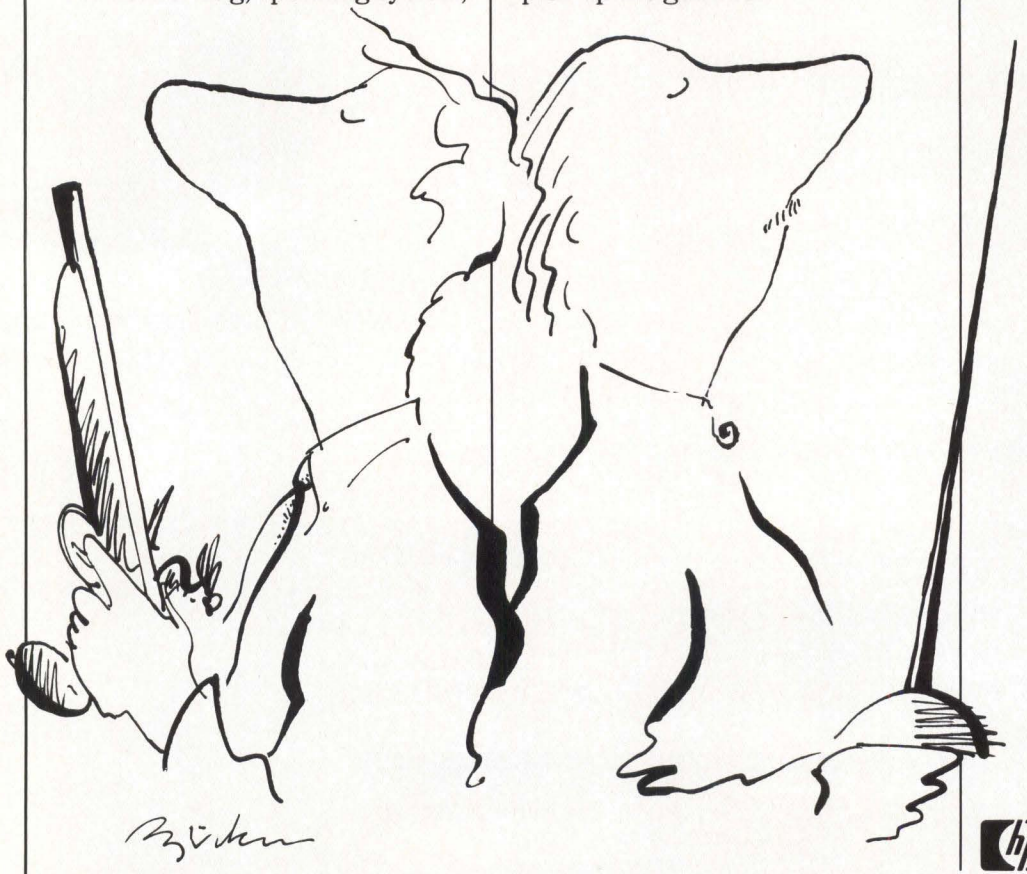

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MEMORY TECHNOLOGY

Bubble memory bursts into niche markets

Megan Nields, Staff Editor

When Intel Corp. introduced magnetic bubble memory (MBM) in the early 1970's, it was hailed as a replacement for conventional disk drive and mass storage media. Indeed, it seemed like the answer to a system integrator's prayers—a storage system with extremely high reliability, immunity to contaminants and resistance to shock.

However, MBM never really got off the ground. The cost per bit was, and is, relatively high for many engineering applications, and the component-fabrication process was complex. In addition, conventional rotating technologies were raising bit densities and lowering costs. As a result, MBM took on a narrower role than expected—primarily in niche markets such as satellite communications, factory automation and certain military applications. Although progress is being made in terms of falling cost per bit and improving yield rates, widespread commercial use of the technology does not appear to be on the immediate horizon. MBM may be here to stay but only in confined areas.

All in all, confusion seems to be the operative word in the bubble memory business today. Intel, once the leading U.S. manufacturer, has recently pulled out of the market, selling its MBM division to MemTech Inc., Folsom, Calif. Companies such as Hitachi America Ltd., Fujitsu Components of America (FCA) and Magnesys have different opinions about MBM's current applications and future.

Hitachi, now the leading international supplier of MBM, has been involved with the technology since 1970. The company's first MBM product, a 16K-bit device, was introduced in 1975. Further offerings included 1M-bit and 4M-bit versions, introduced in 1980 and 1984, respectively. They were marketed as general-purpose memory systems. The company's latest offering, the Picture Frame Coil, is a coin-sized, hermetically sealed edition of the 4M-bit unit that uses about 20 percent less power. It costs $358 in quantities of 1,000 and is the smallest MBM device on the market today.

Magnesys' Removable Bubble Memory Storage Subsystems
come in 3½- and 5¼-inch half-height drives, or in a two-cartridge VME industrial chassis (right).

MBM prices drop

Ed Klink, marketing development manager of Hitachi's Electron Tube Division, Schaumburg, Ill., feels that MBM is an important product for certain niche applications—such as industrial and factory automation, telecommunications and banking—that demand high reliability. According to Klink, military use of MBM is rising significantly and accounts for as much as 40 percent of the market. The company uses ion-implantation technology and a new magnetic circuit design to raise bit density and reduce the package size of MBM devices.

Klink says that the cost per bit of bubble memory has dropped fivefold since 1980, to average approximately 10 millicents per bit. He said he expects it to continue to fall because of higher yields and reduced manufacturing costs. Hitachi's 4M-bit device costs 6.2 millicents per bit, while the hermetically sealed version runs at 8.1 millicents per bit. He places the current worldwide market at about $106 million and expects it to swell to $135 million by 1987. Although Klink predicts that by 1990 more commercial markets will open up, he says that right now MBM is "way beyond engineers' and system integrators' comfort zone in terms of price." He suggests that, before MBM sells in significantly higher volumes, prices will have to drop considerably.

Jerry Houston, strategic marketing manager of Zitel Corp., Milpitas, Calif., places MBM costs at approximately $800 per megabyte while a rigid disk drive might run from $20 to $60 per megabyte, depending on the size on the drive and its market. Houston, like Klink, feels that bit densities will have to increase, if MBM is to be at all cost-effective. Zitel makes customizable, conventional memory systems.

FCA, Santa Clara, Calif., also considers the bubble memory business to be a niche market for harsh-environment operations. General manager Jack Foster does not foresee widespread commercial use of MBM and feels that for many applications, such as desktop computing, it is too expensive—even unnecessary. He says that the company plans to introduce a 4M-bit device in the first quarter of this year. A 16M-bit product is in the development stages. Foster estimates FCA's current domestic market potential at about $10 million and thinks that it will rise incrementally, rather than dramatically.

Magnesys, of San Jose, is probably the only company dedicated exclusively to fabricating solid-state MBMs for integration into data-storage subsystems for extreme environments. Ted Wuerthner, Magnesys president, feels that bubbles are too expensive and too difficult to use when sold as components. He describes them in this form as "a $2,500 answer to a $500 problem." Magnesys' product consists of a compact, 3½- or 5¼-inch removable data cartridge that fits into an electronic drive containing the

control circuitry. A VME industrial chassis version holds two cartridges. The company defines its subsystem as an application-specific product that provides permanent memory storage and is "infinitely customizable for the world outside of air-conditioned offices."

Packaged as subsystems

Spokesmen at Magnesys feel optimistic about MBM's potential. Wuerthner estimates that the MBM market could be worth up to $100 million annually in five years, if more manufacturers took the subsystem approach, which would allow for higher yield rates. The company plans to ship subsystems at a price of $750 apiece in volume orders in the first quarter of this year.

Magnesys aims at four markets:

- Retrofitting of installed personal computers that use either flexible or rigid disks in industrial applications;
- VARs, who, Wuerthner says, resell 80 percent of all the IBM Corp. PCs in the industrial world;
- OEMs who put together process-control equipment;
- Military applications such as ground-based battle planning.

Magnesys subsystems are read/write units equipped with an integral small computer system interface (SCSI), making them plug-compatible replacements for disk drives with the same interface. Wuerthner states: "We recognized that users need tougher memory systems in severe environments due to the fragility of rotating memory or the limits of other technologies. Hence, the need exists for vertically integrated components and systems as cost-effective, solid-state memory devices that are rugged, reliable and removable."

BUBBLE MEMORY VS. CONVENTIONAL STORAGE

	Bubble	Conventional
Reliability	✓	
Power consumption	✓	
Immunity to shock	✓	
Error rate	✓	
Maintenance	✓	
COST		✓

Brad Jones, senior applications engineer for Targa Electronics Systems Inc., Ottawa, agrees that MBM will not be used for commercial applications until it is "a couple of generations ahead of where it is now," in terms of cost vs. performance. He also targets hostile environments where extreme temperatures, vibration and portability are required. Targa builds and supplies MBM subsystems.

Lack of interest

Will Zachmann, vice president of research at International Data Corp., the Framingham, Mass., market research outfit, says that bubble memory has not proved to be the force it was meant to be. He, like Jones, cites improvements in conventional disk drive and CMOS technologies as part of the reason. And he feels that, although prices are coming down, applications are still too specialized. "The idea seemed right," Zachman states, "but it never delivered." He does not see bubble memory taking off in the near future.

Carol Weisenstein, formerly with Intel's MBM operations and now with its automotive department in Folsom City, Calif., says that the MBM market suffered because of the overall economic condition of the computer industry since 1984 and the fact that conventional disk drive technology has dropped in price. As to MBM's future use in personal computer and commercial environments, she says, "Most people in an office environment are willing to put up with some disk drive failures and quirks."

Board manufacturers speak out

Bubbl-tec of Dublin, Calif., markets VMEbus-compatible bubble boards once built around Intel parts. Now, the company will switch to Hitachi devices. Chief engineer Al Foreman says Hitachi, in its 4M-bit device, offers lower prices and higher densities than does FCA. He feels it will be a long time before the cost of MBM is competitive with that of regular storage media.

Plessey Microsystems, Pearl River, N.Y., has been using Hitachi's bubbles in its boards for several years. Doug Patterson, marketing manager for defense and custom products feels that, because MBM technology is a generation ahead of silicon technology, it will show growth and promise.

A look into the future

What about MBM's future? Hitachi is studying new technologies like Bloch-line that can achieve a 1G-byte capacity. Named after Nobel laureate Felix Bloch by its creator, Dr. Susumu Konishi of Japan's Kyushu Univeristy, Bloch-line devices utilize elongated bubbles and offer a 6-msec access time—10 times faster than rigid disks.

A single bubble carries more than 1 bit of data. The bits are represented by changes in polarization within the wall of the bubble domain. Bloch-line technology, which will probably not be implemented until the mid 1990's or later, could finally be the way to significantly lower the cost per bit of MBM devices to appeal to system integrators and engineers for everyday use. Zitel's Houston feels that Bloch-line technology could open a lot of commercial doors to MBM further down the road.

MemTech expects to continue the R&D started by Intel on a 16M-bit chip, while Magnesys will put more work into lowering yields via a wafer-level functional tester and circuits for its subsystem.

There is talk about developing industry-standard MBM components. Hitachi's Klink is trying to form a committee to do this. As he puts it, "What happens to all those people who were using Intel's bubbles? They have to redesign their entire board and use another company's components. This is very expensive." Klink says that Hitachi has made contact with several vendors about using the same architecture.

MBM looks like it will remain in "niche limbo" for the next decade or so. Right now the majority of system integrators do not demonstrate a need for MBM's high reliability and portability. But, whenever the price becomes right in the future, bubbles may float well above their current niche. □

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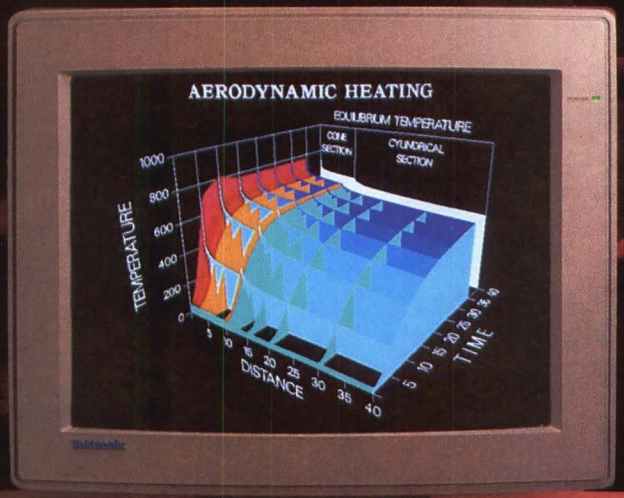

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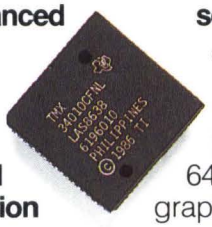

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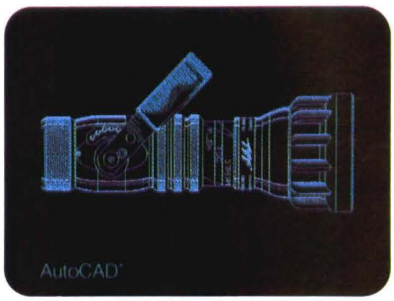

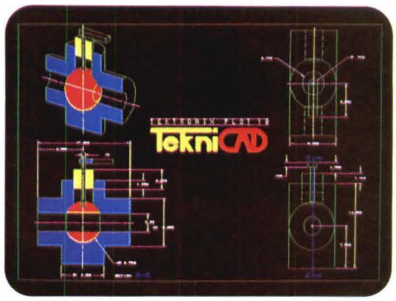

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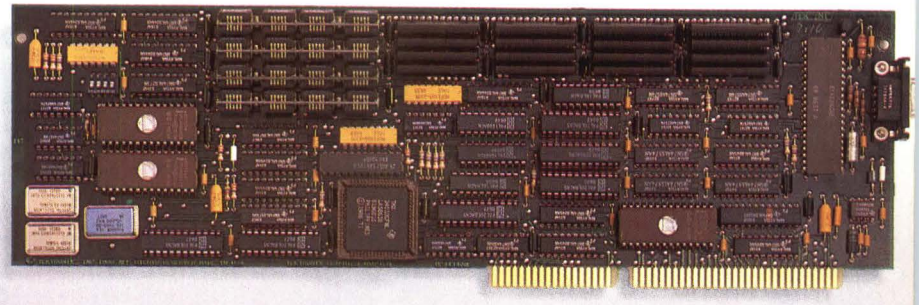

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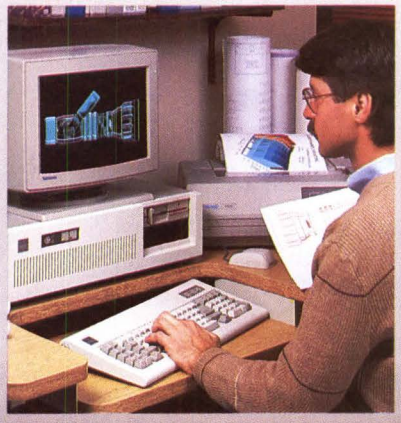

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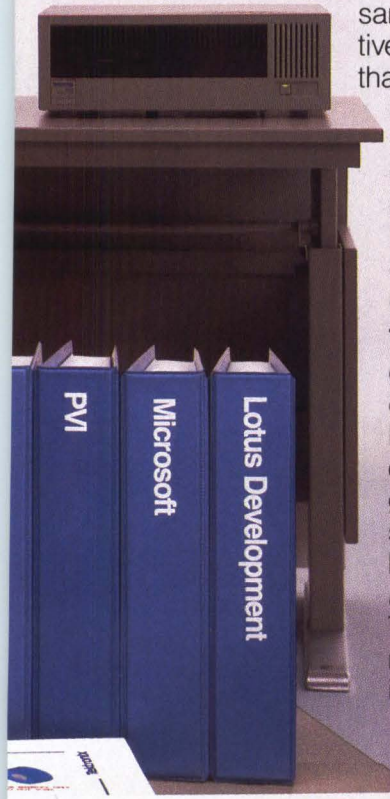

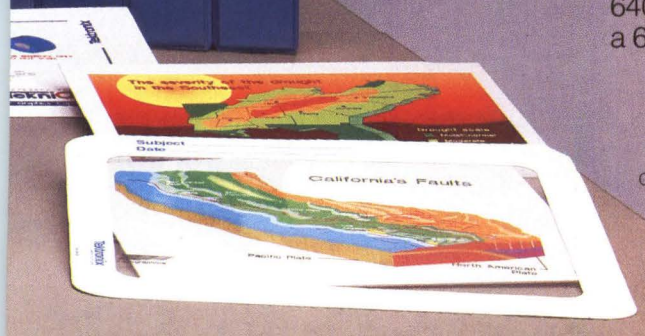

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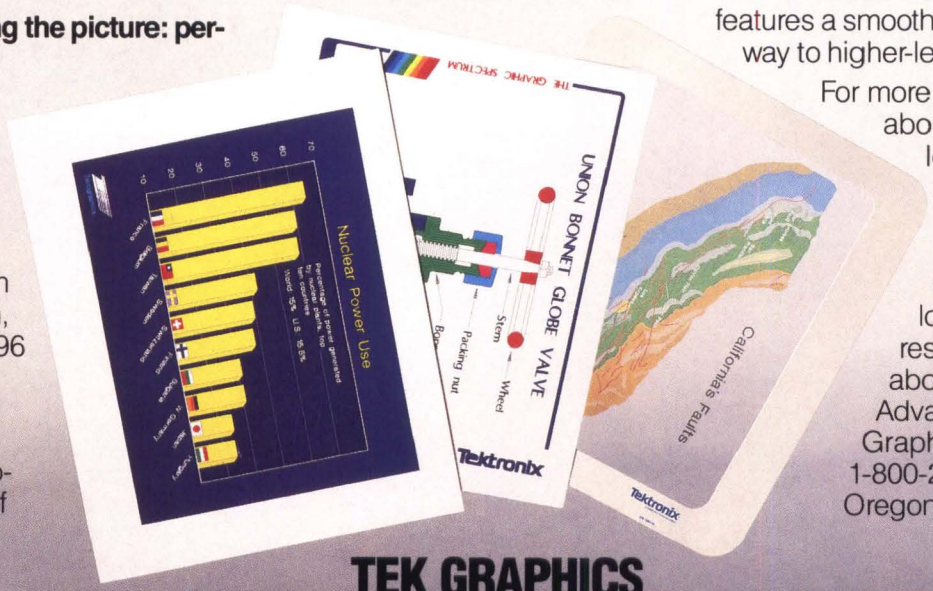

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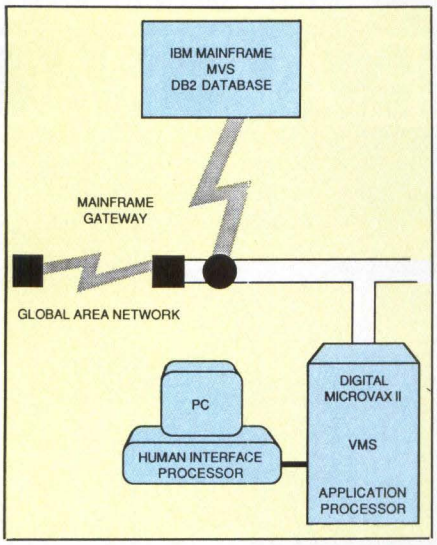

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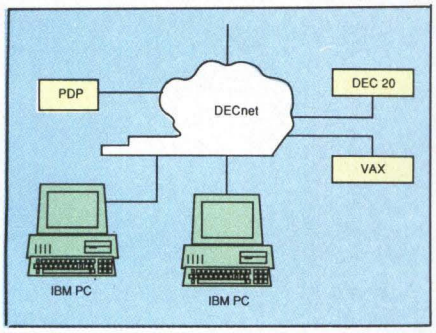

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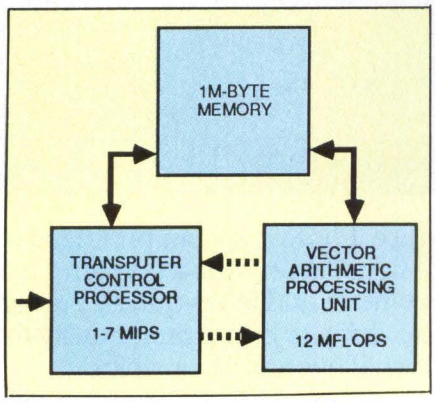

p. 105 . . . . . *Battling the giants*

TRUE DISTRIBUTED DBMSes PRESAGE BIG DIVIDENDS. .65

Distributed database management systems allow users to control locally vast amounts of geographically dispersed data. And local control means better response times, lower communications costs and increased data availability. However, as more users demand these benefits, system integrators must grapple with partitioning databases, maintaining data integrity, keeping data synchronized and solving complex communications questions. The first part of this two-part feature series investigates how some DBMS vendors are addressing the need for large amounts of on-line data in heterogeneous environments.

DATABASE DEVELOPMENT TOOLS: AN EVALUATION . . .77

Can a package be operated in interpreter mode? Does it support full-screen editing of stored text? Is the code procedural or nonprocedural? Is the file-structure network or relational? An independent applications-development company supplies the essential specifications on more than 50 database development tools for software developers and system houses.

LANS LINK PCS TO MAINFRAMES 91

Gateway hardware and software combine a LAN's resources and flexibility with access to mainframe databases. The arrival of IBM Corp. LU 6.2 products and the emergence of LAN-SNA links just happen to coincide with marketing and merger agreements between 3270 board vendors and LAN companies. These machinations signal opportunities for system integrators and OEMs in the micro-to-mainframe market.

MULTIPROCESSORS BOOST SYSTEM POWER 105

System integrators and OEMs should be aware that suppliers use the term multiprocessor rather loosely, but true multiprocessors are optimized for multiple job throughput. *Mini-Micro Systems* profiles the offerings of the major vendors and examines their implementations of CPUs, buses and operating systems.

DEC DIRECTIONS

GRAPHICAL INTERFACE SPEEDS PROGRAMMING . . . 121

Cortex Corp. demonstrates new ways for programmers to produce picture-perfect linked, compiled and documented progams for DEC VAXes, including the MicroVAX.

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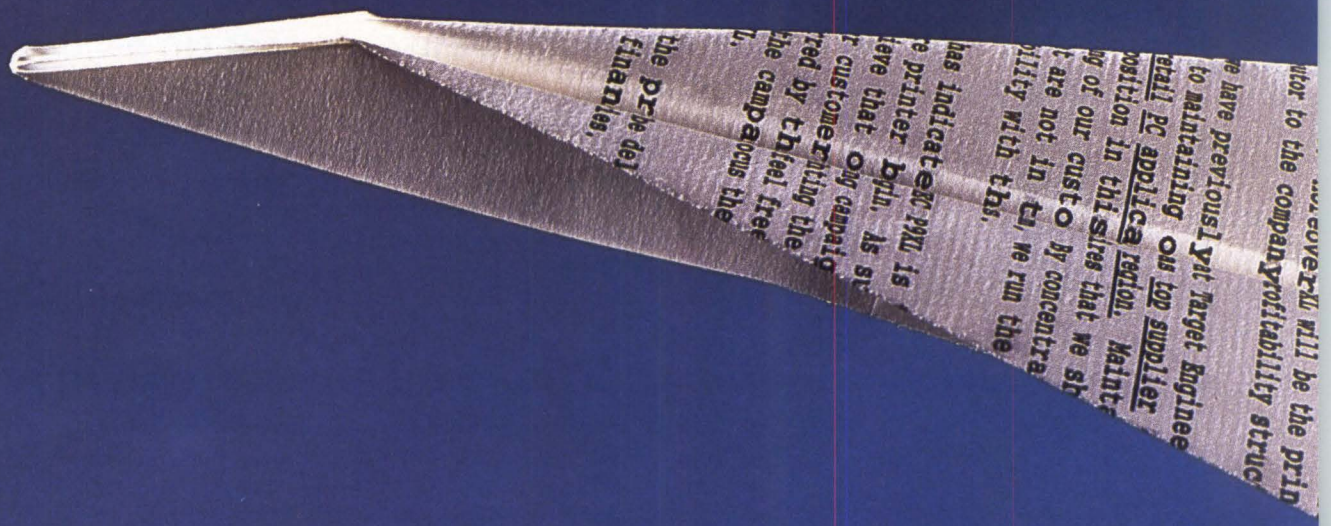

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CIRCLE NO. 31 ON INQUIRY CARD

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(Unretouched photo)

TELEVIDEO 955
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SALES ANALYSIS LATEX SPECIALITY PRODUCTS INC. PERIOD: Q3, 1985

PERSON	ID NUMBER	TERRITORY	CUSTOMER	CUST.NUMBER	PART	NUMBER	ITEM	SHIPDATE	WAREHOUSE	SHIPDEST	CARRIER	CUS
T	101000000	NEW YORK	APEXINC	33333888899	KL234	87654	200	10/02/85	NWPHILIDE	NEW YORK	ACMETRS	
SON	102277754	BOSTON	ZINCINC	33388990044	KL234	50987	007	12/01/85	CENTRALLA	BOSTON	AJAXAIR	
	100000456	CHICAGO	AASEWER	98750372378	KL230	90867	999	ONHOLD	WOODLAWN	CHICAGO	DUMAIR	
N	109857363	ATLANTA	TVSINC	77493887549	KL239	99999	808	11/19/85	ATLANTANW	AUGUSTA	EWFRT	
Y	107584948	MINNIAP	XYZCORP					/07/85	MINNSTPAUL	MINNIAP	TRUCKER	
T	108958488	SANFRAN	JAKINC					/28/86	SANJOSESE	SANMATEO	SHORTAIR	
TT	108674637	SANJOSE	ACDCORP					/08/85	SACRAMENTO	SANJOSE	EZHAULER	
OLD	107563848	LOSANGEL	LYNINC					/18/87	IRVINECA	WESTLAWN	LATRUCK	

TELEVIDEO 955 VS. WYSE WY-50

FEATURES	TVI 955	WY-50
Screen Color	Green or Amber	Green Only
Optional Graphics model	Yes	No
Dynamically allocated non-volatile function key memory	512	128
Maximum non-volatile bytes per function key	256	4
High contrast super dark Matsushita screen	Yes	No
List price	$549	$499

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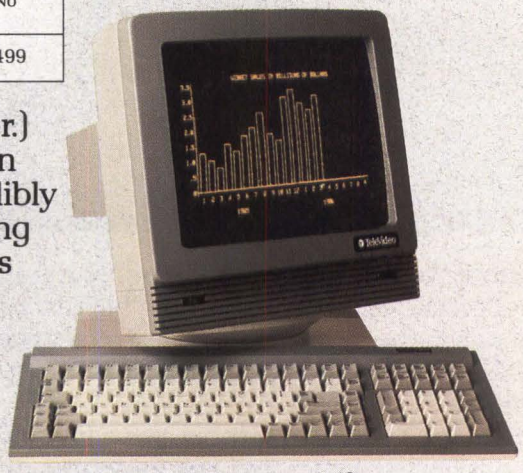

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CIRCLE NO. 32 ON INQUIRY CARD

TRUE DISTRIBUTED DBMSes PRESAGE BIG DIVIDENDS

Despite their slow emergence, varied types of distributed database management systems promise to help integrate heterogeneous computing environments

This is the first of a two-part series on distributed database management systems. The second part will appear in the June issue of Mini-Micro Systems.

Wendy Rauch-Hindin
Special Features Editor

One of the next frontiers in computer processing may well be the development of distributed database management systems. Such DBMSes will meet the increasing needs of users to share vast amounts of on-line data in heterogeneous computing environments. Several vendors have responded to the demand by beginning phased introductions of distributed DBMSes; still more are about to do so.

Distributed DBMSes allow a database administrator to partition a single integrated database and its control system and distribute them across multiple geographically dispersed, autonomous nodes. They do so in such a way that the location of any particular set of data is transparent both to users and applications. In the best case, the data is also synchronized. This partitioning stands in contrast to centralized DBMSes, which allow remote database queries via terminal emulation. The distributed processing possible with such query capabilities is often confused with distributed DBMSes.

The benefits of distributed DBMSes are multifold. First, a distributed design reflects an organization's structure. Second, it allows data to be stored locally, under local control. Local storage decreases response times and communications costs and increases data availability. Third, distributing data across multiple autonomous sites confines the effects of a computer breakdown to its point of occurrence; the data residing on the surviving computers can still be processed.

Fourth, a database's size and its number of users need not be limited by a computer's size and processing power. Instead, distributed DBMSes accommodate an unlimited number of computers, disk drives and users. This results in the fifth advantage. In many cases, multiple, integrated small systems might be less expensive than one large system. Sixth, and perhaps most important, a distributed database need not be constrained by the physical organization of data. Consequently, a distributed database manager and a smart data dictionary can be used to integrate, access, and update heterogeneous databases but still have them appear to users as a single logical database.

Who cares?

Banking organizations are particularly interested in distributed DBMSes, both to help manage their international trading business and to integrate activities in different parts of a bank. For example, they want to maintain domestic and foreign records and audit data in local databases and execute trades locally, but they also want to obtain worldwide status information on an ad hoc basis and execute distributed transactions.

On the other hand, for manufacturing companies with many plants and activities, distributed DBMSes' biggest attraction may be its ability to manage and access data at local sites, while also being able to integrate different types of files and data needed for computer-integrated manufacturing. The military, government agencies and large point-of-sale retail operations are still other examples of potential

A distributed database's structure need not be constrained by the physical organization of data.

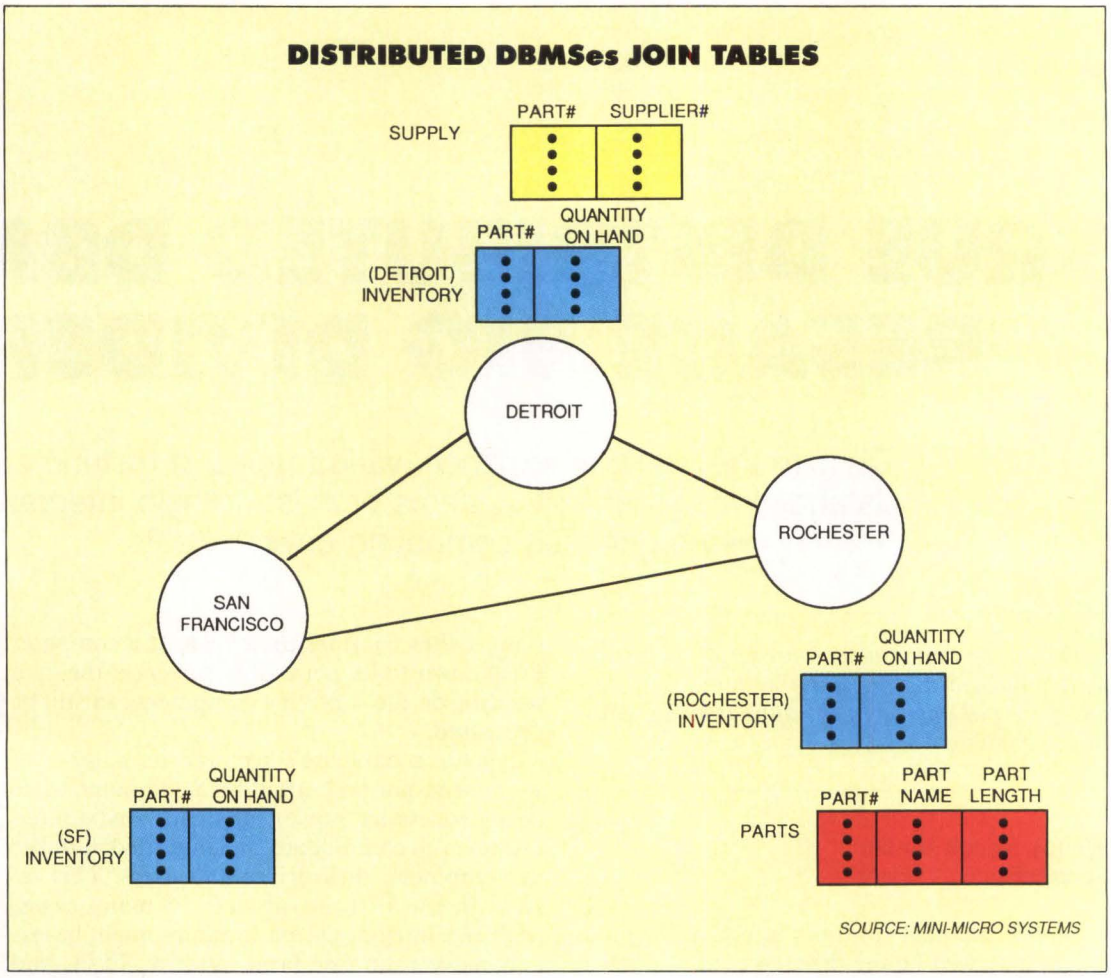


Fig. 1. In a distributed database, *relational tables located at multiple sites can be transparently joined to answer a single query, such as, "Show me the IDs of all the suppliers who make 10-inch bolts that we have a shortage of." (Less than some specified amount is at hand.)*

distributed DBMS users.

Despite this interest of some years standing, the advent of commercial distributed DBMSes has had to wait until a number of thorny technological problems were solved. Chief among the reasons for the market to develop now is the emergence of three types of computer industry standards. The first includes communications standards, such as Open Systems Interconnection, Manufacturing Automation Protocol and Technical and Office Protocols. These standards allow heterogeneous computers to exchange data. The second is the ANSI standard SQL (structured query language), which supports access to different databases. Finally, there is IBM Corp.'s LU (logical unit) 6.2 protocol, which provides a standard interface for transaction processing and allows application programs to communicate via the application program-to-program communication (APPC) facility.

Problems remain

However, many technological and management problems remain to be solved before distributed DBMSes become widely used. Major concerns on the management side are how to distribute and maintain the data. Another problem with distributed DBMSes is a loss of node autonomy because, in order to support access from everywhere in the network, in many ways every node must have the same database design.

Technological problems are largely communications-related. They include excessive software and communications overhead, communication delays, poor response times, low system throughput and high communications costs.

Some database problems, such as query optimization and deadlocks, have for the most part been worked out. However, the communications and synchronization problems, combined with the programming complexity of distributed DBMSes, are too difficult to overcome

quickly. Consequently, most distributed DBMS vendors have adopted a multiphased product-introduction strategy.

As might be expected, the first introductions will incorporate the easiest to implement distributed DBMS features. Future releases will gradually add more capabilities.

Not all distributed databases are equal

Vendors are taking several different approaches to distributed processing and distributed databases (see Table). The oldest approach is to centralize the data but distribute the values of the data to local sites for processing.

Another existing distributed-processing scheme allows a single application to simultaneously access more than one independent database. Any file or database, however, must reside in only one node. IBM's CICS (Customer Information Control System) telecommunications monitor supports such a scheme, as do many DBMSes running on networks that support remote procedure calls.

A third approach provides periodic updated extractions from a centralized database for use at a remote site. This approach is exemplified by Digital Equipment Corp.'s VAX Data Distributor. This database allows users to employ the relational database operator of Digital's Rdb/VMS software to extract or replicate all or a subset of a central database and send it to a target node via DECnet. The database produced is a snapshot-in-time of the central database.

This extract-and-replication facility differs from most previous products in that it automatically updates the target database at a user-specified time. During the update, the extract method creates a new target-database copy, while the replication method updates only data that has changed. Target-database users can use the data for any kind of local processing, but they cannot update the central system.

Despite the name "Data Distributor," many database experts argue that this system is not a truly distributed database. However, this may not matter. For users, the big question is how many distributed database benefits the system provides.

An automobile dealership, for example, can use this type of database to locally replicate and query data associated with the cars it sells and the plants from which it buys. Users gain better response times because the data is local. In addition, this approach decreases network traffic because it decreases the number of remote queries. And the central processor is freed up for other tasks because the processing load is distributed more efficiently. On the other hand, the data might not always be up-to-date. Furthermore, Data Distributor runs only on the VAX family.

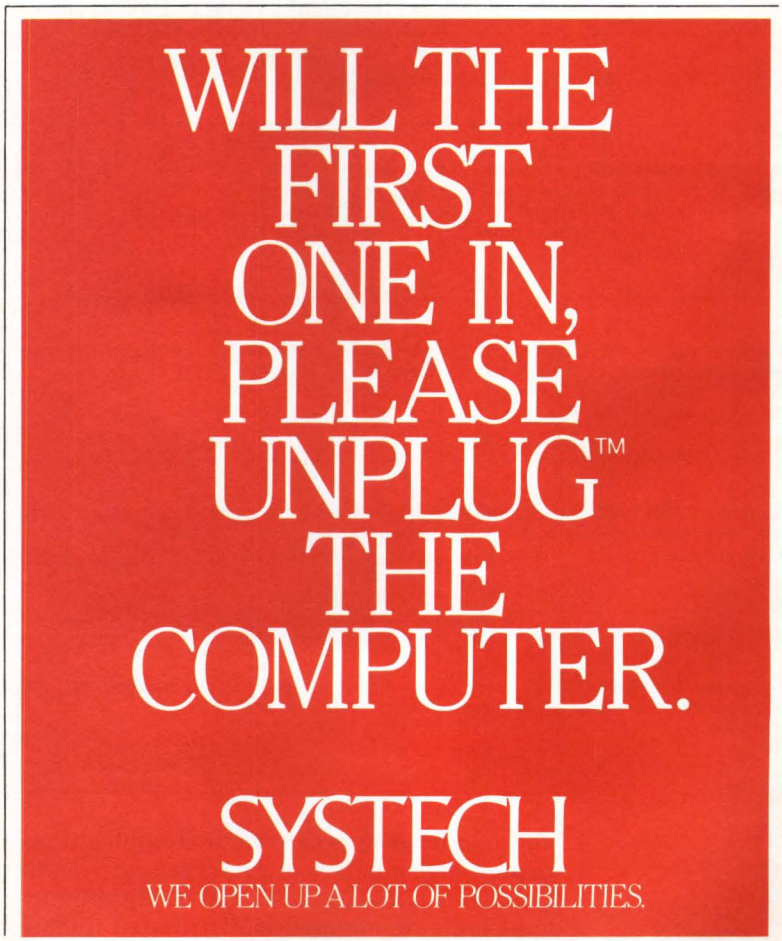
Slice up the database

Partitioning data is really what distributed databases are all about. So, the most common type of distributed database being introduced is that which gives the database administrator the flexibility to partition the database and locate individual data at any location deemed suitable. Usually, it is one that is local to the region where the processing takes place.

Regardless of the location of the data, users see only a single logical database (Fig. 1). They can create a view that is a join or union of tables (relations) in different databases without being aware that the data tables span multiple locations. Knowledge of where any particular requested data is located resides in a data dictionary. The DBMS routes requests to the proper location(s) and returns the data requested.

The major reasons for partitioning the data, as opposed to just replicating it, are to reflect an organization's structure, provide locality of reference and lay the foundations for accessing and managing heterogeneous databases. These benefits must be balanced against the high costs

The oldest database approach is to centralize the data but distribute the values of the data to local sites.



CIRCLE NO. 33 ON INQUIRY CARD

NOT ALL DATABASES ARE CREATED EQUAL

	New technical features	Reliability	Expandability	Communications overhead	Manageability	Data consistency, or integrity
Centralized DBMS: System and data reside in one location on one CPU. Data values may be distributed to geographically dispersed users for local processing.		poor	poor	very high	very good	excellent
Distributed, non-integrated DBMS: Independently operating DBMSes that can be accessed by applications on remote computers.	communications	good	good	low	very good	low
Distributed snapshot DBMS: Copy of the central database created by extraction and replication for use at remote site.	communications	good	very good	low to medium	very good	medium
PARTITIONED, DISTRIBUTED INTEGRATED DBMSes						
Distributed-query DBMS—transparent: Data spans heterogeneous computers and software. Request for file may or may not require users to provide machine location.	communications, partitioning of data, distributed-query processing	very good	very good	low to medium if most requests are local	difficult	could be low
Distributed-query and -update DBMS—transparent: Data spans heterogeneous computers and software.	communications, partitioning of data, distributed-query processing, distributed updates	very good	very good	medium if most requests are local	very difficult	very good
Distributed DBMS with fragmented tables—transparent: Data spans heterogeneous computers and software.	communications, partitioning of data, distributed-query processing, distributed updates, fragmenting of database tables	very good	very good	low to medium if most requests are local	very difficult	very good
Replicated, distributed DBMS: Data is replicated and synchronized at multiple sites.	communications, synchronization of redundant data	excellent	very good	medium because of synchronization requirements	medium	medium to very good depending on synchronization technique

and overhead that can occur if applications require large numbers of data accesses to multiple remote sites. The costs and overhead problems are compounded if distributed update capabilities to keep the data synchronized are involved. For these reasons, most initial introductions of distributed DBMSes support distributed queries, but full distributed-update

facilites are usually planned for later releases.

Tandem Computers Inc. was the first to support distributed queries, distributed updates and synchronized replicated data, with its Encompass database. An outgrowth of Tandem's quest for a fault-tolerant system (where one CPU could transparently process the data and transactions of a failed CPU), Encompass is the only commercial, fully distributed DBMS that has been in the field for several years.

But Tandem no longer stands alone. Relational Technology Inc. (RTI) now offers Ingres/Star, a distributed version of the Ingres database; Oracle Corp. has Oracle SQL*Star, a distributed version of its Oracle database. Both systems can retrieve data and perform joins across multiple sites and update any site in the network, all transparently to the user. However, the current versions of these DBMSes restrict updates to only a single site at a time. The ability to perform the, more difficult, distributed updates within a single transaction must await the next releases.

Applied Data Research Inc.'s new version of DNET, Release 2.0, supports location-independent distributed updates within one transaction. And Computer Corp. of America (CCA) has developed a fully distributed DBMS, with data synchronization capabilities, under contract for the military. CCA is now working on a commercial, general-purpose distributed DBMS called Adaplex. It plans to add distributed capabilities to its model 204 DBMS.

By the end of the year, Unify Corp. also will have a distributed version of its Unify database that will transparently perform distributed updates within a single transaction. And, to round out the list, later this year Informix Software Inc.'s Informix DBMS will support transparent distributed query capabilities that will perform joins on tables located on different machines.

Fragmentation is the next step

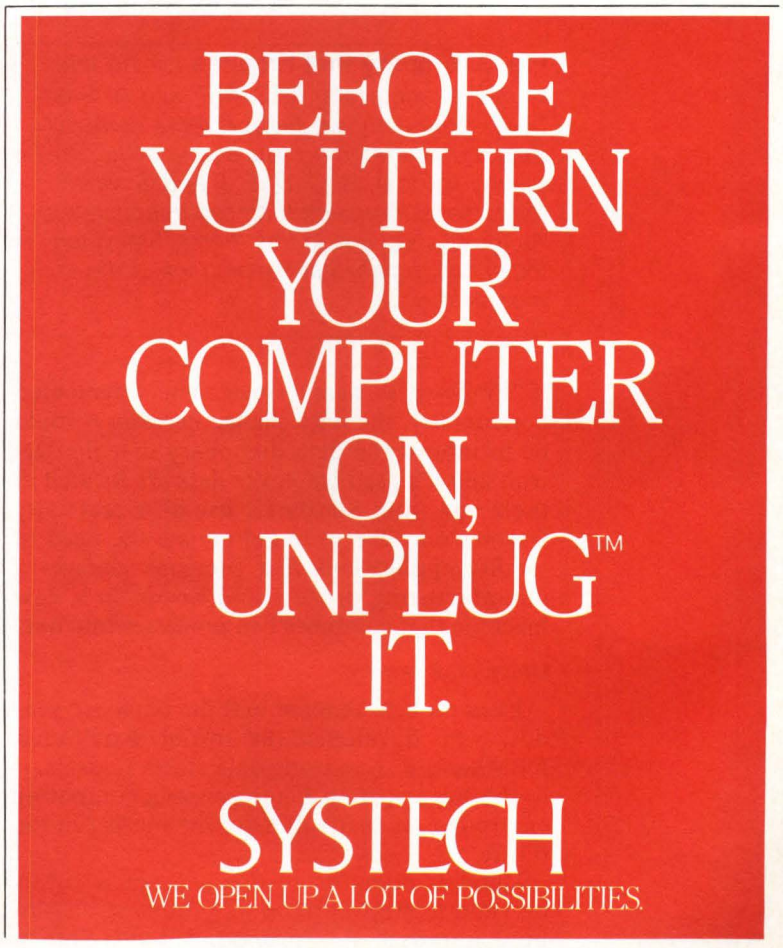
Database vendors are working on distributed DBMSes that allow users to fragment individual database tables and distribute the fragments across different nodes. In a horizontal-fragmentation scheme, different rows, or records, of a particular table might be distributed to different sites. In a vertical-fragmentation scheme, the columns, or field attributes, would reside in different places. In either case, the application program and the DBMS handle the table fragments at the various locations as if they were a single relation. RTI plans this fragmentation capability for the third quarter of 1988; the other database companies have not yet released their dates.

The advantages of fragmenting tables are flexibility and less need for intelligence in applications. Here's why.

As mentioned, reflecting an organization's structure is a major reason for partitioning data. This can be accomplished by storing in separate tables data that is local to a region or operation. Applications that need data from tables at several sites create a join or union of the tables. But, to create that join or union, it is necessary for the application to contain knowledge of how the data is distributed in different tables and how the tables are related. The resulting query can be complex (Fig. 2). If the data is contained in a single table that has been partitioned and distributed, the DBMS manages the complexity.

Partitioning data is really what distributed databases are all about.

The need for automatic management of this complexity is most important when changes are made in an organization. For example, a company with regional offices in Chicago and Detroit might have a "Chicago Employees" relation and a "Detroit Employees" relation. If, as part of a cost-cutting move, the company combines these offices, it would be illogical for it to maintain two separate tables. Unfortunately, combining them into a single "Employee table" for the new regional office requires changing every application that references the Chicago or Detroit employee tables. However,



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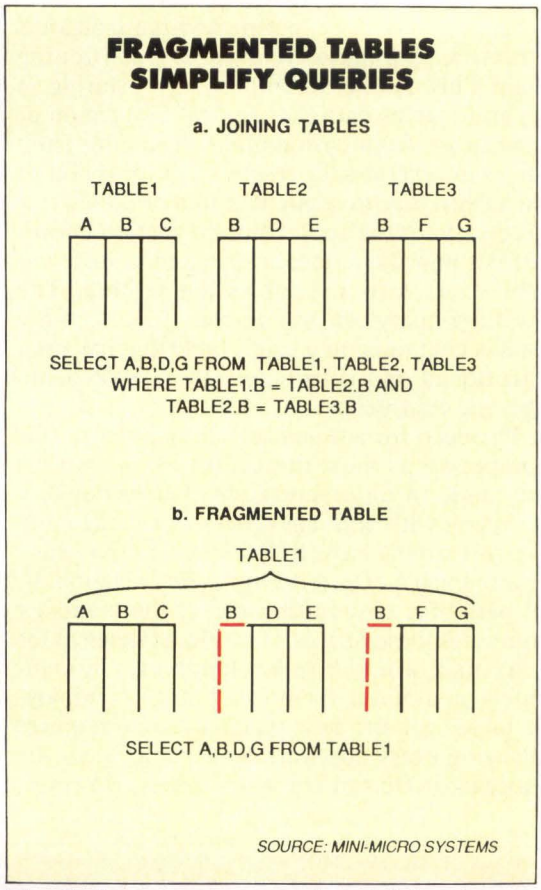

Fig. 2. A query that requires *joining three tables (a) containing ABC, BDE and BFG on field B (the common field) is more complex than a query referring to a single table containing fields A, B, C, D, E, F and G, where the table is fragmented across three sites (b). As the dashed line in this Ingres/Star query indicates, Ingres/Star keeps track of the common field.*

if "Employees" were a single table, fragmented horizontally, the only change necessary would be to inform the data dictionary that the Detroit and Chicago employee data are located in their new site. Similarly, use of a vertically fragmented table would eliminate the need to modify applications if a company changes a manufacturing process and brings in a new machine that combines two processes into one.

Unity in diversity

Even though Tandem and the database vendors who developed the initial distributed DBMSes did so to bring data closer to users, it is the need to link heterogeneous computing environments that will drive the market in the future.

Drawing attention to this concept is IBM's decision to stop work on its prototype distributed database R* (pronounced "R Star"), which supported distribution of data across large mainframes. After having experimented with R* since 1979, IBM found, when it demonstrated the prototype, "that what the customers really wanted was the ability to share and move data within an enterprise, across desktop computers, workstations and intermediate-sized systems that would be connected via local networks or other communications methods," says Robert Yost, one of two managers for IBM's Starburst project. IBM's reaction was to begin development of a new distributed database, called Starburst, which Yost makes clear is still an experimental system.

Big Blue's blueprint

Nevertheless, Starburst is taking into account what appears to be all of the customers' data-sharing requirements. In particular, IBM is focusing on portability and extensibility. As to portability, the initial Starburst is being implemented on the IBM RT PC RISC (reduced instruction set computer) workstation under AIX—IBM's version of System V UNIX—as well as on an Intel Corp. 80286-based PC/AT running PC-DOS. These systems are vehicles for understanding what is necessary to make Starburst portable across a variety of computers, operating systems, networks, databases and so forth.

Long-term work on extensibility was undertaken because the range of applications for workstations and intermediate-sized systems is much greater than the range for mainframes. Extensibility means that the database can be expanded to support new types of data, including text, images, voice, complex objects and abstract data types—as well as support new operations on these data—in order to adapt to changing environments.

The extensibility characteristic actually applies to any database. It is particularly important to distributed DBMS users, because they are likely to want to integrate application data such as CAD/CAM, inventory control, images and statistical databases. And, for performance reasons, these users will want their specialized functions to run at the level of the database, as opposed to the level of the application.

However, specialized data and functions on different machines may introduce several variants of Starburst within the one, albeit distributed, database, as well as heterogeneity in terms of the ability of databases on different machines to work together.

This could lead to a problem that IBM's SNA (Systems Network Architecture) has been accused of. That is, becoming so enormous and multifunctional that, when slimmed down for practical implementation, two of them might not be able to talk to each other. To prevent

such a happening, Starburst designers are trying, from the start, to define a core that should be common to every version of the database. This core will not only permit sharing but also will support the requirements of specific application areas with optimized performance.

Another Starburst objective is a uniform high-level language to access local and distributed data, both within an enterprise and across enterprises. In Yost's view, this high-level language may well be SQL and extensions to SQL, both in terms of the data types and the operations it supports.

It probably will be SQL, in fact. Starburst-gazers agree that Starburst could provide the blueprint for most vendors' future distributed databases, especially in terms of portability and heterogeneity.

UNIX databases are examples—support heterogeneity because they are relational, use SQL, run on a variety of computers from PCs through workstations and minicomputers and frequently work under multiple operating systems. Oracle's SQL*Star, for example, supports transparent queries and updates across the Oracle database and IBM's DB2 and SQL/DS products. And support for the non-SQL-based VSAM and IBM's IMS (Information Management System) are forthcoming later this year. RTI's Ingres/Star is also compatible with DB2 and has a prototype gateway to IMS that uses the SQL interface to IBM's Data Extract (DXT) product. Informix, too, is working on connecting to DB2.

As for mainframe/minicomputer databases, Information Builders Inc. is moving in the direction of a distributed DBMS that supports multiple heterogeneous databases. It is well-positioned to do so because, on a single node, its Focus database can already read, relationally join, and generate reports from any Focus, IBM, or DEC files and can also generate SQL calls to relational databases. And the company has begun extending this capability. As a start, it supports distributed queries and distributed updates, within a single transaction stream and across dispersed Focus databases on DECnet. A smart data dictionary to provide transparency is due next year.

Information Builder's rationale is simple. "Access capability within only one proprietary database or network is a limiting concept in that no large company has all of its data in a single file type," says Verne Sheidler, marketing support manager at Information Builders.

Cincom Systems and Cullinet Software Inc. are in complete agreement with this kind of thinking. According to Cincom, most of its clients have heterogeneous databases, and they are trying to find some way to integrate them. To provide solution, Cincom will extend its existing support for vertically fragmented, replicated data across IBM (IMS, DB2, and VSAM), DEC (RMS), and Cincom (Supra and Ultra) databases and files to still other databases, primarily those that speak SQL. And beginning with distributed query capabilities, it will gradually extend this support across multiple nodes.

For its part, Cullinet claims its customers are overburdened with existing centralized production databases. They want to distribute part of their database processing, application and software development down to departmental minicomputers and PCs.

Cullinet's response was to develop a three-tiered strategy that encompasses distributing not only databases but also applications across PCs, minicomputers and mainframes. The company plans three main products, all SQL-compatible. One is ADS Plus/PC, a PC version of Cullinet's ADS on-line application-development system. The second is IDMS/Distributed, a relational database that will run on VAX computers and PCs. The third is the mainframe-based Release 11 of IDMS/R.

Such multitiered distributed architectures may well be the most promising, near-term way

Most initial introductions of distributed DBMSes support distributed queries, but full distributed-update facilities are usually planned for later releases.

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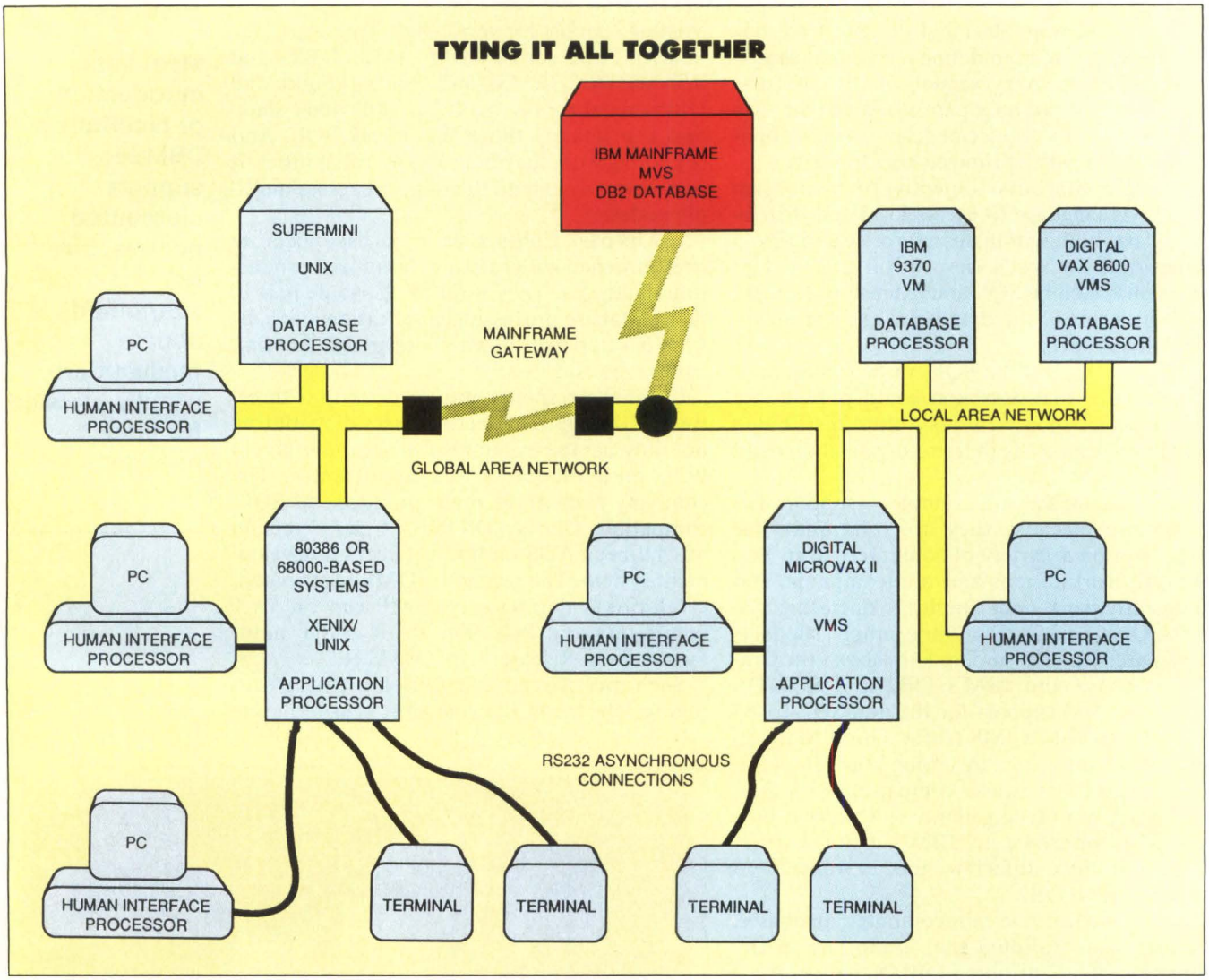

Fig. 3. A multitiered *Cooperative Processing Architecture, from Unify, allows databases and applications to be distributed across interconnected computers, ranging from mainframes and minicomputers to workstations and PCs.*

to cope with data sharing across today's heterogeneous computer systems. Accordingly, another proponent, Unify Corp., has developed what it calls a "Cooperative Processing Architecture" to help application developers grapple with this emerging environment (Fig. 3).

The computer hardware in this architecture is arranged in three tiers: PCs, UNIX- and VMS-based workstations and minicomputers (VM to come) and mainframes. The end-user interface and the data-entry and query tools run on PCs. The PCs provide fast response and interactivity. They also offload UNIX and VMS machines.

The UNIX and VMS machines handle the flow of control and application logic. They provide the large memories and high performance needed by applications. Also, with this cooperative architecture, applications can be distributed across the UNIX or VMS machine and the PC.

The database is handled either by the UNIX or VMS machine or by a mainframe at the third layer. Still other machines can be networked at the second and third layers to distribute the data in the database. Access to the different databases occurs via an SQL interface.

Most vendors today agree with the multilayer distributed processing concept. However, Robert McCord, product marketing manager for distributed technologies at RTI, and Kenneth Cohen, director of product marketing at Oracle, both point out that SQL is not an automatic panacea to database compatibility. Even if high-level SQL statements are identical, subtle differences at the internal level make it necessary to map a database's SQL statements into the call to which each individual implementa-

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Digital Equipment Corp.
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(503) 635-6265
Circle 312

tion responds. Data types must be converted. Also, relations and attributes must appear the same.

Another problem is that most vendors' SQLs are not exactly the same. Adoption of the International Standards Organization standard SQL would promote compatibility but create another problem. Specifically, the SQL currently under consideration by ISO is only a subset of DB2 SQL, and that could create acceptance problems.

A more serious problem occurs, according to Tony Percy, director of product planning at Applied Data Research, if the meaning and identity of the data between different systems are different because the databases were designed without some central data administration. Pieces of data may have the same name but mean different things, or vice versa. Or users of one database may use a zero, meaning no value in a field; users of another may use a specified "null" symbol. In either case, users will receive wrong answers to their queries. And they may not be able to recognize that the answers are wrong.

What all this means is that, to obtain the benefits of distributed DBMS technology requires two things: applications appropriate for distribution and coordination of the distributed databases. Coordination means a change in an individual's style of doing business, and such changes do not happen overnight. Consequently, software developers and system integrators can expect distributed DBMSes to follow the pace of all new commercial technologies: they will evolve slowly. □

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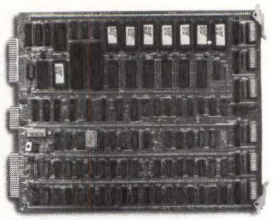

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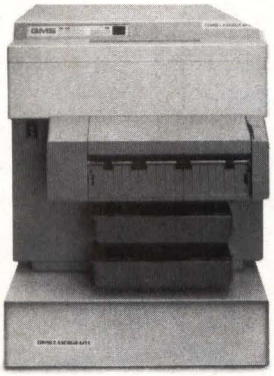

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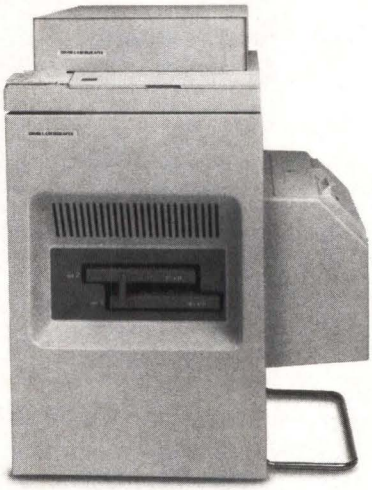

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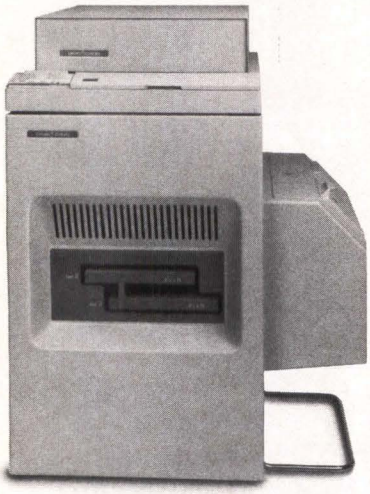

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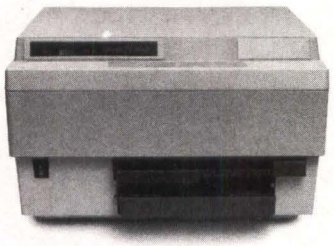

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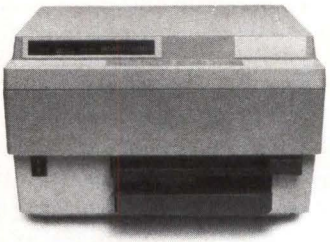

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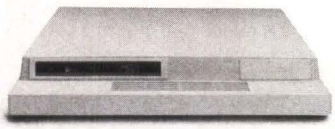

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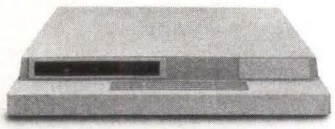

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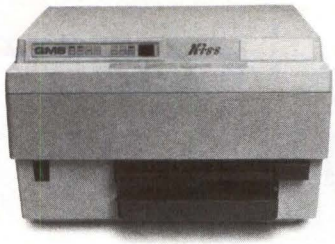

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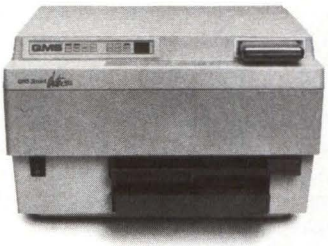

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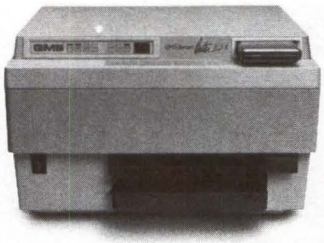

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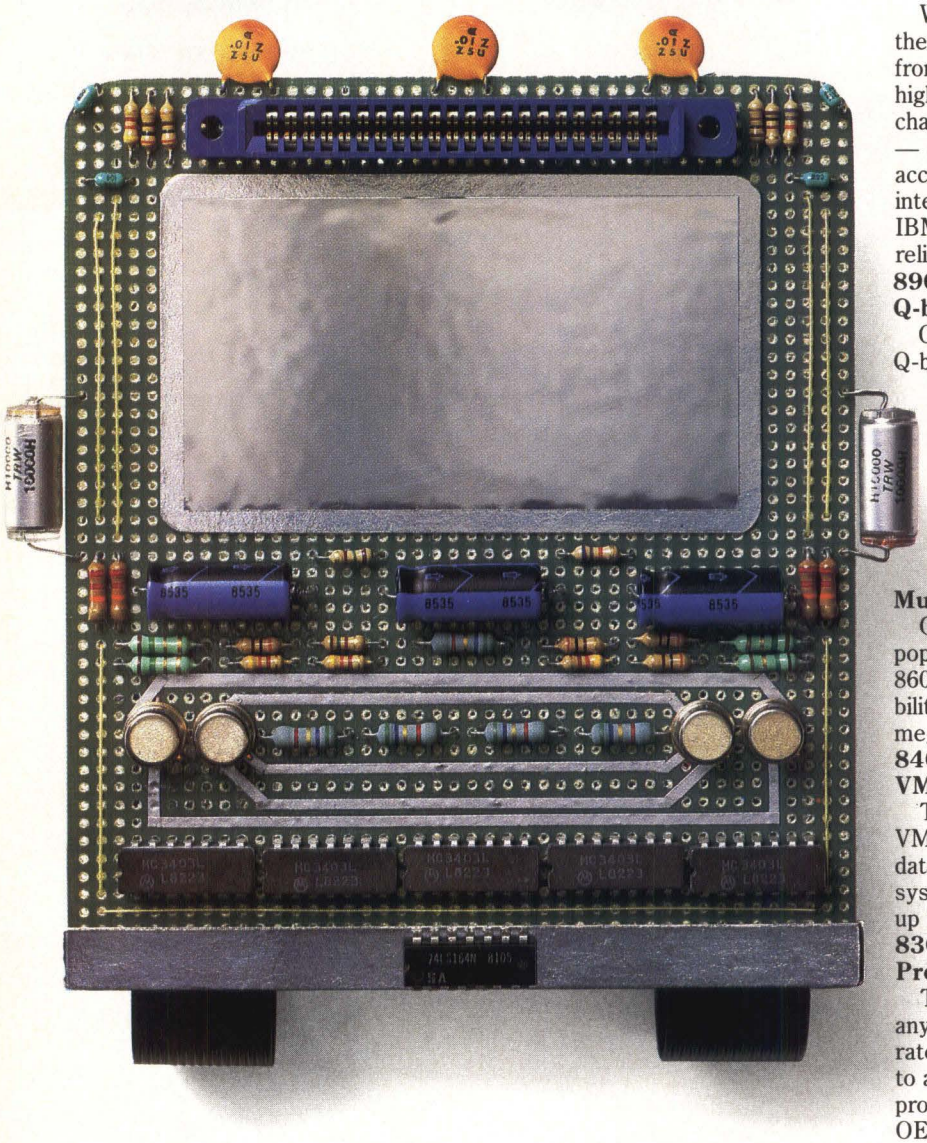

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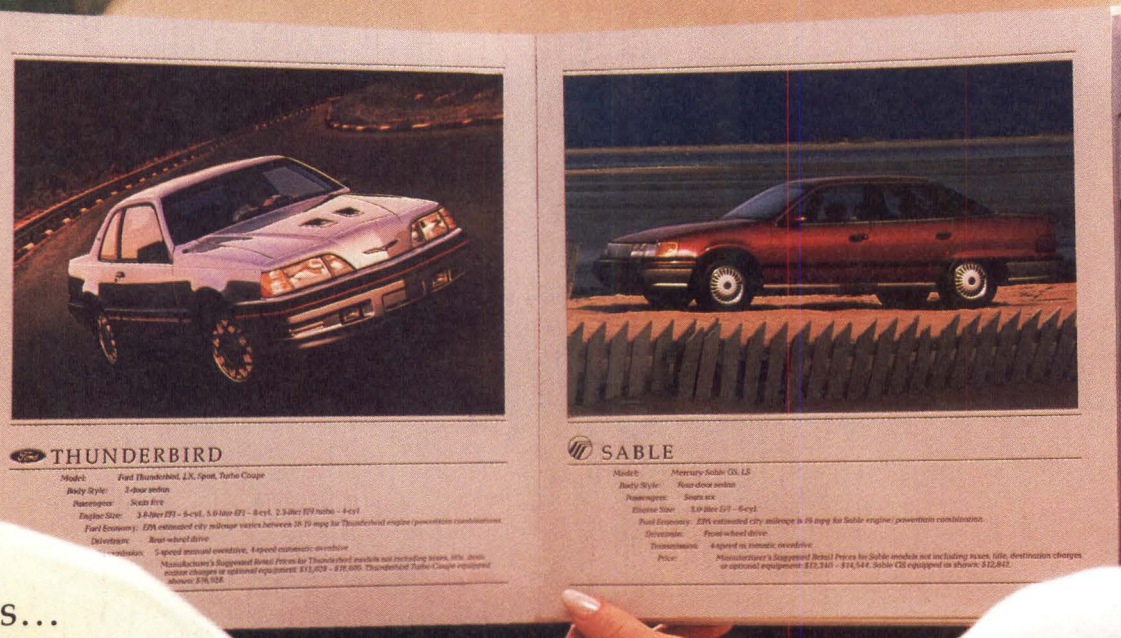

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DATABASE DEVELOPMENT TOOLS: AN EVALUATION

An independent company evaluates over 50 database development tools available for applications developers, software houses and end users

The database market limelight shines primarily on the larger suppliers, such as Ashton-Tate, Informix Software Inc., Oracle Corp., Relational Technology Inc. and Unify Corp. However, to facilitate the work of software developers and system houses, a multitude of smaller suppliers also provide database development tools. Prices for these tools (which range from $35 to over $1,500) vary as widely as the capabilities offered.

To assist database developers, Humanic Systems Co., Lexington, Mass., earlier this year released an evaluation of available development tools. Humanic Systems is an independent applications-development company. Its latest package is the MKS expert system, which the company wrote with a text-oriented database management system. MKS (Management Knowledge System) combines a knowledge base with fourth-generation database languages. Humanic Systems regularly evaluates database development tools for its own use in applications development.

The accompanying "Column Heading Explanations" will assist you in reading the evaluation table. The chart also includes an explanation of the abbreviations used in the table, as well as definitions of some of the terms.

The evaluation table covers over 50 database development packages. Where there are several package entries in a single row, the information in the related column—including prices—applies to a combination of those packages.

The packages are arranged in the following order. The first four entries are packages that support SQL (IBM Corp.'s Structured Query Language) but do not have run-time fees. The next group of packages—through Advanced Development Technologies' The Creator, does not support SQL and does not require run-time fees. Humanic Systems' president, W. Curtiss Priest, explains the importance of run-time fees thus: "For example, if you develop a package and you're facing, say in the case of [Relational Technology's] Ingres database, paying $300 for a run-time license, you can't even think of marketing the package for $200. Ingres and [Oracle's] Oracle database wrap everything in a single package, at a relatively high price."

The next group of packages, from Database Systems Corp.'s QINT to Microrim's R:base 5000, has run-time fees and supports SQL. The next group, from Ashton-Tate's dBASE III Plus to Software Products International's Open Access II, has run-time fees but does not support SQL.

The last group employs languages designed for library search problems. With these packages you do not need SQL, except for internal database control. This group includes text-based management systems (TBMS in the Table) such as Dayflo Inc.'s Dayflo as well as end-user-oriented packages with proximity-searching capabilities, such as ZyLab Corp.'s ZyIndex. An example of a proximity-searching database query is "Did the word 'white' occur next to the word 'dog'?"

Humanic Systems includes this disclaimer with its evaluation: "The evaluation provided was conscientiously performed but may have errors or omissions because of the breadth of the undertaking. No user of the information should make momentous decisions or claims without obtaining and testing the various products described."

A list of database development tool suppliers represented in the table follows the evaluation. The list includes full company addresses and phone numbers.

—David Simpson, Senior Editor

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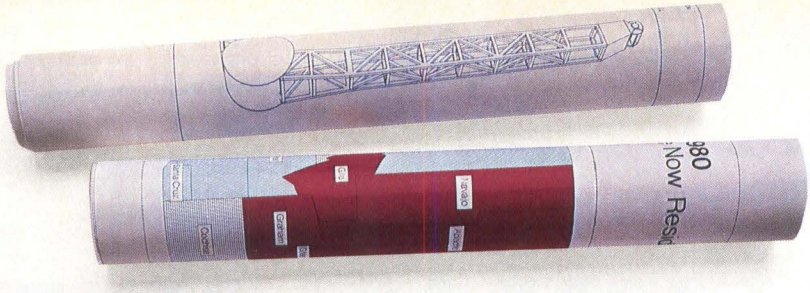

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Column heading explanations

Price—Current list price (VAR pricing is often 40 percent less.)

(RT fee)—Does vendor support run-time applications and if so, what is the royalty fee? If not, what is the cost per application? (There is usually quantity discounting for run-time licenses of up to 50 percent to 70 percent for high volume.)

SQL—Does the package provide SQL (IBM's Structured Query Language) or a similar language?

Text store—Can the package store more than 256 characters per field and, if so, how many? And are they stored within the database structure or as a separate text file? "No" almost always means that there is a 256-character limit, rarely less.

Text editor—Does the package support full-screen editing capability for stored text?

Interpreter—Can the package be operated in interpreter mode to see results of single-line commands?

Compiled/called—Can the code be compiled, and can it be called (or can it call the database management system file handler)?

C-fh—Can a C program access the file handler (and other fourth-generation language commands)?

C-sub—Can the package call C subroutines?

X—Can the package code be compiled to increase execution speed?

(Other supported languages such as Pascal and FORTRAN are included if known.)

Nonprocedural or procedural—Is the code nonprocedural or procedural and, if a mixture, what sort of mixture?

General attractiveness—General attractiveness reflects the range of capabilities and ease of implementation (highly subjective). Note: A low score may simply mean that the package only performs file management, and that, although it may be excellent at that task, it lacks other tools useful for applications developers.

Notes—Includes package comparisons, results of speed tests, or type of file structure such as network or relational.

Definitions and abbreviations

Y—Yes

N—No

Y-N—Parts are; and parts are not

NA—not available

4GL—fourth-generation language: high level of nonprocedural capability

Derby—Derby Information Systems: A company that conducts annual contests in which database companies are invited to compete on a single database-related problem. In other words, the company performs database development tool benchmarks, comparing code, determining how procedural or nonprocedural the code is, etc. The company is located in Berkeley, Calif., (415) 841-1234.

QBE—Query-By-Example: IBM's fill-in-the-form mainframe query language

B-tree—Internal structure of databases used by most relational database vendors

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DATABASE DEVELOPMENT TOOL EVALUATION

Package name / Company	Price ($) (RT fee)	SQL	Text store	Text editor	Interpreter	Compiled/called: C-ith	Compiled/called: X	Compiled/called: C-sub	Nonprocedural/ procedural	General attractiveness	Notes
dbVista[6], dbQuery[8,7] **Raima**	490 (0)	Y (no sub-query)	to memory	N	N	Y	Y[5]	Y	M1	7	advantages of a network database; has limited SQL
dBSQL **Word Tech Systems**	349 (0)	Y	Y[1]	Y[2]	Y	N	Y	Y	M1	9	ran in Derby
pBase **4B Associates**	35 (0)	Y	N	N	Y	N	N	N	M1	7	256K-byte version public domain
c-tree[6]; CQL[7,8,9]; Vitamin C[9]; C-Terp[10] **FairCom; Kurtzberg; Creative Programming; Gimpel**	900 (0)	Y	to compiler limit	Y	Y	Y	Y[5]	Y	M1, M2	10	combination of packages
Phact[6], Pquery[8], Preport[7] **Phact Associates**	965 (0)	Y	9,999	NA	Y-N	Y	Y	Y	M2	7	compare with Btrieve, etc., and c-tree, etc.
dBMAN **Versasoft**	295 (0)	N	N	N	Y	N	N	N	M2	5	much faster than dBASE III, otherwise very similar
c-tree[6], r-tree[7] **Faircom**	650 (0)	N	to compiler limit	N	N	Y	Y	Y	M2	7	faster than Btrieve, portable
dBx Translation **Programmers' Shop**	(0)	N	N	N	N	Y	Y[5]	Y	M2	7	translates dBASE II code into C source code
CLARION **Barrington Systems**	395 (0)	N	80-char. scroll, 65K bytes	Y	Y-N	N	Y	Y	M2	9	COBOL, PL/1-like, financial orientation, many facilities
Paradox **Ansa**	695 (9.95 per 250)	Y (QBE)	N	N	N	Y	N	NA	M2	6	faster than dBASE III, new PAL has many features
Btrieve[6], Xtrieve[8], Rtrieve[7] **Softcraft**	635 (0-Btrieve)	N	4,090	N	Y-N	Y	Y	Y	M2	6	"crash-proof," interface to BASIC as well as C
dBCIII[6] **Lattice**	250/500 (0)	N	Y[1]	Y[2]	N	Y	Y	Y	N	4	standalone ISAM for C, 100% dBASE III compatible
R&R[7] **Concentric Data**	99 (0)	N	Y[1]	Y[2]	Y	N	N	N	M1	3	like Rtrieve, for dBASE III
C-Index[6] **Trio Systems**	395 (0)	N	16K bytes	N	N	Y	Y[5]	Y	N	2	variable length for both key and non-key fields
TAS-PLUS **Business Tools**	69/199 (0)	N	10K bytes	NA browse	Y	N	Y	NA	M1	5	just came out with applications developer
Gennifer **Bytel**	395 (0)	N	Y[1]	Y[2]	Y	N	N	N	Y	4	front-end to dBASE III for easier applications development
File Manager **Integrated Data Technology**	34.95 (0)	N	NA	NA	Y menu	N	N	N	Y	3	relatively unknown package
asm Tree[6] **BC Associates**	395 (0)	N	NA	N	N	Y	Y	Y	N	3	fast because in assembler, relatively unknown package
BTree[6] **SoftFocus**	75 (0)	N	Y 32K bytes	N	N	Y	Y	Y	N	4	no limit to key size except available memory

[1]dBASE III has a memo field that is unlimited in size but not part of the searchable database and outside of the B-tree.
[2]dBASE III has an internal editor that can deal with up to 5K bytes of the memo field; otherwise, the field can be edited by an outside word-processing package.
[3]One can add Lattice's dBCIII to call the dBASE III database from C programs.
[4]Languages are ideal for library-search problems, and it is unnecesary to have SQL except for internal database control.
[5]Source code provided (aids in transportability of application).
[6]B-tree file manager (no query, screen I/O or report generation).
[7]Report generator for a particular file manager or structure.
[8]Query facility for a particular file manager or structure.
[9]Windowing package for screen I/O from within C. See also Panel, Windows for C and Greenleaf.
[10]C interpreter, may add to any C environment package to get interpreter. See also Interactive C and Run/C.
M1: Application language is mixed but predominantly a good nonprocedural language.
M2: Application language is mixed and highly procedural.

DATABASE DEVELOPMENT TOOL EVALUATION

Package name / Company	Price ($) (RT fee)	SQL	Text store	Text editor	Interpreter	Compiled/called: C-fn	Compiled/called: X	Compiled/called: C-sub	Nonprocedural/ procedural	General attractiveness	Notes
CBTree[6] **Micro Computing**	99 (0)	N	Y	N	N	Y	Y[5]	Y	N	4	block retrieval calls, unlmited key length and record length
Any dBASE III compiler (and dBASE III Plus by **Ashton-Tate**)	800 (0)	N	Y[1]	Y[2]	Y	N[3]	Y	Y	M2	7	examples: Quicksilver (WordTech), Clipper (Nantucket) and FoxBASE+ (Fox)—all fast
The Creator **Advanced Development Technology**	99 (0)	N	Y	NA	Y	NA	NA	Y	M2	6	relatively unknown package
QINT **Database Systems**	995 (995)	Y	Y 32K bytes	Y	Y	N	Y	NA	Y	9	IBM DB2 equivalent, ran in Derby
Knowledgeman II **MDBS**	500 (50)	Y	Y	Y	Y	Y	NA	Y	Y	9	very comprehensive
INFORMIX **Informix Software**	995 (395)	Y	Y 32K bytes	Y	Y	Y	Y	Y	M1	10	UNIX strength, VMS; mainframe migration
XDB **Software Systems Technology**	395 (100)	Y	1,000	Y	Y	Y	Y-N	Y	M1	7	ran in Derby, IBM DB2 equivalent
Ingres **Relational Technology**	1,200 plus 400 (application); (300)	Y	2,000	Y	Y	Y	Y	Y	M1	7	ran in Derby, IBM DB2 equivalent, mainframe migration
ORACLE **Oracle/AT&T**	1,500 (350)	Y	Y 64K bytes	NA	Y	Y	Y	many	M1	10	ran in Derby; IBM DB2 equivalent; IBM, DEC, DG, AT&T, etc.; mainframe migration
R:Base 5000 **Microrim**	700 (450 per 5)	Y	1,500; 4,092	N	?	N	Y	Pascal, FORTRAN	M1	7	Focus-like
dBASE III Plus **Ashton-Tate**	500 (250 per 5)	N	Y[1]	Y[2]	Y	N	N	Y	M2	5	no compiler
Revelation **Cosmos**	950 (200)	N	Y 64K	Y	Y	N	Y	Y	M1	6	text DBMS, oriented toward end users
Progress **Data Language**	675 (200)	N	Y 2K bytes	NA	Y	N	N	NA	Y	8	ran in Derby, Focus-like
ZIM **Zanthe**	750 (150)	N	Y 8,192	Y	Y	N	Y	NA	M1	10	Focus-like, but relational with variable field editor
Q-Pro **Q-N-E International**	595 (NA)	N	N	N	Y	?	Y	Assembly	M1	7	business-oriented, dBASE III-based
Dataflex **Data Access**	750 (200)	N	N	N	Y	N	Y	Pascal	M2	7	supports multiple environments
PC Focus **Information Builders**	1,200 (400)	N	N	N	Y	Y	N	Y	Y, M1	8	powerful business tool, network, excellent report generator, mainframe migration
DataEase **Software Solutions**	600 (600)	N	4K bytes per form	Y	Y	N	N	Y	menu, M1	8	filer integrated with WP, applications developer soon
Q&A **Symantec**	300 (300)	N Natural/ Keyword	Y	Y in WP	Y	N	N	N	Y	2	cannot write applications, can have preset reports

[1]dBASE III has a memo field that is unlimited in size but not part of the searchable database and outside of the B-tree.
[2]dBASE III has an internal editor that can deal with up to 5K bytes of the memo field; otherwise, the field can be edited by an outside word-processing package.
[3]One can add Lattice's dBCIII to call the dBASE III database from C programs.
[4]Languages are ideal for library-search problems, and it is unnecesary to have SQL except for internal database control.
[5]Source code provided (aids in transportability of application).
[6]B-tree file manager (no query, screen I/O or report generation).
[7]Report generator for a particular file manager or structure.
[8]Query facility for a particular file manager or structure.
[9]Windowing package for screen I/O from within C. See also Panel, Windows for C and Greenleaf.
[10]C interpreter, may add to any C environment package to get interpreter. See also Interactive C and Run/C.
M1: Application language is mixed but predominantly a good nonprocedural language.
M2: Application language is mixed and highly procedural.

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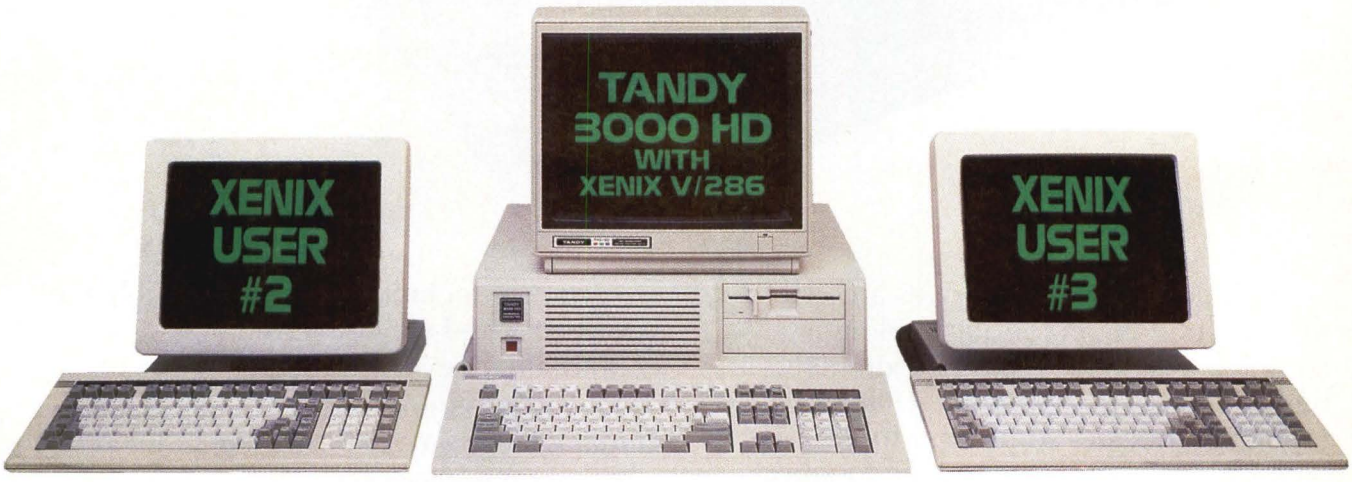

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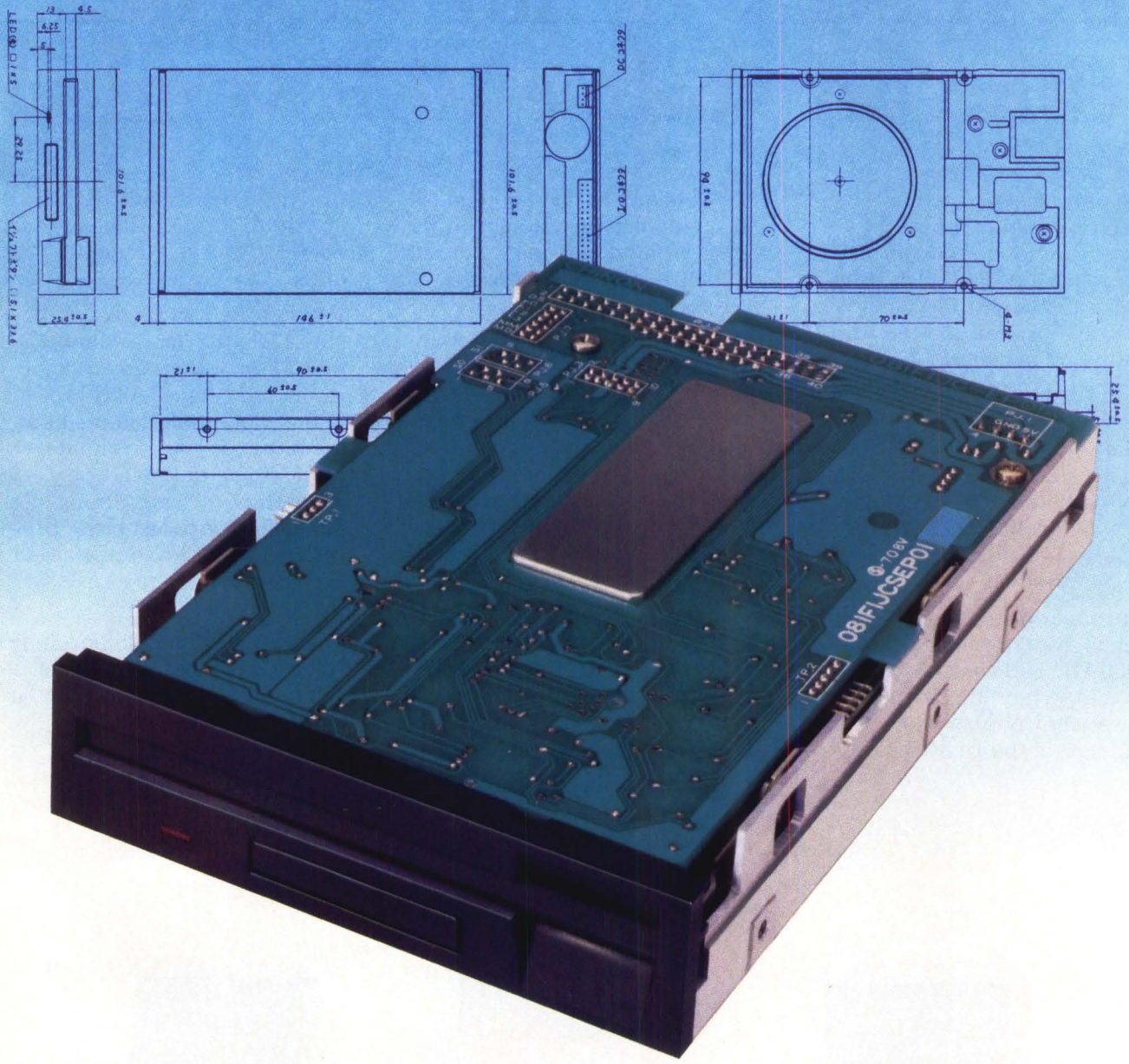

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DATABASE DEVELOPMENT TOOL EVALUATION

Package name / Company	Price ($) (RT fee)	SQL	Text store	Text editor	Compiled/called: Interpreter	Compiled/called: C-ih	Compiled/called: X	Compiled/called: C-sub	Nonprocedural/ procedural	General attractiveness	Notes
Palantir File **Palantir Software**	395 (237)	N	Data bridge to WP	in WP	Y	N	N	N	Y	3	integrated with WP
Open Access II **Software Products International**	595 (not yet)	N	data query from WP	in WP	Y	N	N	N	Y menus	3	like Palantir File and more like Rapid File (Ashton-Tate)
Dayflo **Dayflo**	395 (395)	N[4]	Y	Y	Y	N	N	N	M1	6	broad TBMS (text-based management system)
Marcon **Airs**	1,495 (1,495)	N[4]	Y	Y	Y	N	N	N	Y	5	powerful TBMS
InMagic **InMagic**	975 (975)	N[4]	Y	Y	Y	N	N	N	Y	5	TBMS, slow
AskSAM **Seaside Software**	200 (200)	N[4]	Y	Y	Y	N	N	N	Y	5	TBMS, fast
Citation **Eagle Enterprises**	185 (185)	N[4]	Y	Y	Y	N	N	N	Y	6	information-oriented
ZyIndex **ZyLab**	195/695 (195/695)	N[4]	Y unlimited	Y browse	Y	N	N	N	Y	7	Lockheed Dialog-like, lexical, for law firms, etc.
4-1-1 **Select Information Systems**	149 (149)	N[4]	Y	Y browse	Y	N	N	N	Y	7	more limited searching than ZyIndex, lexical
FYI 3000 **Software Marketing**	395 (395)	N[4]	Y	Y browse	Y	N	N	N	Y	7	lexical
Notebook II **Pro/Tem**	189 (189)	N[4]	Y	Y	Y	N	N	N	Y	4	flat file with variable length fields; TDBS; has footnote, bibliography capability

[1]dBASE III has a memo field that is unlimited in size but not part of the searchable database and outside of the B-tree.
[2]dBASE III has an internal editor that can deal with up to 5K bytes of the memo field; otherwise, the field can be edited by an outside word-processing package.
[3]One can add Lattice's dBCIII to call the dBASE III database from C programs.
[4]Languages are ideal for library-search problems, and it is unnecesary to have SQL except for internal database control.
[5]Source code provided (aids in transportability of application).
[6]B-tree file manager (no query, screen I/O or report generation).
[7]Report generator for a particular file manager or structure.
[8]Query facility for a particular file manager or structure.
[9]Windowing package for screen I/O from within C. See also Panel, Windows for C and Greenleaf.
[10]C interpreter, may add to any C environment package to get interpreter. See also Interactive C and Run/C.
M1: Application language is mixed but predominantly a good nonprocedural language.
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Companies mentioned in the table

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(800) 528-6060
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Airs Inc.
335 Paint Branch Drive
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(301) 454-2022
Circle 333

Ansa Software
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(415) 595-4469
Circle 334

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Culver City, Calif. 90230
(213) 204-5570
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BC Associates
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Fullerton, Calif. 92635
(714) 526-5151
Circle 337

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Bellevue, Wash. 98006
(206) 644-2015
Circle 338

Bytel Corp.
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Berkeley, Calif. 94706
(415) 527-1157
Circle 339

Concentric Data Systems Inc.
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Westboro, Mass. 01581
(617) 366-9035
Circle 340

Cosmos Inc.
3633 136th Place S.E.
Bellevue, Wash. 98006
(206) 643-9898
Circle 341

Creative Programming
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Carrollton, Texas 75011
(214) 245-6090
Circle 342

Data Access Corp.
8525 S.W. 129 Terrace
Miami, Fla. 33156
(305) 238-0012
Circle 343

Data Language Corp.
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Billerica, Mass. 01821
(617) 663-5000
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Database Systems Corp.
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Phoenix, Ariz. 85014
(602) 265-5968
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(714) 476-3044
Circle 346

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San Francisco, Calif. 94115
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4B Associates
2518 Curran Court
Pinole, Calif. 94564
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Perrysburg, Ohio 43551
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Circle 350

Information Builders Inc.
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(212) 736-4433
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InMagic Inc.
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Integrated Data Technology Inc.
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Circle 355

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Pro/Tem Software Inc.
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Walnut Creek, Calif. 94595
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Trio Systems
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Versasoft Corp.
723 Seawood Way
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WordTech Systems Inc.
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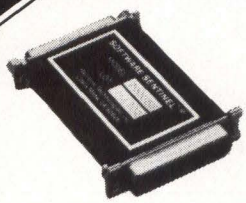

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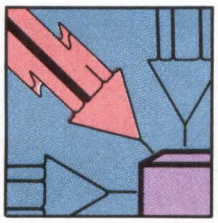

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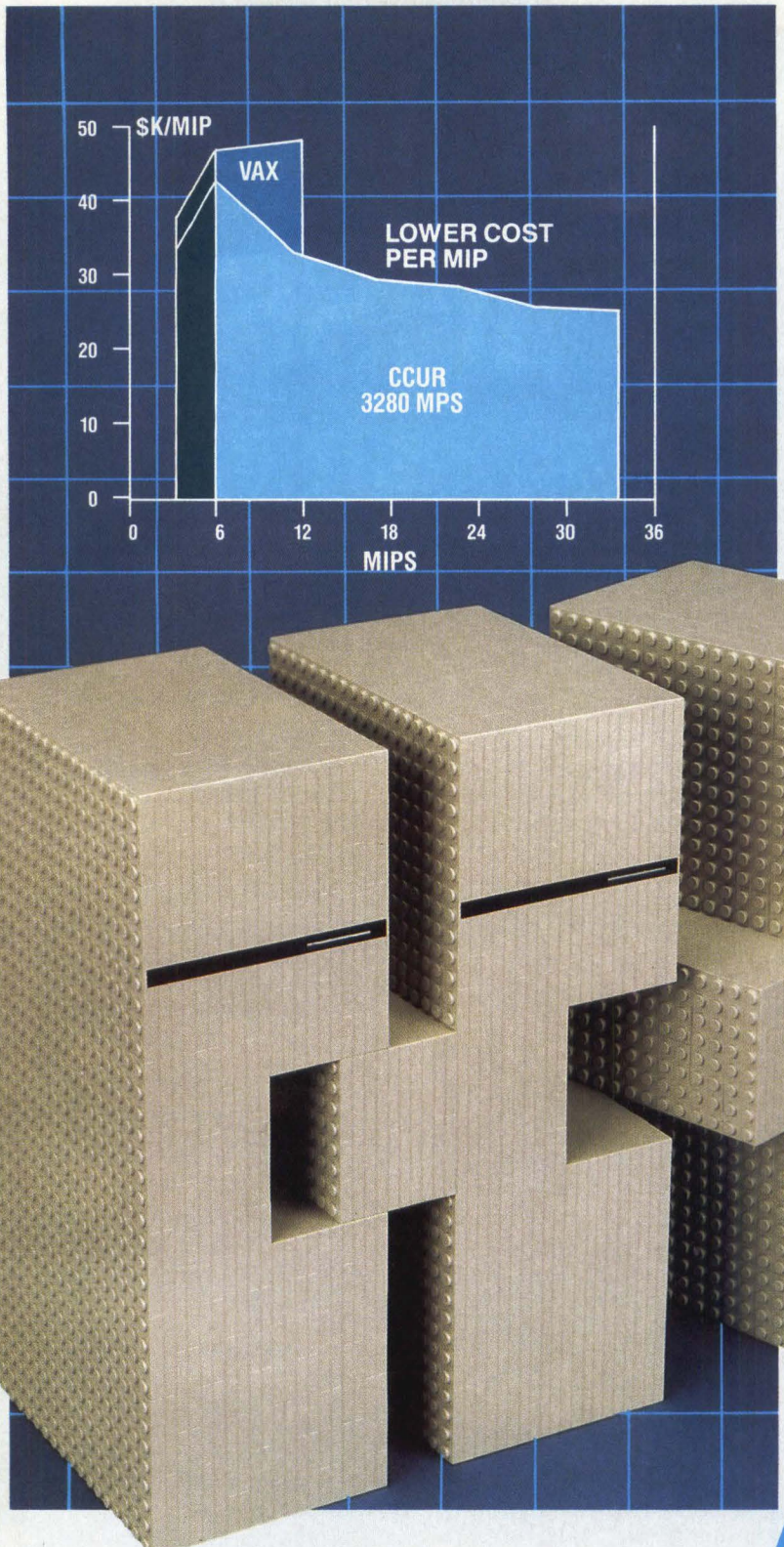

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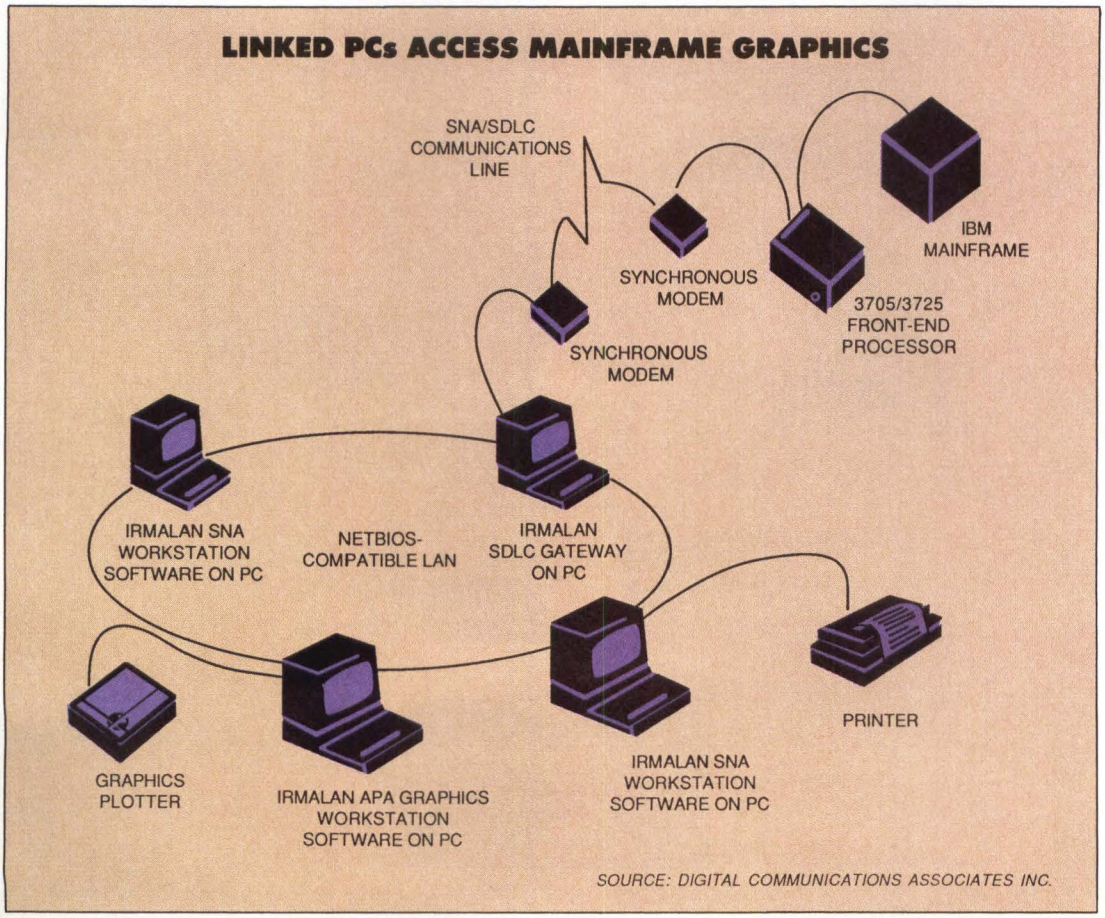
LANs LINK PCs TO MAINFRAMES

Local-area-network gateways to IBM SNA systems challenge conventional 3270 emulators, and LU 6.2 products threaten to rattle the micro-to-mainframe arena

Jesse Victor, Associate Editor

Links between local-area networks (LANs) and IBM Corp. Systems Network Architecture (SNA) systems menace the long-standing dominance of 3270 emulator boards and software as the preferred method of connecting IBM PCs and mainframes. Offered by both traditional emulator vendors and LAN suppliers, such gateways are profiting from growing corporate acceptance of the advantages gained by connecting diverse (and dispersed) personal computers with LANs.

Gateway hardware and software combine a LAN's resource-sharing and configuration flexibility with timely access for personal comput-



IRMALAN/APA Graphics Workstation *software from DCA enables a PC on a NETBIOS-compatible LAN to display, store and print mainframe graphics via the SDLC Gateway remote link and synchronous modems.*

ers to mainframe databases. And the emergence of LAN-SNA links coincides with a spate of marketing, distribution and merger agreements between 3270 board vendors and LAN companies. All this activity is reshaping the micro-to-mainframe market—and offers new and more powerful options to system integrators and OEMs.

Vendors of products that allow PCs to emulate 3270 terminals are responding to these new market forces with software that gives PCs on a LAN access to IBM mainframe data. The products combine traditional 3270-emulation functions, such as multiple host sessions and hot keying between emulator and MS-DOS modes. In many cases, they offer enhanced functionality such as access to mainframe graphics.

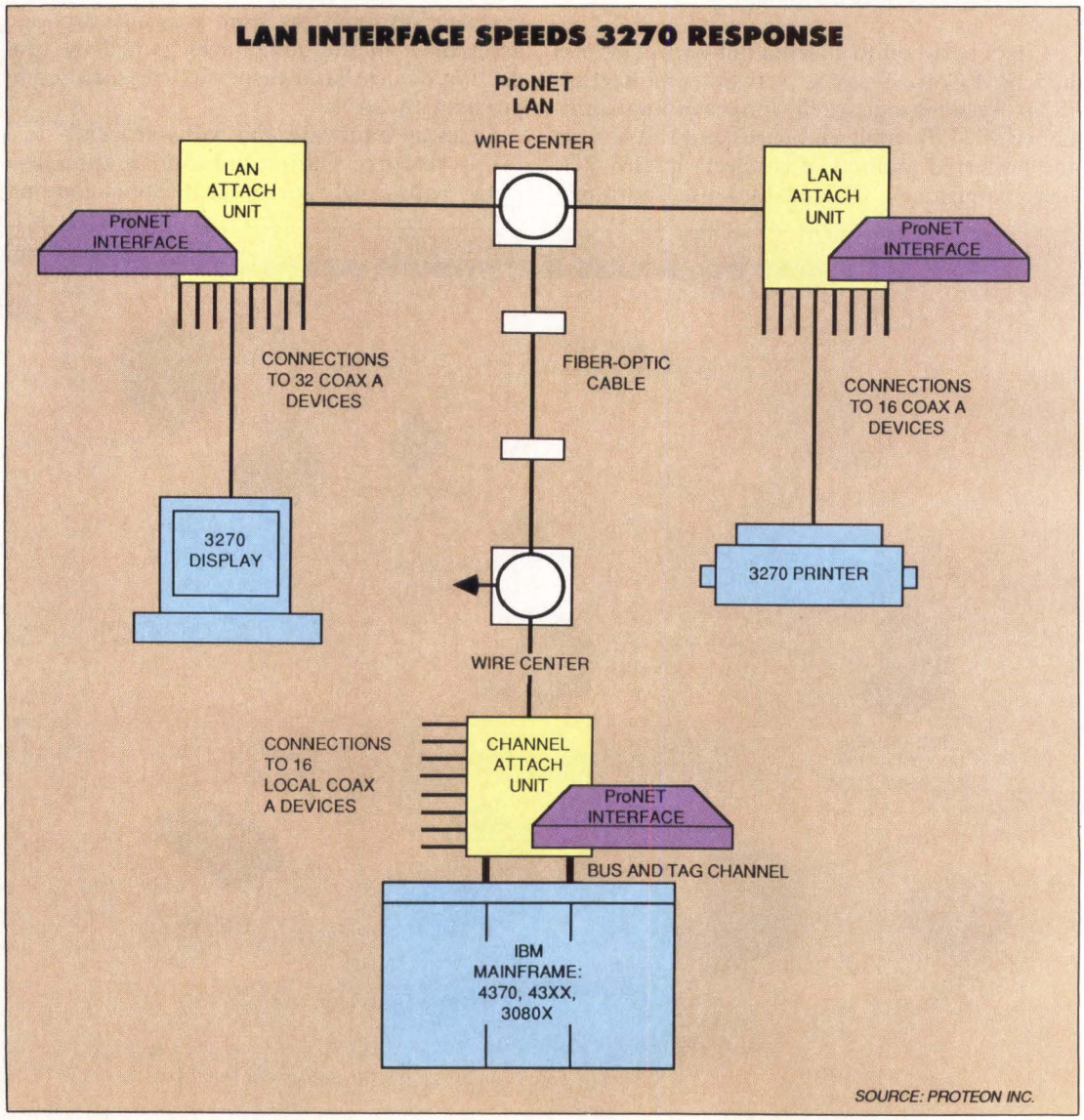
For example, Digital Communications Associates Inc., whose IRMA micro-to-mainframe board is a de facto hardware standard, supplies four products for PCs on an IBM Token-Ring Network—one of which provides on-line mainframe APA (all points addressable) graphics capability.

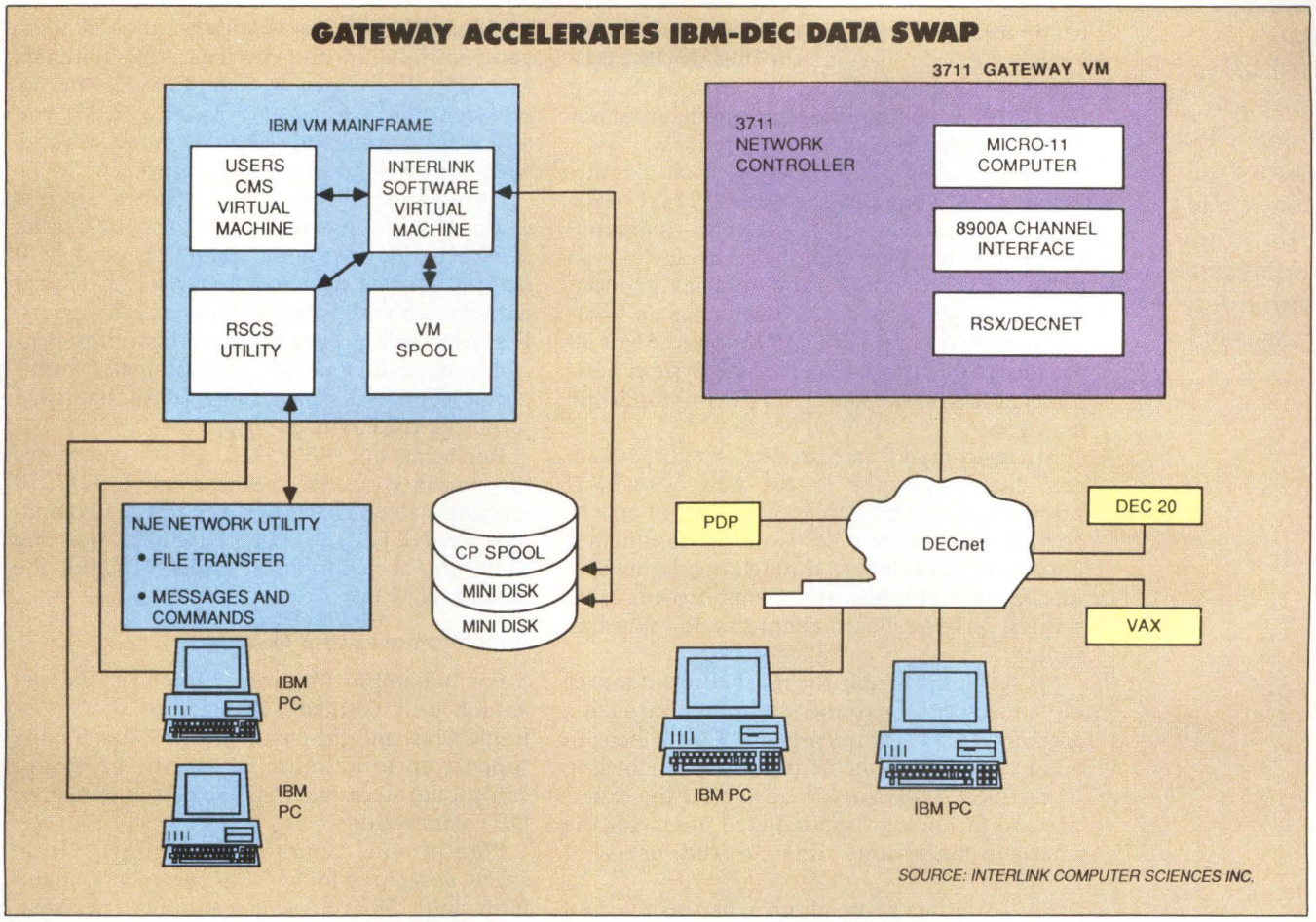
The company's IRMALAN APA Graphics Workstation software enables a PC to display host applications written for the IBM 3179/G terminal and the 3270 PC/G and 3270 PC/GX that use the graphical data display manager (GDDM) 4.0 package. Users can store host graphics images on the PC or send them via the computer graphics interface (CGI) and virtual device interface (VDI) standards to a variety of printers or plotters.

Gateways to versatility

Hot-key capability enables users to switch among five concurrent host sessions and between MS-DOS and terminal-emulation modes. The package supports several of the company's file-transfer programs providing access to IBM mainframe time-sharing option

Replacing an IBM 3247 *cluster controller, Proteon's Network Interface System provides fast, full-screen response for 3270 terminals attached to a mainframe with the company's ProNET-10 or ProNET-80 LAN.*





(TSO), conversational monitor system (CMS) and multiple virtual-storage/time-sharing option (MVS/TSO) environments.

IRMALAN SDLC (synchronous data link control) Gateway and DFT (distributed function terminal) Gateway hardware and software give PCs on a LAN remote and coaxial access, respectively, to the mainframe via a gateway PC. Emulating a 3274 communications controller, the SDLC gateway supports up to 32 concurrent host sessions. It uses a half-height card in the PC to connect to a synchronous modem attached to an IBM 3705 or 3725 front-end processor. The latter connects a card in the gateway PC via coax to a DFT port on an IBM 3274 controller.

Emulator vendor CXI Inc. emphasizes the advantages of its consistent application program interface (API) and user interfaces on all its micro-to-mainframe products and also the ease of upgrading its standard emulator hardware and software with gateways to LANs.

Take, for example, the PCOX/Gateway Coax upgrade or PCOX/Gateway 16 upgrade. Because they are soft-loaded (via flexible disk), they require neither changes in programmable ROM nor local or remote emulator boards in IBM PCs to enable the PCs to serve as gateways to NETBIOS-compatible LANS. The Gateway 16 upgrade provides 16 host sessions for PCs on the LAN.

These products, and the equivalent standalone hardware and software packages, work with PCOX Gateway-WS workstation software installed in each PC on the LAN. Emulating 3278/9 terminals, 3270 PCs and 3287 printers, the workstation package furnishes concurrent windowing of up to five host sessions, one PC session and two notepads for each PC. Included file-transfer software communicates with customer information control system (CICS), CMS and TSO applications on the mainframe.

Charles Morel, CXI chairman and CEO, emphasizes the benefits of a consistent API and user interface over the company's range of micro-to-mainframe and gateway products. "The keyboard, display and printer control interfaces are all the same," explains Morel. "The advantage is that any application program you have written or purchased that runs in a coaxial environment will run in a remote environment as a workstation LAN gateway. It offers a wide choice of micro-to-mainframe application software and leverage of your existing software investment."

AST Research Inc. takes a somewhat differ-

Two-way full-screen communications *among IBM PCs or terminals connected to an IBM VM mainframe and various DEC computers is furnished by Interlink's 3711 Network Controller and associated software, part of its 3711 Gateway (VM) product.*

'A LAN is probably the most efficient means of connecting PCs to the mainframe through a gateway.'

ent approach to SNA/LAN connections. It provides a LAN-5250 emulator link to IBM System 3/X computers—one that enables PCs on the LAN to communicate, without emulator cards, with multiple host computers.

With the AST-5250/Gateway, each gateway PC on a LAN equipped with the 5251/11 Plus emulation card and software can distribute seven 5250 terminal and/or printer sessions to up to 21 other nodes. The gateway product comes with file-transfer software, has an IBM-compatible API for IBM's PC Support 36 or 38 packages and runs on AST's Star System Starlan-type LAN and on NETBIOS-compatible networks.

Micro-to-mainframe product vendors broadcast their strengths in the new SNA-LAN bridge market. They stress their years of experience in refining their 3270- and 5270-emulator hardware and software through upgrading user interfaces, multiple host sessions, hot-key capabilities, 3270 keyboard adapters and other fine tuning.

"A LAN is probably the most efficient means of connecting PCs to the mainframe through a gateway," CXI's Morel argues. "CXI's focus in connecting PCs to the mainframe does not stop where the LAN begins. We can offer the expertise and technology accumulated in serving the micro-to-mainframe link to the users of LANs."

LAN vendors bring another perspective and other strengths to the SNA/LAN gateway arena. They can claim greater familiarity with the intricacies of LAN functions and emphasize fast screen response, without degrading LAN functions but with faster links to the mainframe and—in some cases—fuller emulation of IBM 3270 terminal capabilities.

"If an SNA product is sold by a LAN vendor, you know it will work with the LAN," contends LAN supplier Gateway Communications Inc. president and CEO David McMaster, "If you buy it from somebody else and hope it works with the LAN, you may have a problem."

LAN vendor Proteon Inc. stresses the fast response and full-screen 3270 capability of its 3270 network interface system. Enhanced 3270 features include seven-color graphics, extended data stream and programmed symbol support. Features such as simplified configuration control, remote diagnostics and automatic multiplexer support surpass those of similar IBM products, the company says.

Replacing an IBM 3274 cluster controller, the interface system connects up to 32 3270 terminals to IBM mainframes via the company's ProNET-10 or ProNET-80 LANs. The first runs at 10M bits per second (bps); the second, 80M bps.

Reach remotes at a fast clip

For maximum response, Proteon's Channel Attach unit connects directly to the mainframe's bus and tag channel. LAN Attach units support up to 32 terminals on the LAN with control unit terminal (CUT) ports or enhanced DFT connections.

"We provide remote operation with local speed, compared to the 3274 controller," maintains John Shriver, senior product specialist. "The LAN Attach units provide 70 percent to 80 percent of IBM mainframe channel speed. It's slow to bring up 3270 screens with 9.6K-byte-per-second host links, the speed at which most remote 3270 terminals operate. On the other hand, 56K-byte-per-second connections are expensive. Our product operates two to six

Why system integrators

James J. Mullen, The Orion Group Inc.

Enhancements to IBM Corp.'s Systems Network Architecture, LU 6.2 (Logical Unit 6.2) and PU 2.1 (Physical Unit 2.1) constitute a peer-to-peer communications protocol that permits application programs on diverse computers to directly exchange data without host-computer intervention.

A device-independent protocol, LU 6.2 enables computers under SNA to send and receive data, start and stop execution of remote applications and perform error recovery. A simple, high-level language embodies standard "verbs," such as ALLOCATE, SENDATA, RECEIVANWAIT, to control communications. PU 2.1 provides the lower level protocols necessary for peer-to-peer communications.

IBM is committed to LU 6.2 as its basic strategy for implementing program-to-program communications in future products and has configured the standard on nearly all of its processors. Other major computer vendors have announced support for the protocol, and its recent endorsement by the International Standards Organization means that future processors on Open Systems Interconnection (OSI) networks will be able to conduct peer-to-peer conversations with processors on LU 6.2-based SNA networks.

LU 6.2 also offers system integrators a number of immediate practical advantages for software development. Applications written directly to LU 6.2 are cheaper to develop, more portable and more robust than those based on proprietary protocols for process-to-process conversations. The protocol is well-specified and complete, making major changes unnecessary. Portable implementations of LU 6.2,

times faster than a 56K-byte-per-second connection to the host."

The 3270 system does not degrade the LAN response, Shriver claims. "When we run load tests, the mainframe runs out of steam in pumping out data before the LAN does. The response is good because the deterministic access of the token ring doesn't undergo collisions or back-offs," as do CSMA/CD (carrier sense multiple access with collision detection)or CA (collision avoidance) products.

Proteon offers a similar system, the ProNET/SNA Gateway, which supports up to 32 concurrent PCs on its ProNET-4 or ProNET-10 LANs running Novell Inc. Advanced Netware/P. Each user can run two concurrent host sessions, and the gateway PC—being non-dedicated—can perform other tasks. An alternative link, the Banyan 3270 SNA option, uses a network file server to support 64 simultaneous host sessions and has dynamic network reconfiguration capability.

Broad support for Ethernet LANs

Bridge Communications Inc. spotlights the wide range of terminals and terminal-emulation and file-transfer programs its enhanced EtherTerm 1.2 software supports for PCs on Ethernet (IEEE 802.3) LANs. Emulation programs tested with the package mimic terminals from Digital Equipment Corp. (VT52, VT100, VT220), Tektronix Inc. (4105), Hewlett-Packard Co. (HP 2392) and Data General Corp. (Dasher 210).

The program replaces the PC's basic input/output system's interrupt 14H interface routines with its own interface and uses the Xerox Corp. XNS (Xerox Network Systems) protocol. It permits PCs to access asynchronous ports, X.25-based public data networks and pooled modems in addition to 3270 SNA sessions.

Ethernet LANs running TCP/IP (transmission control protocol/internet protocol) are not excluded from 3270 connectivity. Based on those protocols, Bridge's TCPTerm software allows linked PCs attached to the network with a 3Com Corp. EtherLink controller board to transfer binary and text files (under the ARPANET file-transfer protocol), emulate DEC VT100 terminals and communicate with an IBM host via a CS/1-SNA communications server.

Four concurrent host sessions under the control of a DOS-compatible multitasking executive plus entry to IBM DISOSS (distributed office support system) services are provided by Ungermann-Bass Inc.'s enhanced Net/One 3270 PC package for PCs on its Net/One LAN. Emulating many 3270 and DEC VT100 terminals and 3287 printers, it controls four concurrent terminal and printer sessions and two asynchronous terminal sessions while running DOS-based applications. Support of the IBM 3270 PC Control Program Version 2.1's API allows users to run IBM Personal Services/PC for access to DISOSS services as well as Linkware Corp.'s PC Connection program.

If you want to run your PCs on a LAN running PC/MS-DOS 3.1/3.2 and IBM PC Network-compatible applications, consider 3Com's solution. The 3+3270 package installed in a network server PC on the 3+ network emulates the 3274 cluster controller, 3278 and 3279 (color) terminals and the mainframe model 3287 model 2 printer. It allows local and remote mainframe access for file transfers and transaction processing.

Many companies still rely on the 3770 batch-

LAN vendors claim greater familiarity with the intricacies of LAN functions in promoting gateway products.

can't afford to ignore LU 6.2

such as The Orion Group's sna 62 peer-communications facility, can be bought off-the-shelf to speed the development of LU 6.2-based programs.

In addition, LU 6.2-based applications will migrate readily across the entire range of IBM processors from PCs to mainframes, and porting them to non-IBM processors will not entail significant restructuring of the standard interface.

In contrast to communications based on LU 2, such as conventional 3270 emulation sessions using 1,920-character screens, LU 6.2 sessions can contain characters of almost any length and in any format. With no required record size and no device-specific document-formatting code, network overhead is considerably reduced.

Finally, LU 6.2 supports communications over a wide variety of media—including leased and dial-up phone lines, Token-Ring Network and Ethernet local area networks and X.25 links—without inherent restrictions on the data-transmission rate.

Because LU 6.2 allows network managers to choose the most economical transport medium for each segment of a network, the managers can achieve significant network cost reductions without degrading performance.

James J. Mullen is vice president of sales and marketing at The Orion Group Inc., Berkeley, Calif., which develops OEM SNA software.

transfer protocol instead of SNA/SDLC-3270 links, especially for high-speed remote transfer of data after business hours. The G/SNAnet package from Gateway Communications supports interactive batch transfer from IBM mainframes with remote job entry (RJE) workstations connected to the company's Novell Netware-based G/NET PLUS LAN. The product also stands out in supporting multiple LAN gateways independently of file servers and multidrop lines.

"Having one product with both 3270 and 3770 capabilities is an advantage," maintains Gateway's McMaster. "SNA users might use batch processing 10 percent of the time. But when they use it, they use it a lot, particularly at night to save on-line charges."

Custom command scripts, pop-up menus and API ease file transfers; the non-dedicated PC server uses an Intel Corp. 80186-based communications card. Each PC on the net can access up to four 3270 or 3770 sessions. The company plans to make the G/SNAnet software capable of running on any Netware-based LAN or on the IBM Token-Ring, McMaster says.

Customized remote micro-to-mainframe applications are promised by Integrated Network Systems Inc. using its SDLC Gateway PC Adapter's API. With the board and software installed in gateway PCs, system integrators can implement automatic log-on, transaction routing and store-and-forward functions for other PCs on a NETBIOS-compatible LAN.

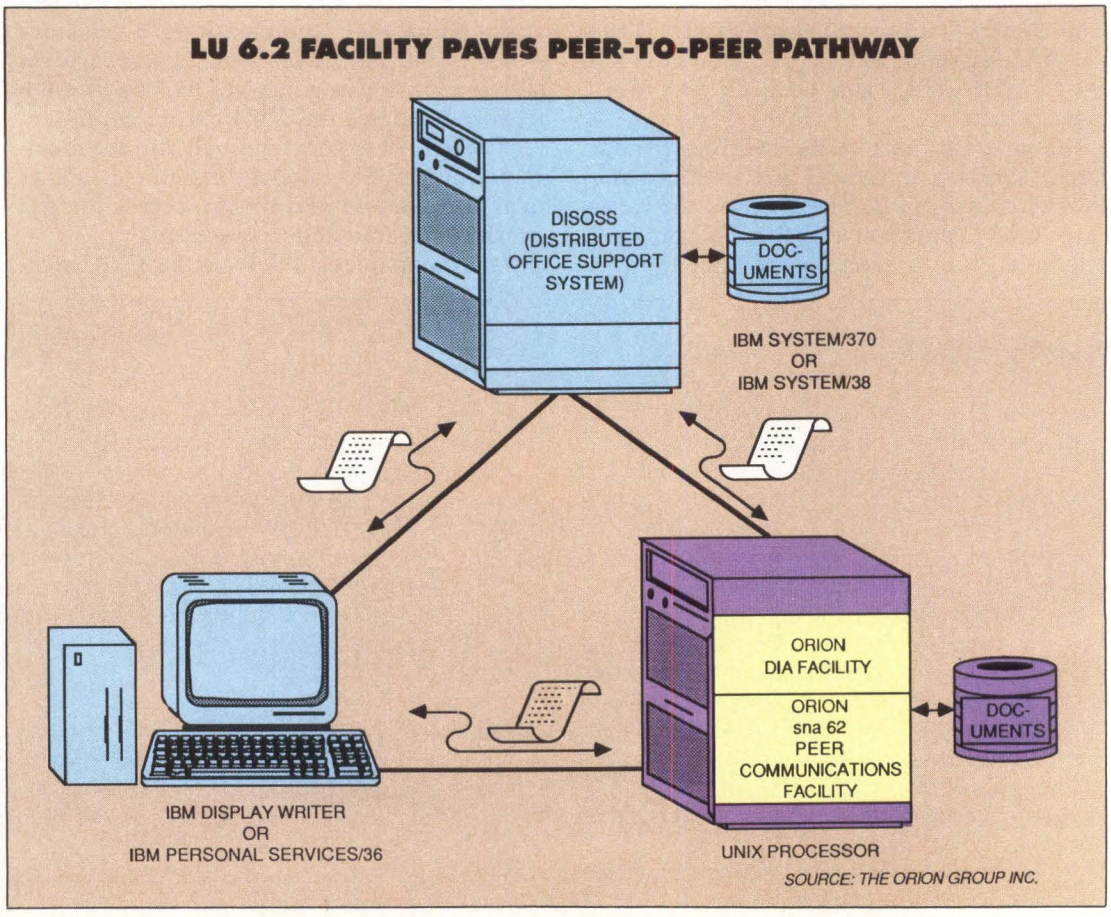
If you don't want to bother with plug-in boards and software for your micro-to-mainframe links, Telex Computer Products Inc. offers 1260 and 1280 Intelligent Workstations with integrated 3278/9 (coaxial) and 3276 (remote) support and mainframe file-transfer options. They can function as communications servers, diskless workstations or zero-wait-state 80286-based PC/XT or PC/AT computers on a LAN.

Run high-end graphics

Many users demand high-end EGA (enhanced graphics adapter)-type graphics on LAN and mainframe-linked PCs, and products from Grafpoint and Ungermann-Bass fill this need.

Supporting IBM's EGA and AT&T Co. and IBM CGAs (color graphics adapters), Ungermann Bass' Net/One 3270 PC Graphics package allows PCs linked to the company's Net/One LAN to run four concurrent 3270 graphic sessions with software such as the IBM GDDM, SAS Institute's SAS/Graph and Integrated Software Systems Corp.'s Tel-A-Graf.

Access to mainframe DISOSS *services and peer-to-peer communications is afforded by Orion's DIA Facility and sna 62 software for applications running on UNIX processors and LU 6.2-compatible packages on IBM PCs.*



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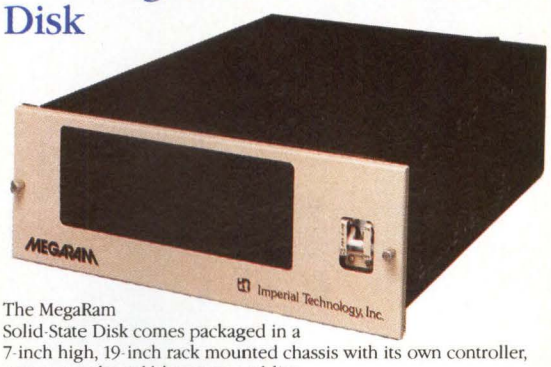

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For demanding applications, Grafpoint's TNET-05 software allows PCs on a LAN to emulate Tektronix 4105 and 4107 color graphics terminals with a device driver processing the terminals' commands under MS-DOS. The 4105 version takes up only about 100K of RAM, and both versions allow users to hot key between graphics and DOS sessions.

Grafpoint's future plans include a version of TNET, emulating the high-end Tektronix 4115, and a coax version linking to SNA networks via a gateway. The company also will offer a package allowing a PC/AT equipped with Tektronix's new SGS 430 stereo color graphics system to emulate a Tektronix 4107 terminal, says Grafpoint CEO Charles Lingel.

Move up to DEC-IBM links

Effectively linking IBM and DEC VAX computer systems with LANs might require more sophisticated, flexible and higher level software-based solutions. Xyplex Inc., for example, offers the distributed Network Processing System, based on a host interface unit, PC controllers, remote gateways and distributed-network processors.

With system software residing in the DEC VMS operating system, it can, the company claims, link IBM and DEC computers and terminals to almost any LAN or wide-area network, including those based on Ethernet, thin-wire Ethernet, CATV broadband or optical fiber.

PC XPANDER hardware and software allows VAXes and PCs to control and execute each other's applications. VAXmail can be run from MS-DOS or data on the VAX can be downloaded into Lotus Development Corp.'s 1-2-3 on a PC, and execution of the program can be initiated from the VAX.

Interlink Computer Sciences Inc. emphasizes similar two-way communications between DEC and IBM environments for its 3711 Gateway in virtual machine (VM) or multiple virtual storage (MVS) versions. They have the additional advantages of direct application-to-application communications, transparent data transfer and full-screen emulation of a DEC VT100 or VT220 terminal on an IBM PC or 3278 terminal.

"You can use the standard IBM file-access procedure to access a DEC file and use standard DEC procedures to access an IBM file," asserts Interlink president Lambert Onuma. "You write the same code to access a DEC file via DECnet as you would to access a VTAM file on the IBM mainframe. With full-screen DEC terminal emulation on an IBM 3278 terminal, as opposed to the line-by-line capability of some products, you can emulate DEC applications like All-In-1, the Editor and videotex."

Onuma claims his product's bilateral full-screen capability, file access to the record level, program-to-program communications and 500K-byte-per-second throughput give it advantages over DEC's SNA Gateway. "With our product, a guy at a terminal has good response time. Going at 56K bytes per second [to a host computer] for terminal emulation is too slow."

LU 6.2 lacks implementations

IBM's LU (logical unit) 6.2 and advanced program-to-program communications (APPC) protocols, plus associated lower level transport mechanisms, will play an increasingly important role in micro-to-mini-to-mainframe and LAN-to-SNA communications (see "Why system integrators can't afford to ignore LU 6.2"). But right now, LU 6.2 is mainly talk and little action.

LU 6.2's current status is defined by four key words: applications, demand, standards and IBM. Without applications, LU 6.2 remains just a potentially powerful protocol. But demand is necessary to spur applications, and most industry observers see little demand.

"There are a lot of our customers talking about LU 6.2, but none saying they would buy LU 6.2 capability if we had it," says Gateway Communication's McMaster. "We have developed LU 6.2 capability on our 80186-based communications-controller card. But we haven't found any applications to warrant putting it on our networks."

Onuma agrees: "I haven't seen many users doing program-to-program communications. The applications aren't set up that way." He contends that confusion among users and system integrators about the great diversity of micro-to-mainframe products—LU 6.2 in particular—is impeding acceptance.

Part of the confusion about the protocol concerns lower level links and much of the rest, some experts assert, stems from IBM. Some products billed as providing LU 6.2 capabilities support only the older physical unit (PU) 2.0 functions and not PU 2.1, which is necessary to fully implement program-to-program communications as well as multiple sessions and multiple links between devices.

IBM's announced support for the enhanced connectivity facility (ECF) architecture, and the latest incarnation of LU 6.2—distributed data management (DDM) architecture linking PCs, System 3/Xs and CICS on 370 mainframes—only serves to muddy the waters further, many observers insist.

In any case, many of the functions promised (and not yet delivered) by ECF, such as creation of mainframe virtual disks, PC access to main-

Effectively linking IBM and DEC VAX computers requires sophisticated, flexible and higher level software-based solutions.

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frame databases and automatic downloading and conversion into popular PC file formats such as DIF (document interchange format) and worksheet, have been offered for years by micro-to-mainframe software.

"I think everybody is waiting on IBM. It will set the tone on how popular LU 6.2 is going to be," maintains Gateway's McMaster. "But there are some loose ends in the strategy. They haven't got it all together yet."

Software integrates LU 6.2

System integrators don't have to wait for IBM, however, to integrate LU 6.2 functionality into their applications. They can use The Orion Group Inc.'s DIA (document interchange architecture) Facility or Network Software Associates Inc.'s (NSA) AdaptSNA LU 6.2/APPC.

An enhancement to the company's sna 62 Peer Communications Facility, DIA Facility contains a set of C language function calls. They allow an application to access IBM mainframe DISOSS/370 library and distribution services. A PC running an IBM package with LU 6.2 capability, such as Personal Services/36, can have similar access and exchange data.

NSA's AdaptSNA package implements both basic and higher level mapped LU 6.2 verbs. The companion AdaptSNA LU 6.2/ASSIST tool kit eases program development with an application shell, interactive learning/simulatiion facilities and high-level language interfaces to C and BASIC.

Orion president Paul Rampel spells out the advantages of LU 6.2-based programs for PCs on a LAN linked to a host computer. "LU 6.2 offloads host processing, such as formatting, to the PC. And throughput is increased because less data has to go back and forth between the PC and host."

For the future, expect LU 6.2 functionality on a chip for advanced workstations, SNA-OSI (Open Systems Interconnection) links using the protocol and an increasing number of LU 6.2-based 3270 and 3770 emulator products. For example, Orion is developing the latter two types of products via development agreements with, respectively, Retix and Xicom Technologies Corp.

The SNA-OSI gateway will permit transparent messaging between OSI-based X.400 store-and-forward services and SNA-based messaging under SNADS (SNA distribution services) and DISOSS through address translation and message formatting. Rampel says the LU 6.2-3270 and -3770 product will ease the transition to LU 6.2 by providing simultaneous LU 6.2 and conventional 3270 emulator functions via support of lower logical units (0, 1, 2, 3) and physical units (2).

Rampel expects long-awaited LU 6.2-based applications from major personal computer software vendors—as well as distributed databases grounded on the protocol—by the end of 1988 or early 1989. CXI's Morel foresees LU 6.2 products much sooner from micro-to-mainframe link vendors—beginning in the second half of this year.

Ultimately, what the protocol represents to both micro-to-mainframe and LU 6.2 product vendors is almost as important as the capabilites it promises: A welcome step toward standardization in a chaotic and confusing market. □

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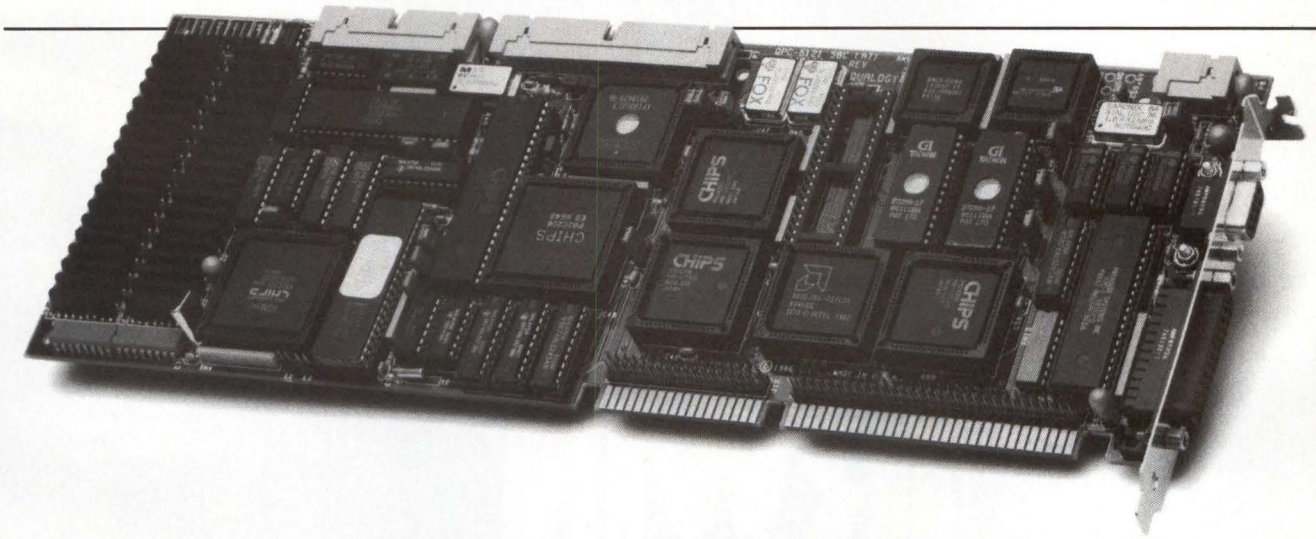

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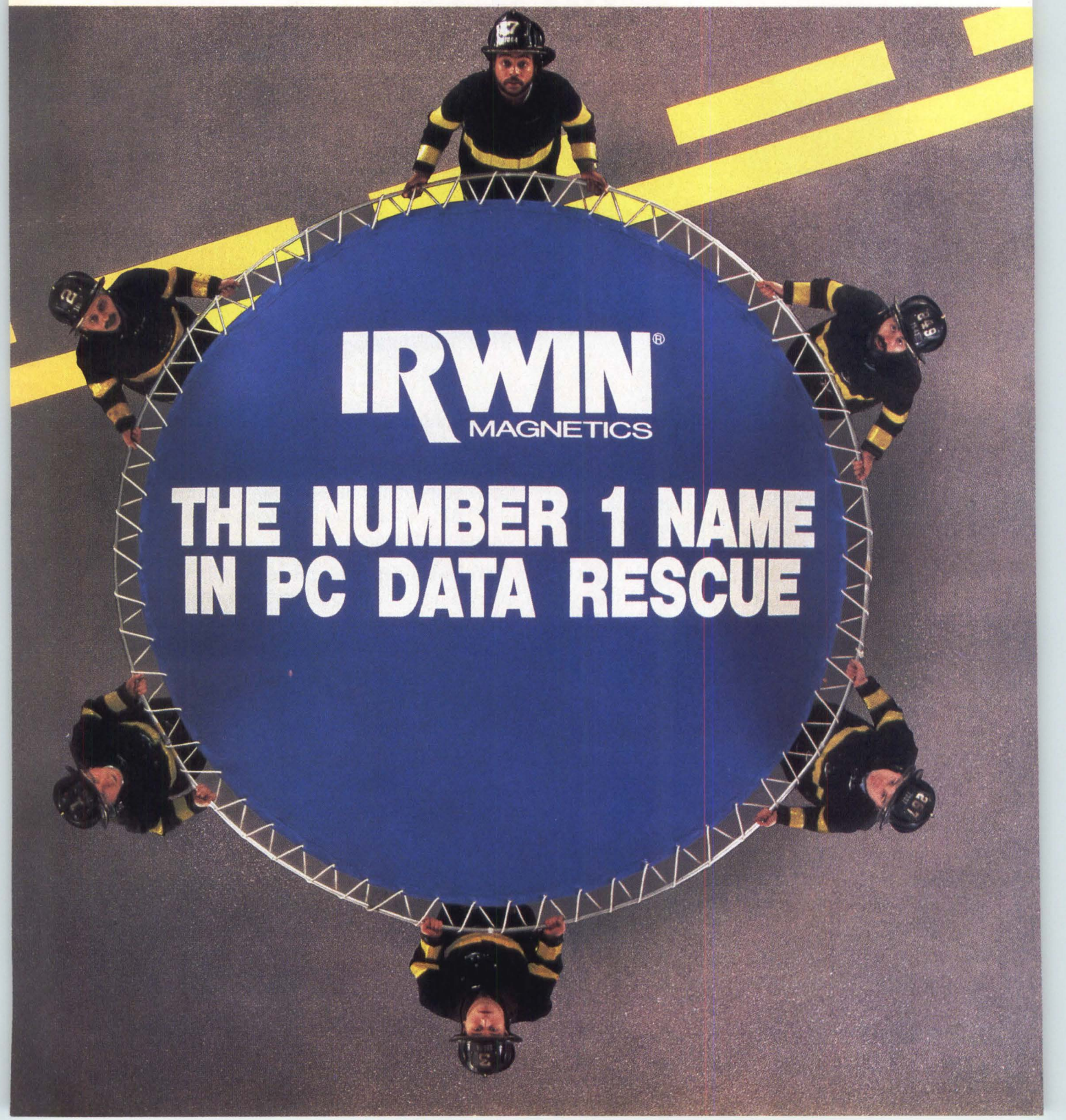

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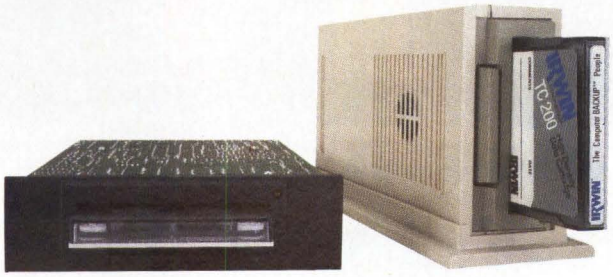

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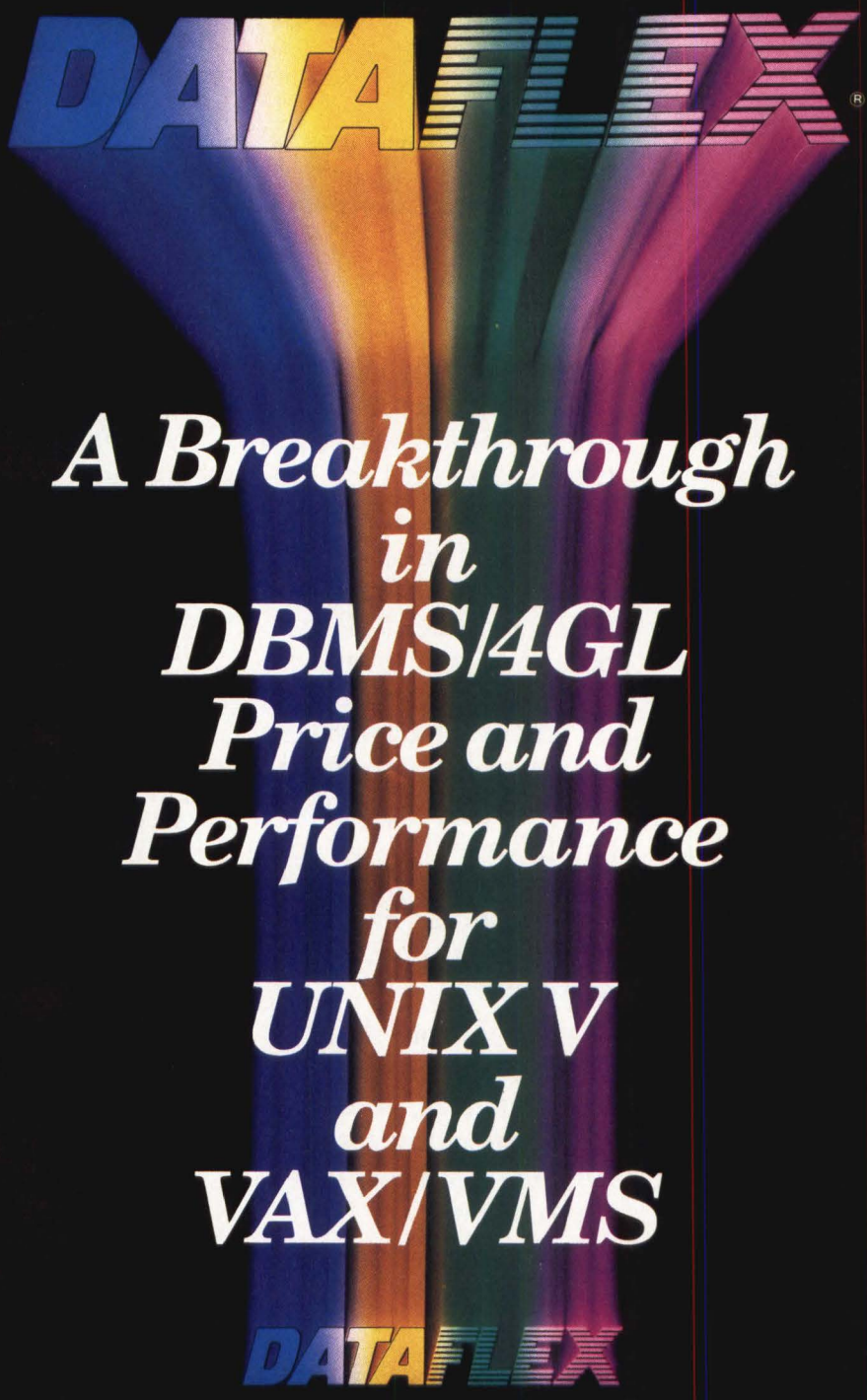

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MULTIPROCESSORS BOOST SYSTEM POWER

By often outperforming uniprocessor minicomputers, multiprocessors can bolster OEMs and system integrators against traditional market giants

Andrew Allison, Contributing Editor

Intensified competition in conventional computers and forecasts of billions of dollars in sales are attracting more and more suppliers to the multiprocessor market. However, early participants have had mixed results in penetrating this midrange market segment, and several have gone out of business.

System integrators and OEMs should be aware that suppliers use the term multiprocessor rather loosely to describe a broad range of system architectures. The scheduler-driven execution of many tasks on a single processor, for example, is often (incorrectly) identified as multiprocessing, rather than multitasking.

Multiprocessor systems are optimized for multiple job throughput. Parallel processors, in contrast, focus on the execution of single jobs. Both, however, employ a number of processors, and the prospective buyer should be more concerned with performance and cost than with what often amounts to architectural semantics.

Multiprocessors are defined here as systems that support a minimum of four processors. Although the same hardware and software implementation strategies apply to both 16- and 32-bit systems, bus bandwidth and address range requirements make 32-bit systems much more attractive for multiprocessor designs.

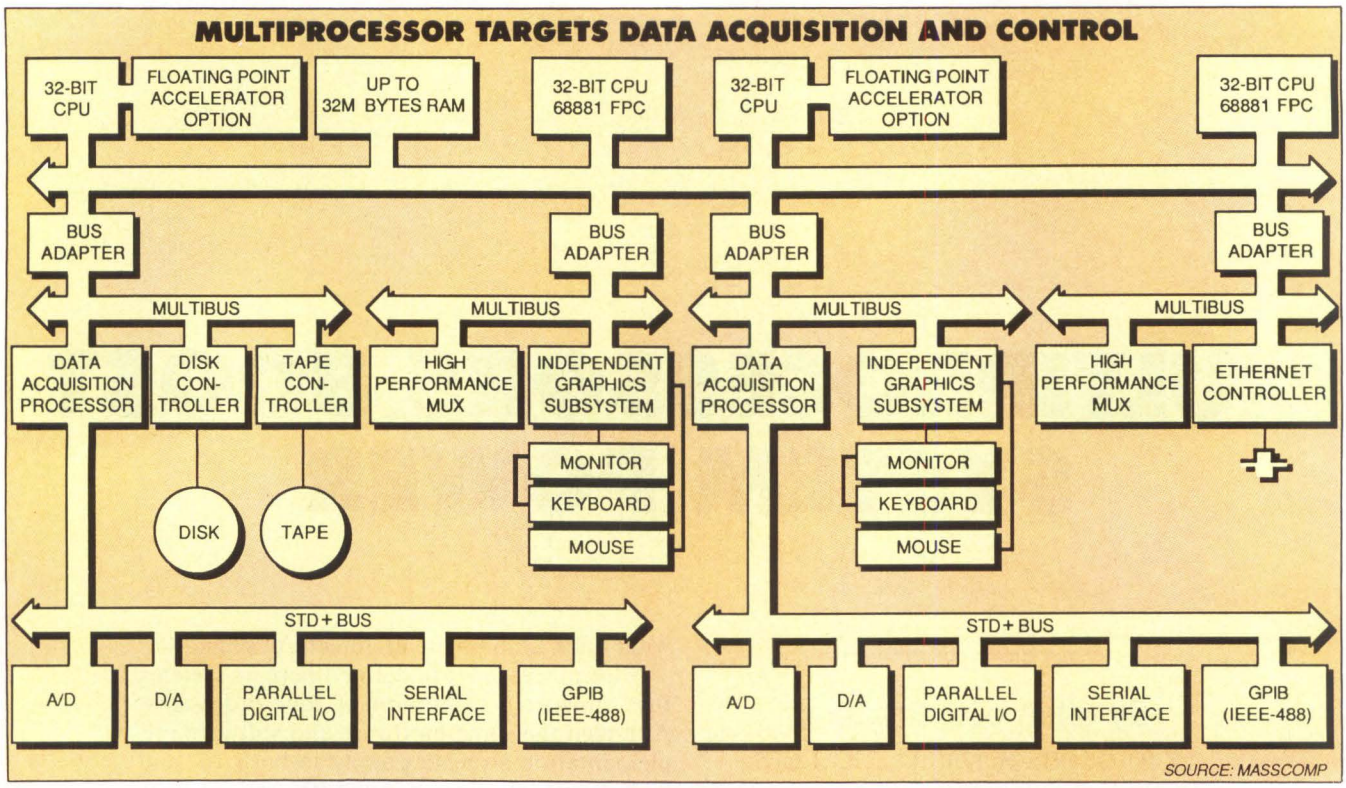
What are the common threads?

Available from numerous suppliers, multiprocessor systems make use of merchant market microprocessors (predominantly the Motorola Inc. MC68020) and established superminicomputer architectures. Most systems are tightly coupled; in other words, the processors share common memory and a single copy of the operating system. On the other hand, the processors in loosely coupled systems have individual copies of the operating system in local memory.

Operating systems for multiprocessors are typically UNIX-derived, with many suppliers offering a choice of System V or Berkeley Version 4.2 compatibility. Each vendor has its own approach to tuning the operating system for multiprocessor operation. Indeed, among systems based on merchant market microprocessors, this tuning is the chief means of differentiation.

The extent of modification required for existing applications and utility software to run in a multiprocessing environment is an important factor: in fact, buyers should view the need for anything more than recompilation with extreme caution.

Systems designed for the commercial multiuser/multitasking market are usually homoge-



The I/O portion of the backplane *in Masscomp's MC5700 is subdivided into four segments, each of which can accommodate standard Multibus controllers in addition to proprietary data-acquisition subsystems, communications and graphics controllers.*

neous (i.e., they use the same processor subsystems(s) throughout). Many such systems employ separate I/O processors. Those intended for specific applications, of which vector processors are the best known, tend to be heterogeneous. Multiprocessor implementations with UNIX-based front ends (such as Digital Equipment Corp.'s MicroVAX or Sun Microsystems Inc.'s workstations) are beginning to replace the more familiar configurations of superminicomputers with attached processors.

Multiprocessors based on microprocessors divide into three categories: low-end multiprocessors (four to 16 processors), midrange multiprocessors—or multimicrocomputers—(16 to 64 processors) and massively parallel systems (more than 64 processors).

What's available?

Convergent Technologies' S/1280 is a typical low-end multiprocessor. Up to four loosely coupled, 68020-based application processor units (APUs) and multiple, application-specific, Intel Corp. 80186-based I/O processors (IOPs) support up to 128 users. All processors share an 11M-byte-per-second asynchronous system bus.

File processors (up to five per system) each support four ST506 disk drives, and data processors (two per system) interface up to six SMD (storage module device) drives and four half-inch tape drives. The APUs run under Convergent's version of UNIX System V Rel.2, and the company's real-time operating system controls the IOPs.

Areté Systems Corp. takes a similar approach with its family of fault-tolerant systems. Its Series 1000 machines support up to four 68020-based APUs, 12 68000-based IOPs and 256 users. Unlike the Convergent implementation, however, Areté's APUs are tightly coupled, with 8K bytes of onboard cache and up to 16M bytes of shared main memory.

Database IOPs (up to four per system) have 256K bytes of onboard static RAM, and support either four disk drives and one cartridge drive or two disk drives and four half-inch tape drives. Communications IOPs (up to 11) include up to 1M byte of static RAM, eight RS232 ports and a parallel port. Three buses interconnect the subsystems; a 12M-byte-per-second processor-memory bus, a 25M-byte-per-second mass storage bus and an 8M-byte-per-second communications and control bus. Over half of the 1,000 systems delivered in the three years ending last December were remarketed by Sperry Corp. (now Unisys).

Another, better known, fault-tolerant system supplier, Stratus Computer Inc., takes a different approach. Stratus' XA-Series systems (remarketed by IBM Corp. as the System/88 and, outside the United States, by Olivetti) incorporate up to six loosely coupled processor subsystems. Each of these contain two CPU modules operating in sync.

Each CPU module contains two microprocessors, plus comparison logic that removes

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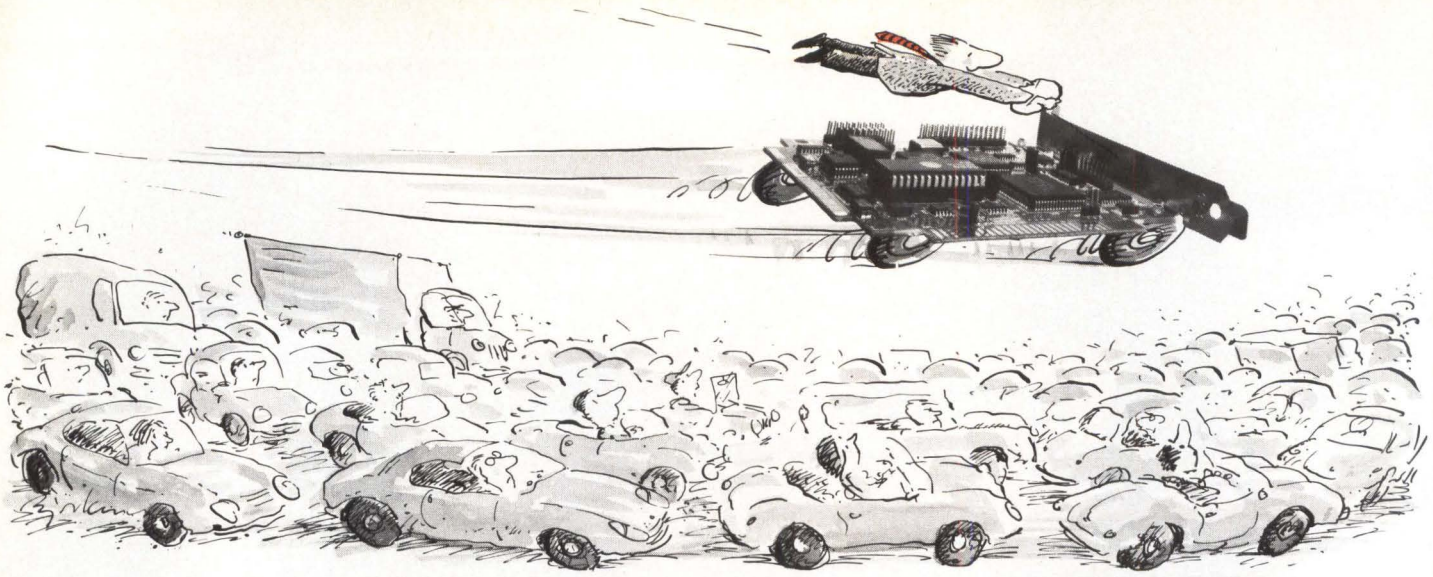

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the module from service and initiates diagnostics in the event of a disparity. Communications and disk controllers, memory and the links between them are also duplexed. Stratus replaced its original, 68010-based product line with 68020-based products in February.

Masscomp targets its multiprocessors at a specific market segment: high-performance, real-time data acquisition and technical computation. The company shipped its first system in November 1982 and its 2,000th over a year ago. The focus on real-time applications, and a timely switch from the original 68010-based product to using 68020s, has kept the company growing in a flat environment.

Masscomp's top-of-the-line MC5700 accommodates up to four processors. The tightly coupled APUs incorporate 8K-byte caches and a 1K-byte TLB (translation lookaside buffer), a proprietary memory-management unit (MMU) and three RS232 ports. A 68881 floating-point coprocessor is standard, but it can be replaced with a standalone floating-point accelerator that triples performance to 3 million Whetstones per processor.

The MC5700 APUs, one I/O bus adapter per APU and up to 32M bytes of shared memory are connected by a 30-slot, 26.67M-byte-per-second, segmented system bus. Each I/O adapter provides a direct-memory access (DMA) Multibus interface. Also available, in addition to the range of conventional I/O controllers, are proprietary subsystems for data acquisition and graphics, and eight-port RS232 multiplexers (eight per system).

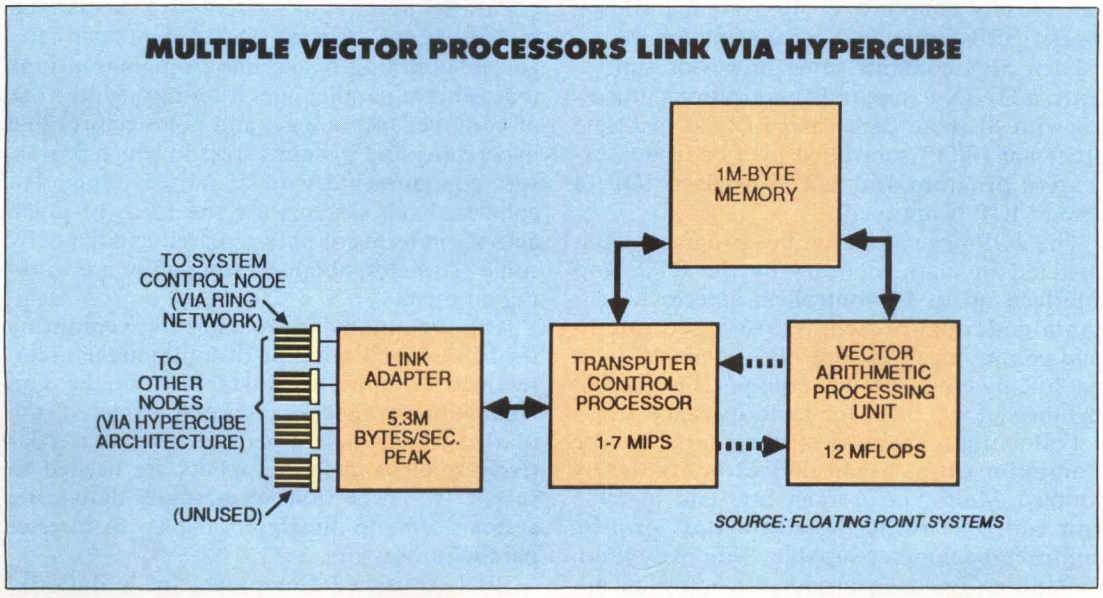
Each system's pair of bit-slice, microprocessor-based, data acquisition and control processors interfaces to two nine-slot STD buses with a combined throughput of 2M bytes per second. Masscomp also offers a range of proprietary analog and digital controllers that enable an aggregate processing rate of 1 million 12-bit samples per second. The operating system supports both UNIX System V and Berkeley UNIX Version 4.2 and is enhanced for real-time operation.

NCR Corp. also has an entry in the microprocessor-based multiprocessor market. The NCR 9800 uses one to eight loosely coupled NCR/32-based APUs, each with up to 16M bytes of local memory. These are linked to one to four shared data storage processors (DSPs) by dual, 3M-byte-per-second channels. The DSPs incorporate from 2M to 16M bytes of battery-backed-up local memory, of which 1M byte is required for system-management software (load balancing, mirroring, error recovery, etc.). Individual APUs handle I/O operations. NCR introduced a 68020-based version of its Tower line in February (MMS, March, Page 33). The Tower 32/800 supports up to four processors in a Multibus II-based system.

Multimicros vie with superminis

Midrange multiprocessors, sometimes called multimicrocomputers (MMS, December 1986, Page 49) achieve superminicomputer and even minisupercomputer performance by combining 16 to 64 processors with memory and I/O subsystems, usually in tightly coupled configurations. Like low-end multiprocessors, they use proprietary system buses, standard microprocessor I/O buses and variations on the UNIX theme.

The best known supplier, Sequent Computer Systems Inc., has installed over 150 of its National Semiconductor Corp. NS32016- and NS32032-based Balance 8000 (two to 12 processors) and Balance 21000 (two to 30 processors) systems since initial deliveries in Decem-



Each processing node *in a T Series system, from Floating Point Systems, includes a high-performance vector processor connected to other processors in a hypercube configuration, and to a system control node via a ring network.*

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Computer	Linpack MFLOPS (64-bit)	(32-bit)
DEC VAX 8800 (2)	2.0	2.7
Sequent Balance 21000 (30)	1.5	2.25
DEC VAX 8550/8700/8800	.99	1.35
Encore Multimax 120 (16)	.5	NA
DEC MicroVAX II	.13	.17
Masscomp 5700	.099	NA
Sequent Balance 8000	.059	.075
Encore Multimax 120	.055	.067

Note: Argonne National Laboratories reports results for single processors. Multiprocessor results, with number of processors in parentheses, are from vendors.

Source: Argonne National Laboratories, Mathematics and Computer Science Division, Technical Memorandum 23, Dec. 8, 1986, unless otherwise indicated.

ber 1984. At press time, announcement of support for another microprocessor was scheduled for this month.

The Balance architecture uses dual-processor modules, each processor having its own floating-point unit (FPU) coprocessor, MMU and 8K bytes of two-way, set-associative cache.

Subsystems are connected by a 26.67M-byte-per-second system bus and a serial link that handles interrupts, semaphores and error management. NS32016-based IOPs (up to four per system) provide SCSI (small computer systems interface) bus and Ethernet interfaces plus two serial ports. Each subsystem supports up to four Multibus couplers. As with all multimicrocomputers, the number of backplane slots (12 for the 8000, 26 for the 21000) is the limiting factor for expansibility.

Tolerant Systems Inc.'s Eternity line is the next most popular of this genre, with 60 installations by the end of last year. As implied by the name, this fault-tolerant implementation can loosely couple over 40 system building blocks (SBBs) via a dual-coaxial interconnect.

Each SBB contains three processor subsystems; a UNIX-compatible applications processor with 8K-byte cache and FPU, a real-time processor (RTP) controlled by a dedicated executive program and a 32016-based IOP (a second IOP is optional).

Suppliers use the term multiprocessor rather loosely to describe a broad range of system architectures.

The IOPs execute channel programs constructed in main memory by the RTP, and interface up to 15 controllers apiece. A self-contained, dual-ported, 32016-based intelligent communication controller connects up to six 56K-byte-per-second serial ports to the I/O channels of two SBBs for fault tolerance.

Following a shaky first two years, Encore Computer Corp. began delivering its tightly coupled Multimax product line late in 1985 and ended 1986 as the third most prolific multimicrocomputer supplier, with over 40 installations. Encore's products employ an approach similar to that of Sequent—two microprocessors per processor card. Encore's system bus—called "Nanobus"—uses separate 32-bit address and 64-bit data paths; and two-, four- and 8-way memory interleaving to provide a 100M-byte-per-second peak throughput.

With the optional Weitek Inc. 1164/1165-based floating-point accelerator, and a standard 64K-byte cache, the Multimax 320 subsystems (up to 20 per system) claim a performance of 2 million Whetstones.

Encore offers two kinds of IOPs: one that incorporates SCSI-bus and Ethernet controllers and one that interfaces three SCSI buses. Each SCSI bus supports four eight-channel disk controllers and a four-channel tape controller. All other I/O takes place via Ethernet connections to 32016-based I/O servers, each with 16 RS232 ports and a parallel printer port. The January announcement of an upgrade to the 32332 implies that Encore stands committed to the 32000 product family.

The fourth member of the original 32000-based multimicrocomputer system suppliers, with 25 systems installed at the end of 1986, is Flexible Computer Corp. The April 1986 announcement of a 68020-based processor module made Flexible the first supplier to offer a truly heterogeneous multimicrocomputer. The FLEX/32 implements a loosely coupled, hierarchical system architecture with three separate buses: local buses that accommodate two processors and/or memory modules, dual synchronous common buses that connect 10 local buses per chassis and an RS422 SelfTest bus that connects all modules in a given chassis. A VMEbus interface on each local bus module (processor or memory) handles all I/O.

Parallel processors stretch the limit

Parallel processing systems are specialized multiprocessor systems. They fall into two categories: common backplane implementations that achieve parallel operation through the use of compiler technology, and architectures like hypercubes and systolic arrays in which processors communicate with a limited number of cohorts. Such systems are the focus of much activity in terms of both research and hype. By some estimates, about 60 companies are working on them.

Although many approaches to overcoming the bandwidth limitation of common bus architectures (frequently mislabeled as the von Neumann bottleneck) are being explored, the market for massively parallel systems is relatively small, and few suppliers are needed to satisfy it. Three that are actually delivering systems serve to illustrate some key features of parallel processors.

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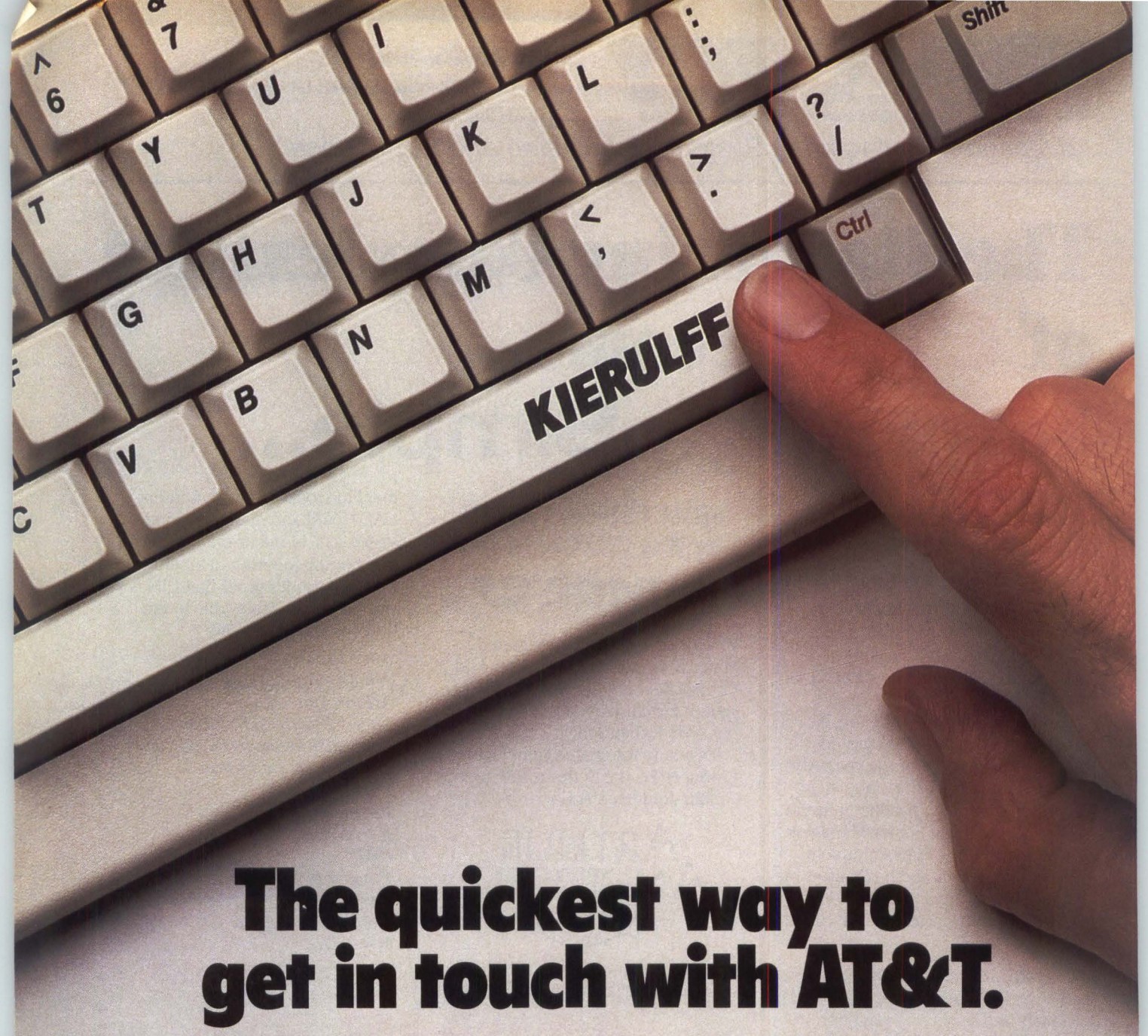

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system, of which there were over 70 installed at the year's end, is an offshoot of parent company Bolt Beranek and Newman Inc.'s many years of experience in multiprocessor-based network switching. It uses packet-switching techniques to directly interconnect multiple processors over 4M-byte-per-second paths that do not require point-to-point connections. Packet switching overcomes a disadvantage of the more commonly employed hypercube architecture, namely, the difficulty of communicating with non-adjacent nodes, at the cost of reduced channel bandwidth.

The tightly coupled Butterfly system is expansible from two to 256 nodes. Each node contains a single-board computer with a 68000 or 68020 processor and up to 4M bytes of shared memory, plus a microprogrammed coprocessor that manages memory references and message transfer. Each node can also accommodate a serial or Multibus controller.

NCUBE Corp., which began deliveries in December 1985 and installed over 50 systems last year, makes use of hypercube architecture. The NCUBE/four provides up to 16 IBM Corp. PC/AT-compatible nodes (providing 30 million instructions per second and 8 million floating-point operations per second) on four four-node modules. The NCUBE/seven accommodates 16 to 128 nodes in a desk-side chassis; and the NCUBE/ten supports 64 to 1,024 nodes in 64-node increments.

Each node consists of a proprietary 32-bit microprocessor with 128K bytes of local memory and 11 pairs of 10M-bit-per-second DMA channels—10 for links to other nodes and one for system I/O. The I/O channel can move data at 90M bytes per second in either direction, for a total bandwidth of 180M bytes per second.

Floating Point Systems Inc., in addition to its range of multiple array-processor implementations (jointly marketed with DEC), offers a parallel-processor line based on the Inmos Ltd. transputer (see "Transputers and occam target concurrent processing"), nine of which were installed during 1986.

Floating Point's T Series systems are organized in a hypercube configuration. Each node consists of a transputer, a vector processor and 1M byte of dual-ported, 160M-byte-per-second shared video RAM. An adapter expands each transputer link to four, providing 16 channels per node.

A special-purpose node connected to all other nodes handles system I/O. In this system node, the vector processor is replaced by a disk

Buyers of multiprocessor systems should view the need for anything more than recompilation with extreme caution.

Transputers and occam target concurrent processing

The occam programming language, developed by Inmos Ltd., is designed specifically for concurrent, or parallel, processing. The language is based on three principles: processes communicate by message passing through explicitly defined one-way channels, do not share variables and synchronize only when communicating. These principles eliminate many problems associated with shared memory (such as contention, and cache and main-memory coherency); permit parallel processes to be remapped from a single processor to multiple processors by simply recompiling the code; and allow program execution to be controlled by the availability of data.

Inmos designed its transputer family of RISC (reduced instruction set computer) microprocessors specifically to provide efficient execution of the occam language. Transputers feature on-chip static RAM, programmable external memory controllers, integral timers and four bidirectional serial (up to 20M-bit-per-second) direct-memory access links, which implement occam channels. Internal memory bandwidth is one 32-bit word per clock cycle (or 80M bytes per second at 20 MHz); external memory runs at up to one-third of that rate.

Inmos introduced its first transputer, the T414, in October 1985. It included 2K bytes of onboard static RAM, and delivered 639K bytes of single-precision (32-bit) Whetstones at 20 MHz using software floating-point operations. In December 1986, the company announced the T800, which incorporates 4K bytes of RAM and a 64-bit floating-point unit. It operates at up to 30 MHz. Inmos claims that the T800 can perform 4 million Whetstones in its initial, 20-MHz implementation.

Occam processes operate on two levels—active and waiting. On a single transputer, active processes run on a round robin basis, with each running to completion or until forced to wait for communication. The number of transputers available is defined at compile-time, and processes are distributed accordingly.

In order to facilitate real-time processing, the active process list is split into high- and low-priority segments, with low-priority segments running only if the high-priority list is empty. Typical response time to a high-priority request is 1 msec, with a 4-msec maximum.

As an illustration of the power of transputer networks, a massively parallel processor employing 311 T414s, Meiko Ltd.'s Computing Surface, runs at 3 billion instructions per second. Upgrading to the T800, which has an integral floating-point processor, is expected to yield 360 million floating-point operations per second. Floating Point Systems Inc., a leading array processor supplier, has also introduced a transputer-based parallel processor product line.

Growth in the multiprocessor segment will likely come at the expense of (and be resisted by) established players.

controller interfacing a front-end processor, currently a MicroVAX-based workstation. Other I/O controllers for the system node are under development.

Supermini makers remain reluctant

Only two of the established superminicomputer suppliers, Concurrent Computer Corp. (formerly Perkin-Elmer Data Systems) and Gould Inc. (formerly S.E.L.) offer multiprocessor systems.

Concurrent's 3200MPS product line tightly couples a 3230XP, 3250XP or 3280 CPU and up to nine attached processors via a 64M-byte-per-second bus, under the control of a proprietary, real-time, multitasking operating system (OS/32). The auxiliary processors are identical to the central processor but are configured (and dynamically reconfigurable) as IOPs or auxiliary processing units. Each 3200MPS has a shared memory interface that permits several 3200MPS systems to access an external shared memory system or to cross-couple two 3200MPS systems.

Like the Concurrent systems, Gould's Concept/32 family of superminicomputers can be configured as asymmetric multiprocessor systems. A 26.67M-byte-per-second SELbus supports up to eight attached processors. Unlike the 3200MPS, however, the Gould systems are loosely coupled, with each processor having its own 16M-byte address space. Thus, different operating systems can be downloaded from the host to the nodes. The multiSEL, announced in January, is a prepackaged, four-processor configuration of the single-board microSEL implementation of the Concept/32 architecture.

Although not classified as general-purpose minicomputers, Tandem Computers Inc.'s NonStop fault-tolerant systems are multiprocessors and fit best within the established superminicomputer category. NonStop systems consist of two to 16 loosely coupled processors connected by dual, 20M-byte-per-second buses. (It can be argued that, for fault-tolerant applications, the added robustness outweighs the cost of the additional physical memory and communications overhead of loose coupling.)

I/O is handled by dual-ported controllers connected to the separate I/O buses of two processors. As the market leader in the fault-tolerant systems area, Tandem has probably installed more multiprocessor systems than the rest of the industry combined.

Technology pat, market dicey

Few technology issues remain unresolved in the multiprocessor field. Loosely and tightly coupled systems of minicomputer and microprocessor-based APUs are available from several suppliers. Dynamic load balancing is now common, and the capability to parallelize tasks is emerging.

Differences between implementation strategies usually revolve around the specific tasks for which the systems are best suited. In general, low-end multiprocessors are used in workstation, network server and multiuser applications, while multimicrocomputers and minicomputer-based multiprocessors compete with superminicomputers. The major questions are the size of the available market and the number of suppliers that it can support.

Of the superminicomputer suppliers, only Concurrent and Gould have fielded multipro-

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Concurrent Computer Corp.
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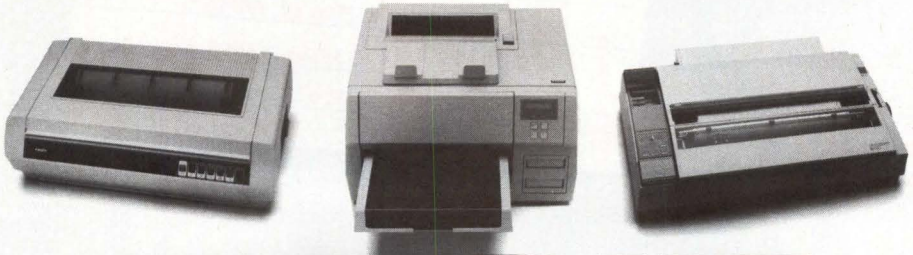

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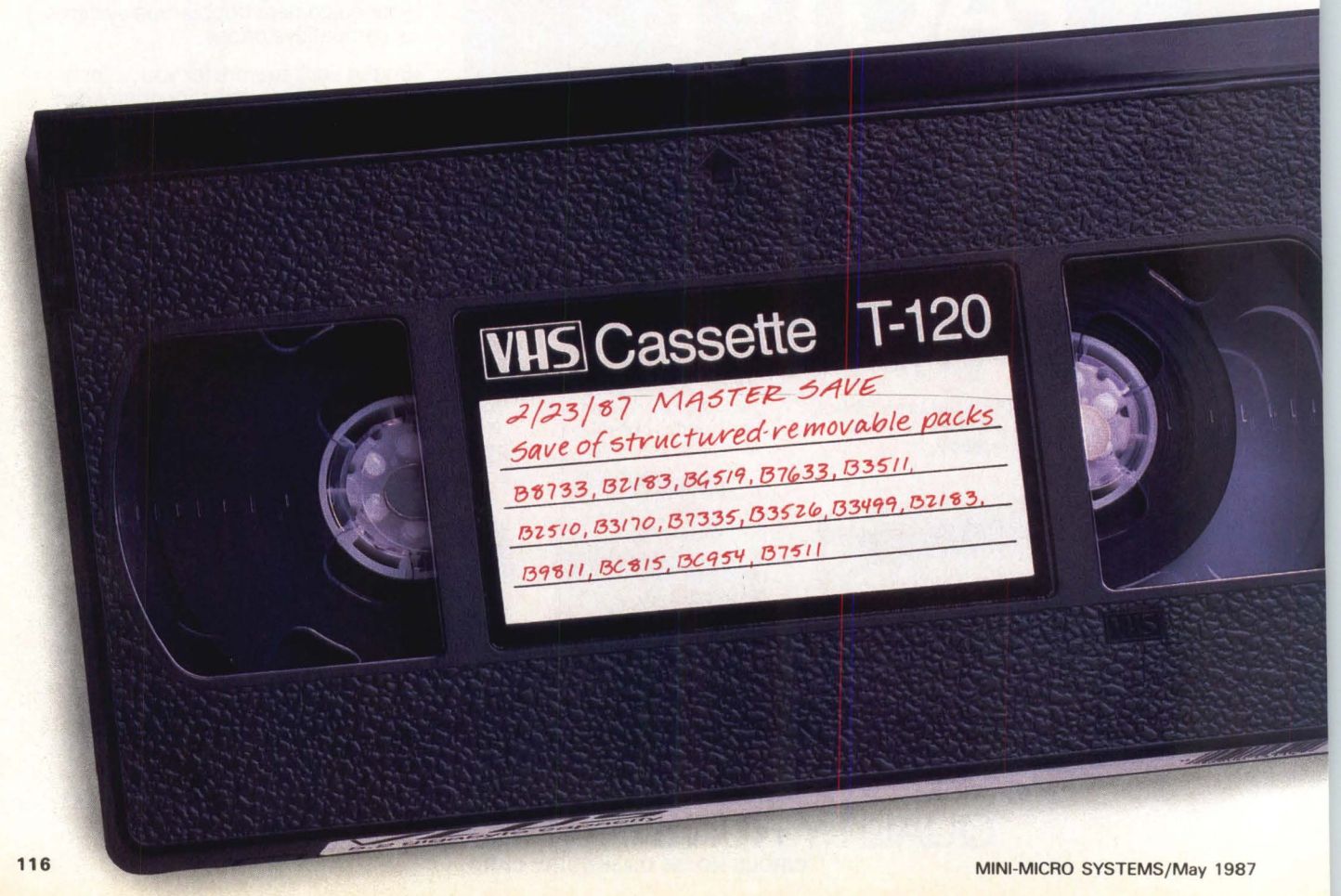

cessors (as opposed to distributed processing configurations like DEC's VAXcluster). This situation probably exists because of the large physical size and cost of processor increments, but also says something about superminicomputer manufacturers' perception of the importance of multiprocessors.

Similarly, in the mainframe market, most participants have chosen to remarket microprocessor-based systems—e.g. IBM-Stratus, Siemens-Sequent, and Unisys (Burroughs-Convergent and Sperry-Areté)—rather than develop their own multiprocessor systems.

The fault-tolerant market segment may exemplify the market as a whole. Despite optimistic forecasts in the early part of the decade, which lured several start-ups and much venture capital into fruitless efforts, the multiprocessor subsegment of the on-line transaction-processing market yielded just over a billion dollars in revenues last year. Most of that went to just two companies (Tandem, $836 million, and Stratus, $125 million).

The consensual forecast for the computer industry as a whole for the remainder of the decade predicts growth of roughly 10 percent per year. If the forecast is right, growth in the multiprocessor segment would presumably have to come at the expense of (and be resisted by) the established players. New market entrants such as minisupercomputer and RISC suppliers will provide fierce competition.

Clearly, a pitched battle will rage (with a high casualty rate) between superminicomputer, minisupercomputer and multimicrocomputer/parallel-processor suppliers for what is now the high end of the superminicomputer market. The flexibility of multiprocessor systems (variable granularity, incremental growth capability and fault-tolerance etc.) suit them well for niche markets and midrange multitasking applications.

Thus, attractive opportunities exist for suppliers and OEMs who clearly establish realistic objectives. For their part, system integrators should employ a few key criteria in making purchasing decisions, i.e. evaluate the fit between application and multiprocessor-implementation strategy, the range of performance required, the price/performance characteristics across the range and the survivability of the candidate suppliers. □

Andrew Allison is a management consultant specializing in minicomputer and microcomputer technology, products and markets. Before establishing his practice in 1977, he had spent over 12 years with Digital Equipment Corp., Rolm Corp. and Advanced Micro Devices.

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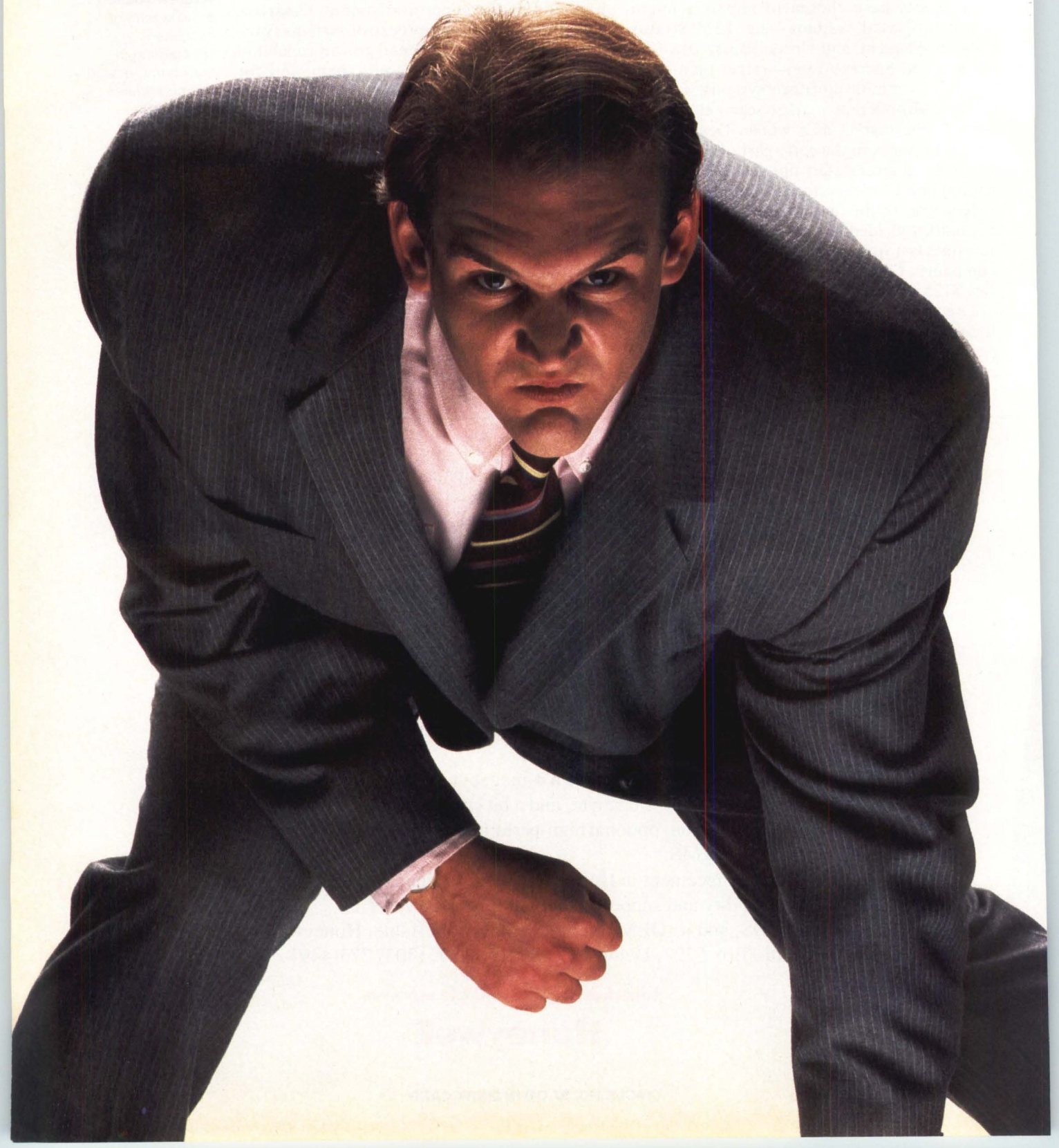

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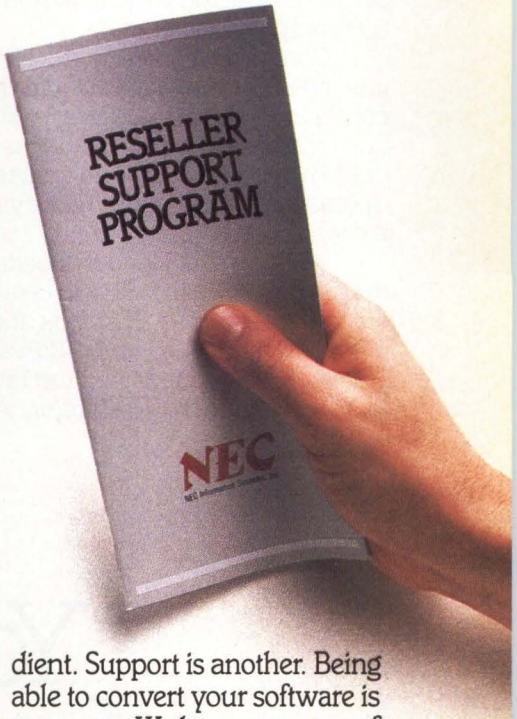

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GRAPHICAL INTERFACE SPEEDS PROGRAMMING

Use of a graphics-based user interface, called 'Picture Programming,' and an application generator accelerates VAX software production

Craig Hill, Cortex Corp.

Programmer productivity is a chief goal of software developers today. One method of decreasing the time—and, hence, the money—that good software development requires is to program in a graphical mode. In this approach, software developers use pictures—icons, line drawings and so forth—to produce complete applications.

One company, Cortex Corp., recently introduced CorVision, which uses a technique called "Picture Programming" to bring this capability to programmers developing software for Digital Equipment Corp. VAXes, including the MicroVAX. It works in much the same way that hardware engineers use workstations and computer aided design/computer aided manufacturing systems to simplify design tasks. That is, application developers sitting at an IBM Corp. PC/AT or compatible (including VAXmate) use CorVision to draw up a complete design for a piece of software. That includes data-dictionary fields, file structures, menus, screens, reports and custom logic. Then, by pushing a button, the developer produces a completely linked and compiled application for the DEC VAX in machine language—and complete system documentation—directly from the drawings.

All of this vastly reduces the time it takes to create an application by hand coding in a language like COBOL. Indeed, a recent estimate based on studies of users of the current Cortex product, Application Factory, which uses much of the same underlying technology, suggests that it may cut the time required by a factor of 10 or more.

In effect, CorVision automates most of the software life cycle. It establishes an integrated design, development and maintenance environment that automatically generates complex, multiuser applications. These applications run on VAX-fami-

DEC uses graphics on COBOL generator

Michael Tucker

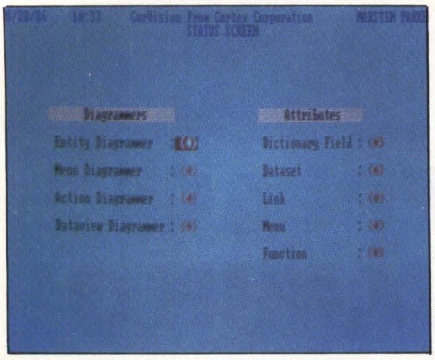
The use of graphics to improve programmer productivity has become a main theme of modern software development. Increasingly, developers are finding that not only is a picture worth a thousand words but also 10,000 lines of code.

One of the premier exponents of the graphics approach is Digital Equipment Corp. Last February, for example, DEC introduced a COBOL generator with a graphics-based interface. The product runs on the VAX and allows developers to use a mouse or cursor keys to create flowchart-like diagrams that are then converted into modules of COBOL source code.

DEC's VAX COBOL Generator is not a fourth-generation language for the computer-illiterate, or even for the computer literate in a great hurry. Instead, it's meant for experienced COBOL programmers who would use the generator in much the same way a senior management-information system (MIS) officer might use an entry-level assistant—to handle the actual, tedious task of coding to specifications already defined by an expert.

As such, the DEC Generator probably addresses the needs of MIS professionals who must work in COBOL but would like some of the advantages of a code generator—arguably this is a different market from the one targeted by Cortex Corp. with CorVision. Yet, in the long run, the larger meaning of the products is the same. Both demonstrate that the majority of computer users, even unusually sophisticated users, are demanding that computers take up the most uncreative, repetitive aspects of software development.

Michael Tucker is a former associate editor of *Mini-Micro Systems.*



Picture Programming *allows an application to be symbolically represented by a series of diagrams depicting the structure and relationship of its components. This and the following screen shots show how CorVision can be used to develop an application. Here, the Status Screen displays red "gateways" into the diagrams and attributes of the application components.*

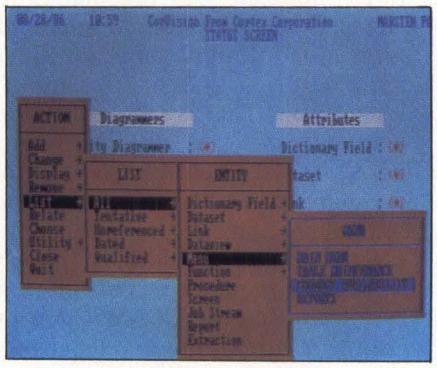
ly computers using the VMS operating system. The product includes an interactive graphics environment that captures the application's design. This graphics environment is resident on the PC/AT or compatible and is tightly coupled through a transparent link to the VAX, where a central repository stores the information captured on the PC and drives an application generator based on Application Factory.

CorVision links front-end diagramming with back-end code-generation capabilities. Today's application-development tools are usually for only one end or the other.

Eliminates hand coding

Most software-production automation tasks so far, have concentrated on the back end of the development cycle. Typical back-end tools include fourth-generation languages (4GLs) and code, or application, generators. 4GLs streamline the coding portion of development through powerful instruction sets with procedural and non-procedural components, data dictionaries and programming and formatting aids. Code, or application, generators automate to varying degrees the laborious process of hand coding. The functionality of the generator output varies significantly among products. Some application generators only generate program modules, which need to be linked by hand. Others generate completely linked and compiled applications.

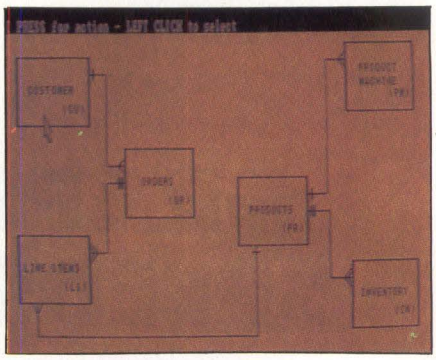
More recently, tools have appeared on MS-DOS machines to automate the front end, or design phase, of the life cycle. Most of these provide an automated drawing board that allows production of numerous design diagrams employing structured diagramming techniques by manipulating symbols and icons. They improve productivity in much the same way as word processing by allowing easy editing and storage of graphic images. None, to date, capture the necessary information in a format usable by back-end tools for code generation.



Opening a gateway *with a mouse, a developer receives pop-up menus that provide on-line access to all existing application specifications. The developer also uses the gateways to navigate among diagrammers and attribute screens.*

CorVision automates the software-development life cycle by capturing the necessary information with the diagrams on the PC to drive a generator on the VAX. The CorVision generator uses the proven technology of the Application Factory to produce complete functional applications. This allows a developer to move directly from visual design specifications or pictorial representations to a complete compiled and linked application.

Both CorVision and Application Factory rely on a tightly integrated series of modules to specify, document and generate applications. An "intelligent guidance system" recommends the next logical step in the design and specification process and interactively keeps track of the completeness and consistency of the specification. In Application Factory, specification occurs by interactively filling in forms managed by facilities on a VAX. The specifications are resident in a central repository, which provides input for an application generator.



The entity diagrammer *allows developers to visually represent the structure and form of the data. Relationships between each of the files are diagrammed using standard diagramming methods.*

With CorVision, in contrast, a developer defines a complete view of the application using Picture Programming techniques. This involves using line drawings, icons, pop-up menus and windows instead of forms. Icons represent application components and relationships. Context-sensitive pop-up menus facilitate direct navigation between specification modules by pointing at "visible gateways" on the screen with a mouse. This visual-development environment provides extremely fast access for viewing and updating parts of an application.

For example, a user points with a mouse to an icon in a diagram that represents a file. A window opens to display the record layout to which it is associated. The user then points to another visual gateway for a field in the record layout and another window opens to display the field definition. The field definition includes a label and such information as the length of the field and whether characters are alpha or numeric, plus field

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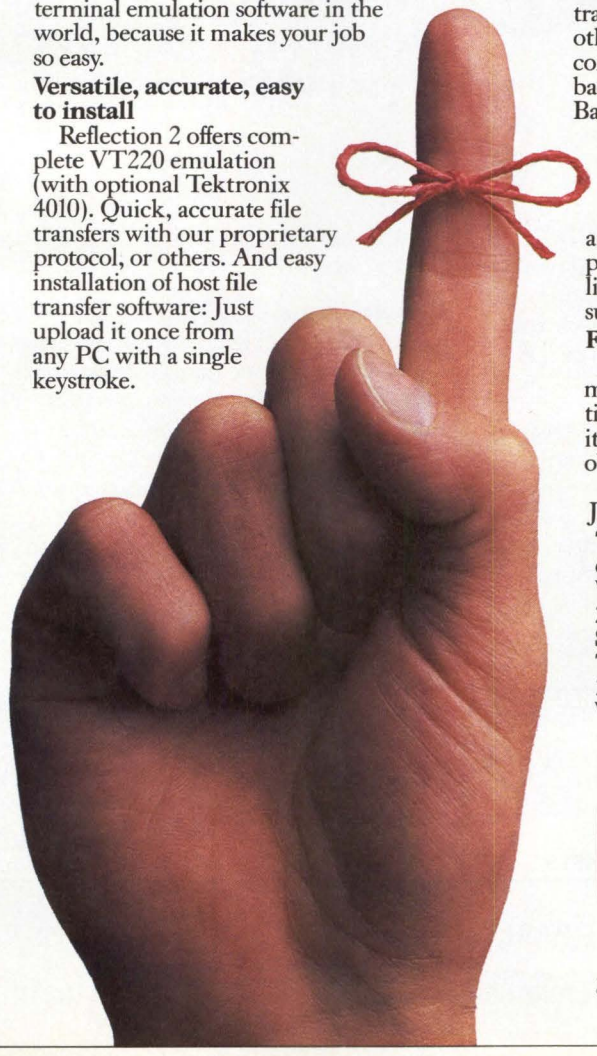

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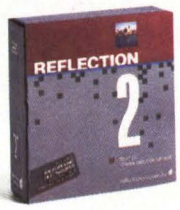

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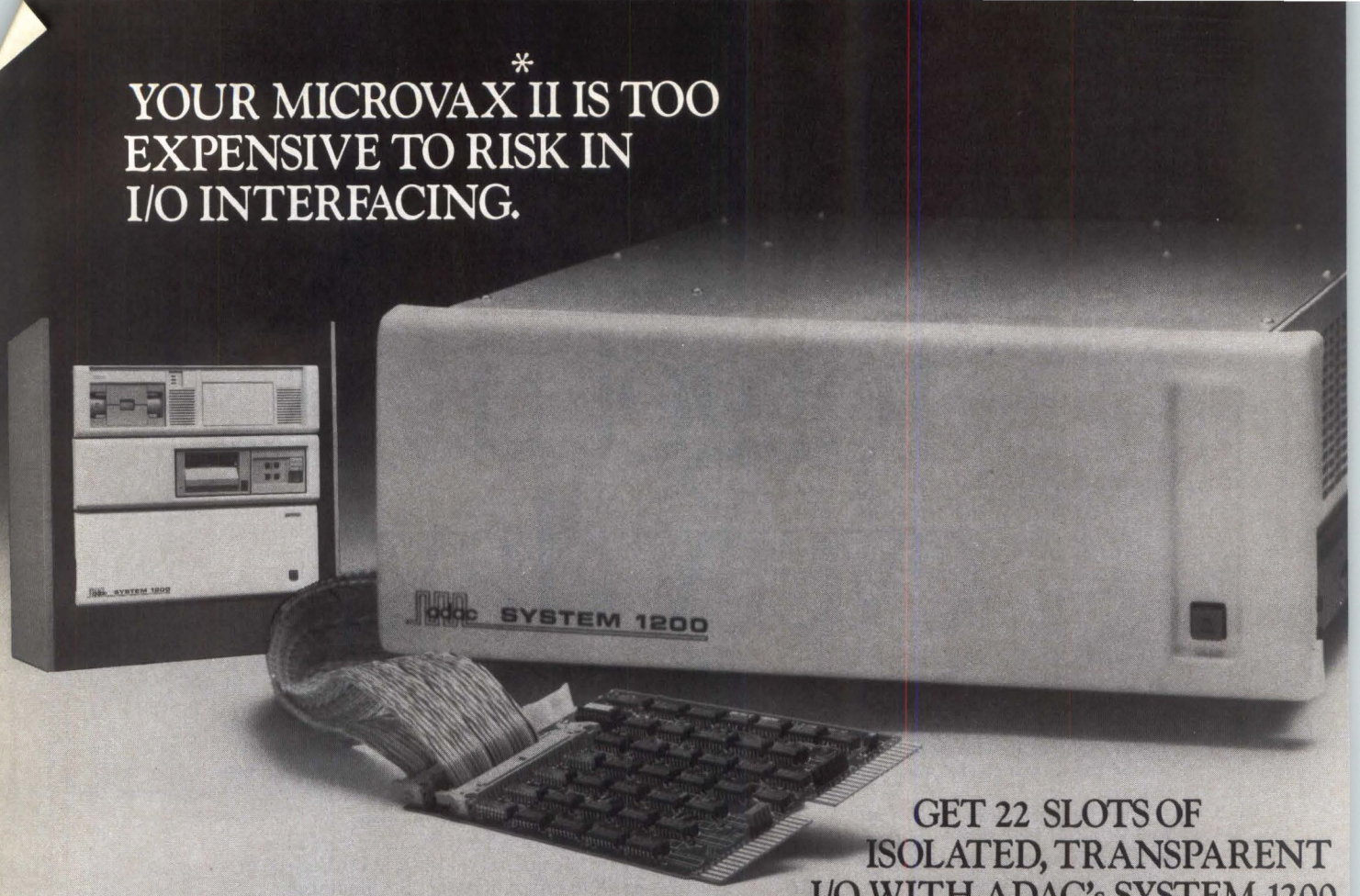

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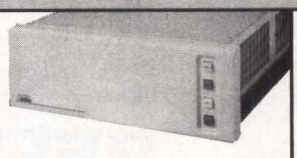
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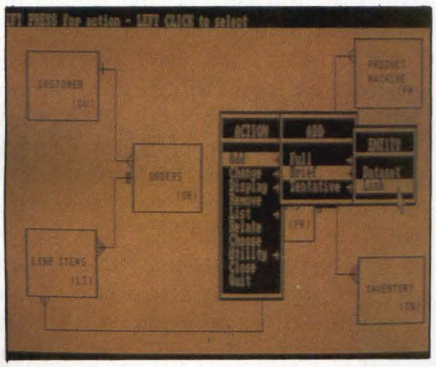
CIRCLE NO. 61 ON INQUIRY CARD

edits such as range checks. The user then edits the definition and returns to the original diagram. The graphic representation of the file is automatically revised to reflect any changes in the definition. Likewise, manipulation of icons directly results in automatic changes to the underlying specification.

The central repository on the VAX stores all the specifications with its changes. It contains the information that drives the format and content of the PC diagrams as well as the input specification for the application generator on the VAX. Because all PCs in a CorVision development environment share the same central repository, changes made by one developer automatically show up on another de-

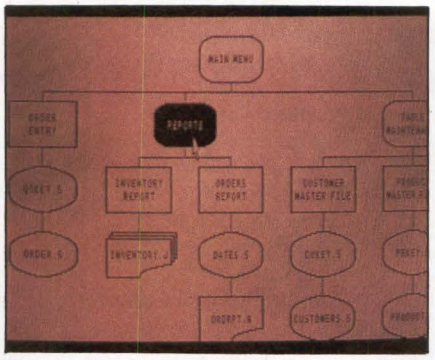


Using the pop-up menus *in the entity diagrammer, the developer can specify the relationships between the various files by defining the link structure.*

veloper's workstation. In this way, the central repository helps maintain consistency within a development team and makes projects easier to manage.

Maintenance becomes a problem

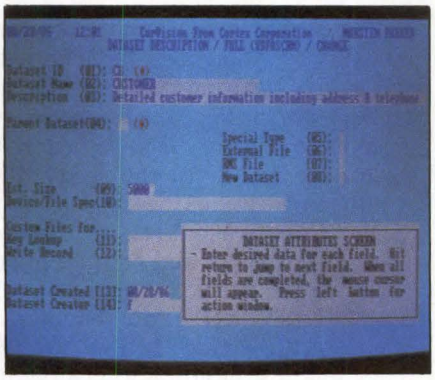
Applications developed with CorVision are maintained in the same way they are developed. Because the description of the application is kept in the central repository, changes are implemented by changing the descriptions. Once again, a developer uses Picture Programming techniques to manipulate diagrams, icons and their underlying specifications. The modifications or enhancements are tracked by the intelligent guidance system and stored in the central



The menu diagrammer *visually represents the logical flow of the application from the user's perspective. Different icons represent menu choices, functions, screens, reports and custom procedures. Additions or changes to the menu diagram result in the restructuring of the application.*

repository. The CorVision generator then regenerates only the affected parts of the application code as well as changes to data and data structures in the production application. Because software maintenance typically consumes 60 percent of the software life cycle, CorVision could significantly improve productivity in this costly and difficult task.

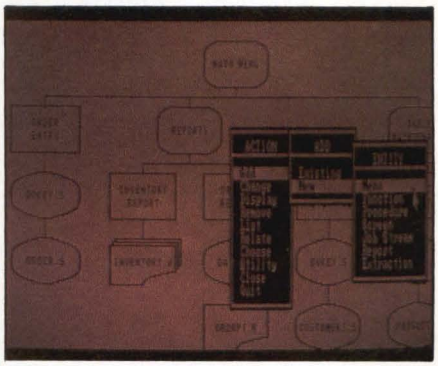
The use of Picture Programming to capture high-level specifications results in the automatic generation of an estimated 95 to 98 percent of the code necessary for a production application. The remaining, customized, code is written in a proprietary



A dataset attribute screen *allows developers to window in on the icon representing a file to display its attribute screen, which defines the details of the structure of the file.*

4GL language called "Builder," or is added from libraries of 3GL routines. Builder programming is done with the help of an additional Picture Programming tool called "Action Diagramming." Action Diagramming structures, visualizes and self-documents the program code interactively as the developer types at the terminal. Syntax, consistency and completeness checks are performed by CorVision, on-line and in conjunction with the central repository and intelligent guidance system.

Custom coding is typically used to add specific procedures, such as check-digit routines and complex cross-field validations. CorVision provides numerous hooks throughout the design and specification process

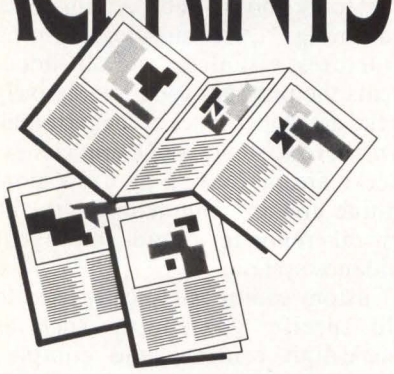


With pop-up menus *in the menu diagrammer, developers can specify the major components and structure of the applications.*

for the addition of custom logic where desired. Hooks insert flags at places in an application where the program executes the custom code. For example, the input of a credit card number in a data-entry screen might trigger a routine to validate a check digit of the number.

CorVision supports the larger theme of an open architecture. It uses DEC's RMS (Record Management Services) file system and, in the near future, Rdb, DEC's relational database software. The product supports VAX clusters, DECnet and standard VMS data types. This means programmers can build applications that share data with other DEC applications. In addition, the generated application can use routines or existing

REPRINTS



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Spec summary

- **Product:** CorVision
- **Company:** Cortex Corp., 138 Technology Drive, Waltham, Mass. 02154, (617) 894-7000
- **Machines supported:** IBM Corp. PC/AT and compatibles and Digital Equipment Corp. VAXes and MicroVAXes
- **Memory requirements:** 640K bytes on the PC/AT, 4M bytes on the VAX
- **Communications supported:** RS232C, Ethernet
- **Price:** $50,000 to $175,000, depending on the VAX model.

program libraries written in any DEC-supported language. This feature facilitates application integration with external devices.

Because the computer generates the code, CorVision applications are bug-free. Automatic compilation to machine code at the time of generation means that the application is efficient. Production applications perform at a level that is comparable to those written in a compiled 3GL such as COBOL or BASIC.

Benchmarks show compression

It is difficult to determine exactly how much CorVision will improve programming productivity. However, much may be inferred from usage studies of Application Factory. These reveal dramatically compressed software development time. For example, a survey completed this year of 26 applications at 22 sites found an average improvement ratio in application-development productivity of 13 to 1.

The survey used function-point analysis, a language-independent measure of programmer productivity, to measure project resources using Application Factory relative to a 3GL such as COBOL. In the study, the number of screens per application ranged from five to 204 with an average of 48. The number of reports ranged from zero to 90 with an average of 17. The average number of files was 37 with a range of four to 108. The smallest application was the equivalent of 8,000 lines of COBOL, while the largest was 250,000 lines. The average was 75,000 lines.

At an E.I. DuPont de Nemours & Co. installation in Camden, S.C., Application Factory delivered a 600 percent productivity improvement in a reimplementation with more functionality. The application, used in a fiber-manufacturing environment, was a tracking application that required interfacing to five external devices used in weighing, packaging and distributing unfinished goods in process. In this case, DuPont received estimates from three development shops of 28, 36 and 38 worker-months. Using Application Factory, the project required two people and only two and a half calendar months, or five worker-months.

Such dramatic productivity increases are directly attributable to automation of a major part of the software development life cycle. CorVision, by adding the visualization of application design to proven generator technology, takes the automation process much further than Application Factory. It makes relationships among various application components easier to understand. Diagrams at the same time convey more information and are a precise medium of communication. An easy-to-use graphical design and specification environment should further enhance the productivity improvements documented with CorVision's predecessor. □

Craig Hill is the president and founder of Cortex Corp., Waltham, Mass. Prior to founding Cortex, he was the director of Eastern Operations at Inforex and held positions at IBM Corp.

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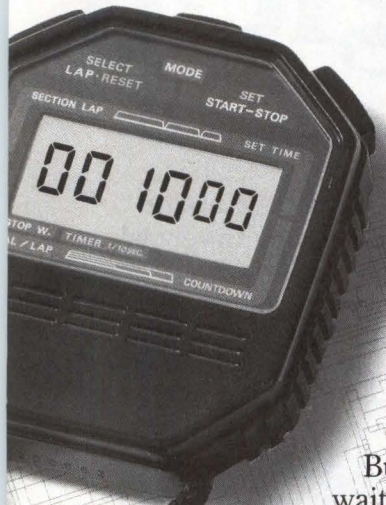

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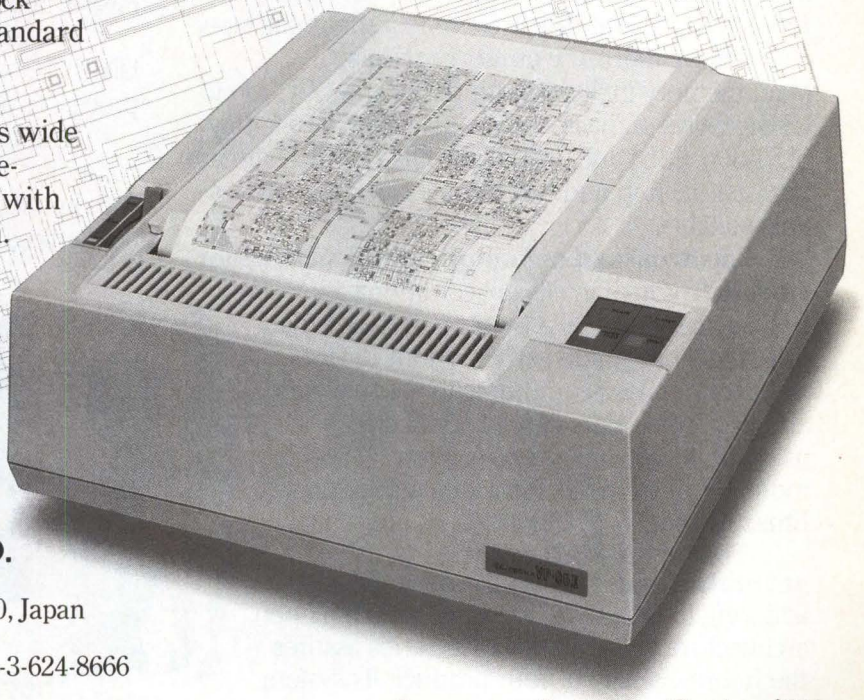

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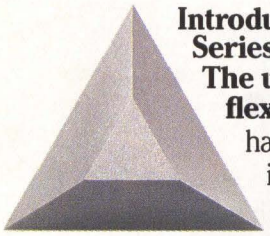

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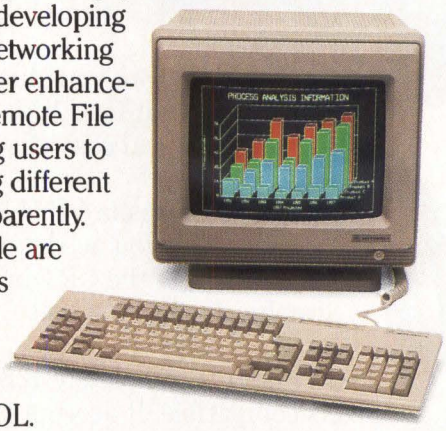

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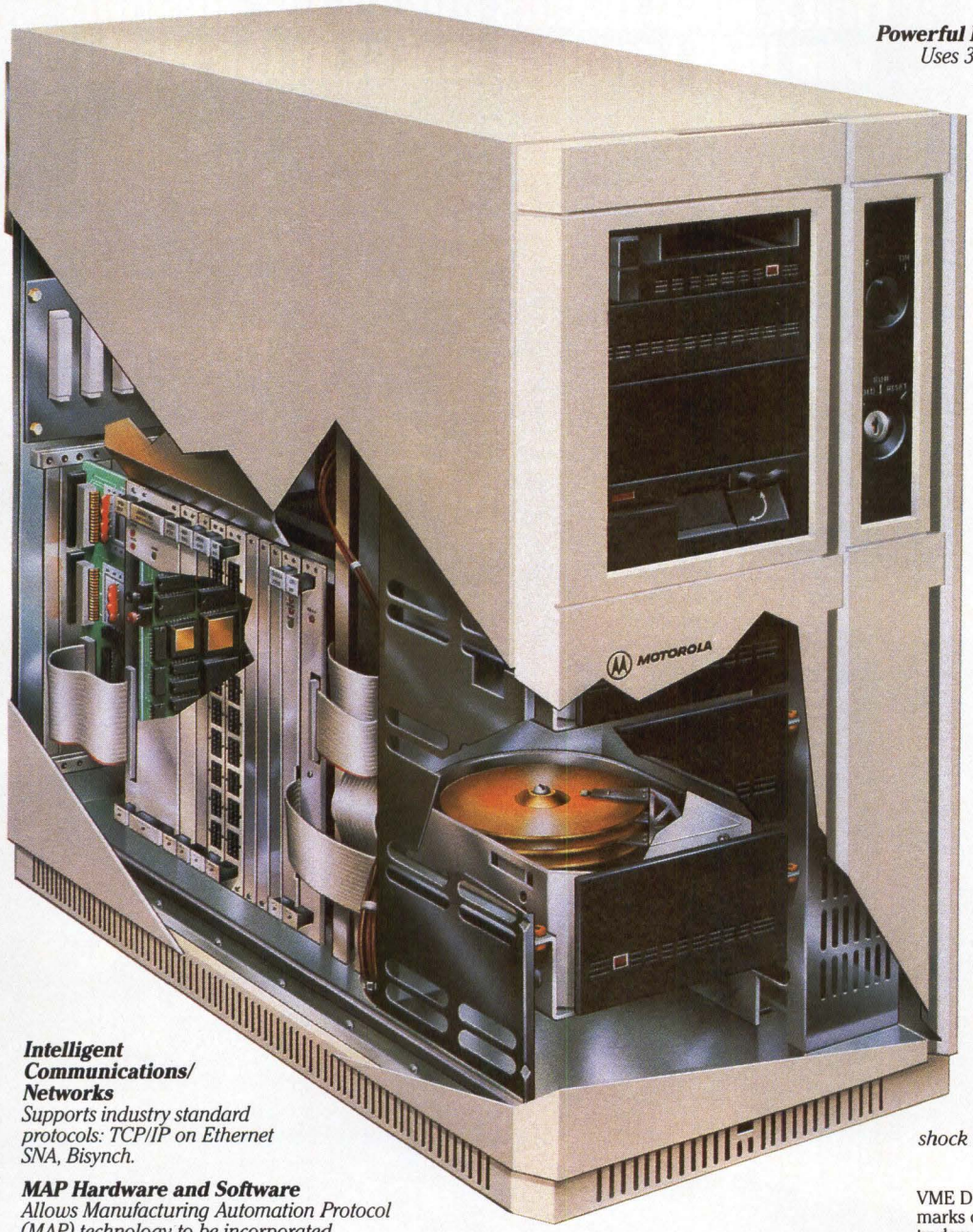

Powerful Processors
Uses 32-bit MC68020 MPU and MC68881 Floating Point co-processor; easy upgrade to next generations.

UNIX-V.3/Remote File Sharing (RFS)
Uses SYSTEM V/68–compliant with AT&T's UNIX System V Release 3 with RFS for easy system networking. Real-time executives are available.

Large Main Memory
Up to 16 Megabytes, with both ECC and parity.

Flexible Mass Storage, up to 1.3 Gigabytes
Internally, up to 4-5¼" mass storage drives including floppy and Winchester drives, ¼" streaming tape. SMD disk and 9-track tape interfaces for additional external mass storage.

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Local and Remote Diagnostics
Provides for cost effective remote testing via modem and comprehensive local testing.

Complete Development Support
Supports C, Pascal, FORTRAN, COBOL and other high-level languages; varied development tools available.

Attractive/Sturdy Enclosure
Floormount enclosure meets UL, CSA, VDE, IEC, FCC requirements; shock mountings for disk drive protection.

Intelligent Communications/ Networks
Supports industry standard protocols: TCP/IP on Ethernet SNA, Bisynch.

MAP Hardware and Software
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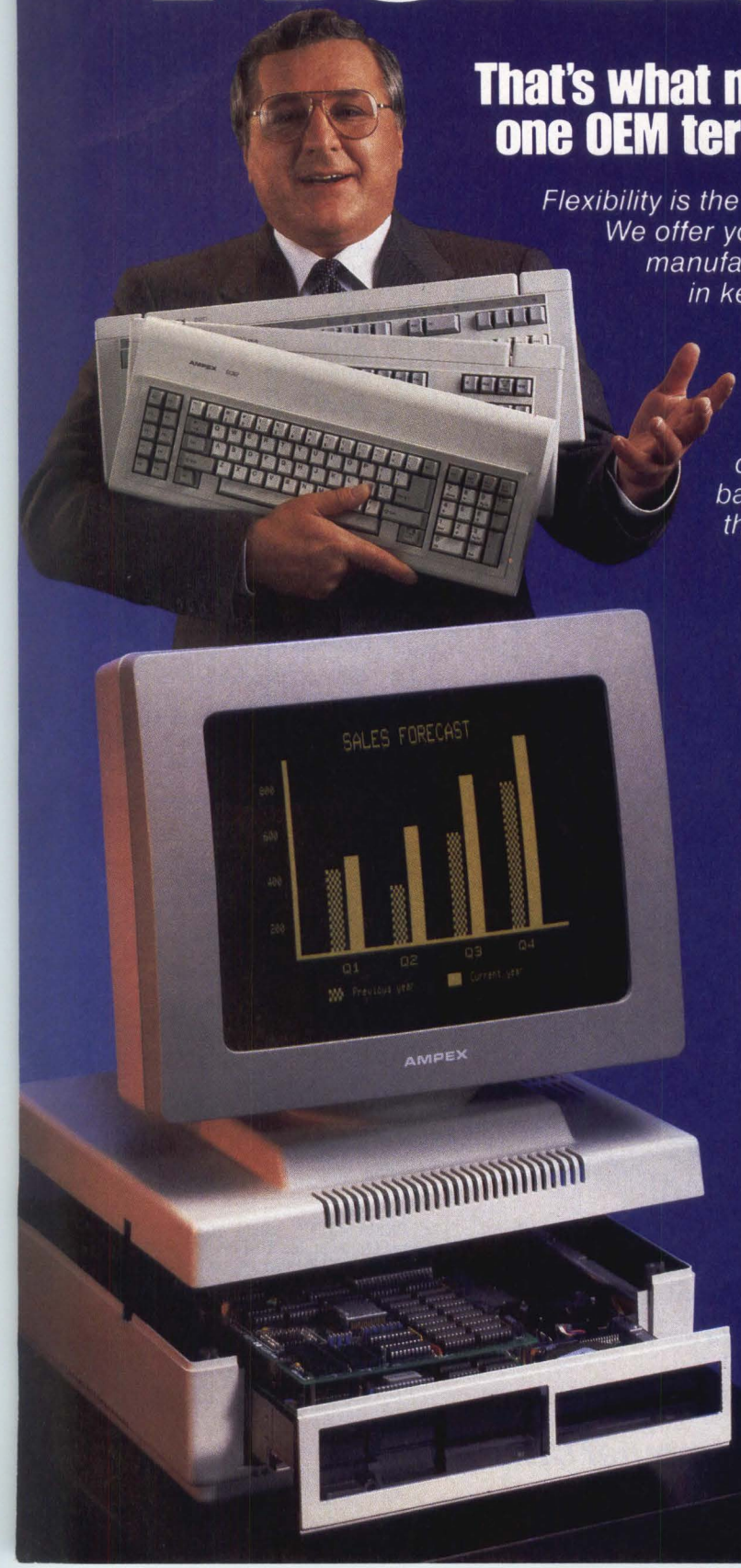

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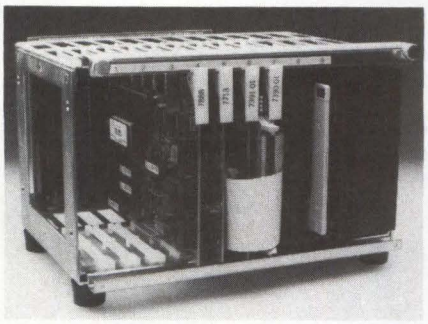
Megan Nields, Staff Editor



Computer aims at industrial uses

- IBM PC/XT compatible
- Two models
- Microsoft MS-DOS 3.2

System 2, an IBM PC/XT-compatible computer, is geared toward factory-floor applications. The unit offers IBM PC/XT compatibility and is based on Microsoft's MS-DOS 3.2 operating system. Model 10 supplies 128K bytes of CMOS static RAM, expandable to 128K bytes, and two semiconductor storage units. Model 20 adds a 3½-inch flexible disk drive. Both systems contain a serial port and up to 23 expansion slots. $1,195, model 10; $1,595, model 20. **Pro-Log Corp.,** 2560 Garden Road, Monterey, Calif. 93940, (408) 372-4593.

Circle 401

Computer sports 80386 processor

- 2M bytes of RAM
- Parallel port
- IBM PC/AT compatible

Equippped with an Intel 80386 microprocessor, the CP80386Top computer runs at 16 MHz. The IBM PC/AT-compatible unit supplies 2M bytes of RAM, parallel and serial ports, and a slot for the 80287 math coprocessor. A 1.2M-byte flexible disk drive reads, writes and formats in 360K-byte mode. The unit runs more than twice as fast as the PC/AT. $4,995. **Distribution Plus,** 7313 Grove Road, Frederick, Md. 21701, (301) 695-0478.

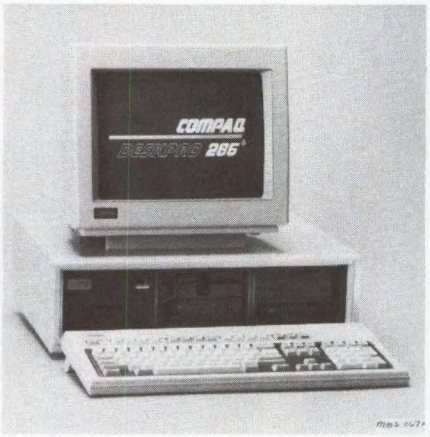
Circle 402

Computer suits IBM PC/AT

- 80286 CPU
- 1M byte of memory
- 1.2M-byte disk drive

An IBM PC/AT-compatible computer, the ST-100 utilizes an 80286 microprocessor. The unit provides 1M byte of memory, a 1.2M-byte flexible disk drive and flexible and rigid disk controllers. Options include an 80287 coprocessor. $1,295. **IBI Systems Inc.,** 6842 N.W. 20th Ave., Fort Lauderdale, Fla. 33309, (305) 978-9225.

Circle 403

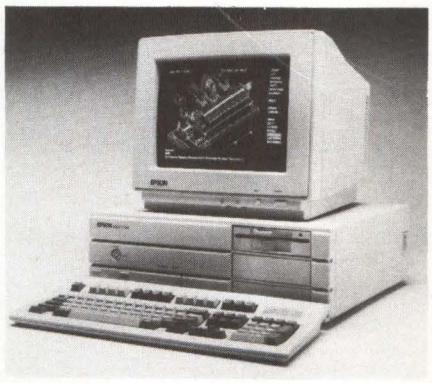


Three-model desktop based on 80286 processor

- 12 MHz
- 8.1M bytes
- 8-, 16-bit slots

Available in three configurations, the 12-MHz Compaq Deskpro 286 replaces the original Deskpro 286. The unit uses an Intel 80286 dual-speed processor, up to 8.1M bytes of memory and up to 80M bytes of fixed disk storage. The model 1 sports 256K bytes of RAM and a 1.2M-byte flexible disk drive. Models 20 and 40 offer 640K bytes of RAM. Up to five 8- and 16-bit expansion slots are available. $2,999, model 1; $3,999, model 20; $4,999, model 40. **Compaq Computer Corp.,** 20555 FM 149, Houston, Texas. 77070, (713) 370-0670.

Circle 404



Computer employs 80286 processor

- 640K bytes of RAM
- Six expansion slots
- RS232C, parallel port

An IBM PC/AT-compatible personal computer, the PowerMate 1 employs an 80286 processor running at 8 MHz. The unit comes standard with 640K bytes of RAM expandable to 8.6M bytes, a 1.2M-byte flexible disk drive and a rigid disk controller. It includes six expansion slots, an RS232C port and a parallel port. MS-DOS 3.2 and GW BASIC 3.2 are provided. $1,995. **NEC Information Systems Inc.,** 1414 Massachusetts Ave., Boxborough, Mass. 01719, (617) 264-8000.

Circle 405

286 computer offers nine slots

- 6, 8, 10 MHz
- 640K bytes of RAM
- 1.2M-byte flexible drive

The Equity III+ computer utilizes an 80286 microprocessor running at 6, 8 or 10 MHz. It offers 640K bytes of RAM, expandable to 15.5M bytes, and a 1.2M-byte flexible disk drive. A second configuration supplies a 40M-byte rigid disk drive with a 28-msec average access time. The IBM PC/AT-compatible unit features built-in serial and parallel interfaces and nine expansion slots. $2,695, $3,895 with rigid disk drive. **Epson America Inc.,** Suite 450, 1901 Ave. of the Stars, Los Angeles, Calif. 90067-6067, (213) 539-9150.

Circle 406

The people who make Seagate

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Marti

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Marti's research helped develop Seagate's DISC DATA MANAGER™, a storage subsystem that expands modularly from 80 MB to over a gigabyte.

"We use multiple drives in the DISC DATA MANAGER so you buy exactly the amount of storage that you need," Marti said. "You can upgrade as your needs grow simply by installing an additional drive. Multiple drives also allow people to keep duplicate copies of important files for added protection."

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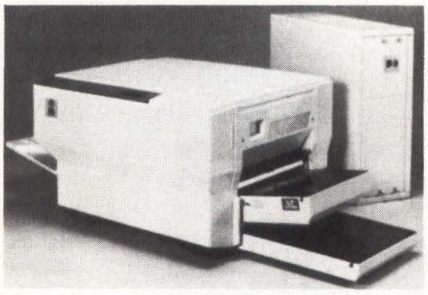
Laser printers hold 3M bytes of RAM

- 300-dpi resolution
- Four emulation modes
- 25 fonts

The LaserPro Silver Express and Gold Express laser printers provide 300-dpi resolution and font-download capabilities. They emulate Diablo 630, Epson FX-80, Hewlett-Packard LaserJet and NEC 3550 devices. The first model targets CAD/CAM and desktop publishing applications. It features 768K bytes of RAM, 25 bit-mapped fonts and a proprietary Command Language. The second unit has a memory-expansion option that doubles the standard 1.5M bytes of memory to 3M bytes. It offers HP's HPGL graphics language. $2,995, Silver Express; $3,695, Gold Express. **Office Automation Systems Inc.,** 8352 Clairmont Mesa Blvd., San Diego, Calif. 92111, (619) 576-9500.

Circle 407



Device combines printer, plotter

- Nonimpact unit
- 2,000-sheet capacity
- Proprietary controller

The BGL nonimpact printing/plotting system utilizes a proprietary graphics controller and an electro-photographic engine. It features a 2,000-sheet capacity and Tektronix 4010 and 4014 emulation. The unit supports vector draw, alpha notation, point plot and incremental plot. It produces A-sized and B-sized copies. Four engines are available. $17,900. **BGL Technology Corp.,** 438 Constitutional Ave., Camarillo, Calif. 93010, (805) 987-7305.

Circle 408

Laser printer outputs 8 ppm

- 512K bytes of memory
- Six built-in fonts
- Memory boards

The Hewlett-Packard LaserJet Series II laser printer produces 8 ppm. It comes resident with 512K bytes of memory for desktop publishing, word processing and spreadsheet printing. Features include two font-cartridge slots, a 200-sheet input bin and a 16-character front-control-panel display. Memory boards are available in 1M-, 2M- and 4M-byte configurations. The unit offers six built-in fonts and RS232C and Centronics interfaces. Up to 32 fonts can be downloaded. $2,495. **Hewlett-Packard Co.,** 1820 Embarcadero Road, Palo Alto, Calif. 94303, phone local sales office.

Circle 409

Dot matrix printers offer seven colors

- 24-pin, 18-pin units
- 250, 360 cps
- 256K-byte buffer

The P2424C and P2418C are 24-pin and 18-pin dot-matrix printers, respectively. The first unit runs at 360 cps in draft mode, 180 cps in correspondence mode and 120 cps in letter-quality mode; the second device prints 250 cps in draft mode and 125 cps in letter-quality mode. Features include a 4K-byte buffer, expandable to 256K bytes, multiple font cartridges and Epson compatibility. Both printers perform seven-color printing. $1,295, P2418C; $1,395, P2424C. **Alps America,** 3553 N. First St., San Jose, Calif. 95134, (408) 946-6000.

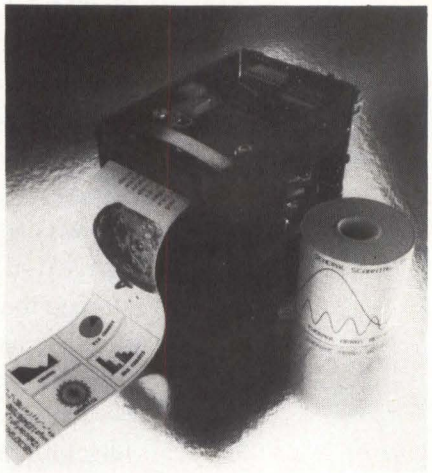
Circle 410

Laser printer produces 15 ppm

- 300 dpi
- Bit-map controller
- 21 fonts

Generating 15 ppm, the 1500 laser printer provides a 300-dpi resolution and 21 standard fonts. The unit features a dual page buffer with 3.5M bytes of memory that permits the controller to store the image being printed while creating a second bit-map for the next page. It emulates Tektronix 4014 graphics with four font sizes. Interfaces include an RS232C and a proprietary parallel. $11,990. **Talaris Systems Inc.,** 5160 Carroll Caynon Road., P.O. Box 261580, San Diego, Calif. 92126, (619) 587-0787.

Circle 411



Two-inch printer suits OEMs

- 200 by 800 dpi
- Proprietary software
- Programmable speeds

A thermal array printer, the 2-inch AR-41, aimed at OEMs, furnishes a resolution of 200 by 800 dpi. Proprietary software provides over 13 functions. Features include automatic paper feed, programmable speeds and a Centronics interface. The device suits graphics, text, bar codes and histograms. $420. **General Scanning Inc.,** 500 Arsenal St., P.O. Box 307, Watertown, Mass. 02272, (617) 924-1010.

Circle 412

"It's easy looking at you, kid."

This is the screen that dreams are made of–the ADDS 2020. Its unique 70Hz refresh display gives a stunning flicker-free performance. Along with a presentation so brilliant your operators will be happy to work with it all day.

And you'll appreciate our supporting cast of bigger-than-life characters. Presented on a 14" flat green, amber or white screen, our easy-to-look-at double wide and double high/wide characters can be viewed in your choice of 80 or 132 column format. With operator selectable settings for brightness and contrast.

Brains and beauty.

But more than just a terminal that's great to look at, the ADDS 2020 gives you brains behind the beauty. Our exclusive HelpNotes℠ feature lets you program assistance messages directly into the terminal. So you can actually use our hardware to simplify your software.

The 2020 also gives you intelligent desk accessories like a clock, alarm, calendar and a calculator that can work directly with your current application.

Screen test an ADDS 2020 today. It could be the beginning of a beautiful relationship. For more information on the 2020 or our entry-level 1010, the first terminal in its class to offer a built-in parallel printer port, call 1-800-231-5445. In N.Y. 516-231-5400. Ask for Displays Marketing.

ADDS
Applied Digital Data Systems Inc.
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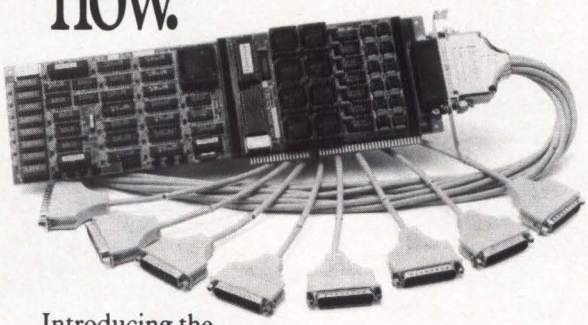
CIRCLE NO. 65 ON INQUIRY CARD

Introducing multi-channel communications boards 400% faster than what you're probably using now.



Introducing the DIGIBOARD COM/Xi Series front-end processor. Intelligent multi-channel communications boards 400% faster than the industry standard.

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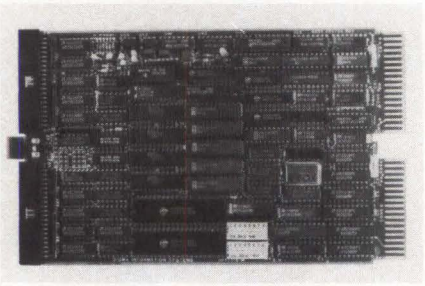
CIRCLE NO. 66 ON INQUIRY CARD

NEW PRODUCTS
DATACOM

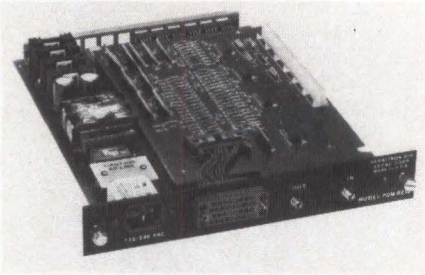


Multiplexer furnishes DEC compatibility

- Eight lines
- 256-character buffer
- 38.4K baud rate

The SCD-DHV11/8 asynchronous multiplexer is compatible with DEC operating systems and diagnostics. It offers eight lines with EIA RS232C and RS422 operation. A 256-character buffer for received characters and DMA is provided. The unit supplies baud rates to 38.4K. Each communication line is independently programmable and includes switch-selectable device addresses. $792. **Sigma Information Systems,** 3401 E. La Palma Ave., Anaheim, Calif. 92806, (714) 630-6553.

Circle 413



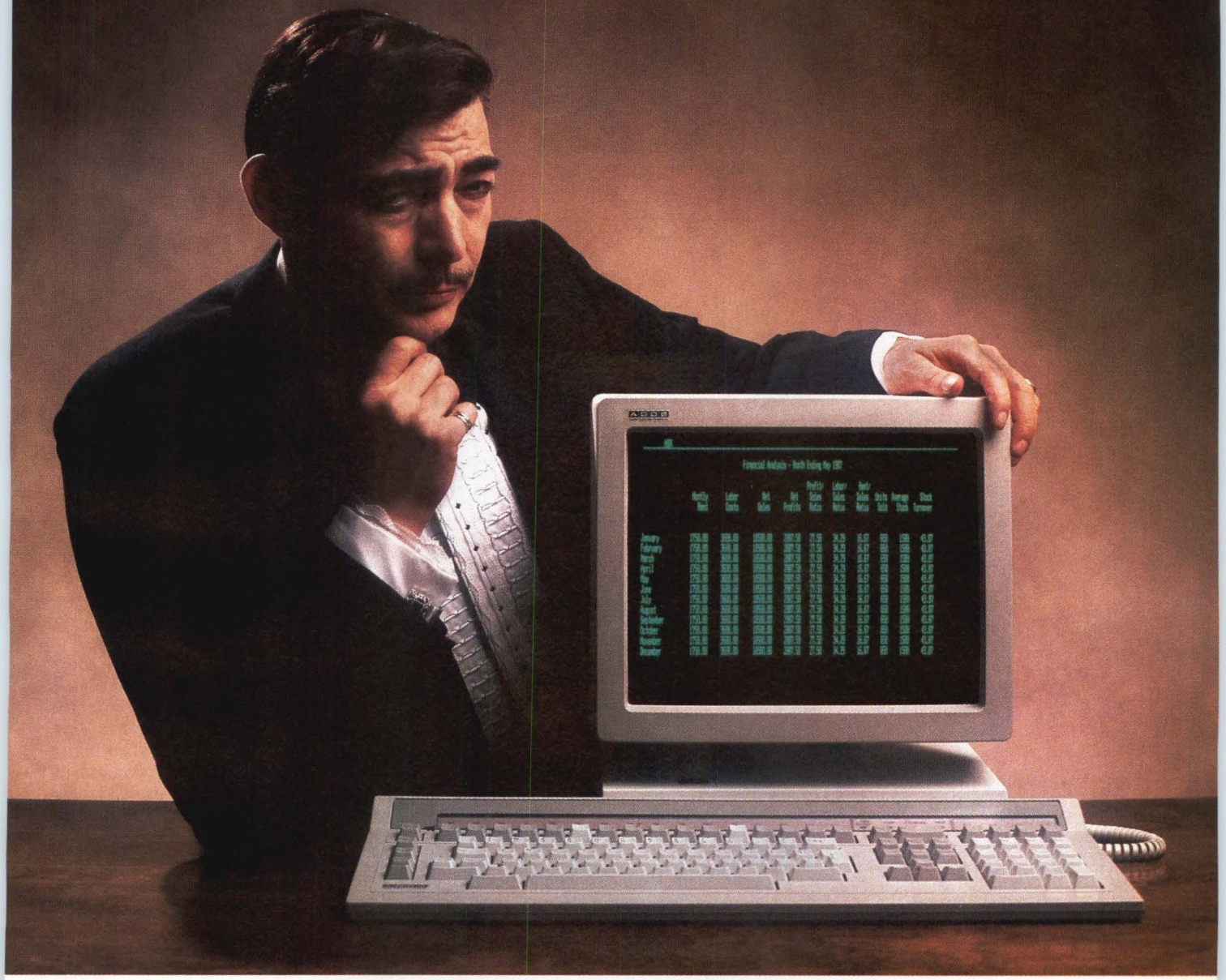
Communications link uses fiber optics

- V.35 compatible
- Up to 76.8K bps
- Full duplex

A single-channel, fiber-optic communications link, the FOM 9218 transfers data over a 2-km topology. It is compatible with V.35 interfaces with up to 76.8K-bps operation in synchronous or asynchronous mode. Two full-duplex units can be configured as a modem link or an interface extender. The device supplies fully transparent data, clock and control signals. $1,328. **Versitron Inc.,** 6310 Chillum Place, N.W., Washington, D.C. 20011, (202) 722-8600.

Circle 414

"Frankly, my dear, you need a flicker-free screen."



Now tired-eye problems are gone with the wind, with the DEC-compatible ADDS 3220. The 3220's unique 70Hz refresh display gives one of the most brilliant flicker-free screen presentations ever.

And you'll appreciate our double features, too. Like our easy-to-read double high and double high/wide characters, viewed in a choice of 80 or 132 column format. All presented on a 14" flat green, amber or white screen. With user selectable settings for brightness and contrast.

A truly sophisticated performance.

But more than just great looks, the ADDS 3220 turns in a great performance, too. Our DEC-style keyboard enhances the performance of your software. With value-added features like 22 fully programmable function keys and 256 bytes of non-volatile memory that help you distinguish your product from the competition.

Naturally the ADDS 3220 is fully compatible with the DEC VT220, VT100, VT52, and ANSI X3.64. What's more, it won Digital Review's 1987 "Best Alphanumeric Terminal of the Year" award.

Preview one today. Let us show you that when it comes to award-winning performances ADDS gives a darn. For more information, call 1-800-231-5445. In N.Y. 516-231-5400. Ask for Displays Marketing.

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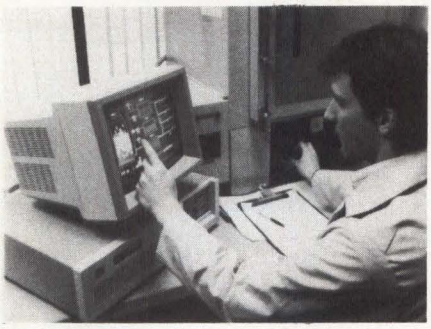
CIRCLE NO. 86 ON INQUIRY CARD



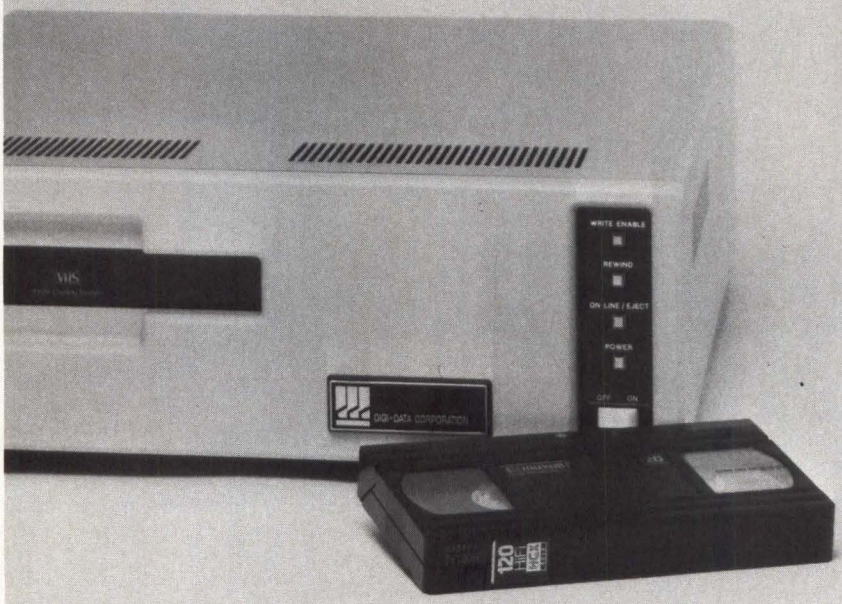
Monitor displays up to 64 colors

- 0.31-mm dot pitch
- 14-inch unit
- 800 by 560 pixels

A multisynchronous monitor, Multisynch Touch displays up to 64 colors on a 14-inch screen. The unit incorporates a 0.31-mm dot pitch and an 800-by-560-pixel resolution. It works with graphics boards having scanning frequencies from 15.75 kHz to 35 kHz. $1,795, OEM pricing available. **MicroTouch Systems Inc.,** 10 State St., Woburn, Mass. 01801, (617) 935-0080.

Circle 415

2.5 Gigabytes



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CIRCLE NO. 67 ON INQUIRY CARD

Graphics terminal uses MC68020 processor

- 4.5M bytes of memory
- 1,280 by 1,024 pixels
- Pan and zoom

An interactive imaging and graphics display terminal, the 4660 is designed around a Motorola MC68020 microprocessor and a 6881 floating-point coprocessor. It offers up to 4.5M bytes of memory, independent pan and zoom and two look-up tables. Resolution is 1,280 by 1,024 pixels. The unit supports up to nine 4-bit refresh memory groups. Features include a built-in video multiplexer and a 4M-pixel-per-second raster bus. $18,700. **Ramtek Corp.,** 2211 Lawson Lane, Santa Clara, Calif. 95052-8024, (408) 988-2211.

Circle 416

Color terminal targets CAD applications

- 512K bytes of memory
- 19-inch screen
- 640 by 480 pixels

An intelligent, color graphics terminal, the 4209 targets low-end CAD and technical data analysis applications. The unit displays 640 by 480 pixels on a 19-inch screen and supplies 512K bytes of memory plus DEC VT100 compatibility. Up to 16 graphics colors and eight alphanumeric colors are selectable from a 4,096-color palette. An upgrade kit is available. $6,995. **Tektronix Inc.,** P.O. Box 500, Beaverton, Ore. 97077, (503) 644-0161.

Circle 417

Unleashing a powerful new species of Firebreather. The mini supercomputers from Gould.

There's a vast world of difference between the power of a super minicomputer and our new Firebreathers — the Gould NPL™ family of mini supercomputers. It's a whole new category of compatible Gould computers that bridges the gap between giant supercomputers on the one hand and superminis on the other.

The Gould NPL family offers you the power and speed of supercomputers at the cost of superminis, and they are every bit as easy to use. NP1, the first Firebreather in the NPL family, delivers performance equal to first generation supercomputers.

Harness the power:

- Multiprocessor parallel architecture.
- High performance scalar and vector processing.
- Real memory expandable to 4 billion bytes.
- Industry standard I/O subsystems.
- Continuous throughput 5 times faster than any supermini.
- Gould's proven UNIX®-based operating system, UTX/32®.
- Languages that include vectorizing FORTRAN and highly optimized C compilers, plus Ada®

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Consider this power applied to complex scientific and engineering computations, simulation, real time data acquisition and intensive program development.

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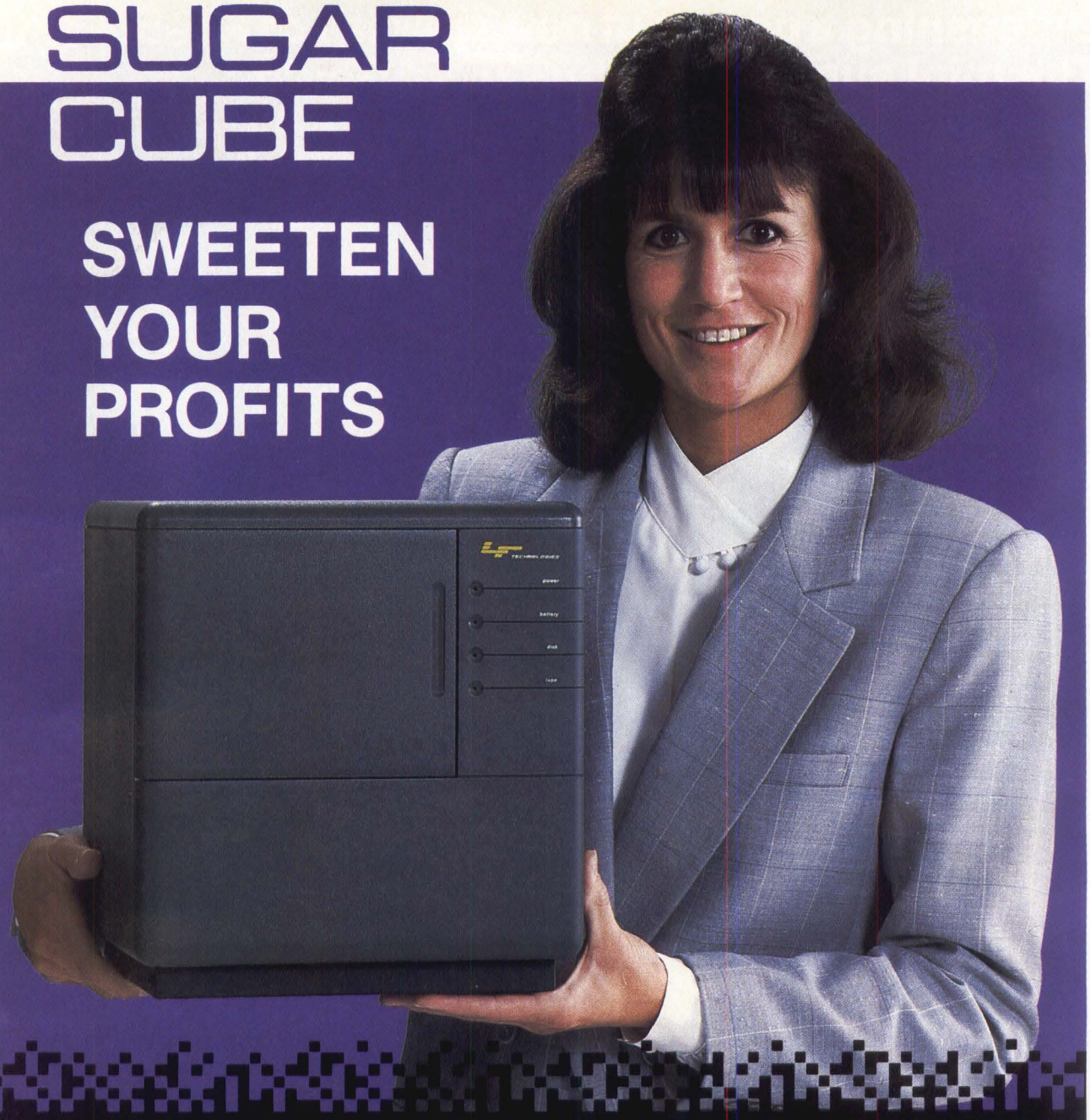
SUGAR CUBE

SWEETEN YOUR PROFITS



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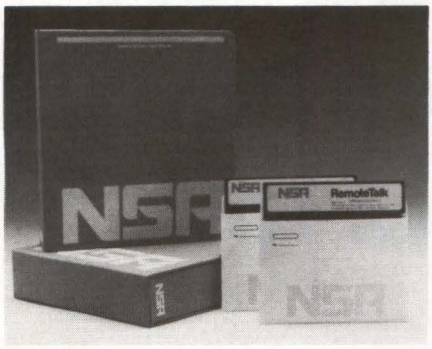
CIRCLE NO. 69 ON INQUIRY CARD

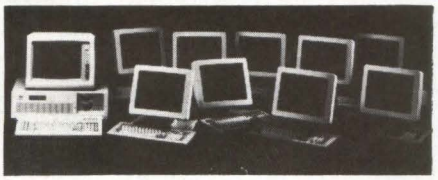
SOFTWARE



Datacom software links personal computers

RemoteTalk is an IBM-compatible PC-to-PC synchronous communications package with remote control and file transfer capabilities. Compatible with 18 SDLC boards, the software communicates via IBM's SDLC protocol at up to 19.2K bps. A synchronous modem is available. $295 and higher. **Network Software Associates Inc.,** 22982 Mill Creek, Laguna Hills, Calif. 92653, (714) 768-4013.

Circle 418



OS supports 10 IBM PC/ATs

An operating system for the IBM PC/AT and compatibles, Pick Version 2.0 supports up to 10 users. The package provides advanced virtual-memory architecture and relational database capabilities. It supports three parallel printer ports, streaming cartridge tape drives and rigid disk drives. $1,295. **Pick Systems,** 1691 Browning, Irvine, Calif. 92714, (714) 261-7425.

Circle 419

DBMS software turns PC/AT into server

A database management system, SQLBase Version 3.1 turns IBM PC/ATs into relational database servers that can be accessed by multiple PCs running on the IBM Token-Ring Network. The software operates on NETBIOS-compatible networks. It includes a C application programming interface. $995, single-user version; $1,995, multiuser version. **Gupta Technologies Inc.,** Suite 240, 1040 Marsh Road, Menlo Park, Calif. 94025, (415) 321-9500.

Circle 420

Software runs DOS on 386-based computers

Control/386 software runs on 80386-based computers and supplies compatibility with 8088- and 80286-based systems. The package provides 32-bit emulation of AST's Enhanced Expanded Memory Specification and the Lotus/Intel/Microsoft Expanded Memory Specification. It allows users to run DOS applications on the 80386 CPU and can be customized. $8.00, Quantity 5,000. **Phoenix Technologies Ltd.,** 320 Norwood Park S., Norwood, Mass. 02062, (617) 769-7020.

Circle 421

Full-time Employment for your Laser Printer

Everyone knows printers are expensive, especially laser printers. And most of the time, your printer just sits there waiting for something to do.

BUFFALO PRODUCTS has unveiled the intelligent way of keeping your printers employed full-time. . .with the newest addition to our line of intelligent buffers, the SX model.

The Buffalo SX features 10 total input and output ports, combining both serial and parallel interfacing, giving you total flexibility to arrange your resource network.

You can have up to 7 PC's sharing 3 output devices (printers, laser printers, modems, plotters, etc.), 2 PC's sharing 8 output devices or practically any combination in between.

Some of the outstanding features include:

- 256K dynamically allocated buffer, user upgradable to 1024K.
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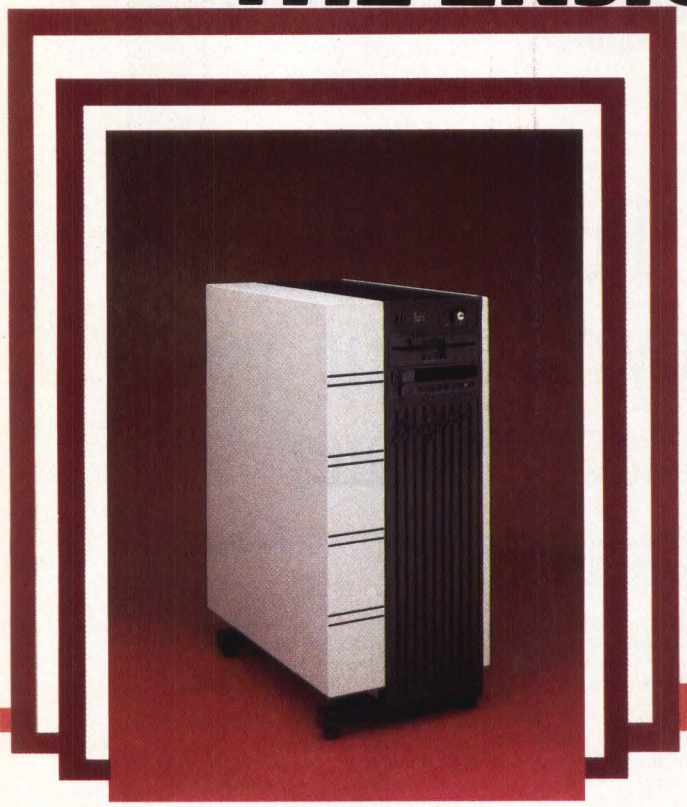
CIRCLE NO. 70 ON INQUIRY CARD

THE 100 USER 32-BIT 80386 BASED COMPUTER

THE ENSIGN 386:100



The Computer You Will Not Outgrow!

This is the ultimate 80386 based multi-user computer you have been waiting for. At a base price not much higher than 386 PC type machines, the Ensign 386:100 can expand to be a computer that you will not outgrow.

The key to the Ensign's multi-user performance is its intelligent serial and disk controllers. Using up to four 68010 CPU's and over 1MB of buffer memory to handle serial and disk overhead, the 80386 is free to provide its full performance to as many as 100 users.

32-Bit Intel 80386 Processor

- 16-100 serial I/O ports
- 1-24MB memory
- 60MB streamer tape
- 25-840MB disk storage
- 1MB disk/serial I/O buffer memory
- 1-4 slave 68010 processors

Need Software? The Ensign 386:100 can run it all.

PC-MOS 386*

A multi-user MS-DOS look alike, that takes advantage of the 80386's multi-user capability.

XENIX 386*

The most popular commercial version of UNIX*. AT&T System V compatible.

THEOS 386*

The latest version of THEOS (OASIS) for the 80386.

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If you use multi-user systems and need low prices and high performance then give us a call. IBC is the only company that can sell you a low cost 80386 computer that will last you for life.

VARS, call IBC now to find the best dealer discounts in the industry. If you don't, your competition will.

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CIRCLE NO. 71 ON INQUIRY CARD

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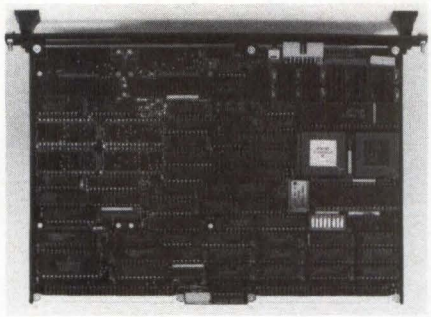
SUBASSEMBLIES

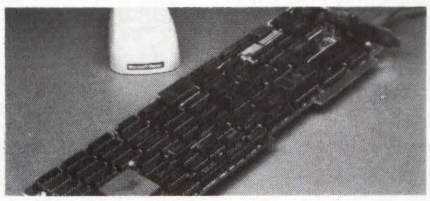


SBC features modular I/O functions

- Two RS232C ports
- MC68000 processor
- 2-, 4-channel DMA

The OB68K/VSBC1 single-board computer uses a Motorola MC68000 processor and features over 20 modular I/O functions. It supplies two asynchronous RS232C ports and two RS422 ports and two- or four-channel DMA. A bus-interrupt generator allows the unit to function as an intelligent slave. Features include 512K bytes of RAM. A 68010 processor is optional. $1,036. **Omnibyte Corp.,** 245 W. Roosevelt Road West Chicago, Ill. 60185-3790, (312) 231-6880.

Circle 422



Graphics controller works with IBM PC

- 10,000 cps
- 1,280 by 960 pixels
- 82786 coprocessor

A monochrome graphics controller for the IBM PC/XT and PC/AT, Desktop 1280 supplies a bit-block transfer rate of 10,000 cps and a line drawing rate of 1.25 million pixels per second with a resolution of 1,280 by 960 pixels. The Intel 82786-based device supports a 64-Hz non-interlaced refresh rate and the IBM Color Graphics Adapter. It can display two pages of text simultaneously. Features include pan and zoom. $1,295. **Verticom Inc.,** 525 Weddell Drive, Sunnyvale, Calif. 94089-2114, (408) 747-1222.

Circle 423

VMEbus adapter supports 128 devices

The HPS-6945 is a VMEbus-compatible host adapter for Unplug, a proprietary data communications subsystem. It allows support of up to 128 peripherals at distances to 1,000 feet away from the host computer, without use of repeaters. The device features a MC68010 microprocessor running at 12.5 MHz and 512K bytes of RAM. $1,770. **Systech Corp.,** 6465 Nancy Ridge Drive, San Diego, Calif. 92121, (619) 453-8970.

Circle 424

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CIRCLE NO. 72 ON INQUIRY CARD

All-In-One AMT Office Printer™

FONTS AND PRINT MODES

The AMT Office Printer can store up to eight resident fonts. You can print these fonts in Letter, Memo, or Draft mode. Letter mode produces true letter-quality characters at 45 cps. Memo mode produces characters that are near-letter-quality at 100 cps. Draft mode produces draft-quality characters at 250 cps. Here are some examples:

Courier 72, one of the most popular business typefaces, prints 10 characters to the inch.

Letter Gothic 12, another widely-used typeface, prints 12 characters to the inch.

Gothic 17, a font that is perfect for printing spreadsheets, prints 17.1 characters per inch.

Trend PS, a proportionally-spaced typeface, comes in handy when typing formal documentation.

Scientific 10:

$$\frac{1}{H} = \sum_{i=1}^{i=n} dx \left| \frac{\sin x^2}{\cot x^2} \right|$$

$$\epsilon \approx \sum_{\beta}^{1-Q} \frac{\partial n-1}{\partial t} = g \sum_{k=1}^{N} c_k \beta_k \cdot g \sum_{k=1}^{N} c_k \beta_k$$

SOFTWARE COMPATIBILITY

Since the AMT Office Printer can emulate a Diablo 630 or C-150, Qume Sprint 11, IBM Color Printer, or Epson printer, the AMT works with virtually any off-the-shelf software package.

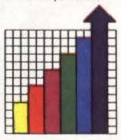
SPECIAL EFFECTS

The AMT Office Printer can perform many special printing functions, like those shown below:

- Variable slant
  - *10-degrees*
  - *20-degrees*
  - *30-degrees*
- Expanded
  - Vertical
  - Horizontal
  - Or both
- **Bold**, **shadow** and underscored
- Automatic text formatting
  - Centering
  - Justification

GRAPHICS

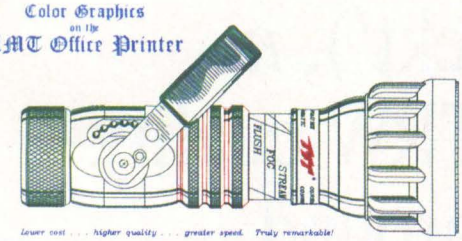
Finally, the AMT Office Printer can print full-color graphics with variable dot resolutions up to 240V x 480H dots per inch.



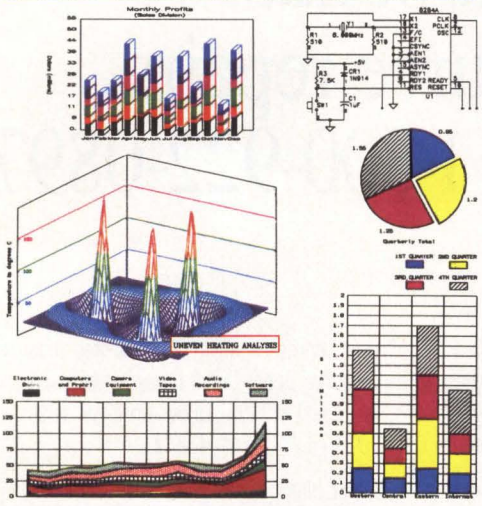
PRINTER COMPATIBILITY

The AMT Office Printer can contain multiple resident emulations. This feature lets you turn the AMT Office Printer into a variety of other popular printers. For example, if you're using a program that supports only the Epson JX-80 printer and not AMT, just press a single button and the AMT is instantly compatible.

Color Graphics on the AMT Office Printer



Lower cost . . . higher quality . . . greater speed. Truly remarkable!



1157 Tourmaline Drive, Newbury Park, CA 91320, U.S.A.
Telephone: USA (805) 499-8741 · FAX: USA (805) 498-4147 · Telex: 286695

New

The AMT Office Printer™ PLUS

Tired of juggling three or more separate devices to meet your printing needs? Confused about which technology—daisywheel, dot-matrix, plotter, ink-jet, thermal or laser—is right for you? Worried about software/printer compatibility?

Introducing the *AMT Office Printer PLUS*, an all-in-one printing solution that does the job of all these devices with superb print quality, speed, and the ability to mix text with multicolor high-resolution graphics.

How can one printer do so much? With an ingenious print mechanism, unrivaled font, graphic and color flexibility, multiple co-resident emulations, plus widespread hardware and software compatibility.

The AMT Office Printer PLUS is applications-oriented. For *word processing*, there is better-than-letter and near-letter-quality text, a font library with both fixed and proportionally-spaced fonts, variable pitches, language support, IBM graphic symbols, scientific and technical character sets, and built-in features that italicize, color, bold, shadow, super/subscript, underscore, expand, center, and justify text. For *data processing*, there is high-speed, draft-quality text with up to 264 characters per line. For *business graphics, CAD/CAM/CAE plots, and other precision graphic applications*, there are full-color graphic modes providing resolutions up to 240V x 480H dots per inch. And for *technical applications*, there is custom font generation, font download, plotter emulation, and many other printing utilities.

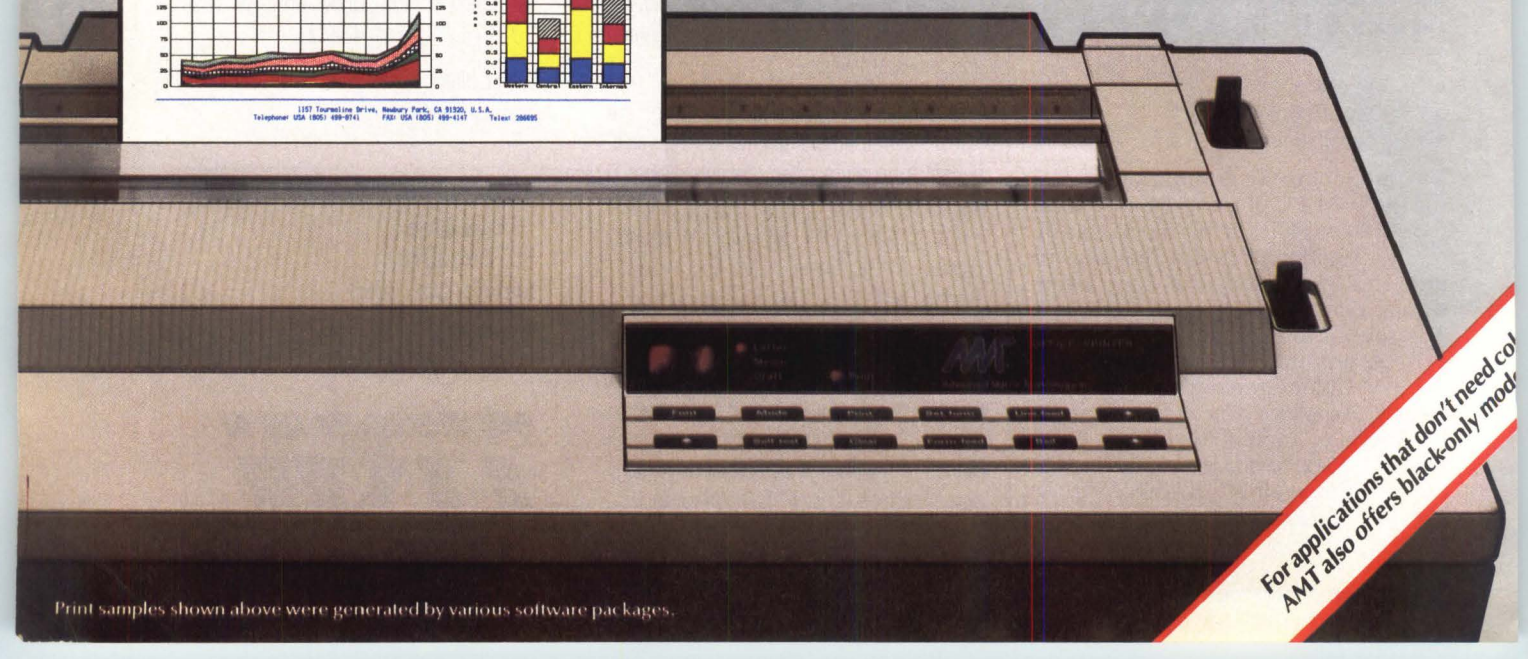
Most importantly, the AMT Office Printer is fully compatible with software that drives the Diablo 630™, Diablo C-150 Ink-Jet Printer™, IBM Model 5182 Color Printer™, or Epson JX-80™. So just plug the printer into your computer's serial or parallel port, load your favorite software, and begin printing.

Isn't it about time to solve all your printing problems? *The all-in-one AMT Office Printer PLUS!*

CIRCLE NO. 90 ON INQUIRY CARD

1157 Tourmaline Drive
Newbury Park, CA 91320 (805) 499-8741
European sales office UK (0) 7356-71464

Advanced Matrix Technology, Inc.



For applications that don't need co
AMT also offers black-only mod

Print samples shown above were generated by various software packages.

HOW TO OPTIMIZE YOUR LASER PRINTER

Edward Teja, Contributing Editor

Three classes of programs can make your personal computer and laser printer do more, and do it better. In selecting the programs, though, understanding their differences is critical, because vendors won't enlighten you unless you ask questions.

In the first class are the printer-control programs that let you specify fonts and control page formats independent of your application program. Printer-control programs embrace all of the enhanced printing utilities, such as those that allow users to change fonts, highlight (with semi-gray scale), draw lines and boxes and, possibly, merge graphics and text.

The second class of programs lets you embed format commands that are executed as your documents are printed. And the third class are what many think of as WYSIWYG, or "what you see is what you get," page-composition packages.

The second class provides powerful software capabilities, if you have the patience to master them. Examples of this type of program include Polaris Software's PrintMerge and Ram-resident PrintMerge. Each offers interesting benefits to users but, for reasons that will become clear, they are examined separately.

PrintMerge is a natural publishing environment for those who use Micropro International Corp.'s WordStar for word processing. The command formats and logic are similar to those used in that popular word processing package. In fact, PrintMerge is recommended for use only with WordStar. At any rate, the more you use the package, the more you'll like the power and consistency it provides.

A key strength of PrintMerge lies in its powerful formatting tools. Handling the typesetting of tables, for instance, is usually difficult. Many programs require you to collapse data (remove all spaces) and separate data fields with commas. Not so with the versatile PrintMerge: here, one simple instruction defines the characteristics of the input data; another defines the format of the output. Thus, you can accept data from a spreadsheet, word processing package or other source and use it without retyping.

A major difference between PrintMerge and similar programs is that this package controls the printing process. It provides a proportional-spacing algorithm that produces attractive output, and with every format difficulty encountered, the solution is evident—once you look at the commands in the text.

PrintMerge isn't the easiest package to use, but its logic and consistency make it understandable. And it is powerful. Its one shortcoming lies in its inability to use graphics images generated by popular bit-image paint programs.

On the other hand, Ram-resident PrintMerge lets users control the printer, change type fonts, draw lines and boxes and, what is of particular importance, merge graphic images with text.

Now, logic would dictate that a package called Ram-resident PrintMerge would be a faster version (not having to load fonts from disk) of the PrintMerge program. This is not the case. Ram-resident PrintMerge is a printer-control utility (a class 1 program) that has similarities to the class 2 PrintMerge package, but is substantially different both in how it works, and what it is trying to do.

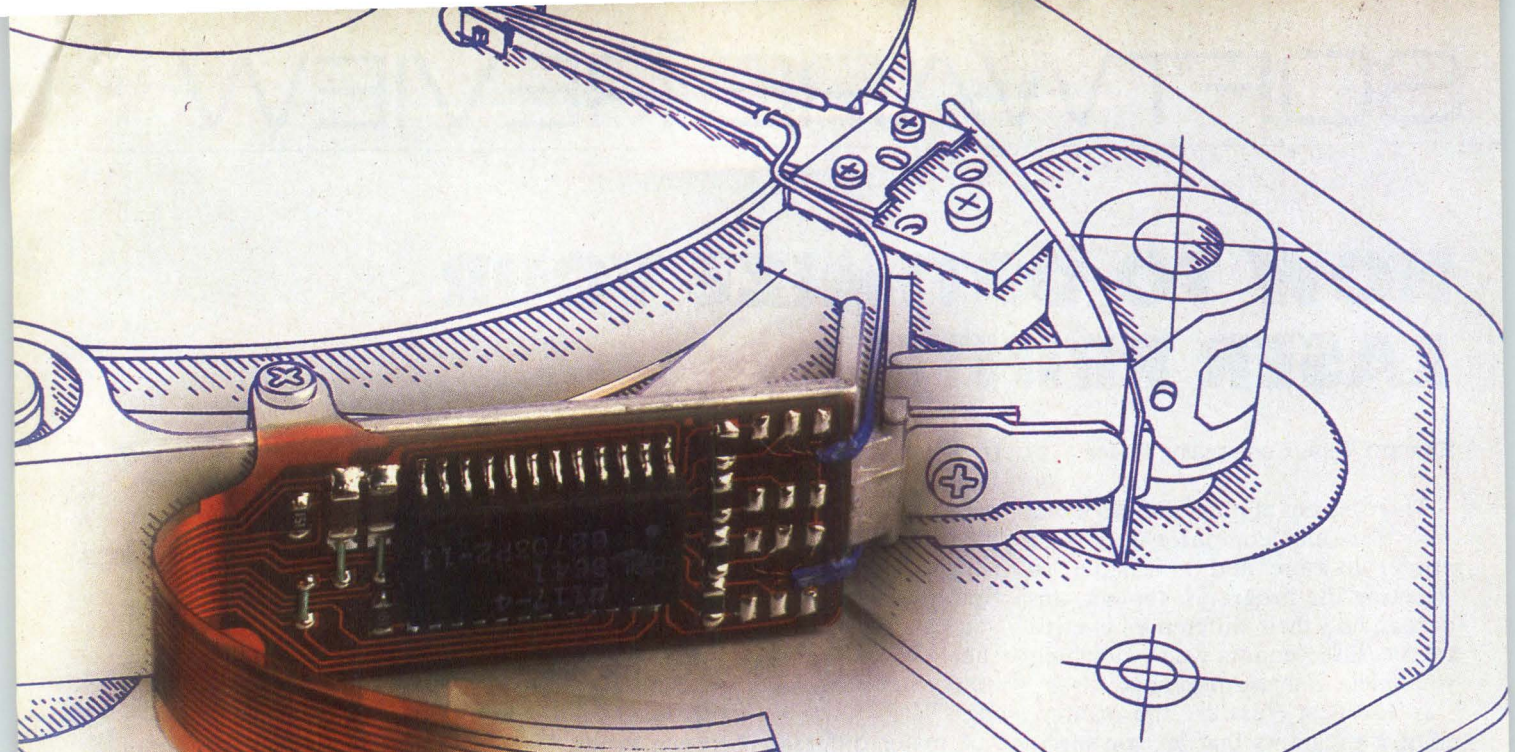
We ran into problems making this product work, and most of those problems came from the fact that we expected it to be an extension or superset of PrintMerge. Furthermore, the documentation was of little help here. Polaris president Jack Leach admitted the shortcomings of the documentation and told us that his company is already at work on new, clearer manuals. And he acknowledges the difficulties in learning the software. "But if a person sticks to it," he says, "they'll find that the effort is worth it." We agree. What is practically unforgivable is that both packages are called PrintMerge, leading to the understandable conclusion that, originally, Ram-resident PrintMerge was intended to be a true superset of PrintMerge.

A second caveat with this program is that it is intended for word processing packages, such as Ashton-Tate's Framework, that don't provide for managing more than one printer font. Using WordStar as the text-generation program begs for trouble. Leach explained that sellers are supposed to ask potential buyers what word processing package they intend to use and steer WordStar users away from Ram-resident PrintMerge.

Along with Ram-resident PrintMerge is a utility called Crunch ($49.95) that helps the Hewlett-Packard Co. Laserjet printer cope with the large files that graphics require. The utility shrinks the size of the file by eliminating unnecessary graphics commands. This helps the throughput—and you'll need all the help you can get. A reasonably complex page (containing a few tables) can take 8.5 minutes to print, and this comes from what supposedly is an 8-ppm printer, when it's confined to text.

In the end, both packages are worth their price. Impatience with PrintMerge's shortcomings quickly gives way to amazement at its power. But with either package expect to spend a full day just learning how to use it.

PrintMerge *and* Ram-resident PrintMerge, *Polaris Software, 613 W. Valley Parkway, Suite 323, Escondido, Calif. 92025, (619) 743-7800. $124 and $149 respectively.*



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CIRCLE NO. 75 ON INQUIRY CARD

Mini-Micro Systems

Spring Peripherals Handbook

INTRODUCTION

Product reference tables: terminals and printers **149**
Precipitous price erosion continues in the terminals market; dot-matrix printers approach commodity status; and impact line printers remain heavy-duty workhorses, despite pressure from laser printers.

PRODUCT GUIDES

Alphanumeric display terminals **151**

Dot-matrix character printers **161**

Impact line printers **169**

HOW TO USE THE PRODUCT GUIDES

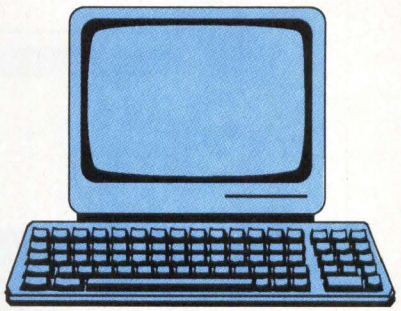
This edition of the *Peripherals Handbook* contains three *Product Guides* beginning on Page 151. Each *Product Guide* contains price and specification information, arranged alphabetically by company name. These tables are based on mail- and telephone-survey information.

Accompanying each vendor's name is the mailing address, telephone number and a circle number with which you may request additional information using the reader-service card located at the end of the issue.

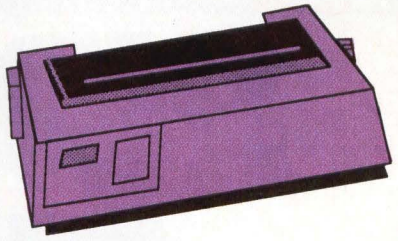
To check product prices or specifications:
- Find the appropriate product table
- Find the alphabetically listed vendor.

To select a product:
- Turn to the appropriate product table
- Study the product offerings
- Use the address information found with the company name to contact the vendor.

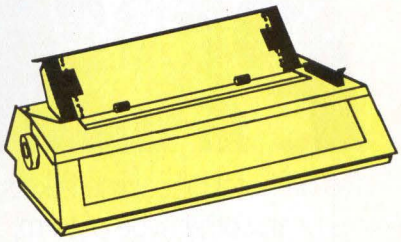
To comment on the *Peripherals Handbook*, or to suggest future product coverage, contact the Chief Editor, *Mini-Micro Systems, Peripherals Handbook*, Cahners Publishing Co., 275 Washington St., Newton, Mass. 02158-1630



p. 151 . . . . . Prices fall



p. 161 . . . . . Commodity status



p. 169 . . . . . Remaining strong

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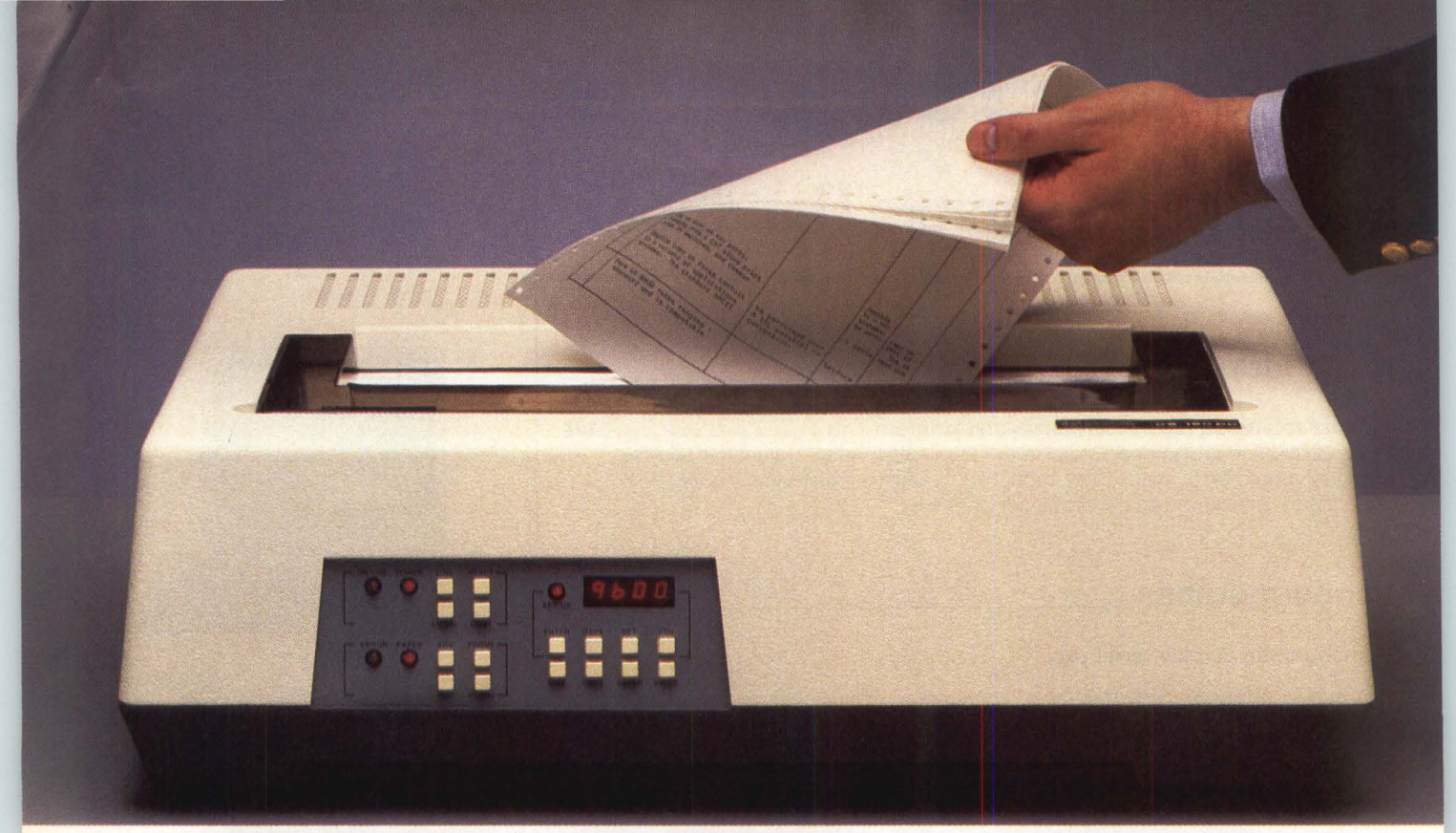
BPA ABP



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Rip off hotel bills, airline tickets, invoices or any other type of form, up to six copies thick. Datasouth Demand Document printers put them out day and night, and let you rip them off without losing the next form.

Datasouth Demand Document printers feature bidirectional dot matrix printing at 180 cps. You can print to within ½ inch of the tear-off bar, without affecting the next form. The push-button front panel and LED readout make our printers exceptionally easy to use.

There's a Datasouth Demand Document printer for almost any communications environment. The DS 180 DD has standard Serial and Centronics-type parallel interfaces. The TX 5180 DD emulates the IBM 5256, 5224 and 5225 printers in System 34/36/38 environments. And the CX 3180 DD emulates the IBM 3287 in 3270 environments.

No matter what kind of form you're printing, there's a Datasouth printer that could be doing it better. So call us at 1-800-222-4528, and ask about our Demand Document printers.

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PRODUCT REFERENCE TABLES: TERMINALS AND PRINTERS

Precipitous price erosion continues in the terminals market; dot-matrix printers approach commodity status; and impact line printers remain heavy-duty workhorses, despite pressure from laser printers

The tables in *Mini-Micro Systems'* biannual *Peripherals Handbook* are structured as general guidelines for volume buyers making critical purchasing decisions. We have mailed over 350 questionnaires and have made over 100 follow-up calls to provide you with as complete a listing as possible.

The product table covering alphanumeric display terminals lists 110 devices from 45 manufacturers. Terminal manufacturers have been plagued by precipitous price erosion over the last few years, which has led to a minor shakeout. But industry analysts predict a sales upswing beginning late this year. Their optimism stems from the increased popularity of multiuser microcomputers, which can accommodate more and more terminals, and the growth in terminal-intensive applications, such as on-line transaction processing and distributed data processing.

For example, a recent report by Frost & Sullivan Inc., New York, predicts that the overall terminals market will climb from 3.6 million units shipped in 1986 to more than 4.3 million in 1987. The market research company expects the number to top 8 million by 1992. Measured in constant 1986 dollars, that would represent a jump from $12.6 billion in 1986 to over $24 billion in 1992.

IBM Corp.'s 3270 family of terminals accounts for over 25 percent of the total installed base in the United States. Among intelligent-terminal manufacturers, IBM and Digital Equipment Corp. hold commanding shares, 18 percent and 16 percent, respectively, according to Frost & Sullivan.

One of the more important technological advances in the terminals market is the development of denser, often proprietary, chips that reduce the number of discrete logic components. This parts reduction in turn contributes to greater reliability.

Another trend revolves about single terminals that address all three major terminal categories: ASCII, ANSI and PC terminals. PC terminals do not have full PC compute power; rather, they are designed specifically for attachment to multiuser PCs.

Dot-matrix printers, our second product category, face fierce competition from laser printers (MMS, April, Page 83). However, manufacturers are making technological improvements to protect market share in data logging, general-purpose graphics and near-letter-quality correspondence (MMS, December 1986, Page 26). Improvements include a shift to 24-pin printheads, faster speeds, more emulation modes, wider carriages and inexpensive add-ins for color output. Dot-matrix technologies such as ink-jet and thermal transfer lead the way to better color output (MMS, January, Page 85.) Fueling the move toward color is an increasing availability of software that takes advantage of the color capabilities of matrix printers.

CAP International Inc., a market research company in Marshfield, Mass., pegs shipments of impact matrix printers at 3.5 million units in 1985, 4.5 million in 1988 and 4.8 million in 1991. In dollars, that's $2.3 billion in 1985, $3.4 billion in 1988 and $2.9 billion in 1991. Price reductions account for the predicted drop in revenues from 1988 to 1991.

Impact line printers are also feeling the competitive heat of laser printers. Impact line printers seem destined for moderate growth at best. Nevertheless, *Mini-Micro Systems* rounded up 15 manufacturers of these high-volume, heavy-duty-cycle workhorses. They represent more than 40 products from which to choose.

— David Simpson

Personal lasers, like chairs, weren't built to be shared.

Our new laser takes on as many as 10, comfortably.

Dataproducts' new LZR 1230 is the first laser printer in its class that's enough machine to go around.

At 12 copies a minute, for instance, it has the speed to take on up to ten office overachievers at once.

Plus it has the stamina to keep up that pace to the tune of 10,000 pages a month. Over twice the duty cycle of the LaserJet.

While personal lasers are ready to quit after the first 100,000 pages, ours is just getting started. On its way to 600,000.

The LZR 1230 also has three user ports (one parallel, two serial), standard. So three different computer systems can share it at the same time. No more cable switching.

And when it comes to handling paper, nothing in its class can touch the LZR 1230. It can automatically feed up to 750 pages—of various sizes—plus 100 envelopes. Without being tended. Takes labels and transparencies, too.

What's more, it emulates the Diablo 630, Epson FX-80 and HP LaserJet Plus. So you don't have to throw away your old software.

All of which makes it the perfect printer for sharing. Call us. And stop playing musical chairs.

LZR 1230

Dataproducts® laser printers

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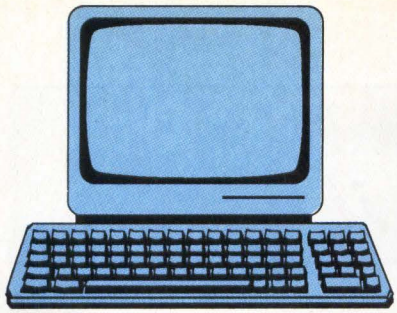

ALPHANUMERIC DISPLAY TERMINALS

Company / Model	Terminal type	Display size, color (diagonal inches)	Screen format (col.×lines)	Interfaces	Emulations	Price $ (quantity)	Notes, features
3M CO. (TELETERMINAL PRODUCTS)							**Circle 611**
311 Turquoise St., Milpitas, CA 95035, (408) 943-1970							
Whisper Screen 1923	intelligent	9-inch, monochrome	80×25	RS232C	DEC VT52, VT100		12 programmable function keys, built-in modem
Whisper Screen 1924	intelligent	9-inch, monochrome	80×25	RS232C	DEC VT52, VT100		12 programmable function keys, built-in modem
ADAC CORP.							**Circle 612**
70 Tower Office Park, Woburn, MA 01801, (617) 935-6668							
2200CRX	intelligent/graphics	7-inch, monochrome	64×24	RS232C		1,900(Q1)	bar graphs, plotting
ALTOS COMPUTER SYSTEMS							**Circle 613**
2641 Orchard Parkway, San Jose, CA 95134, (408) 946-6700							
Altos III	intelligent	14-inch, green	132×26	RS232C	TeleVideo 1910	795(Q1)	16 or 32 programmable function keys, split screen
Altos IV	intelligent	14-inch, green	80×26	RS232C	ADDS VP; TeleVideo 925, 1910	495(Q1)	16 or 32 programmable function keys, split screen
AMPEX CORP. (COMPUTER PRODUCTS DIV.)							**Circle 614**
200 N. Nash St., El Segundo, CA 90245, (213) 640-0150							
210 plus	intelligent	14-inch, monochrome	132×25	RS232C	ADDS Viewpoint, Regent; Hazeltine; Lear Siegler; TeleVideo	419(Q1)	14 programmable function keys, line graphics, 7 national character sets
220	intelligent	14-inch, monochrome	132×25	RS232C	DEC VT52, VT100, VT102, VT220	529(Q1)	15 programmable function keys, split screen, scroll
232	intelligent	14-inch, monochrome	132×25	RS232C	TeleVideo 925	499(Q1)	10 programmable function keys, line graphics
ANN ARBOR TERMINALS INC.							**Circle 615**
6175 Jackson Rd., Ann Arbor, MI 48103, (313) 663-8000							
Ambassador XL	intelligent/graphics	15-inch, monochrome	80×60	RS232C, RS422	DEC VT52, VT100	1,595(Q1); 1,275(Q100)	programmable keyboard, scroll, zoom, line drawing graphics
VXL	intelligent/graphics	15-inch, monochrome	160×60	RS232C, RS422	DEC VT52, VT100	2,795(Q1); 2,235(Q100)	programmable keyboard, line drawing graphics, scroll, zoom, 8 windows
GXL	intelligent/graphics	15-inch, monochrome	80×60	RS232C, RS422, current loop	DEC VT52, VT100; Tektronix 4010, 4014	3,090(Q1); 2,475(Q100)	bit-mapped graphics, PLOT 10 software, polygon draw and fill, scroll, zoom
CHI CORP.							**Circle 616**
26055 Emery Rd., Cleveland, OH 44128, (216) 831-2622							
EMP-SI	intelligent	14-inch, monochrome	133×25	RS232C, Centronics	IBM, Sperry	1,675(Q1); 1,340(Q100)	reprogrammable keyboard, 101 programmable keys, 22 programmable function keys
MP-UTS	intelligent	14-inch, monochrome	133×25	RS232C, Centronics	Sperry	1,125(Q1); 900(Q100)	reprogrammable keyboard, 101 programmable keys, 22 programmable function keys
MP-3270	intelligent	14-inch, monochrome	133×25	RS232C, Centronics	IBM 3278	1,125(Q1); 900(Q100)	reprogrammable keyboard, 101 programmable keys, 22 programmable function keys
CIE SYSTEMS INC.							**Circle 617**
2515 McCabe Way, Irvine, CA 92714, (714) 660-1800							
CIE 7103	editing	14-inch, monochrome	132×27	RS232C, RS422	ADDS Viewpoint; DEC VT100; IBM 3180-1, 3180-2	645(Q1)	80 function keys, split screen
CIE 7800	editing	14-inch, monochrome	132×27	RS232C, coax	IBM 3178, 3191, 3278; DEC VT100	795(Q1)	24 function keys, RPQ support
CIE 7900	editing	13-inch, 7-color	132×27	RS232C	IBM 3179, 3279; DEC VT100	1,695(Q1)	24 function keys, printer port

ALPHANUMERIC DISPLAY TERMINALS

Company / Model	Terminal type	Display size, color (diagonal inches)	Screen format (col.×lines)	Interfaces	Emulations	Price $ (quantity)	Notes, features
CIE TERMINALS INC.							**Circle 618**
2505 McCabe Way, Irvine, CA 92714 (714) 660-1421							
CIT 20+	editing	14-inch, monochrome	80×25	RS232C	ADDS Viewpoint; Lear Siegler ADM 3A, ADM 5; Televideo 910	399(Q1)	32 shifted function keys, non-glare screen, double-size characters
CIT 101XL	editing	14-inch, monochrome	132×25	RS232C	DEC VT100, CIT 101e	699(Q1)	32 programmable function keys, multi-page memory
CIT 224	editing	14-inch, monochrome	132×25	RS232C, RS422	DEC VT220	699(Q1)	60 function keys, 11 set-up menus
DATAMAXX USA CORP.							**Circle 619**
1815 S. Gadsden St., Tallahassee, FL 32301, (904) 224-8213							
1200 Series	intelligent	14-inch, monochrome	132×26	RS232C	Data General, DEC VT100, IBM 3278	1,195-2,495(Q1); 850-1,695(Q100)	40 function keys
7000 Series	intelligent	14-inch, monochrome	132×26	RS232C	Data General, DEC VT100, IBM 3278	1,695-1,995(Q1); 1,360-1,695(Q100)	40 function keys
DATAMEDIA CORP.							**Circle 620**
11 Trafalgar Square, Nashua, NH 03063, (603) 886-1570							
ColorScan 90	intelligent/graphics	12-inch, 8-color	132×24	RS232C, current loop	ADDS Regent 25, Hazeltine 1420, Lear Siegler ADM 3A	1,850(Q1); 1,203(Q100)	17 precoded keys, 8 user-defined windows, non-volatile set-up mode
Elite 60	editing	14-inch, monochrome	80×25	RS232C	ANSI X3.64; DEC VT100, VT101	950(Q1); 646(Q100)	15 programmable, 12 precoded keys; 1 page of memory
Elite 90	editing	14-inch, monochrome	132×24	RS232C, current loop	ADDS Regent 25, Hazeltine 1420, Lear Siegler ADM 3A	925(Q1); 629(Q100)	17 precoded keys, 8 user-defined windows, non-volatile set-up mode
DATAPOINT CORP.							**Circle 621**
9725 Datapoint Dr., San Antonio, TX 78284, (512) 699-7000							
7350	editing/graphics	14-inch, monochrome	80×24	RS232C, RS422	Datapoint 8230	1,495(Q1); 1,091(Q100)	8 function keys, 10 control keys, split screen, character graphics
8216	editing/graphics	14-inch, monochrome	80×24	RS232C	IBM PC, TeleVideo 925	599(Q1); 440(Q100)	10 function keys, 10 control keys, character graphics
8242	editing/graphics	14-inch, monochrome	84×24	RS232C	Datapoint 8220	1,095(Q1); 799(Q100)	10 function keys, 5 control keys, split screen, character graphics
DECISION DATA COMPUTER CORP.							**Circle 622**
400 Horsham Rd., Horhsam, PA 19044, (215) 674-3300							
3761-41/61	editing	14-inch, monchrome	80×24	twinax	IBM 5291	1,195(Q1)	24 command keys, record/play back
3781-01/21	editing	15-inch, monochrome	132×27	twinax	IBM 3180, 5291	1,650(Q1)	24 command keys, record/playback, RS232C printer port
ENTERPRISE SYSTEMS CORP.							**Circle 623**
P.O. Box 698, Dover, NH 03820, (603) 742-7363							
DV7000	intelligent	12-, 14-inch; monochrome	84×24	RS232C, RS422, RS423, current loop	ANSI X3.64, Ann Arbor		10 function keys, printer buffer, industrial
DV8000	intelligent/graphics	14-inch, 16-color	80×24	RS232C, RS422, RS423	ANSI X3.64		screen editor, character and line drawing graphics, industrial
DV9000	intelligent/graphics	14-inch, 16-color	80×24	RS232C, RS422, RS423	ANSI X3.64		screen editor, character and line drawing graphics, industrial
ERICSSON INFORMATION SYSTEMS AB							**Circle 624**
(Data Terminals Division, System 11), S-16398 Stockholm, Sweden, 46-8-7937000							
DU1110	editing	15-inch, monochrome	80×24	twinax	IBM 5251		
DU1111	editing	12-inch, monochrome	80×24	twinax	IBM 5291		
DU6225	editing	15-inch, monochrome	80×24, 132.x 24	RS423, current loop	DEC VT220		
FALCO DATA PRODUCTS INC.							**Circle 625**
1294 Hammerwood Ave., Sunnyvale, CA 94089, (408) 745-7123							
F500	intelligent	14-inch, monochrome	132×44	RS232C, RS422	ADDS, DEC, Hazeltine, TeleVideo, Wyse	795(Q1)	16 function keys
F5220	intelligent	14-inch, monochrome	132×44	RS232C, RS422	DEC VT52, VT100, VT200	595(Q1)	13 function keys
F5500	intelligent	14-inch, monochrome	132×44	RS232C, RS422	ADDS Viewpoint, Data General, IBM, TeleVideo, Wyse	495(Q1)	16 function keys

ALPHANUMERIC DISPLAY TERMINALS

Company / Model	Terminal type	Display size, color (diagonal inches)	Screen format (col.×lines)	Interfaces	Emulations	Price $ (quantity)	Notes, features
GENERAL BUSINESS TECHNOLOGY INC. 1891 McGaw Ave., Irvine, CA 92714, (714) 261-1891							**Circle 658**
7700DS	dumb/graphics	14-inch, monochrome	80×25	twinax	IBM 5291	1,450(Q1)	bit-mapped graphics
7710DS	dumb/graphics	14-inch, monomchrome	80×25	twinax	IBM 3179-2	1,550(Q1)	24 function keys, bit-mapped graphics
GENERAL DIGITAL CORP. 160 Chapel Rd., P.O. Box 1657, Manchester, CT 06040, (203) 647-9700							**Circle 626**
VuePoint II	intelligent	10½-inch, monochrome	40×12	RS232C, RS422, RS423, RS485, current loop, TTL			touch sensitive display, 3 pages of memory, 240 programmable touch areas
Smart VuePoint	intelligent	10½-inch, monochrome	40×12	RS232C, RS422, RS423, RS485, current loop, TTL			additional on-board CPU off-loads processing from controller
HEWLETT-PACKARD CO. (ROSEVILLE TERMINALS DIV.) 8020 Foothills Blvd., Roseville, CA 95678, (916) 786-8000							**Circle 627**
2392A	intelligent	12-inch, monochrome	80×24	RS232C, RS422, Centronics	DEC VT52, VT100	1,375(Q1)	8 function keys, 4 pages of memory
2394A	intelligent	12-inch, monochrome	80×24	RS232C, RS422, Centronics	DEC VT52, VT100	1,875(Q1)	8 programmable function keys, 8 pages of memory
HONEYWELL INFORMATION SYSTEMS INC. 200 Smith St., Waltham, MA 02154, (617) 895-6000							**Circle 628**
HDS1	editing	14-inch, monochrome	80×25	RS232C, RS422	ADDS, Hazeltine, Lear Siegler, TeleVideo, Wyse	525(Q1)	10 programmable function keys
HDS3	editing	14-inch, monochrome	80×25, 132×25	RS232C, RS422	DEC VT52, VT100, VT220	750(Q1)	14 programmable function keys
HDS7	editing	14-inch, monochrome	80×25, 132×25	RS232C, RS422	ANSI X3.64, VIP 7824	1,200(Q1)	12 programmable function keys, scroll
HUMAN DESIGNED SYSTEMS INC. 3440 Market St., Philadelphia, PA 19104, (215) 382-5000							**Circle 629**
HDS2200	editing	15-inch, monochrome	132×25	RS232C	DEC VT52, VT100, VT220	795(Q1)	42 function keys, 4 pages of memory
IBM CORP. 900 King St., Rye Brook, NY 10573, (914) 934-4828							**Circle 630**
3162	intelligent	14-inch, monochrome	29×29	RS232C, RS422A	DEC VT52, VT100, VT220	640-724(Q1)	12 function keys, split screen, scroll
3163	intelligent	12-inch, monochrome		RS232C, RS422A	DEC VT100, TeleVideo 950	895-985(Q1)	12 function keys
INFORMER COMPUTER TERMINALS INC. 12781 Pala Dr., Garden Grove, CA 92641, (714) 891-1112							**Circle 631**
200-205	intelligent	12-inch, monochrome	80×24	RS232C	DEC VT102; IBM 3178, 3276; dual 3178/VT100	995(Q1); 796(Q100)	
200-207	intelligent	9-inch, monochrome	80×24	RS232C	DEC VT102; IBM 3178, 3276, 5251; dual 3178/VT100	1,390(Q1); 1,112(Q100)	
200-213	intelligent	10.2×5.7-inch, monochrome	80×25	RS232C	IBM 3276	3,500(Q1); 2,800(Q100)	24 programmable function keys, built-in modem
INTECOLOR CORP. 225 Scientific Dr., Norcross, GA 30092,(404) 449-5961							**Circle 632**
ColorTrend 210	editing/graphics	14-inch, 8-color	132×24	RS232C	ANSI X3.64; DEC VT52, VT100	1,295(Q1); 945(Q100)	12 programmable function keys, vector graphics
ColorTrend 220	editing	14-inch, 8-color	80×24	RS232C	DEC VT52, VT100, VT220	1,695(Q1); 1,095(Q100)	25 function keys, 15 programmable function keys
ITT COURIER TERMINAL SYSTEMS INC. P.O. Box 29039, Phoenix, AZ 85038-9039, (602) 894-7000							**Circle 633**
1778	editing	12-inch, monochrome	80×24	coax	IBM 3270	1,295(Q1)	24 programmable function keys
9210	editing	14-inch, monochrome	80×24	coax	IBM 3270	1,295(Q1)	24 programmable function keys
9230/9236	editing/graphics	15-inch, monochrome/7-color	132×24	RS232C	DEC VT100, IBM 3270	1,995/2,595(Q1)	24 programmable function keys, split screen
KIMTRON CORP. 1709 Junction Court, Bldg. 380, San Jose, CA 95112, (408) 436-6550							**Circle 634**
KT-5 Version L	intelligent	14-inch, monochrome	132×24	RS232C	ADDS, DEC, Hazeltine, Lear Siegler, TeleVideo	399(Q1)	82 programmable function keys

ALPHANUMERIC DISPLAY TERMINALS

Company / Model	Terminal type	Display size, color (diagonal inches)	Screen format (col.×lines)	Interfaces	Emulations	Price $ (quantity)	Notes, features
KT-7 Version L	intelligent	14-inch, monochrome	80×25	RS232C	Data General D100, D200; DEC VT52, VT100; TeleVideo 920, 925	499(Q1)	84 programmable function keys
KT-7/PC Version L	intelligent	14-inch, monochrome	80×25	RS232C	IBM PC/AT/XT, TeleVideo 925	499(Q1)	20 programmable function keys
LEE DATA CORP.							**Circle 635**
7075 Flying Cloud Dr., Eden Prairie, MN 55344, (612) 828-0300							
1222	editing	15-inch, monochrome	80×24, 132×27	coax	IBM 3180	1,885(Q1)	24 programmable function keys, windowing, 4 sessions
2131	editing	14-inch, 7-color	80×24, 132×27	coax	IBM 3179, 3279	2,265(Q1)	24 programmable function keys, windowing, 4 sessions
LEE DATA CORP. (PHAZE TERMINAL DIV.)							**Circle 636**
7650 E. Redfield Rd., Scottsdale, AZ 85260, (602) 991-6855							
1179	editing	14-inch, 7-color	80×24	Centronics	IBM 3179, 3279	1,865(Q1)	24 programmable function keys
1191	editing	14-inch, monochrome	80×24	coax	IBM 3278, 3191	1,115(Q1)	24 programmable function keys
LIBERTY ELECTRONICS USA							**Circle 637**
332 Harbor Way, South San Francisco, CA 94080, (415) 742-9960							
Freedom ONE	intelligent	14-inch, monochrome	132×96	RS232C	ADDS Viewpoint, Lear Siegler ADM 31, TeleVideo 950, Wyse WY-50	449(Q1)	16 function keys
Freedom ONE plus	intelligent	14-inch, monochrome	80×96	RS232C	Freedom ONE	549(Q1)	16 function keys
Freedom ONE Turbo	intelligent	14-inch, monochrome	132×96	RS232C	DEC VT52, VT100, VT220; Data General Dasher	599(Q1)	16 function keys
LINK TECHNOLOGIES INC.							**Circle 638**
47339 Warm Springs Blvd., Fremont, CA 94539, (415) 651-8000							
220	editing	14-inch, monochrome	132×26	RS232C, RS422, RS423, current loop	DEC VT52, VT100, VT220	595(Q1)	38 programmable function keys, split screen
MC3	editing	14-inch, monochrome	132×44	RS232C, RS422, Centronics, current loop	DEC, Lear Siegler, TeleVideo, Wyse	546(Q1)	40 programmable function keys, split screen, parallel port, 6 pages of memory
PC Term	editing	14-inch, monochrome	132×26	RS232C, current loop	PC Term, TeleVideo 925, Wyse WY-50	649(Q1)	40 programmable function keys, split screen, bidirectional auxiliary port
MEGADATA CORP.							**Circle 639**
35 Orville Dr., Bohemia, NY 11716, (516) 589-6800							
8188-4	editing	15-inch, monochrome	80×25	RS423	OEM interfaced	2,800(Q100)	up to 100 function keys, split screen
8188-6	editing	15-inch, monochrome	135×26	RS232C, RS422	Data General 410	2,700(Q100)	up to 100 function keys, windowing
8188-7	intelligent	15-inch, monochrome	132×32	RS232C, Centronics, SCSI	ADDS, DEC, IBM, Sperry, TeleVideo	2,250(Q100)	
MICRO-TERM INC.							**Circle 640**
512 Rudder Rd., Fenton, MO 63026, (314) 343-6515							
Foresight 4520	intelligent	14-inch, monochrome	80×25, 132×25	RS232C, RS423, current loop	ANSI X3.64; DEC VT52, VT100, VT220	695(Q1)	15 programmable function keys, split screen, 2 pages of memory
Foresight 4525	intelligent	14-inch, monochrome	80×25, 132×25	RS232C, RS423, current loop	ANSI X3.64; DEC VT52, VT100, VT220	795(Q1)	15 programmable function keys, split screen, 7 pages of memory
Foresight 4560	intelligent/graphics	14-inch, monochrome	80×25, 132×25	RS232C, RS423, current loop	ANSI X3.64; DEC VT52, VT100, VT220; Tektronix 4010, 4014	1,295(Q1)	15 programmable function keys, split screen, 7 pages of memory
MODULAR COMPUTER SYSTEMS INC. (MODCOMP)							**Circle 641**
1650 W. McNab Rd., Fort Lauderdale, FL 33310, (305) 977-1823							
4614-A	editing/graphics	14-inch, monochrome	132×26	RS232C		550(Q1)	64 programmable function keys, 20 editing keys, split screen, line graphics characters
NCR CORP.							**Circle 642**
1700 S. Patterson Blvd., Dayton, OH 45479, (513) 445-5000							
7930	editing/graphics	12-inch, monochrome	80×25	RS232C	NCR 7900-1, 7901; ADDS Viewpoint	995(Q1); 650(Q100)	24 function keys, split screen, 12 graphic symbols
7958	editing	14-inch, monochrome	80×25		IBM 3270	1,395(Q1)	24 function keys

ALPHANUMERIC DISPLAY TERMINALS

Company / Model	Terminal type	Display size, color (diagonal inches)	Screen format (col.×lines)	Interfaces	Emulations	Price $ (quantity)	Notes, features
PARADYNE CORP.							**Circle 643**
8550 Ulmerton Rd., Largo, FL 33540, (305) 530-2000							
7812	intelligent	12-inch, monochrome	80×24	current loop	IBM 3278 Model 2	1,300(Q1); 1,135(Q100)	24 function keys
7814	intelligent/graphics	14-inch, monochrome	132×43	RS232C, current loop	IBM 3278 Model 2, 3, 4, 5	2,400(Q1); 2,095(Q100)	24 function keys
7913	intelligent/graphics	13-inch, monochrome	80×32	RS232C, current loop	IBM 3279 Model 2B, 3B	3,100(Q1); 2,700(Q100)	24 function keys
PDS TECHNOLOGIES INC.							**Circle 644**
2000 Black Rock Turnpike, Fairfield, CT 06430, (203) 333-5183							
Ruggedized	editing	14-inch, monchrome	80×25	RS232C, RS422, current loop	ADDS, DEC, Hazeltine, Lear Siegler, TeleVideo		10 function keys, industrial
PLESSEY PERIHPERAL SYSTEMS							**Circle 645**
17466 Daimler Ave., Irvine, CA 92714, (714) 261-9945							
PT224	intelligent	14-inch, monochrome	132×24	RS232C, current loop	DEC VT52, VT100, VT102, VT220	795(Q1); 585(Q100)	45 programmable function keys, split screen, scroll
PRIME COMPUTER INC.							**Circle 646**
Prime Park, Natick, MA 01760, (617) 655-8000							
PT200	intelligent	14-inch, monochrome or 15-color	132×48	RS232C, RS422		895-1,695(Q1)	26 editing function keys, 26 application function keys
SCOTT SYSTEMS INC.							**Circle 647**
99-C South St., Hopkinton, MA 01886, (617) 435-9578							
5101	intelligent	9-, 12-, 14-inch; monochrome	64×30	RS232C, current loop	PARS	3,500(Q1)	24 function keys, split screen
5271	intelligent	9-, 12-, 14-inch; monochrome	64×30	RS232C, current loop	IBM 3270 bisynch	3,500(Q1)	24 function keys
5301	intelligent	9-, 12-, 14-inch; monochrome	64×30	RS232C, current loop	PARS	3,500(Q1)	24 function keys, split screen
TAB PRODUCTS CO.							**Circle 648**
1400 Page Mill Rd., Palo Alto, CA 94304, (415) 852-2400							
E-22	intelligent	15-inch, monochrome	132×27	RS232C	DEC VT52, VT100, VT220	660(Q1); 395(Q100)	51 function keys, split screen, 2 pages of memory
TEC INC.							**Circle 649**
2727 N. Fairview Ave., P.O. Box 5646, Tucson, AZ 85703, (602) 792-2230							
Data-Pad	editing	9-inch, monochrome	80×16	RS232C	DEC, Hazeltine, Lear Siegler, TeleVideo	995(Q1)	10 programmable function keys, scroll, portable, LCD display
TEC ET 80	editing	15-inch, monochrome	80×25	RS232C	ANSI X3.64	1,795(Q1)	16 programmable function keys, split screen, scroll
TEC ET 100	editing	15-inch, monochrome	80×25	RS232C	DEC VT100	1,795(Q1)	16 programmable function keys, split screen, scroll
TELEVIDEO INC.							**Circle 650**
1170 Morse Ave., P.O. Box 3568, Sunnyvale, CA 94088-3568, (408) 745-7760							
905	intelligent	14-inch, monochrome	80×24	RS232C, current loop	ADDS, Hazeltine, Lear Siegler, Qume, TeleVideo	409(Q1)	32 programmable function keys
9220	intelligent	14-inch, monochrome	80×24, 132×24	RS232C, RS423, current loop	DEC VT52, VT100, VT220	619(Q1)	30 function keys, 28 editing keys
PC Station	editing	14-inch, monochrome	80×26, 132×26	RS232C, parallel	IBM PC; Kimtron KT-7/PC; Link PC Term; TeleVideo 905, 925	629(Q1)	IBM PC/AT-style keyboard
TELEX COMPUTER PRODUCTS INC.							**Circle 651**
6422 E. 41st St., Tulsa, OK 74135, (918) 627-1111							
078-2	dumb	12-inch, monochrome	80×24	RS232C		1,295(Q1)	24 command keys
179-2	dumb	14-inch, 7-color	80×24	RS232C		2,095(Q1)	24 command keys
180-2	dumb	15-inch, monochrome	132×27	RS232C		1,995(Q1)	24 command keys
TERMIFLEX CORP.							**Circle 652**
316 Daniel Webster Highway, Merrimack, NH 03054, (608) 424-3700							
HT/40	dumb		2 lines×16 characters	RS232C		395(Q1)	hand-held, LCD display
HT/1000	intelligent		4 lines×16 characters	RS232C		795(Q1)	4 function keys, LCD display, hand-held, battery pack
ST/32	dumb		2 lines×16 characters	RS232C		195(Q1)	hand-held, LCD display

ALPHANUMERIC DISPLAY TERMINALS

Company / Model	Terminal type	Display size, color (diagonal inches)	Screen format (col.×lines)	Interfaces	Emulations	Price $ (quantity)	Notes, features
VISUAL TECHNOLOGY INC. 1703 Middlesex St., Lowell, MA 01851, (617) 459-4903							**Circle 653**
Visual 601	editing/graphics	14-inch, monochrome	132×50	RS232C, RS422, RS423	ADDS, Hazeltine, Lear Siegler, Tektronix, TeleVideo, Wyse	695(Q1)	48 function keys, split screen, scroll, bit-mapped graphics, PLOT 10 compatible
Visual 602	editing/graphics	14-inch, monochrome	132×50	RS232C, RS422, RS423	ADDS, DEC, Hazeltine, Lear Siegler, Tektronix, TeleVideo, Wyse	695(Q1)	45 function keys, split screen, scroll, bit-mapped graphics, PLOT 10 compatible
Visual 603	editing/graphics	14-inch, monochrome	132×50	RS232C, RS422, RS423	DEC VT52, VT100, VT220; Tektronix 4010, 4014	695(Q1)	45 function keys, split screen, scroll, bit-mapped graphics, PLOT 10 compatible
WYSE TECHNOLOGY 3571 N. First St., San Jose, CA 95134, (408) 433-1000							**Circle 654**
WY-60	intelligent	14-inch, monochrome	132×44	RS232C	ADDS, Hazeltine, IBM, Lear Siegler, TeleVideo, Wyse	599(Q1)	16 function keys, split screen
WY-85	intelligent	14-inch, monochrome	132×26	RS232C	DEC VT52, VT100, VT220	599(Q1)	15 programmable function keys
WY-350	intelligent	14-inch, 8-color palette	132×26	RS232C	ADDS, Hazeltine, Lear Siegler, TeleVideo	999(Q1)	16 programmable function keys, split screen
ZENTEC CORP. 2400 Walsh Ave., Santa Clara, CA 95051, (408) 727-7662							**Circle 655**
ADM 220	intelligent	14-inch, monochrome	80×25, 132×25	RS232C, asynch ASCII		595(Q1)	15 function keys, scroll, non-volatile set-up mode
ADM 1000	intelligent	14-inch, monochrome	80×25	RS232C, asynch		399(Q1)	4 programmable function keys
8392	intelligent	14-inch, monochrome	80×27, 132×27	RS232C, RS422	HP 2382A, 2392A, 2621B, 2622A	1,195(Q1)	scroll

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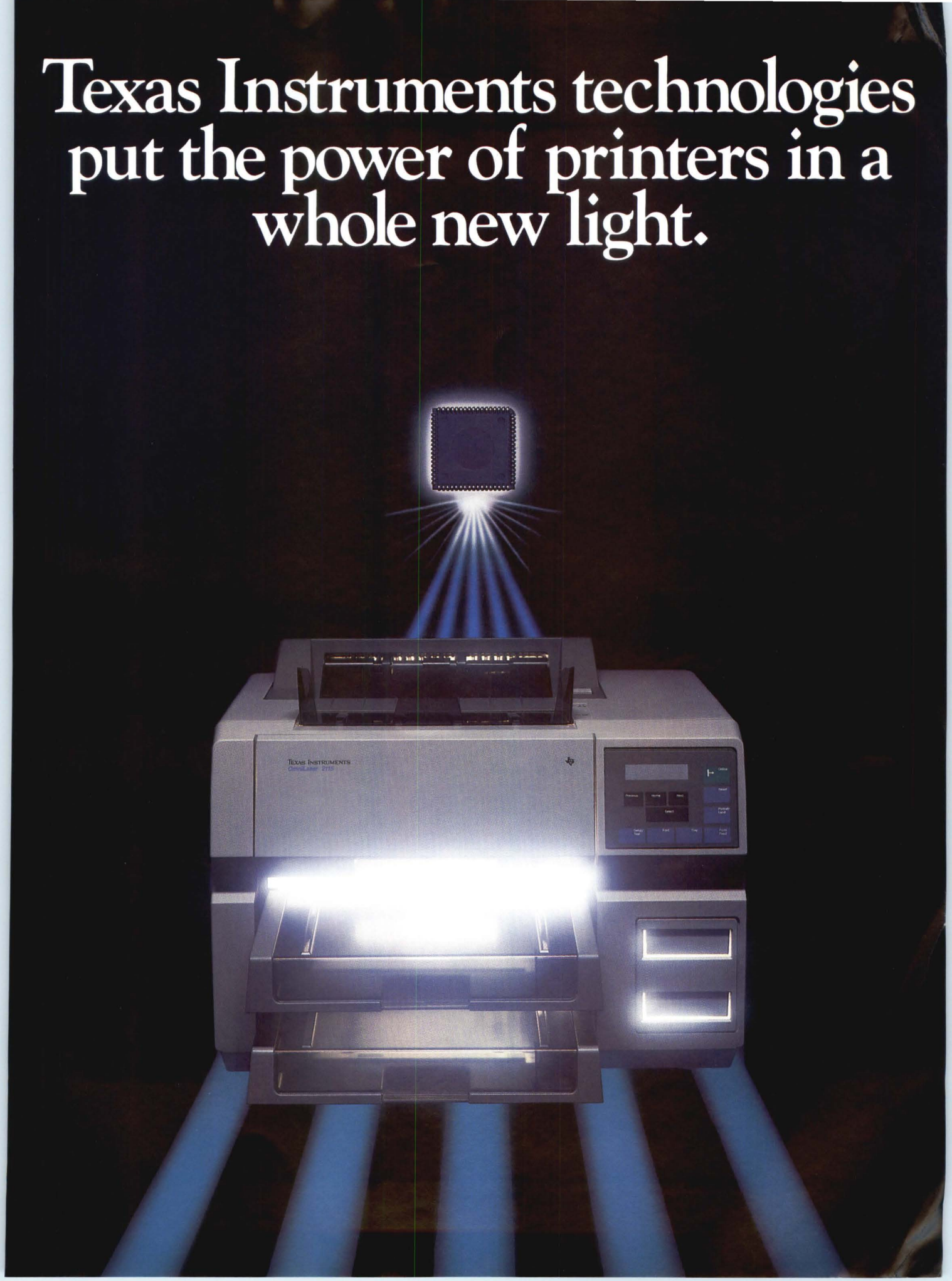

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The first generation of laser printers represented a major step forward in printing capabilities. But that was just the beginning.

Thanks to advanced, second-generation print engines and proprietary TI controllers, we've created a family of laser printers that offers improved compatibility and up to 10 times the duty cycle, 15 times the machine life and five times the paper capacity of their first-generation counterparts.

For example, first-generation lasers were capable of handling 3,000 pages per month. But with TI OmniLaser™ Printers, you can produce as many as 25,000 pages a month, and at speeds of eight and 15 pages per minute.

It's what we put into OmniLaser Printers that makes their output so special.

OmniLaser Printers combine advanced electro-photographic technology with the latest semiconductor technology. Text and images are produced with outstanding resolution by addressing over 7.5 million dots on each page. But since each dot occupies a separate area of memory, it takes large-scale

TI's expertise in semiconductor technology allows us to create specialized components to provide laser printer users with increased ease-of-use, reliability and power.

to work on paper.

processing and memory power to manipulate, store and print these documents.

That's why our OmniLaser Printers perform so well. Because when it comes to semiconductor technology, TI wrote the book. Starting with our invention of the integrated circuit back in 1958, and continuing today with our MegaChip™ technologies that produce advanced semiconductor systems-on-a-chip, nobody has done more to increase the power, density and capability of the devices that are becoming the heart of laser printers.

The intelligence inside an OmniLaser Printer is a case in point. It's a proprietary TI controller that's so powerful, it has more sheer processing capability than you'd find inside an IBM® PC AT™ computer.

We also made our OmniLaser Printers easier to operate. Because when you've been building printers as long as TI has, you develop an understanding of ergonomic factors. Like the convenience that comes from placing virtually all of the operator controls on an easily accessible front panel.

With PostScript®, the integration of text and graphics is anything but an afterthought.

PostScript, a standard in the desktop publishing industry, is a page description language that lets you control the placement, size and appearance of every element in your document. It's supported by both the OmniLaser 2108 and 2115 models, and with it you can produce cleaner, clearer, more professional output than was ever previously possible.

The OmniLaser Printer family also includes models that emulate the features of many printer standards, including HP LaserJet Plus, HPGL and IBM Pro Printer™, and since they're compatible with IBM, Apple® and others, there's an OmniLaser printer that's right for most applications.

These convenient plug-in cartridges provide for easy font selection, either manually or under software control.

The TI printer family includes laser printers, forms printers, personal printers and high-output models designed for shared-resource environments.

▶ *See back page for more information.*

The printers you need if your needs are demanding.

Our family also includes shared-resource serial-impact printers.

Most shared-resource environments are pretty tough on the hardware involved. So it follows that the more widely your resource is shared, the tougher it'll need to be. Which is one good reason to consider our OMNI 800™ family.

Our Model 810, for example, has become the standard for heavy-duty system printers. Over the years, they've proved themselves to be so durable, most of the world's largest airlines depend on them for ticket printing.

Then there's our Model 880s, which feature high-throughput, near-letter-quality printing and high-resolution raster graphics for data processing environments. And just about the only maintenance they require is the occasional ribbon change.

Increase operator productivity and eliminate forms waste.

The latest addition to our printer family is the Model 885 demand document printer. Just like the other family members, it's designed to be rugged and offer superior paper handling. But its differences make it ideal for applications where space is limited and paper waste is a consideration.

We've added a zero tear-off capability that eliminates forms waste. Simply put, it uses just one form where most printers would also use a second. It's front-loading, handles up to five-part forms with ease, and thanks to its small footprint, fits on a desk or countertop.

TI's 885 demand document printer includes a zero tear-off capability to eliminate forms waste.

Mini or mainframe, our printers connect to IBM.

Plug in TI's SNA/SDLC coax option and you can connect many of our durable printers to your IBM 3270 system quickly and cost-effectively. In the same way, plug in the TI Twinax option, and you can connect a TI printer to your System 34, 36 or 38.

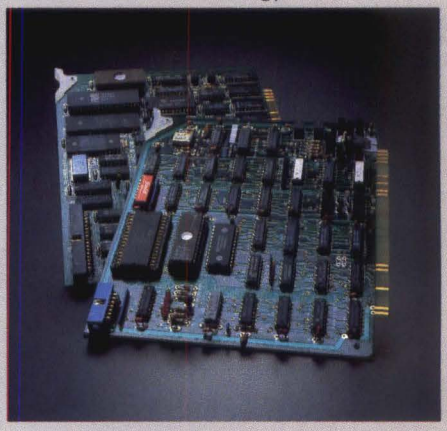
The personal printers.

Our family of personal printers is well known for its sturdy qualities. We build them to offer industrial strength and design durability, coupled with convenient features like easily changeable font cartridges.

They feature dual-mode, letter-quality, color and graphics printing, and come in both 80- and 132-column models. And since they're compatible with most PC hardware and software on the market, they can help in virtually any application.

Durability and technology. A combination that's engineered to work for you.

As you can probably tell, there's a broad range of TI printers designed to fill most any need. And as different as they are in function, they have a couple of things in common: durable design and advanced technology.



Optional interface boards make TI printers compatible with IBM's 3270 protocol, or with System 34, 36 or 38 minicomputers.

At Texas Instruments, building printers that deliver these qualities isn't just a goal, it's a commitment. We call it putting TI technologies to work on paper. And all you need to do to put it to work for you is call us toll-free at **1-800-527-3500.** Call us soon. Because with your input, we can get to work on improving your output.

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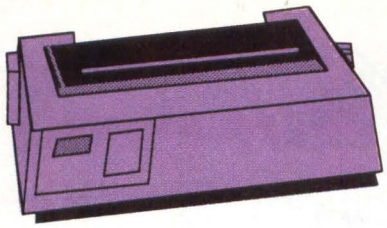
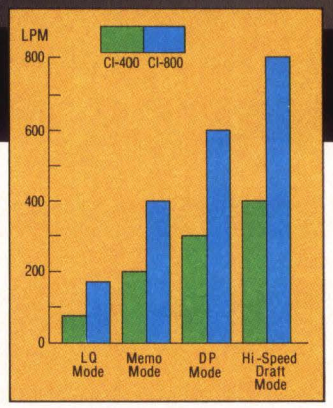
TEXAS INSTRUMENTS



MATRIX CHARACTER PRINTERS

Company / Model	Print method (matrix size)	Print speed (cps)	Characters/line	Interfaces (Transmission rate)	Price $ (quantity)	Notes, features
3M CO. (TELETERMINAL PRODUCTS)						**Circle 566**
311 Turquoise St., Milpitas, CA 95035, (408) 943-1970						
1902/1912	thermal (5×7)	40	40, 80	RS232C (300 to 9.6K bps)	299(Q1)	bit-image graphics
1904/1914	thermal (5×7)	40	40, 80	Centronics	289(Q1)	bit-image graphics
ADVANCED MATRIX TECHNOLOGY INC.						**Circle 567**
1157 Tourmaline Dr., Newbury Park, CA 91320, (805) 499-8741						
AMT 2000 Office Printer	impact	45, 100, 250		RS232C, Centronics, ASCII parallel, Diablo, Qume, NEC (110-19.2K bps)	1,845(Q1)	color printing for graphics and text, noise level less than 55 dB(a)
AMT 2100 Office Printer	impact	45, 100, 250		RS232C, Centronics, ASCII parallel, Diablo, Qume, NEC (110-19.2K bps)	1,645(Q1)	color printing for graphics and text, noise level less than 55 dB(a)
ALPS AMERICA						**Circle 568**
3553 N. First St., San Jose, CA 95134, (408) 946-6000						
ALQ224	impact (24×36)	240	80, 96, 160	RS232C, Centronics	695(Q1)	7-color printing, bit-image graphics
P2000	impact (18×23)	250	136, 163, 272	RS232C, Centronics	995(Q1)	bit-image graphics
P2424C	impact (24×36)	360	136, 163, 272	RS232C, Centronics	1,395(Q1)	7-color printing, bit-image graphics
APPLE COMPUTER INC.						**Circle 569**
20525 Mariani Ave., Cupertino, CA 95014, (408) 996-1010						
Imagewriter II	impact (7×8)	250	programmable	Appletalk, serial	595(Q1)	color printing, bit-mapped graphics
BROTHER INTERNATIONAL CORP.						**Circle 570**
8 Corporate Place, Piscataway, NJ 08854, (201) 981-0300						
M-1709	impact (7×9)	50, 200, 240	136	RS232C, Centronics (9.6K bps)	699(Q1); 517(Q100)	bit-image graphics, noise level 55 dB(a)
M-1724	impact (18×24)	60, 72, 180, 216	136	Centronics, RS232C (9.6K bps)	899(Q1)	graphics
M-4018	impact (9×11)	100, 400-480	136	Centronic, RS232C (9.6K bps)	1,895(Q1)	color printing, graphics
C. ITOH ELECTRONICS INC.						**Circle 571**
19300 S. Hamilton Ave., Torrance, CA 90248, (213) 327-9100						
9700	impact (24×33)	100-250	272, programmable	RS232C, Centronics (19.2K bps)	1,395(Q1)	bidirectional graphics, quiet mode, 32K-byte buffer
9815	impact (18×36)	135-400	272, programmable	RS232C, Centronics (19.2K bps)	1,995(Q1)	bidirectional graphics, programmable font cartridges
TPX-80	thermal (24×15)	50, 80	80, 96, 136	Centronics (9.6K bps)	350(Q1)	color printing, noise level less than 50 dB(a)
CIE TERMINALS INC.						**Circle 572**
2505 McCabe Way, Irvine, CA 92714, (714) 660-1421						
Tri Printer Model 10, 20, 30	impact (17×16)	88-350	233, programmable	RS232C, Centronics (19.2K bps)	1,995(Q1)	removable interface, plug-in font cartridge
CITIZEN AMERICA CORP.						**Circle 573**
2425 Colorado Ave., Santa Monica, CA 90404, (213) 453-0614						
120D	impact (9×9)	25, 120	40, 48, 80, 96, 136, 160	parallel	269(Q1)	graphics
MSP-10/15	impact (9×9)	40, 160	40-136/68-231	parallel	499/599(Q1)	graphics
MSP-20/25	impact (9×9)	50, 200	40-160/68-272	parallel	499/749(Q1)	graphics
DATAPRODUCTS CORP.						**Circle 574**
6200 Canoga Ave., Woodland Hills, CA 91365, (818) 887-8000						
8070 PLUS	impact (18×9)	100, 300, 400	132, 158, 226	RS232C, Centronics (9.6K bps)	2,099(Q1)	color printing, bit-image graphics

Four Lines. No Waiting.



Our new CI-400 and CI-800 dot matrix line printers just added an extra way to get things done fast: A fourth speed we call our *EXPRESS* line. Which is going to make three-speed line printers look old-fashioned and awkward. And a thing of the past.

The four-speed CI-400 and CI-800 printers can print just about anything that your business needs. The CI-400, for example, prints out 400 lines per minute for high-speed data processing assignments. On the other line, tight and accurate letter quality at 85 lpm. In between you get 300 lpm for crisp, high-contrast bar codes and graphics, and a convenient 200 lpm memo mode.

The CI-800 takes four speeds even further. For even faster flexibility at 170, 400, 600 and 800 lines per minute.

No matter what speed's on line, both printers use C.Itoh's proprietary long-life print head design, and a small dot wire to fill those hard-to-reach corners for corporate letter quality correspondence and solid industry-specified bar codes.

All of which means you don't have to change lines to use one printer for one job and a different printer for another. Because the four speeds are all in one. Ready and waiting.

The new CI-400 and CI-800 line printers. You'll like our new line. In four different ways.

For more information on the CI-400 and CI-800, contact CIE Terminals, a C.Itoh company, 2505 McCabe Way, Irvine, CA 92714; or call (714) 660-1421 or our toll-free number (800) 624-2516.

C.ITOH
CIE Terminals

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CIRCLE NO. 80 ON INQUIRY CARD

MATRIX CHARACTER PRINTERS

Company / Model	Print method (matrix size)	Print speed (cps)	Characters/line	Interfaces (Transmission rate)	Price $ (quantity)	Notes, features
DATASOUTH COMPUTER CORP.						**Circle 575**
4216 Stuart Andrew Blvd., Charlotte, NC 28210, (704) 523-9500						
DS 180	impact (9×7)	180		RS232C, Centronics (110-9.6K bps)	1,395(Q1)	dot-addressable graphics
DS 220	impact (9×7)	220		RS232C, Centronics ((110-9.6K bps)	1,695(Q1)	dot-addressable graphics
DICONIX INC. (KODAK CO.)						**Circle 576**
3100 Research Blvd., Dayton, OH 45420, (513) 259-3100						
150	ink jet	150	85	RS232C, Centronics	479(Q1)	graphics, light weight, portable
EPSON AMERICA INC.						**Circle 577**
2780 Lomita Blvd., Torrance, CA 90505, (213) 539-9140						
EX-800	impact (9×9)	300	80, 96	parallel, serial (300-9.6K bps)	749(Q1)	color printing, graphics
EX-1000	impact (9×9)	300	80, 96	serial, parallel (300-9.6K bps)	995(Q1)	color printing, graphics
LQ-2500	impact (18×18)	324	136, 163	serial, parallel (300-9.6K bps)	1,595(Q1)	color printing, graphics
ERGO SYSTEMS INC.						**Circle 578**
1758 Junction Ave., Suite G, San Jose, CA 95112, (408) 436-7722						
HUSH 80	thermal (6×7)	80	40, 80, 160, programmable	RS232C, Centronics (300-1200 bps)	165-230(Q1); 132-184(Q100)	bit-mapped graphics, portable
FACIT INC.						**Circle 579**
9 Executive Park Dr., P.O. Box 334, Merrimack, NH 03054-0334, (603) 424-8000						
4528	impact (9×9)	165-225	80, 136	RS232C, Centronics (9.6K bps)	1,175-1,895(Q1)	bit-mapped graphics
B3350	impact (18×18)	200	80, 136, programmable	RS232C, Centronics (9.6K bps)	1,195-1,265(Q1)	color printing, bit-mapped graphics
C7500	impact (18×18)	400	80, 136, programmable	RS232C, Centronics (9.6K bps)	1,195-2,495(Q1)	color printing, bit-mapped graphics
FLORIDA DATA CORP.						**Circle 580**
600D John Rodes Blvd., Melbourne, FL 32935, (305) 259-4700						
130	impact (8×12)	75-600	85-132, 237	RS232C, Centronics, Dataproducts (up to 19.2K bps)	3,995(Q1)	
3000	impact (8×12)	195-600	85-132, 237	RS232C, Centronics, Dataproducts (up to 19.2K bps)	3,495(Q1)	
FUJITSU AMERICA INC.						**Circle 581**
3055 Orchard Dr., San Jose, CA 95134, (408) 946-8777						
DL2400	impact (36×24)	60, 180	136	Centronics, IBM (200-9.6K bps)	1,195(Q1)	color printing; graphics; double, triple bin sheet feeder
DL2600	impact (36×24)	80, 240	136	RS232C, Centronics, Diablo, IBM (600-9.6K bps)	1,795(Q1)	color printing; graphics; double, triple bin sheet feeder
DX2100/2200	impact (18×16)	44, 220	80, 136	RS232C, Centronics, Epson (200-9.6K bps)	545/695(Q1)	graphics
GENERAL BUSINESS TECHNOLOGY INC.						**Circle 582**
1891 McGaw Ave., Irvine, CA 92714, (714) 261-1891						
5220DP	impact (9×9, 9×18)	400	up to 198	twinax	3,995(Q1)	
5222DP	impact (9×11, 17×11)	200	up to 198	twinax	2,495(Q1)	
5227FA	impact (9×9)	120	up to 132	twinax	1,995(Q1)	
GENICOM CORP.						**Circle 583**
Genicom Dr., Waynesboro, VA 22980, (703) 949-1170, (800) 437-7468						
1020/1025	impact (36×18)	100, 200	136-226/80-137 programmable	RS232C, Centronics, Diablo, Epson, IBM (9.6K bps)	998/798(Q1)	dot-addressable, block, line drawing graphics
3000 Series	impact (21×18)	90-180, 300-400	136-244, programmable	RS232C, Centronics, Diablo, IBM (9.6K bps)	1,995-2,645(Q1)	dot-addressable, block, line drawing graphics
3210	impact (9×18)	60, 240	132-226, programmable	RS232C, Centronics, IBM, Okidata (9.6K bps)	1,495(Q1)	dot-addressable, block, line drawing graphics
HEWLETT-PACKARD CO.						**Circle 584**
P.O. Box C-006, Vancouver, WA 98668-C006, (206) 254-8110						
HP 2934A	impact (9×12, 36×24)	67, 200	136, 223	RS232C (9.6K bps)	2,995(Q1)	bar code generation

MATRIX CHARACTER PRINTERS

Company / Model	Print method (matrix size)	Print speed (cps)	Characters/line	Interfaces (Transmission rate)	Price $ (quantity)	Notes, features
QuietJet Plus	ink jet (19×12, 19×32)	40, 48, 160, 192	132, 158	RS232C, Centronics	799(Q1)	noise level less than 48.5 dB(a)
ThinkJet	ink jet (11×12)	150	80	RS232C, Centronics, HP-IB, HP-IL	495(Q1)	dot-addressable graphics
HONEYWELL INFORMATION SYSTEMS INC. 200 Smith St., Waltham, MA 02154, (617) 895-3490						**Circle 585**
PRU7175 Model 34	impact (9×9, 18×60)	45, 200	132, 158, 198, 220	RS232C, RS422A (9.6K bps)	2,450(Q1); 1,960(Q100)	graphics, bar codes
PRU7250 Model 46	impact (11×9, 36×18)	70, 400, 480	136, 163, 204, 227	RS232C, RS422A (19.2K bps)	3,495(Q1); 2,796(Q100)	7-color printing, graphics
HONEYWELL INFORMATION SYSTEMS ITALIA 390 Fourth St., San Francisco, CA 94017, (415) 974-6116						**Circle 586**
4/21	impact (9×11, 18×36)	40, 200	136, 232	RS232C, Centronics (9.6K bps)	849(Q1)	bit-mapped graphics, plug-in interface
4/66	impact (9×11, 9×36, 18×36)	75, 180, 480	136, 213, programmable	RS232C, RS422 (19.2K bps)	2,400(Q1)	color printing, bit-mapped graphics, fanfold and cut sheet feeder
4/66P	impact (9×11, 9×36, 18×36)	75, 180, 480	136, 233, programmable	RS232C, RS422, Centronics (19.2K bps)	2,995(Q1)	color printing, bit-mapped graphics, plotter emulation
IBM CORP. Old Orchard Rd., Armonk, NY 10504, (914) 765-1900						**Circle 587**
4202	impact (9×12)	40, 100, 200	136, programmable	RS232C, Centronics (9.6K bps)	799(Q1)	bit-mapped graphics, 8K-byte buffer
4210	impact (9 x 12, 9 x 24, 18 x 24)	40, 100, 200	66, 220, programmable	twinax	1,800(Q1)	
4224 Model 2C2	impact (7×7, 7×13, 12×13)	100, 200, 400	132, 158, 198	IBM 43XX, 303X, 308XX, 309X, System/370, 3174/3274 Control Unit	6,700(Q1)	color printing; bit-image, vector graphics
INFOSCRIBE INC. 1808 Michael Faraday Court, Reston, VA 22090, (703) 689-2805						**Circle 588**
800	impact (19×18)	40, 200	136, 163, 224	RS232C, Centronics, current loop (9.6K bps)	1,895(Q1); 1,137(Q100)	dot-addressable graphics, ruggedized
1100	impact (19×18)	40, 200	136, 163, 224	RS232C, Centronics, current loop (9.6K bps)	1,490(Q1); 894(Q100)	dot-addressable graphics, ruggedized
1400	impact (24×18)	80, 400	136, 163, 224, programmable	parallel (9.6K bps)	1,845(Q1); 1,107(Q100)	dot-addressable graphics, ruggedized
JDL INC. 2801 Townsgate Rd., Suite 104, Westlake Village, CA 91361, (805) 495-3451						**Circle 589**
850 EWS	impact (12×24, 36×24)	144, 360	136, 163, 232, 272	RS232C, Centronics (600-19.2K bps)	2,495(Q1)	14-color printing, graphics, plotter emulation
850 EWS/GL	impact (12×24, 36×24)	144, 360	136, 163, 232, 272	RS232C, Centronics (600-19.2K bps)	3,495(Q1)	14-color printing, graphics, plotter emulation, HP-GL compatible
MANNESMANN TALLY CORP. 8301 S. 180th St., Kent, WA 98032, (206) 251-5500						**Circle 590**
MT87	impact (24×18)	200		RS232C, Centronics, Apple serial (9.6K bps)	599(Q1)	dot-addressable graphics
MT290	impact (40×18)	200	132, 154, 218, 264	RS232C, current loop, IEEE (9.6K bps)	1,099(Q1)	dot-addressable graphics
MT490	impact (48×18)	400	132, 158, 198, 225	RS232C, Centronics (9.6K bps)	2,549(Q1)	color printing, dot-addressable graphics
MODULAR COMPUTER SYSTEMS INC. (MODCOMP) 1650 W. McNab Rd., Fort Lauderdale, FL 33310, (305) 977-1823						**Circle 591**
4228	impact (9×7)	150	132	RS232C (110-9.6K bps)	4,140(Q1) 3,519(Q100)	
4856	impact (9×7)	150	132	parallel DMP	4,400(Q1); 3,740(Q100)	
NCR CORP. 1700 S. Patterson Blvd., Dayton, OH 45479, (513) 445-4000						**Circle 592**
6411	impact	180	80, 136	RS232C, Centronics (19.2K bps)	795(Q1)	color printing, bit-mapped graphics
6444	impact	400	136, programmable	RS232C, Centronics (19.2K bps)	2,695(Q1)	bit-mapped graphics

Workaholics

THE GENICOM 3000 SERIES

Printers that don't know when to quit

Business success demands hard work. That's why more and more businesses depend on the Genicom 3000 series. Six hardworking, reliable printers that make life easier.

You name it.
The 3000s can handle it.

No matter what you need in a rugged business printer—3000's your number. Just look at these job qualifications. Data processing printing at a blazing 400 cps. Letter quality at an unmatched 180 cps. And reliable paper handling for even the most demanding applications.

Need a trained specialist? The 3000s are ready. With extra quiet printers that crank the work out at under 55 dBA. Printers with seven color capability for presentation quality business graphics. Even printers for bar codes.

Best of all, there's a 3000 series printer built specifically for your office. For dependable printing with everything from a single PC to a multi-terminal information system.

Real team players.

The 3000 series printers make fast friends with their co-workers. Because they're compatible with any computer worth mentioning. And software packages like Lotus 1-2-3®, Symphony® and WordStar®.

So, don't waste time with a clockwatching printer. Hire one of the workaholics. A Genicom 3000 series printer. For more information, contact your nearby Genicom dealer.

Or call 1-800-437-7468.
In Virginia, call
1-703-949-1170.

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GENICOM®
The Printers That Mean Business.
Genicom Drive, Waynesboro, VA 22980

CIRCLE NO. 79 ON INQUIRY CARD

MATRIX CHARACTER PRINTERS

Company / Model	Print method (matrix size)	Print speed (cps)	Characters/line	Interfaces (Transmission rate)	Price $ (quantity)	Notes, features
NEC INFORMATION SYSTEMS INC.						**Circle 593**
1414 Massachusetts Ave., Boxborough, MA 01721, (617) 264-8000						
P5XL	impact (24×36)	100, 290	132-272	RS232C, Centronics, Diablo, Epson (9.6K bps)	1,495(Q1)	color printing, graphics
P6	impact (24×36)	65, 216	80-160	RS232C, Centronics, Epson (9.6K bps)	699(Q1)	graphics
P9XL	impact (24×36)	140, 400	132-272	RS232C, Centronics, Diablo, Epson (9.6K bps)	1,795(Q1)	graphics
NEWBURY DATA INC.						**Circle 657**
2200 Pacific Coast Highway, Suite 208, Hermosa Beach, CA 90254, (213) 372-3775						
OSP 1	impact (9×8, 9×5)	110, 180	1-226, programmable	Centronics (9.6K bps)	1,330(Q1); 770(Q1000)	
OSP 2	impact (12×10, 12×20)	100, 200	1-226, programmable	Centronics (9.6K bps)	1,420(Q1); 822(Q1000)	
OSP 3	impact (12×20)	50, 100, 200	1-226, programmable	Centronics (9.6K bps)	1,690(Q1); 980(Q1000)	
NISSHO INFORMATION SYSTEMS CORP.						**Circle 594**
10855 Business Center Dr., Suite 100, Cypress, CA 90630, (714) 952-8700						
NP-910	impact (9×12, 17×24)	58, 350	132-237	RS232C, Centronics, coax, twinax (up to 19.2K bps)	1,445(Q1)	bit-mapped graphics, plug-in cartridge interfaces
NP-2410	impact (24×18, 24×36)	150-225, 300-540	132-237	RS232C, Centronics (up to 19.2K bps)	1,845(Q1)	bit-mapped graphics, plug-in cartridge interfaces
OKIDATA						**Circle 595**
532 Fellowship Rd., Mt. Laurel, NJ 08054, (609) 235-2600						
Microline 193 Plus	impact (9×9, 17×17)	38, 180	136, 163, 233	RS232C, RS422 (up to 19.2K bps)	749(Q1)	bit-image graphics
Microline 293	impact (9×9, 17×17)	100, 200	136, 163, 233	RS232C, RS422, parallel (up to 19.2K bps)	949(Q1)	14-color printing, bit-image graphics
Microline 294	impact (9×9, 17×17)	100, 400	136, 163, 233, programmable	RS232C, RS422, parallel (up to 19.2K bps)	1,499(Q1)	14-color printing, bit-image graphics
OLYMPIA USA INC.						**Circle 596**
P.O. Box 22, Somerville, NJ 08876, (201) 722-7000						
NP 80	impact (9×9)	200	40, 48, 68, 80, 96, 137	Centronics (9.6K bps)	499(Q1)	graphics, 7K-byte buffer
NP 136	impact (9×9)	200	81, 136, 163, 233	Centronics (9.6K bps)	649(Q1)	graphics, 7K-byte buffer
OUTPUT TECHNOLOGY CORP.						**Circle 597**
E. 9922 Montgomery, Spokane, WA 99206, (509) 926-3855						
OT-700n	impact (9×7)	700	68, 81, 113, 136, 163, 226, programmable	RS232C, Centronics (up to 9.6K bps)		dot-addressable graphics, bar codes
OT-850XL	impact (9×7)	850	68, 81, 113, 136, 163, 226, 247	RS232C, Centronics (up to 19.2K bps)	2,395(Q1)	graphics, bar codes
OT-880XL	impact (9×7)	850	68, 81, 113, 136, 163, 226, 247	twinax, parallel	3,795(Q1)	graphics, bar codes, 3 heads
PERSONAL MICRO COMPUTERS INC.						**Circle 598**
275 Santa Ana Court, Sunnyvale, CA 94086, (408) 737-8444						
DMP-85	impact (7×9)	120	80, 96, 137, programmable	Centronics	295(Q1)	proportional print, bit-mapped graphics
PRINTEK INC.						**Circle 599**
1517 Townline Rd., Benton Harbor, MI 49022, (616) 925-3200						
910	impact (9×9, 24×18)	200	up to 227	RS232C, Centronics (9.6K bps)	1,595(Q1)	dot-addressable graphics
920	impact (9×9, 24×18)	340	up to 227	RS232C, Centronics (9.6K bps)	2,395(Q1)	dot-addressable graphics
FormsPro 2000	impact (9×9, 24×18)	200	up to 227	RS232C, Centronics (9.6K bps)	2,095(Q1)	dot-addressable graphics
PRINTRONIX INC.						**Circle 600**
17500 Cartwright Rd., Irvine, CA 92714, (714) 863-1900						
S7024	impact (7×9)	240	68, 81, 136, 163, 232, programmable	RS232C, Centronics, IBM 3270, 5225 (9.6K bps)	1,365(Q1)	color printing, bit-mapped graphics
SINGER DATA PRODUCTS						**Circle 601**
790 Maple Lane, Bensenville, IL 60106, (312) 860-6500						
612	impact (18×36)	400	132, 158, 198, 237, programmable	RS232C, Centronics, current loop, Diablo (150-9.6K bps)	less than 1,700(Q1)	bit-mapped graphics

MATRIX CHARACTER PRINTERS

Company / Model	Print method (matrix size)	Print speed (cps)	Characters/line	Interfaces (Transmission rate)	Price $ (quantity)	Notes, features
615	impact (18×36)	400	132, 158, 198, 237, programmable	RS232C, Centronics, current loop, Diablo (150-9.6K bps)	less than 1,700(Q1)	color printing, bit-mapped graphics
PC	impact (18×36)	400	132, 158, 198, 237, programmable	RS232C, Centronics, current loop, Diablo (150-9.6K bps)	less than 1,700(Q1)	color printing, bit-mapped graphics
STAR MICRONICS AMERICA INC. 200 Park Ave., Suite 3510, New York, NY 10166, (212) 986-6770						**Circle 602**
NB-15	impact (24×13, 24×15)	100, 300		Centronics	1,449(Q1)	
NB24-15	impact (24×27, 24×31)	60, 180		Centronics	1,099(Q1)	
SYNTEST CORP. 40 Locke Dr., Marlboro, MA 01752, (617) 481-7827						**Circle 603**
SP-2010	impact (5×9)	130	80	RS232C, Centronics (110-9.6K bps)	1,035(Q1)	rackmount, ruggedized
TANDY CORP. (RADIO SHACK) 1800 One Tandy Center, Fort Worth, TX 76102, (817) 390-3011						**Circle 604**
DMP 130	impact (9×9, 18×18)	100	80, 132, programmable	Centronics (600 to 2.4K bps)	349(Q1)	graphics
DMP 430	impact	180	80, 132	Centronics (600 to 2.4K bps)	699(Q1)	graphics
DMP 2110	impact	240	80, 132	Centronics	1,295(Q1)	graphics
TELEX COMPUTER PRODUCTS INC. 6422 E. 41st St., Tulsa, OK 74135, (918) 627-1111						**Circle 605**
214XP	impact (9×9, 18×24)	100, 400	136, 220	twinax	5,100(Q1)	label printing applications
TEXAS INSTRUMENTS INC. P.O. Box 809063, Dallas, TX 75380-9063, (800) 527-3500						**Circle 606**
850XL	impact (9×9, 15×18)	35, 150	80, 134	RS232C, RS422, RS488, parallel (200-9.6K bps)		bit-mapped graphics, bidirectional printing, 256K-byte buffer
855	impact (9×9, 32×18)	35, 150	80, 134	RS232C, RS422, RS488, parallel (300-9.6K bps)		bit-mapped graphics, 256K-byte buffer, dual mode
860XL	(9×9, 15×18)	35, 150	136, 272	RS232C, parallel		bit-mapped graphics, wide-carriage version of 850XL
TOSHIBA AMERICA INC. 2441 Michelle Dr., Tustin, CA 92680, (714) 730-5000						**Circle 607**
P321	impact (24×36)	72, 216	80, 132	RS232C, Centronics (19.2K bps)	699(Q1)	graphics
P341	impact (24×36)	72, 216	136, 226	RS232C, Centronics (19.2K bps)	1,099(Q1)	graphics
P351 Model 2	impact (24×36)	100, 300	136, 226	RS232C, Centronics (19.2K bps)	1,599(Q1)	color printing, graphics
WANG LABORATORIES INC. One Industrial Ave., Lowell, MA 01851, (617) 459-5000						**Circle 608**
VS-PM017	impact	400	132	RS232C (9.6K bps)	2,100(Q1)	noise level less than 55 dB(a)
VS-PM019	impact	200	132	RS232C (9.6K bps)	1,395(Q1)	
WENGER PRINTERS AG Im Kagen 23/25, CH-4153 Reinach, Switzerland, (061) 76 87 87						**Circle 609**
Wenger 1/1	impact (9×12, 18×36)	30, 160	40, 48, 60, 68, 80, 96, 120, 137	RS232C, RS422A, Centronics, current loop (110-19.2K bps)		bit-image graphics, noise level less than 48 dB(a)
Wenger 3/1	impact (9×12, 18×36)	75, 400	66, 80, 100, 112, 132, 158, 198, 220, 226	RS232C, RS422, Centronics (300-19.2K bps)		color printing, bit-image graphics
Wenger 4/1	impact (9×12, 18×36)	100, 130, 400, 600	66-300	RS232C, RS422, Centronics, current loop (50-19.2K bps)		color printing, bit-image graphics
XEROX CORP. (BUSINESS SYSTEMS GROUP) P.O. Box 24, Rochester, NY 14692, (800) 334-6200						**Circle 610**
Companion 34LQ	impact (9×11, 18×60)	60, 270	132, 226	RS232C, RS422A, Centronics (1.2K to 9.6K bps)	1,399(Q1); 1,119(Q100)	bit-mapped graphics

American Electronics Association and Electronic Business present:

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The Japan Electronics seminar on October 7 in Osaka is designed to help European and U.S. executives seek out new business opportunities in Japan. The day-long seminar, which will coincide with the Japan Electronics Show, has been structured to provide attendees with a statistical overview of the Japanese electronics industry, as well as a preview of upcoming technological trends.

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CONFIRMED SPEAKERS:

Kaoro Kubo, vice president and general manager of NTT International. "The Japanese telecommunications industry: Opportunities for foreign suppliers"

Kazuhiko Kobayashi, manager of the Systems Engineering Division of Hitachi Ltd. "Factory automation in the Japanese computer industry"

Hiroshi Komiya, head of the Saijou Works, Mitsubishi Electric Corp. "Manufacturing technology in the semiconductor industry"

Bill Totten, president of Ashisuto K.K. "The Japanese market for U.S. and European software"

David H. Johnson, senior manager for Network Systems Sales, AT&T International. "Opportunities for U.S. communications manufacturers in Japan"

Dinker Bir, vice president of technology at Northern Telecom Japan Inc. "Trends in telecommunications"

Pat O'Malley, strategic marketing director for the Semiconductor Sector at Nippon Motorola Ltd. "The Japanese semiconductor market"

Gen Narui, regional manager for Educational Services at Nihon Digital Equipment Corp. "Recent developments in artificial intelligence at DEC"

Stephen Donovan, representative director of Monolithic Memories K.K. "Selling niche products in Japan"

Shohei Kurita, Tokyo editor for Electronic Business, author. "The Fifth Generation Computer Project"

Gene Norrett, vice president and director of the Semiconductor Industry Group, Dataquest Inc. "Electronics trends among countries on the Pacific Rim"

Alberto Socolovsky, associate publisher and editorial director of Electronic Business. "Structural differences between the U.S. and Japanese electronics industries"

Speaking on "Trends in consumer electronics":

Nobuyoshi Yokobori, manager of the R&D Planning Office, Corporate Engineering Division, Matsushita Electric Industrial Co. Ltd.

Masaru Yamano, executive vice president, Sanyo Electric Co. Ltd.

Tadashi Sasaki, corporate management advisor, Sharp Corp.

Nobuo Tateishi, executive vice president, Omron Tateishi Electronics Corp.

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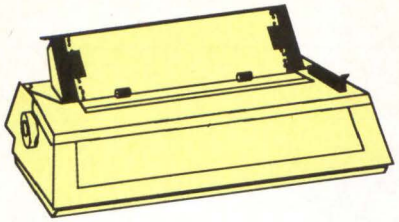

IMPACT LINE PRINTERS

Company / Model	Print speed (lpm)	Characters per line	Forms width (inches)	Interfaces (Transmission rate)	Price $ (quantity)	Notes, features
CIE TERMINALS INC.						**Circle 551**
2505 McCabe Way, Irvine, CA 92714, (714) 660-1421						
CI-300+	85-300	266, programmable	3.5-16	RS232C, Centronics, Dataproducts (19.2K bps)	4,495(Q1)	bar codes, dual microprocessors with RAM and ROM
CI-600+	170-600	266, programmable	3.5-16	RS232C, Centronics, Dataproducts (19.2K bps)	6,795(Q1)	bar codes, dual microprocessors with RAM and ROM
DATAPRODUCTS CORP.						**Circle 552**
6200 Canoga Ave., Woodland Hills, CA 91365, (818) 887-8000						
B-300/600/1000	300/650/1025	132, 136		RS232C, RS422, Centronics, Dataproducts (19.2K bps)	6,143/8,642/12,936(Q1)	
BP-1500/2000	1500/2000	132, 136	3.5-18.75	RS232C, Centronics, Dataproducts (19.2K bps)	22,700/30,390(Q1)	acoustic cabinet
LB-300/615	330/650	136	3-16	RS232C, Centronics, Dataproducts (19.2K bps)	5,495/6,795(Q1)	direct access VFU, universal power supply
DECISION DATA COMPUTER CORP.						**Circle 553**
400 Horsham Rd., Horsham, PA 19044, (215) 757-3322, (800) 523-6529						
6706	600	132, 198	4-16	twinax	11,250(Q1)	bit-mapped graphics
6807	700	132	3.5-17.5	twinax	11,450(Q1)	
DIGITAL EQUIPMENT CORP.						**Circle 554**
200 Baker Ave., West Concord, MA 01742, (617) 264-1111						
LG01	600		4-16	RS232C, Dataproducts (1200 to 19.2K bps)	11,950(Q1)	
LG02	600		4-16	RS232C, Dataproducts (1200 to 19.2K bps)	14,000(Q1)	graphics
LP27	1200	132	3.5-18	Dataproducts	29,000-33,000(Q1)	
GENERAL BUSINESS TECHNOLOGY INC.						**Circle 555**
1891 McGaw Ave., Irvine, CA 92714, (714) 261-1891						
3320LP	900	132	4-18	twinax	12,500(Q1)	acoustic cabinet
5240	300	198	3.5-16	twinax	7,195(Q1)	
5241	600	198	3.5-16	twinax	9,595(Q1)	
GENICOM CORP.						**Circle 556**
Genicom Dr., Waynesboro, VA 22980, (703) 949-1000						
4410	400	132, 158, 175, 198, 217, programmable	3-16.54	RS232C, Centronics, Dataproducts, Printronix (19.2K bps)	6,195(Q1)	dot-addressable, block, line graphics
4440	800	132, 158, 175, 198, 217, programmable	3-16.54	RS232C, Centronics, Dataproducts, Printronix (19.2K bps)	7,795(Q1)	dot-addressable, block, line graphics
4500 Series	400, 800	132, 158, 175, 198, 217, programmable	3-16.54	coax, twinax	7,790-9,420(Q1)	dot-addressable, block, line graphics
HETRA COMPUTER AND COMMUNICATIONS INDUSTRIES INC.						**Circle 557**
P.O. Box 9000, Sebastian, FL 32958, (305) 589-7331						
3106	6000	132	3.5-19	RS232C, Centronics, current loop, Dataproducts, IEEE 488 (19.2K bps)	10,000(Q1)	
3300	1000	132	3.5-19	RS232C, Centronics, current loop, Dataproducts, IEEE 488 (19.2K bps)	14,000(Q1)	

IMPACT LINE PRINTERS

Company / Model	Print speed (lpm)	Characters per line	Forms width (inches)	Interfaces (Transmission rate)	Price $ (quantity)	Notes, features
HEWLETT-PACKARD CO. (BOISE DIV.)						**Circle 558**
11311 Chinden Blvd., Boise, ID 83714, (208) 323-2297						
2563B	300	132-220	3-16.7	RS232C, RS422C, Centronics, Dataproducts, IEEE 488 (19.2K bps)	5,700(Q1); 4,731(Q100)	raster graphics
2564B	600	132-220	3-16.7	RS232C, RS422C, Centronics, Dataproducts, IEEE 488 (19.2K bps)	12,445(Q1); 10,080(Q100)	raster graphics
2567B	1200, 1600	132-220	3-18	RS232C, RS422C, Centronics, Dataproducts, IEEE 488	28,050(Q1); 21,879(Q100)	raster graphics
HONEYWELL INFORMATION SYSTEMS INC.						**Circle 559**
200 Smith St., Waltham, MA 02154, (617) 895-6000						
PRU9901/9902	300/600	132/136	3-15	DPS 6	11,500-14,450(Q1); 8,050-11,115(Q100)	
PRU9903/9904	900/1200	136	4-19	DPS 6	26,000-33,000(Q1); 18,200-23,100(Q100)	
IBM CORP.						**Circle 656**
Old Orchard Rd., Armonk, NY 10504, (914) 765-1900						
4234 Model 2	120, 300, 400		3.5-16	twinax	8,800(Q1)	
4245-T20	2000		3.5-22	twinax	35,000(Q1)	
5262	650		3.5-16	twinax	13,500(Q1)	
MANNESMANN TALLY CORP.						**Circle 560**
8301 S. 180th St., Kent, WA 98032, (206) 251-5500						
MT660	600	80, 100, 120, 132, 150, 198, programmable	4-16	RS232C, RS422, Centronics, current loop, Dataproducts	8,490(Q1)	dot-addressable graphics
MT690	900	80, 100, 120, 132, 150, 198, programmable	4-16	RS232C, RS422, Centronics, current loop, Dataproducts	10,500(Q1)	dot-addressable graphics
MODULAR COMPUTER SYSTEMS INC. (MODCOMP)						**Circle 561**
1650 W. McNab Rd., Fort Lauderdale, FL 33310, (305) 974-1380						
4240	300	132	16	Dataproducts	8,600(Q1); 6,885(Q100)	
4241	600	132	16	Dataproducts	10,250(Q1); 8,713(Q100)	
4242	1000	132	16	Dataproducts	15,875(Q1); 13,494(Q100)	acoustic cabinet
PRINTRONIX INC.						**Circle 562**
17500 Cartwright Rd., Irvine, CA 92713, (714) 863-1900						
MV150B	200	132, 165, 220	3-16	Centronics; Dataproducts; IBM 3287, 5225	3,745(Q1)	raster graphics
P1013	134	80, 96	4.5-11, 2-10	Centronics	795(Q1)	dot-addressable graphics
P6000 Series	400, 800	up to 256	3-16	RS323C; Centronics; IBM 3203, 3287, 5225	5,800-8,600(Q1)	graphics plot mode
STORAGE TECHNOLOGY CORP.						**Circle 563**
2270 S. 88th St., MD-3N, Louisville, CO 80028, (303) 673-6543						
5000-050	up to 5000	132	3.5-22.4	Dataproducts, IBM FIPS	46,100(Q1)	dual hammer banks
TELEX COMPUTER PRODUCTS INC.						**Circle 564**
6422 E. 41st St., Tulsa, OK 74135, (918) 627-1111						
225	600, 800	132, 220	3-16	twinax	12,800(Q1)	
WANG LABORATORIES INC.						**Circle 565**
One Industrial Ave., Lowell, MA 01851, (617) 459-5000						
5573	250	132	16		9,000(Q1)	
5574-1	600	132	16		15,000(Q1)	
5575	1100	136	16		26,000(Q1)	

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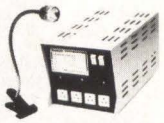

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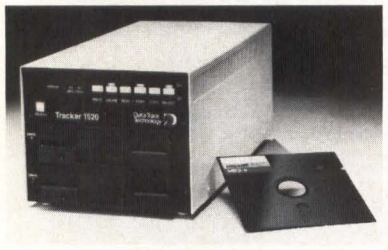

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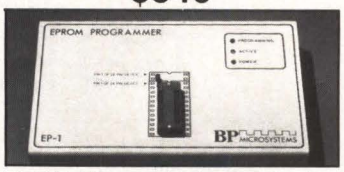

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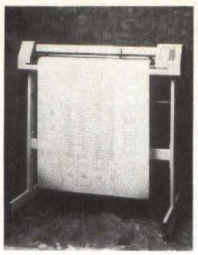

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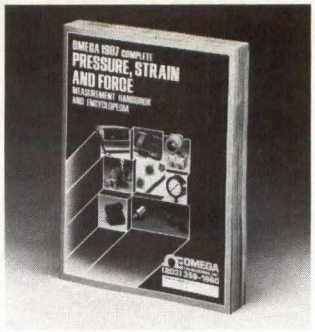

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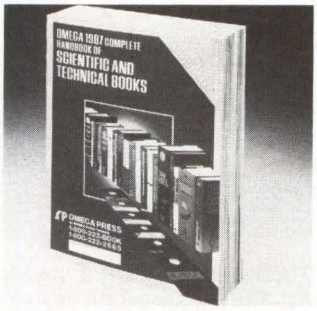

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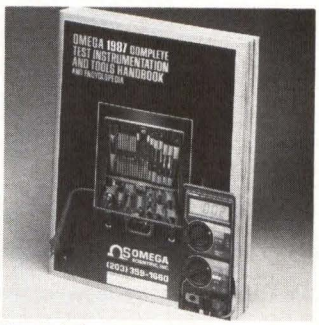

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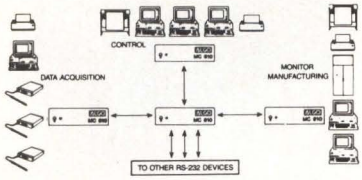

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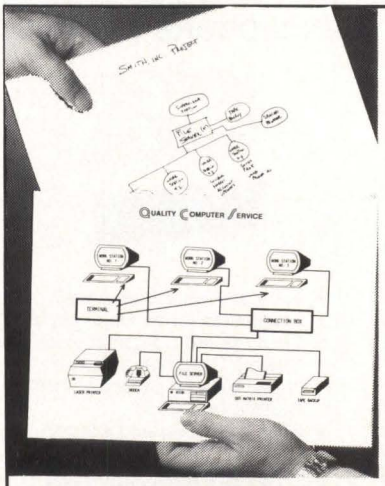

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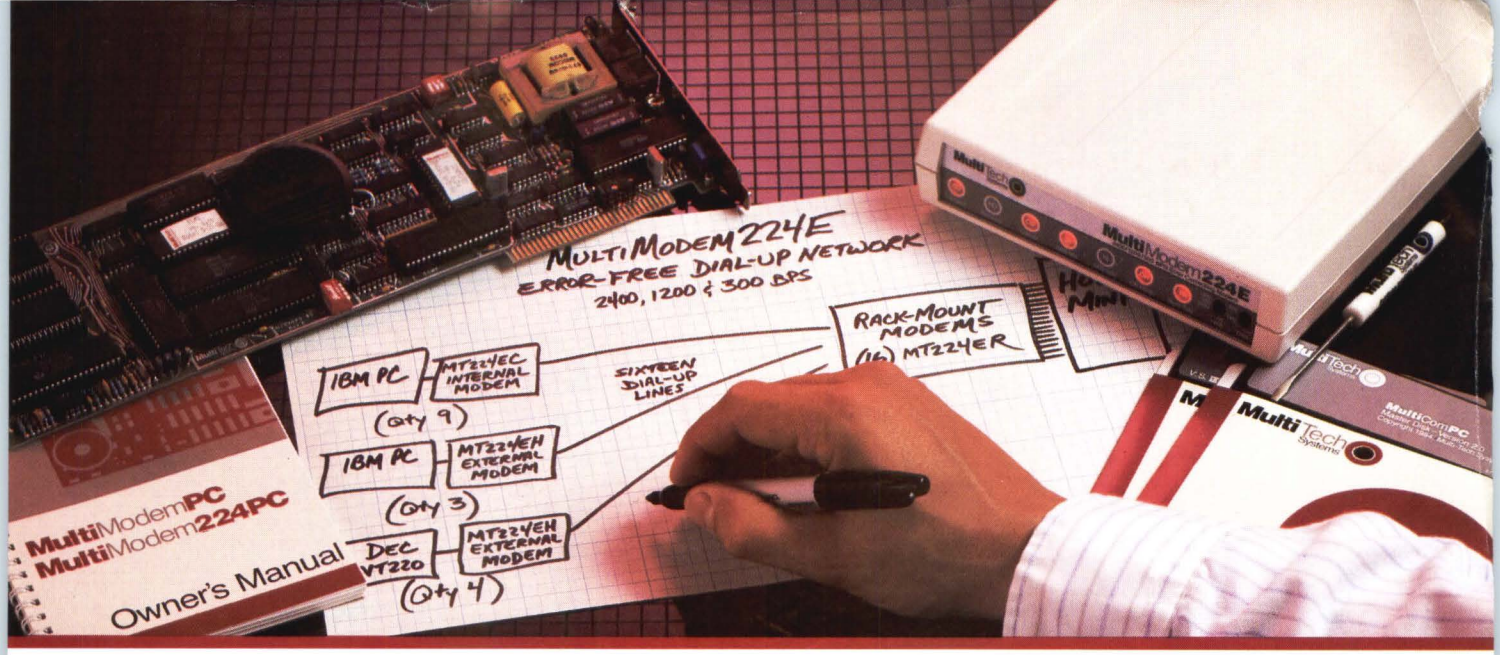

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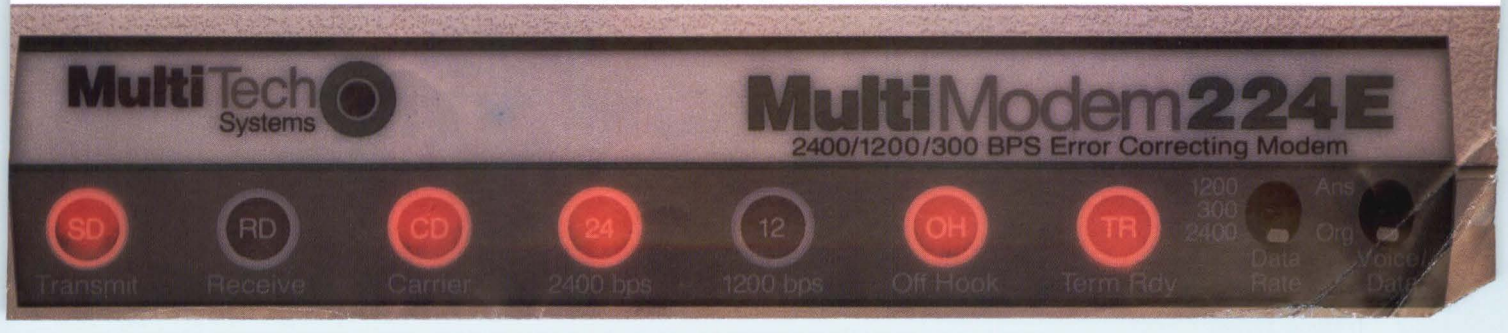

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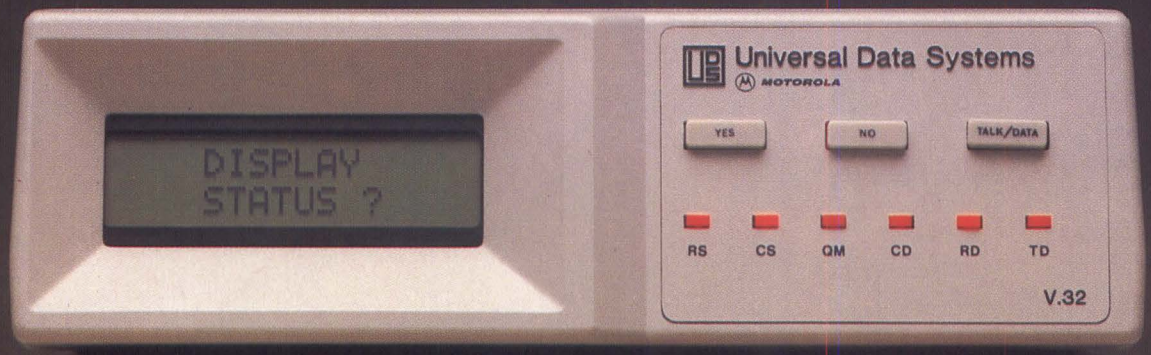

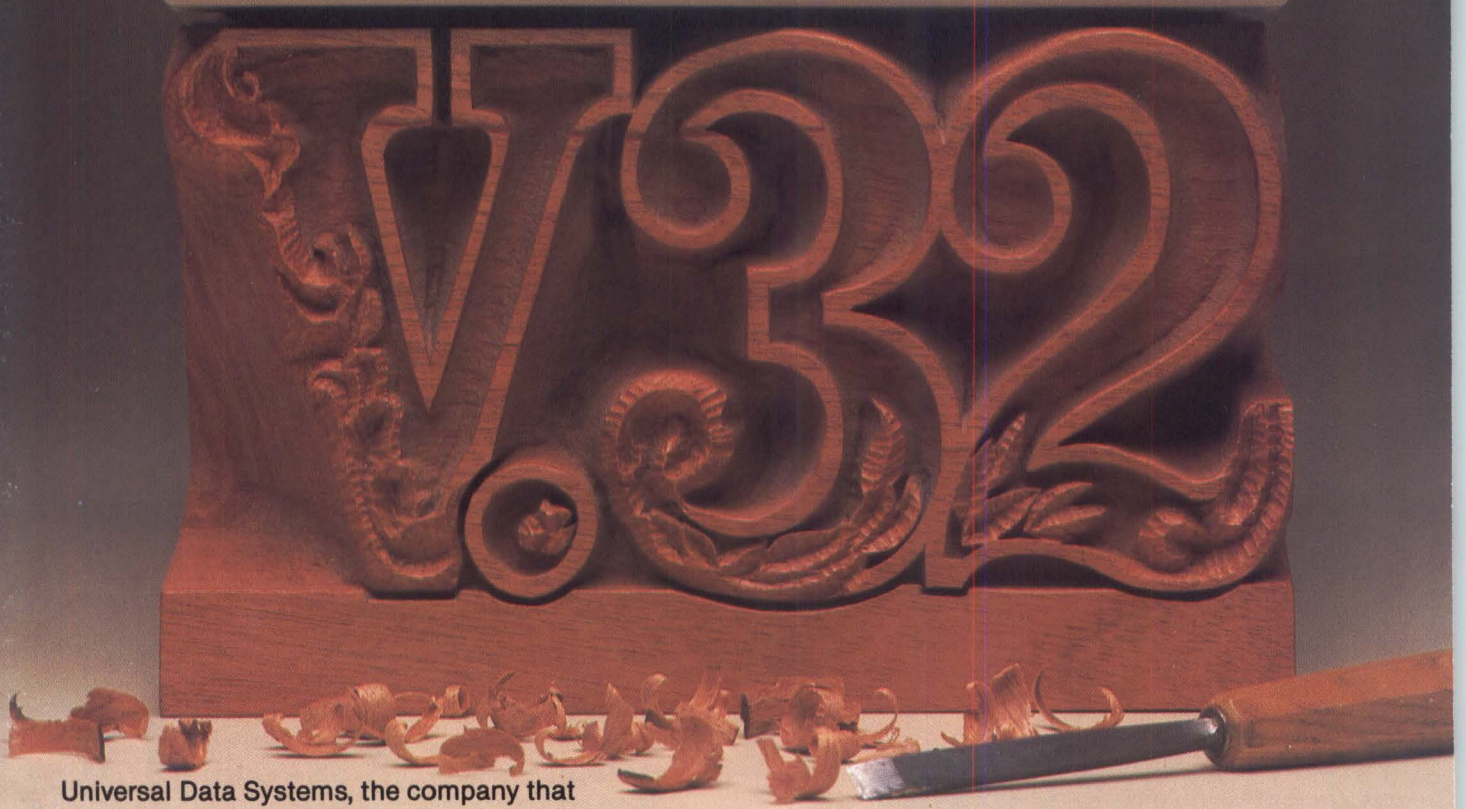

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