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The compact size of Rodime's drive suddenly puts large-scale storage into areas never considered before. The 350 series is one-fourth the volume of a 5¼" Winchester drive. And the 250 series, which includes mounting brackets and a face plate, fits into the same space as a half-height 5¼" Winchester offering even further shock and vibration isolation. Now, system designers have a new level of flexibility. One area that has received attention is use with portable computers. Several major portable computer manufacturers have already incorporated Rodime 3½" Winchester disk drives into their products. There are other equally exciting areas such as desk top computer systems, intelligent terminals, point-of-sale terminals, industrial controllers, telecommunications systems, navigation and guidance systems, and portable instrumentation. In fact, the list of potential uses is only limited by the imagination of the system designer.

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In a few short years, Rodime has established itself as a major force within the Winchester disk drive industry. Rodime is one of the few manufacturers that are delivering 5¼" Winchester drives with a broad range of capabilities up to 54 megabytes. And is the only manufacturer delivering high-performance 3½" Winchester drives in production quantities.

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Because of innovative and fast-moving technology, a barrage of graphic standards have emerged to contend for widespread acceptance by the computer graphics industry. Graphics standards would permit system integrators to install graphics subsystems into computer systems with little effort, graphics vendors could add value to accepted software specifications, application programs would run on many vendors' computers and terminals, and sophisticated users could select graphics equipment from a wide variety of vendors. But, because the graphics industry is relatively young, with impressive growth and significant technology gains in a short time, numerous proposed graphics standards battle for supremacy.

For example, the International Standards Organization adopted the Graphical Kernel System (GKS), a 2-D line-drawing interface, in 1982 as a draft international standard. And the American National Standards Institute (ANSI) Technical Committee on Computer Graphics Programming Languages (X3H3) has begun the several years' process of acceptance.

In 1977, the Association for Computing Machinery's (ACM) Special Interest Group on Computer Graphics (SIGGRAPH) presented the Core system—a 2-D and 3-D line-drawing interface. Because it was the first major graphics proposal, the Core system has become a widely known but informal de facto graphics standard.

Another ANSI-adopted graphics standard is the Initial Graphics Exchange Specification (IGES). This standard, undergoing revision, provides for the representation and communication of product-definition data(330,225),(620,273) in computer-aided-design/computer-aided-manufacturing (CAD/CAM) equipment.

Also under development is the Virtual Device Metafile (VDM) standard for communicating and archiving graphical pictures. This standard—a draft proposal in ANSI X3H3—allows low-level routines to process data for display on any graphics device.

Closely associated with VDM is the Virtual Device Interface (VDI) standard. This method—undergoing evaluation—defines a uniform protocol for interfacing to graphics devices.

Related to VDI is the North American Presentation Level Protocol Syntax (NAPLPS). This ANSI-accepted standard deals with interfacing graphics to commercial Videotex systems.

Yet another ongoing development under ANSI X3H3 auspices is the Programmer's Hierarchical Interactive Graphics System (PHIGS). This standard extends the Core System by supporting 3-D hierarchical graphics data for computer modeling applications in CAD/CAM systems.

Lastly, the ANSI X3H3 Committee is also generating the Programmer's Minimal Interface to Graphics (PMIGS). This method represents a low-end version of the 2-D GKS system.

Because they are the most advanced, provide many applications, are easier to integrate and resist major changes, the GKS and VDI standards have found widespread acceptance. But in the volatile graphics industry, a single standard will apparently not satisfy all the application needs of this growing and changing market. However, standards that solve portability and interfacing issues should prove successful. But in the final analysis, whether standard or non-standard, graphics systems must still furnish user-acceptable cost, performance, reliability and quality. And thus, the market will establish de facto graphics standards, regardless of official sanctions.
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ACT READIES 16-BIT MICROCOMPUTER WITH INFRARED AND VOICE I/O

Applied Computer Techniques Plc., Birmingham, England, which manufactures the popular Apricot 16-bit microcomputer, is preparing the fourth wave of 16-bit microcomputer technology. Its new systems, which were planned for European introduction in late June, and U.S. introduction by September, employ the Intel 8086 microprocessor and Microsoft Corp.'s MS-DOS operating system. But that's where the similarities to the IBM PC end. The new machines start with an as-yet-unnamed $1,600 version that can drive virtually any monitor. The more powerful Executive version sports a 25-line-by-80-column liquid-crystal display, supports a 640-by-400-dot color graphics display and has voice-recognition abilities. The Executive with 500K bytes of memory should sell for less than $3,000. Both units use an infrared keyboard, an infrared roller-ball mechanism that can be used like a mouse, and a Sony Corp. of America microfloppy drive. The models can use Apricot add-in boards.—C. Warren

LIBERTY AND CIE TERMINALS AIM AT DEC-COMPATIBLE TERMINAL MARKET

Liberty Electronics USA and CIE Terminals are slated to challenge Digital Equipment Corp. with DEC-compatible terminals at this month's National Computer Conference in Las Vegas, Nev. CIE's CIT-220+ emulates DEC VT220 and VT100 functions. The two-piece, tilt-and-swivel monitor has a 12-inch diagonal screen with a non-glare P4 phosphor. Green and amber phosphors are optional. The CIT-220+ also has a DIN-standard keyboard. Liberty should unveil two DEC-compatible terminals that reportedly are software-compatible with the VT220, VT100 and VT52. The Freedom 220 and Freedom 222 will both offer the same ergonomic tilt-and-swivel monitor and low-profile DIN keyboard as Liberty's Freedom 200 and Freedom 212. The Freedom 220 will list for $795. The $1,395 Freedom 222 voice/data terminal incorporates the same integral Bell 212A-compatible modem, auto-dial and -receive capability and non-volatile directory as the Freedom 212. Both terminals should be available this month, with volume shipments projected for August. CIE also plans to introduce the model 20 IBM PC-compatible serial dot-matrix printer at NCC. The $1,995 model prints at 87.5 characters per second (cps) in near-letter-quality mode and 360 cps in data-processing mode. It has a plotting capability of 240 by 140 dots per inch.—T. Moran, L. Valigra

RICOH INTRODUCES TWO PORTABLE COMPUTERS

Ricoh Co. Ltd. has introduced two portable computers, the SP50 and SP25, in Japan, but has not decided on a U.S. introduction date. The hand-held SP25 unit includes an 8-bit processor, 32K bytes of ROM and 32K to 56K bytes of RAM. It has a 16-character-by-2-line liquid-crystal display with 5-by-7-dot characters. Also included are RS232C and 300- to 9,600-baud communications. An attachable printer is optional. The lap-sized SP50 can be more fully configured with floppy disk drives, a CRT and a tiny 1½-inch screen that pops up in the SP50 box that includes cartridge storage devices. The SP50 with a keyboard sells for about $844 in Japan. Both units can run on either nickel-cadmium batteries or electricity.—L. Valigra
WAVE MATE EYES IBM PC-COMPATIBLE MARKET WITH 80286-BASED MOTHERBOARD

Wave Mate Inc., Hawthorne, Calif., is preparing a late September unveiling of an IBM PC-compatible motherboard built around the 6-MHz Intel 80286 processor. Aimed at system integrators, the board can support 640K bytes of RAM. It is said to be physically and functionally compatible with the PC's motherboard. By using a pre-fetch mechanism and a microprocessor, the board handles instruction incompatibilities between the 8088 and 80286. Evaluation units are expected in late November. Single-unit price with 256K bytes of on-board RAM should be $2,450.—C. Warren

DEC RELEASES NEW VAX/VMS, COMMON LISP

Digital Equipment Corp.'s latest version of the VAX/VMS operating system includes enhanced VAXcluster support that makes the 16-node VAXcluster look more like a single distributed system. For example, under VAX/VMS 4.0, all files in a VAXcluster are viewed as a single entity, meaning that users do not have to specify a disk's location when accessing files on another VAX in the cluster. Print and batch queues are also cluster-wide. A job controller provides cluster-wide job balancing. A VAX/VMS 4.0 license sells for $10,000. Other new DEC VAX products include MicroVMS for the new MicroVAX I, which is compatible with VAX/VMS; the Common LISP artificial-intelligence language; an enhanced FORTRAN; the VAX graphical kernel standard (GKS) graphics software package conforming to ANSI and International Standards Organization GKS standards; DECnet software with extended network addressing; and a PDP-11-based terminal server that optimizes terminal connections in VAXclusters or Ethernet local-area networks. Late last month, DEC also added the UNIX-like VENIX operating system to the Professional 350. Most of the new products should be available by September. VENIX is available now.—D. Bright

MORROW PLANS SUPERMICRO FOR NCC RELEASE

Morrow Inc. plans to introduce a four- to eight-user MC68000-based supermicrocomputer at this month's National Computer Conference in Las Vegas, Nev. It will support Unisoft's UNIX System V port. Priced at less than $9,000 for retailers, it comes with 512K to 2M bytes of main memory, one to four 16M- or 34M-byte Winchester disk drives, an optional 5M-byte removable hard disk drive and one to four 400K-byte, 5¼-inch floppy drives. The price for OEMs is less than $6,500. An MC6861 memory-management unit accompanies the 10-MHz MC68000. The IEEE-696 bus system should be available in August. In mid-September, Morrow plans to add 80188-based slave processor boards running the MS-DOS operating system and housing 128K to 512K bytes of memory for local applications.

ADAPTEC RELEASES RLL CHIP, IBM PC XT CONTROLLER

Adaptec Inc., Milpitas, Calif., has enlarged its Winchester disk controller family with the AIC-270, an enhanced run-length-limited (RLL) encoder/decoder chip and the ACB2010, an improved controller board for the IBM PC XT. The AIC-270 supports 2/7 RLL encoding and decoding and supports a 10M-bit-per-second data-transfer rate. It converts high-speed 2/7 RLL encoded data from the disk drive to non-return-to-zero data for use by
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THE MULTIBUS BREAKTHROUGH PEOPLE

MINI-MICRO SYSTEMS/July 1984

CIRCLE NO. 11 ON INQUIRY CARD

17
Only Microware's OS-9 Operating System Covers the Entire 68000 Spectrum

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OS-9 is versatile, inexpensive, and delivers outstanding performance on any size system. The OS-9 executive is much smaller and far more efficient than Unix because it's written in fast, compact assembly language, making it ideal for critical real-time applications. OS-9 can run on a broad range of 8 to 32 bit systems based on the 68000 or 6809 family MPUs from ROM-based industrial controllers up to large multiuser systems.

OS-9’s Outstanding C Compiler is Your Bridge to Unix

Microware’s C compiler technology is another OS-9 advantage. The compiler produces extremely fast, compact, and ROMable code. You can easily develop and port system or application software back and forth to standard Unix systems. Cross-compiler versions for VAX and PDP-11 make coordinated Unix/OS-9 software development a pleasure.

Support for Modular Software — An OS-9 Exclusive

Comprehensive support for modular software puts OS-9 a generation ahead of other operating systems. It multiplies programmer productivity and memory efficiency. Application software can be built from individually testable software modules including standard “library” modules. The modular structure lets you customize and reconfigure OS-9 for specific hardware easily and quickly.

A System with a Proven Track Record

Once an underground classic, OS-9 is now a solid hit. Since 1980 OS-9 has been ported to over a hundred 6809 and 68000 systems under license to some of the biggest names in the business. OS-9 has been imbedded in numerous consumer, industrial, and OEM products, and is supported by many independent software suppliers.

Microware Systems Corporation
1866 NW 114th Street
Des Moines, Iowa 50322
Phone 515-224-1929
Telex 910-520-2535

Microware Japan, Ltd
3-8-9 Baraki, Ichikawa City
Chiba 272-01, Japan
Phone 0473(28)4493
Telex 299-3122

OS-9 is a trademark of Microware and Motorola. Unix is a trademark of Bell Labs.

CIRCLE NO. 12 ON INQUIRY CARD
the controller. The encoding scheme reportedly increases disk capacity by more than 50 percent. The chip should be available in the third quarter of this year. The ACB2010 non-interleaved Winchester controller for the new IBM PC XT and compatible units supports defective-sector skipping and logical disk partitioning. It extends the 32M-byte storage limit of some systems for $255 in quantities of 1,000 or more units.—C. Bailey

CHARLES RIVER ADOPTS VMEBUS FOR ITS SUPERMICRO FAMILY

Charles River Data Systems Inc. plans to put its VERSAbus MC68000-based UNIX and UNOS supermicrocomputers on the 32-bit VMEbus. The first product to use the VMEbus will be the Universe 2203, a two-board processor housing a 12.5-MHz MC68000 processor and running the UNIX System V and UNOS UNIX-like operating systems. It is scheduled for NCC introduction and availability. Price of the system with a 35M-byte hard disk drive and an 8-inch floppy disk drive or streaming-tape drive is $15,000 to $20,000, depending on memory. Additionally, Charles River plans to offer the product in unbundled form, offering the two-board CPU set for $4,000 in single-unit quantities. This represents the company’s push toward OEM and value-added market sales.—L. Valigra

SPECTRA LOGIC TO INTRODUCE SIX NEW DISK CONTROLLERS

Three new disk/tape controllers from Spectra Logic Corp., Sunnyvale, Calif., will support both removable pack or Winchester hard disks and start/stop or phase-encoded and group-coded-recording streaming-tape drives. The controllers are intended for use with Data General Corp., Digital Equipment Corp. and Texas Instruments Inc. minicomputers. The controllers support any combination of four storage module device drives and as many as eight formatted ½-inch tape drives without modification to the operating system. Data-transfer rates are 2M bytes per second for disk and 800K bytes per second for tape. Dubbed the Spectra 17 and 27 for DG systems, the Spectra 111 and 121 for DEC units and the Spectra 116 and 126 for TI computers, the products were expected to be introduced at NCC and shipped this year.—C. Bailey

SORD REMARKETS AURAGEN FAULT-TOLERANT SYSTEMS IN JAPAN

Sord Computer, which currently remarkets Charles River Data Systems Inc.’s computers under the Sord label in Japan, will also remarket fault-tolerant systems from Auragen Systems Corp., Fort Lee, N.J. The multiyear agreement is worth as much as $25 million and also involves technology exchange. Late last year, Auragen struck a similar technology-licensing agreement with European computer giant Nixdorf AG. Auragen’s system 4000 incorporates clusters of MC68000s and runs UNIX. The Charles River system is also MC68000- and UNIX-based but is not being promoted as fault-tolerant.—D. Bright

MATRIX INSTRUMENTS ENHANCES MICRO GRAPHICS OUTPUT

The VideoWriter 832 from Matrix Instruments Inc., Orangeburg, N.Y., lets users interface any ASCII port to an analog device, such as film recorders, modems, microcomputers and television cameras. The $2,195 system provides
a resolution of 832 by 639 or 640 by 480 dots or two pages at 512 by 512 dots and a selection of 16 colors from a palette of 4,096. Output is to a video red-green-blue monitor. The model 832 can accept ASCII commands for fill, circle and polygon fill. The system includes hardware pan and zoom and has drivers for mice, digitizers and trackballs.—C. Warren

ARRAY PROCESSOR ADDS NEW DIMENSION TO IBM PC AND COMPATIBLES

Designed for applications that require local number-crunching power, the APB-3024PC array processor from Marinco Inc., San Diego, is designed to fit into any open slot on the IBM Corp. Personal Computer. Using an AMD29116 bit-slice processor, the board executes 8 million instructions per second and handles complex math and 24-bit floating-point and 16-bit integer arithmetic. The board is available for both IBM PC and Multibus computers for $4,250. For specialized code development the company offers a $2,500 software-development kit with an assembler, a debugger and listing utility.—C. Warren

ROBOT-LIKE ARM DIGITIZES 3-D OBJECTS

The Perceptor robot-like arm digitizing system from Micro Control Systems Inc., Vernon, Conn., senses 3-D X, Y and Z coordinate positions through precision potentiometers in each of its five joints. The device has a resolution of 0.007 inches and can be linked to any computer via an RS232C serial port. An on-board Z80A microprocessor handles the arm. The tip of the arm can be replaced with other sensors such as temperature probes or strain gauges to add a fourth dimension to the digitized object. Price is $5,500 in OEM quantities.—C. Warren

J&E COMPUTER SERVICES HAS LOW-COST FLOPPY DISK EXERCISER

The model 911 floppy disk exerciser from J&E Computer Service, Chino, Calif., is for 8-, 5½- and sub-4-inch drives with industry-standard interfaces such as the Shugart Corp. ANSI X379. The exerciser can support single- and double-density and single- and double-sided drives. Adapters are available for Osborne Computer Corp. and Apple Computer Inc. computers. Price is $550.—C. Warren

TECH FILES: A QUICK LOOK AT INDUSTRY DEVELOPMENTS

PRINTER FILES: Centronics Data Computer Corp. recently announced the $299 Great Little Printer (GLP) for personal computer applications. The 6.6-pound GLP prints at 50 characters per second (cps) in draft mode and 12 cps in near-letter-quality mode. Both RS232 serial and Centronics parallel interfaces are available. Evaluation units will be shipped next month. Centronics also announced a 24-pin dot-matrix printer, a seven-color dot-matrix printer and a 220-cps correspondence-quality printer.—D. Bright

Delphax Systems, Mississauga, Ontario, planned a National Computer Conference introduction of an intelligent printer called the S 6000. The printer uses the company's 2460 ion-deposition print engine and a Digital Equipment Corp. LSI-11 processor to produce text and graphics at more than 60 pages per minute. Production units should be available in September. End-user prices range from $60,000 to $70,000. OEM discounts are available.—T. Moran
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So if you want more than DEC can give you, call DSD. And discover the big difference a ¼" can make. *Prices lower in quantities.
One-year-old Ergo Systems Inc., Menlo Park, Calif., is introducing its HUSH 80 80-column, 80-cps thermal dot-matrix printer. The HUSH 80 will come in AC and rechargeable nickel-cadmium battery-powered versions. The battery-powered device weighs 48 ounces, including a 100-foot-long integral paper roll. The AC-powered HUSH 80 lists for $160; the battery-powered version sells for $190. HUSH 80s with a Commodore or Centronics interface should be available this month, with an RS232 version expected in the fall.—T. Moran

PLOTTER FILES: Expected late this year from marketing company Western Graphtec Inc., Irvine, Calif., is the model DA6500 computer/plotter, priced at less than $1,800. The plotter has a built-in microcomputer, 16K bytes of RAM, a 4-line, 4-column liquid-crystal display and a three-pen cartridge. The plotter can accept programs from a full-sized keyboard or can download programs and work in a standalone interactive mode without the intervention of a host computer. The bed measures 8½ by 11 inches. Plotting speed is 8 inches per second, and resolution is 0.004 inches.—C. Warren

MICRO FILES: Beginning on Oct. 1, Apple Computer Inc. will work directly with its 1,800 dealers instead of going through manufacturers' representatives. Sales vice president William Campbell says the reason is twofold: to bring economies of scale to Apple's marketing and sales program, and to bring Apple closer to its customers.—D. Bright

Weighing a scant 20 pounds and measuring 14 square inches, the NNC Oasis computer series uses Phase One Systems Inc.'s 16-bit multiuser OASIS operating system. Although the compact system is primarily designed for multiuser applications, a single-user version that can be upgraded to a multiuser unit is available. The systems can accommodate a 20M-byte or 40M-byte Winchester disk drive. OEM prices are available.—C. Warren

GRAPHICS FILES: Built around the IEEE-696 (S-100) bus structure, the PC-Graphics board from CompuCorp, Hayward, Calif., emulates IBM Corp.'s PC color graphics functions. CompuCorp expects to unveil the board, which has been viewed by selected OEMs, this month, and plans to ship in high volumes in late August. Single-unit price is $495.—C. Warren

NOTES FROM OVERSEAS: Altos Computer Systems Inc. reportedly is negotiating a deal that would turn over worldwide marketing rights on its Pick operating system-based 586 microcomputer to start-up U.K. distributor Unison Technology Plc. The all-inclusive pact would mean that Altos would delegate to Unison the responsibility for marketing Altos' own system in the U.S. Unison would set up offices in Silicon Valley. Altos provided the initiative for the changeover, according to Neil Ratcliffe, president of Unison's parent company, Interactive Data Machines. Unison is contemplating subcontracting Far East sales of the 586 to a single distributor. Unison expects to generate $9.7 million in Pick business in Europe this year.—M. O'Gara
Britain's **Acorn Computers Ltd.** is setting up a joint venture in Palo Alto, Calif., to develop compact laser disk drives designed as floppy disk drive replacements. The start-up, christened Optical Information Systems Inc., is an equally divided collaboration with turntable maker Better Sound Reproduction Ltd., Hong Kong. With no set media standard, the pair is comfortable borrowing from the recording industry by using a 12-cm. (roughly 4-inch) format for storing about 500M bytes of information. In 18 months, the R&D facility should have readied the first read-only production models. Acorn officials expect the compact lasers to sell at current Winchester disk prices but project a significant cost savings on a price-per-megabyte basis, especially for large accounts.—M. O'Gara

The first commercial implementation of **Intel Corp.'s** anticipated 82586 Ethernet chip set popped up last month in England at 18-month-old network house **Torus Systems Ltd.** The heralded chip appeared as an integral part of Torus' initial product, Icon, a graphics-controlled local-area network integrating communications, videotex, electronic mail and telephone dialing. The Torus gear, priced at roughly $1,300 per node for both hardware and software, runs the PC-DOS operating system and reportedly links as many as 100 256K-byte IBM PCs or look-alikes over a 1-km. (1.6-mile) network. Its concurrent software includes 450 context-specific help messages.—M. O'Gara

Concomitant with Torus Systems Ltd.'s Icon introduction, **Acorn Computers Ltd.** bought a 25 percent share of Torus, Cambridge, England, for $520,000. Torus intends to sell Icon in the U.S. by year-end. It is currently evaluating whether to sign a distributor, go through Acorn's U.S. sales network or start its own operation.—M. O'Gara

**IBM Europe S.A.,** Paris, is abandoning its internal organization based along individual product lines in favor of one based on business areas. IBM confirmed the reorganization will give its British, German, French and Italian subsidiaries, its four largest European operations, a greater and more direct voice in the company’s overall planning process. An IBM spokesman says the reorganization is a worldwide charter and would extend to IBM’s Americas/Far East unit.—M. O'Gara

The fate of **Victor Technologies Inc.** appears to be in the hands of an international auction. At press time, two new bids for the U.S. microcomputer company had been planned. Diversified Swedish electronics company Datatronics offered $31 million in cash and 20 cents per $1 to Victor's secured creditors while German microcomputer supplier Beta Systems offered $27 million in cash. Both bids top the complicated proposal made by Britain's ACT, which has been valued at around $16 million. Reportedly, both new entrants would also be willing to acquire the remnants of Victor's U.S. operations, which ACT's proposal excludes. The 11th hour challenges to ACT raise questions about whether Victor will successfully emerge from its Chapter 11 status as well as ACT's chance of international success if it fails to win Victor's continental subsidiaries and distribution outlets.—M. O'Gara
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A unique cast aluminum base design provides a very rigid frame and acts as a heat sink, eliminating the need for a cooling fan. So the Mechatron runs silently between jobs.
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<table>
<thead>
<tr>
<th>COMPARE THE MECHATRON SERIES 50</th>
<th>Printing Speed (CPS)</th>
<th>Mean Time Before Failure (Hrs.)</th>
<th>Mean Time To Repair</th>
<th>Weight</th>
<th>Suggested List Price</th>
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<td>30 min.</td>
<td>45.5 lbs.</td>
<td>$2595</td>
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Compaq aims PC-compatible Bullet for a repeat round of success

Lori Valigra, Senior Editor

In 1982, a handful of entrepreneurs drew a crowd of onlookers when they placed $10 million of venture-capital money in a local Houston bank. Even the bank president came out to see who could deposit such hefty funds when even large oil companies were stalled by the recession. The group came from a high-technology start-up, Compaq Computer Corp., maker of IBM-compatible portable computers. Because of its subsequent success, Compaq has stayed at the center of attention ever since.

Its strategy of introducing a portable while others mimicked IBM Corp. with desktop systems kept Compaq at arms's length from IBM. This more distant strategy paid off handsomely: the company posted a record-breaking $111.2 million in revenues during its first year, having sold just over 53,000 computers. About half that number were sold in the first quarter of this year.

Though Compaq's corporate goal is to be one of the top five personal computer manufacturers, it remains to be seen whether the company can sit tight in the eye of the PC-compatible market hurricane, remain innovative and resist being swept in with the me-too clone companies.

Compaq's shot at repeating its success was expected late last month with a family of desktop systems called DESKPRO and code-named the "Bullet." Intended to be a step ahead of IBM's machines in performance, Bullet is based on the Intel Corp. 8086 processor and employs 256K-bit semiconductor memories in the top-of-the-line model. It thus offers performance improvements over Compaq's 8088-based portable line and IBM's PCs.

Prices are comparable to new IBM PC prices, ranging from $2,495 for an entry-level system sporting the DOS 2.1 or 1.1 operating system, 128K bytes of RAM, a single diskette drive and a 25-line-by-80-character monitor to $7,195 for the top model including 640K bytes of RAM, a monitor, one diskette drive, one fixed drive and one tape drive. The integral drives mark Compaq's first use of half-height mass-storage devices. Half-height drives will eventually be available in Compaq's portables. A 20M-byte Winchester disk drive option has not yet been priced, but is scheduled for September availability. The tape drive is $1,075.

Compaq plays product improvements as its trump card against IBM and other compatible suppliers. "We innovate, but not against compatibility," explains Rod Canion, Compaq president and co-founder. He says PC compatibility is also binding to IBM's new products because of the existing volume of PC-compatible software. Adds Canion, "This market does not exist because of IBM, but the software base does, and we are compatible with this."

The Bullet includes several enhancements over IBM's PC. In addition to using the faster 8086 and 256K-bit memory chips, the systems have a switch for an 8088 clock rate mode, a board and a screen combining high-resolution text and graphics, a backup tape drive option, modular assembly of the four-product line, more unoccupied add-in card slots, and a 200W power supply to accommodate future mass-storage options. (Compaq's portables use a 120W power sup-
Additionally, Compaq claims to offer stronger dealer margins.

One example of how Compaq chose compatibility over speed is its selection of a slower 8-bit bus for the 16-bit 8086. Says Compaq director of engineering Gary Stimac, “This is the hard part of IBM compatibility.” Stimac recommends exercising Compaq’s memory options, because populating the motherboard with memory allows users to address 16-bit-wide words. Adding an external memory board means employing the 8-bit bus, so only 8-bit-wide words can be addressed.

Offering lower prices and quicker availability of products is not enough in the IBM-compatible microcomputer market, explains Can­ion. To succeed, a company must offer product advantages. An advantage Compaq touts is its switchable processor speeds. By hitting the control, alternate and delete keys simultaneously, users can flip back and forth between the common-mode 8088 speed and the turbo-mode 8086 speed. The company expects most users to stay in 8086 mode, which runs popular programs such as Lotus Development Corp.’s 1-2-3 integrated software and Microsoft Corp.’s Flight Simulator. The turbo speeds drawing of graphics on the display two to three times over a similarly configured IBM PC. In one demonstration, the IBM PC finished 28 seconds after the Bullet.

But 8088 speed may be necessary to run some entertainment and communications packages with timing considerations. Despite Compaq officials’ initial concerns, the Bullet was able to run the communications module of Lotus’ Symphony integrated program.

Compaq plans to supply dealers with a list of software that runs on the Bullet and will note mode restrictions, says B. Kevin Ellington, vice president of Compaq’s office computer division.

Compaq touts a two-for-one slot savings in getting high-resolution...
EXAMINING COMPAQ'S BULLET

<table>
<thead>
<tr>
<th>Model</th>
<th>Without monitor</th>
<th>Including monitor</th>
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<tr>
<td>128K-byte RAM single-diskette drive</td>
<td>$2,240</td>
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<td>256K-byte RAM dual-diskette drives</td>
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<td>256K-byte RAM single-diskette drive 10M-byte fixed disk serial interface/clock card</td>
<td>$4,740</td>
<td>$4,995</td>
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<tr>
<td>640K-byte RAM (using 256K-bit RAMs) single-diskette drive 10M-byte fixed disk 10M-byte fixed disk back-up serial interface/clock card</td>
<td>$6,940</td>
<td>$7,195</td>
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</table>
Liberty’s Freedom 212 integrates terminal and telephone functions

Tom Moran, Associate Editor

Aiming at a near-$2 billion market by the end of the decade, Liberty Electronics USA, San Francisco, has launched the Freedom 212, described as the first voice/data terminal that combines the telephonic features of a display phone with the data-processing capabilities of a full-function terminal.

The Freedom 212 has an integral 110-/300-/1,200-baud modem with auto-dial and -answer capability, a detached DIN-standard 106-key keyboard, a 12-inch monochrome display and a buffered bidirectional printer port. It attaches to a user’s desk telephone through a standard jack.

With a price of $1,295, the Freedom 212 can operate as a remote data terminal using its integral modem, as a voice/data display telephone or—as with the modem disabled—as a Liberty Freedom 200 terminal (MMS, November 1983, Page 46). External computers can speak to the 212 as if it were a standalone device via the Bell 212A- and -103-compatible integral modem.

Resident telephonic software

The modem automatically logs onto data services and enters passwords, has auto-redial capability and can be programmed to call a group of numbers until one answers. When the terminal is hooked to a printer, it receives and prints files while unattended. The telephonic software resides in ROM, and additional on-board non-volatile memory stores phone numbers for both voice and data calls.

A directory screen displays the last name and number called; lists names and numbers; and, in the case of data services or remote devices, stores and sets the parity, baud rate and other configuration parameters. The bottom of the screen displays dialing options that can be executed with the function keys.

Liberty president George Chao says the terminal market is changing significantly. “We are now in an application-driven environment. We see a very large vacuum in the market today that can be addressed much as the personal computer addressed an unfulfilled need by packaging an existing technology.”

Chao predicts that all terminals will address the voice/data market by 1990. “Once you get to monolithic, [modems] will be jelly beans. I think it may happen as early as 1987, depending on the progress made in monolithics. If [monolithic modems] start hitting the streets later this year, they’ll be about $30 to $50, which means, semiconductor trends being what they are, modems will be $10.” Chao says that, at that price, integrating modems into terminals will be nearly universal.

Greg Carlsted, industry analyst for Dataquest Inc., San Jose, Calif., expects a high growth rate for voice/data terminals. Sales hit $41 million in 1983, Carlsted says, adding, “We believe the market will increase in 1984 to approximately $153 million, growing at a compound annual growth rate from 1984 to 1988 of about 81 percent, with sales in 1988 of $1.6 billion.” Carlsted adds that the early terminal products will lead to product families. “A [company like] Rolm Corp. will have a number of these terminals that will fill a number of market needs. We believe that families of products will be necessary to remain competitive.”
AT&T sets value-added strategy

Stephen J. Shaw
Washington Editor

Less than a month after announcing its 3B computer family, American Telephone & Telegraph Co. concluded its first agreement with a value-added reseller, M/A-COM Sigma Data (MSD) Inc. MSD, a Rockville, Md., system integrator, announced in April that it will integrate the 3Bs into systems for sale to the federal government. The move to outside marketers came as no surprise, but some observers criticize AT&T's apparent lack of computer marketing skill.

AT&T Technologies Inc., the deregulated arm of AT&T, was unlikely to rely solely on its extensive—but largely inexperienced—sales force in trying to move quickly into the unfamiliar commercial computer market. Agreements with third-party resellers have traditionally provided manufacturers—most notably IBM Corp.—a fast track in getting new products to end users. AT&T's deal with MSD, which sells primarily to the federal government, also complements AT&T's traditional strength in dealing with government customers, especially the U.S. Department of Defense.

AT&T is also seeking other value-added resellers (VARs). A source close to the company says AT&T has developed a strategy to market the 3B minicomputers that includes arrangements with a half-dozen VARs in six vertical market niches, including computer-aided design and computer-aided manufacturing. An AT&T spokesman says only that AT&T Technologies is looking at VARs with "technical, industrial or communications-type customers." AT&T is also trying to attract VARs by placing ads in numerous computer trade publications. The ads state: "Business partners wanted. Major U.S. firm seeks partners for new business venture with huge dollar potential. Excellent prices/terms/discount schedules for right parties."

The three-year non-exclusive pact with MSD, however, raises some significant and disturbing questions about AT&T's viability in the mini-computer and desktop computer markets. First, AT&T relies on third parties for 3B system integration and makes extensive use of consultants such as Stanford Research Inc. and McKinsey & Co., which evaluated MSD. The "hired gun" attitude seems to be a frank admission of AT&T's lack of computer marketing expertise. Although industry analysts are generally giving high marks to the Bell Laboratories' technology in the 3B computer family, AT&T's marketing skills remain unproven.

Second, AT&T is running a considerable, but unavoidable, risk in allowing VAR salespeople to call on potential customers before AT&T's internal sales organization has gelled. AT&T Technologies has two sales forces selling the 3Bs. One operates through AT&T Information Systems (ATTIS), and the other works under AT&T Technology Systems, formerly Western Electric. Under the Federal Communications Commission's Computer II separation guidelines, the two divisions cannot engage in joint marketing activities; that is, salespeople from each division cannot walk into a prospect's office together, nor can the two marketing staffs share customer information. When the sales forces of MSD and other resellers are added to the picture, potential customers could be faced with the prospect of entertaining three or more salespeople hawking the same computers.

Ideally, according to AT&T's scenario, ATTIS will concentrate on selling systems incorporating the 3Bs, private-branch exchanges and office communications products to Fortune 1,000 businesses that want to increase productivity through office automation. VARs and third-party resellers will sell to smaller accounts that desire the mix-and-match approach that tailors hardware and software from a variety of manufacturers for specific applications. AT&T Technology Systems will continue to market to ex-Bell telephone operating companies and to independent telecommunications companies.

"There will be a degree of coordination among the marketing staffs for the 3B," asserts an ATTIS spokesman. "The two groups won't be competing against each other or against the value-added resellers."

MSD president Richard Litsinger disagrees with this assessment. "AT&T Technologies is not relying on ATTIS as its only outlet for the 3B. We'll be running into ATTIS in the federal marketplace," he says.

The sales forces from AT&T Technology Systems, ATTIS, and MSD "will knock each other's heads off in the federal marketplace," comments Charles Robbins, director of communications and office automation at International Data Corp., a market research and consulting organization.

"The marketing distinctions in terms of who sells to which customers won't work the way AT&T anticipates [they will] on paper." The long-term success of AT&T's marketing strategy for the 3B family depends on how well the company refines the marketing guidelines for each internal division and the third-party resellers it chooses. "The key is proper coordination among all the players," says Robbins.

Until the guidelines are defined, AT&T will rely heavily on such resellers as MSD to address specific market niches. VARs will provide AT&T the time it needs to train its computer sales forces while minimizing delays in getting the 3Bs to market.
NCC hosts test of file-transfer equipment

Marjorie Stenzler-Centonze
Associate Editor

This month, the National Bureau of Standards (NBS), General Motors Corp. and Boeing Computer Services Co. will test two types of local-area networks (LANs)—one for business and one for industry—at the National Computer Conference in Las Vegas, Nev. The tests involve 14 computer and communications companies that are backing a government/industry effort to develop networked-equipment compatibility in the business environment.


The demonstration at NCC follows the recent signing of an agreement by NBS, GM and Boeing to generate and promote product development implementing the international Open Systems Interconnection (OSI) standards.

Boeing president Robert L. Dryden says the standards, developed by the International Standards Organization (ISO), will enable computer users and manufacturers to develop and operate cost-effective computer networks using various manufacturers’ equipment. “Without international standards, the choices facing users of these systems are either the development of ad hoc solutions to interconnect incompatible products or the utilization of a single vendor’s system as a common denominator to connect other manufacturers’ systems. These solutions, though effective, have been costly to develop and maintain as computer technology changes,” Dryden says.

OSI functions defined

The OSI-defined architecture for distributed information-processing systems is a seven-layer division of the various data-communications functions of a network. OSI also identifies the common protocols needed for each layer to communicate with other layers. Networks developed according to the OSI concept will be vendor-independent and will support different types of equipment. The NBS, the American National Standards Institute and the Institute of Electrical and Electronics Engineers support the OSI standards.

ISO developed the OSI reference model, a framework that divides the functions of a network into seven layers. The layers of the model handle the physical connections of a computer to a communications medium and the means by which data gains access to the network.

The higher layers set up connections between systems and data structures so that data can be reliably transmitted and received. The fourth layer, transport, controls information flow, including file transfers, from a sender to a receiver. The NCC demonstration will show the transport layer working with a carrier sense multiple access with collision detection (CSMA/CD) network for business use and the token bus network designed for use in factory computer systems.

Exhibit to feature file transfer

Robert Rosenthal, manager of the LAN program at the NBS, says the demonstration will show multiple vendors using level 4 transport protocols to transport files from one machine to another. NBS plans to participate by evaluating exhibiting manufacturers’ adherence to level 4.

“This kind of demonstration is of major importance to the industry,” Rosenthal states. “When you have major corporations using their own financial resources and asking the government to assist in testing protocols that have been internationally accepted, that in itself is greatly significant.”

Not good for small companies?

Many major corporations support the effort to establish networking standards. But the idea may not be quite as appealing to small companies, says Mike MacNaughton, president of the consulting company Business Development International, Franklin Lakes, N.J. While MacNaughton agrees that establishing standards is desirable, he cites a problem for the myriad small- and
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medium-sized companies that have entered the market since “LAN” became the buzzword. “Anyone who is in the business of making micros or anything that relates to them has got themselves a LAN, and I’d be surprised if any of them will meet the standards that are coming out of NBS,” he states.

MacNaughton says that, while the NBS effort is valiant, it may better suit major manufacturers and not most small ones. “Most manufacturers will not adhere to standards in this country unless there is a commercial reason for them to do so,” he adds. Small companies cannot take advantage of the commercial benefits of adherence to standards, given the expense of designing products to meet those standards, MacNaughton points out.

Response is strong NBS sources say outside vendors have responded positively to the standards effort. “For a long time, people have been looking forward to a coming-out party for OSI, and it was just a matter of reaching a consensus in the international community,” Rosenthal says. Many computer networking vendors are interested in developing implementations, testing them at the NBS and then developing product lines, says Rosenthal. “There are still a lot of holes, though,” he explains. “We don’t have an inter-net protocol in place at layer 3 yet, and we are not demonstrating session or presentation protocols. We are looking only at a LAN physical layer, a logical link-control layer and a transport layer. That still leaves layer 3, 5, 6 and 7 protocols to be tested, and that’s an enormous amount of work.”

Apple introduces portable Apple II
Tom Moran, Associate Editor

Apple Computer Inc. recently unveiled the Ile, a portable member of the Apple II family, at a San Francisco exposition called “Apple II Forever.” Apple developed the Ile to satisfy two long-term objectives—to prolong the life of the profitable Apple II family and to strengthen the company’s presence in the portable computer market. Apple reportedly received orders for more than 50,000 Iles on the day of its introduction.

Ile requires monitor

Although the $1,295 Ile weighs only 7½ pounds, Apple is billing it as “transportable” rather than “knee-top” because it requires either the optional Apple Monitor Ile or another display. The $199 9-inch Monitor Ile weighs 11 pounds and displays 24 lines by 80 columns on its green phosphor screen.

The Ile includes a video expansion port that drives a red-green-blue monitor, a TV set or an option-al liquid-crystal display (LCD). The 24-line-by-80-column LCD will be available in the fourth quarter of 1984. At less than 3 pounds, the LCD screen would significantly reduce the weight and volume of the Ile, making it a true knee-top machine.

Other interfaces include two high-speed serial ports, a mouse/game-paddle/joystick port, an external disk-drive port and a port for a 9V to 20V DC power unit. The serial ports support modems, printers and plotters. The Ile also has a headphone jack and a volume-control knob for its built-in speaker. Unlike previous Apple II products, the Ile has no internal expansion slots.

The Ile uses a 65C02 microprocessor, which is the complement - metal - oxide - semiconductor
The low-power-consumption runs at version of the 6502 CPU used in previous Apple II family machines. The low-power-consumption 65C02 runs at 1.02 MHz. Apple has expanded the RAM of the IIc to 128K bytes from the Ile's 64K bytes.

**Drive retains software base**

Although it measures only 2¾ by 12 by 11⅛ inches, the IIc sports an integrated 5½-inch 140K-byte floppy disk drive. Future knee-top portable computers will most likely have integral 3½-inch microfloppy drives, which Apple uses in its transportable Macintosh and desktop Lisa 2 systems. However, Apple opted for a 5¾-inch drive in the IIc to allow the system to access the huge Apple II software base. The IIc does not currently run CP/M programs.

To increase the potential market for the IIc, Apple introduced native-language versions for France, West Germany, Italy and the United Kingdom. A switch on the 63-key keyboard changes it from the American configuration to the native-language layout. On machines sold in the United States, the switch toggles between standard QWERTY and Dvorak layouts.

Sandra Gant, an analyst for InfoCorp, a Cupertino, Calif., research concern, expects Apple to ship 550,000 Iles and 350,000 IIcs in 1984. The 900,000-unit total represents an increase of 150,000 over InfoCorp's previous 1984 forecast. Gant expects Apple to control the actual mix of Iles and IIcs through pricing, promotion and production. Ken Lim, analyst for Dataquest, a San Jose, Calif., market research group, projects that the market for portable computers will grow from $518 million in 1983 to about $4.4 billion in 1984 and to more than $15 billion by 1988.

Apple will market the IIc through its dealer base and through selected department stores, amounting to more than 2,000 outlets in the United States. The company projects that two-thirds of the IIcs sold will be used in homes, with schools and businesses accounting for the remaining one-third.

To reduce competition between the IIc and IIe, Apple dropped the list price of a IIe with 64K bytes of RAM and one disk drive to $995. Discounters will sell the IIe for several hundred dollars below list price, which will bring the IIe into the home computer market and possibly into conflict with tough competitor Commodore Business Machines Inc. Apple will attempt to avoid such conflict by keeping the IIe out of mass-merchandising outlets and by positioning it against the PCjr.

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**DRI enhances Concurrent PC-DOS**

**David Bright, Assistant Editor**

Digital Research Inc., Pacific Grove, Calif., has added several features to its Concurrent PC-DOS for a new retail version targeted at corporate managers. Since last fall's Comdex, the company has signed about 50 OEMs for the multitasking operating system, according to operating systems marketing manager Darrell Miller.

The retail Concurrent PC-DOS runs as many as four PC-DOS or CP/M-86 applications simultaneously. Enhancements include communications, menus, windowing, a Rolodex-like database-management system and a print spooler. Digital Research recommends using an IBM Corp. PC with 512K bytes of memory and a hard disk with Concurrent PC-DOS.

The communications feature includes a third-party software program for accessing local and remote databases such as The Source news-retrieval service. While the system is in use, a remote dial-up link allows a remote user to leave electronic messages in a mailbox. A two-user system can be created by hooking a dumb terminal to the PC's asynchronous port.

The operating system allows the display of as many as four applications in variable-sized windows at one time. A cut-and-paste feature allows integration, such as the movement of spreadsheet data to a word-processing document in another window. Users can also customize or bypass the menu system, scroll through the Rolodex-like system or make automatic searches. The print spooler incorporates a queuing system similar to that on minicomputers and mainframes, with two output devices operating simultaneously, and items in the queue can be reordered.

The $295 retail Concurrent PC-DOS should be available in the third quarter.

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**NEXT MONTH IN MMS**

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Graphics software colors Mindset computer

Marjorie Stenzler-Centonze
Associate Editor

Plugging IBM Corp.'s perceived product gaps has made many companies rich. This could be the case with Mindset Corp., Sunnyvale, Calif., which this month expects to provide retailers with its IBM PC-compatible Mindset personal computer. Mindset is banking on what is likely to be the IBM PC's most notable weakness: graphics.

"In entering the business as a new company, we felt we needed to do something very different," says Mindset president Roger H. Badertscher, a former Atari executive. Badertscher says the Mindset microcomputer is intended not as an IBM PC substitute but as a graphics-intensive alternative. Much of the software differentiating the product from the IBM PC is just coming on-line, he says.

The Mindset, which is designed around the Intel Corp. 16-bit 80186 microprocessor, derives its graphics power from two custom graphics coprocessors made by VLSI Technology Inc., San Jose, Calif. The basic system, with 64K bytes of RAM, two ROM cartridge ports and a keyboard, sells for $1,099. A fully configured 256K-byte system with two 5¼-inch, 360K-byte floppy disk drives sells for $2,398.

A three-pronged strategy

Mindset's three-part software strategy includes IBM PC software; optimization for windows, icons and a mouse cursor controller; and graphics. "We believe there are some broad graphics application categories where graphics will be an end in itself and not just a tool to make a spreadsheet easier to use," Badertscher notes.

Initial software offerings include more than 70 packages. The machine runs most software written for the IBM PC, including Lotus Development Corp.'s 1-2-3 integrated program. Mindset is marketing a series of packages that takes advantage of the machine's graphics ability and also pushing the development of products designed for the machine by independent software vendors.

Bill Gates, president of Microsoft Corp., Kirkland, Wash., says the availability of high-quality graphics will be the next step in improving personal computers and may be a bigger leap than processor technology's move from 8 to 16 bits. Microsoft is focusing on software for the Mindset as well as Apple Computer Inc.'s Macintosh microcomputer. "Both machines share a vision of graphics," Gates says. "Apple is setting its own standards and is willing to create a software base apart from IBM; Mindset has chosen to take advantage of the existing [IBM] software base."

Fitting into retail channels

Egil Juliussen, chairman of research company Future Computing Inc., Richardson, Texas, says the Mindset fits well into the office/home personal computer market alongside the IBM PC and the Apple IIe.

Differentiating Mindset at the retail level is graphics software, says Badertscher. Mindset has private-label deals for three $99- to $399-graphics packages for professional users. The packages are Designer from the IBM PC; Lumena by Time Arts Inc., Santa Rosa, Calif., a mouse- or keyboard-generated business graphics generator featuring a free-running display that generates moving-slide presentations; and Lumena by Time Arts Inc., Santa Rosa, Calif., a color package that supports a mouse and a digitizing tablet through Mindset's RS232 interface.

Mindset is making available two telecommunications packages, Telecom and Telecom+ for use with 300- and 1,200-baud modems. Both feature full-color user interfaces to...
identify commands and labels. The company is also marketing an enhanced version of Microsoft's GWBASIC, designed to enable beginning programmers to create graphics-intensive programs, and CADDRAFT, a $495 menu-driven drafting tool by Personal CAD Systems Inc., Los Gatos, Calif. CADDRAFT, aimed at designers and engineers, features a user-selectable grid system that enables users to build basic designs by choosing from a combination of lines, arcs, shapes, symbols and text.

Mindset's developments also include incorporation of higher-level graphics commands into hardware. According to Ralph Gilman, senior vice president of research company Infocorp, Cupertino, Calif., this means that independent software companies will have to adhere to Mindset's standards—at least at some level. "If software companies are willing to do that, then their support can really help the product along," Gilman says. He believes market maturity will be another factor.

Gilman adds that the primary question, as far as Mindset is concerned, is whether a market for advanced graphics yet exists. "Mindset has an excellent innovation, but they don't have very much of a differentiation in the market because the market doesn't value graphics as much now as it will in a couple of years."

Stratus fault-tolerant systems challenge Tandem

David Bright, Assistant Editor

Stratus Computer Inc., Natick, Mass., has introduced two new fault-tolerant computer systems that may pose a serious threat to Tandem Computers Inc., Cupertino, Calif., which now dominates the fault-tolerant market.

Stratus, with its FT200 (previously called the Stratus/32 continuous-processing system), was formerly a low-end player in the market. But, thanks to the new XA 400 and XA 600 systems, which use multiple Motorola 68010 virtual-memory processors, Stratus will now be able "to compete head-on with the best that Tandem has," states Omri Serlin, president of ITOM International Co., a Los Altos, Calif., market research and consulting company specializing in fault tolerance.

Serlin says that, although Stratus' price/performance advantage over Tandem isn't tremendous, the two companies are now in the same league. Prices for the XA 400 start at $185,000, while XA 600 prices begin at $300,000.

Market is huge

With at least 175 installations so far, Stratus is one of the more established start-ups in the fault-tolerant business. Stratus, like most fault-tolerant manufacturers, targets the on-line transaction-processing market segment. Most analysts agree that this segment will enjoy tremendous growth in the next few years. Market research company InfoCorp, Cupertino, Calif., predicts the worldwide transaction-processing market will grow from $8.3 billion in 1982 to $27.8 billion in 1986. And Serlin says the market has the potential to reach $32 billion by 1986.

In typical transaction-processing environments, such as banking and airline reservation systems, most of the jobs are I/O-bound; there's not
A micro-packaging solution to the age old problem of space.

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much number crunching involved. Therefore, the use of performance ratings, which are based on number-crunching power and measured in millions of instructions per second, may not be a fair way of comparing transaction-processing systems. Comparing the number of transactions per second (TPS) is much more accurate, although it's not a standard benchmarking method. Serlin says the figures Stratus and Tandem released to him from banking environments seem to offer a reasonable comparison. The Stratus XA 600 system runs at 5 to 7 TPS, and each Tandem NonStop TXP processor runs at about the same level. The Tandem system contains two to 16 processors, but when users add processors the performance doesn't increase quite linearly, he adds. A two-processor NonStop TXP processes about 10 to 12 TPS, while the Stratus XA 400 handles 4.1 TPS.

**Hardware is duplicated**

The Stratus XA 400 has two CPUs performing identical operations. Each unit contains four 68010 processors, each of which can work separately or in parallel. Each self-checking CPU board performs as many as 8 million checks per second. If the checks on one of the boards don't match, that CPU automatically becomes disabled while the other continues operation. All basic system components, except for the tape drives and tape controllers, are mirrored, which means they perform the same operations simultaneously. Any of the boards can be replaced while the system is running.

Some other systems, like those from Tandem, also duplicate hardware, but employ software-checkpointing schemes to ensure continuous operation. In Tandem's NonStop TXP, for example, no single processor serves as a complete backup for another. Instead, built-in system utilities disperse copies of transactions occurring on each CPU to the other CPUs. If one CPU fails, the CPUs with the backup transactions pick up from the last good software checkpoint. Transaction back-out software, added by Tandem in 1981, reduces the probability of losing transactions when reverting to checkpoints, explains Serlin. Tandem added the system software that assigns backup processors in 1981.

An XA 400 with 4M bytes of redundant memory (for a total of 8M bytes), two 450M-byte Winchester disk drives, communications lines for 30 terminals, six terminals, Virtual Operating System (VOS) and COBOL lists for $300,000. An XA 600 with 16M bytes of redundant memory, two 450M-byte Winchesters, line support for 128 terminals, six terminals, VOS, COBOL and a
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600-line-per-minute line printer sells for $425,000. In comparison, a Tandem Non-Stop TXP with two CPUs, 4M bytes of RAM for each CPU, two 540M-byte Winchester disks, line support for 31 terminals, six terminals, Tandem's Guardian operating system and COBOL lists for $364,000. Additional processors, with 2M bytes of RAM, sell for $96,000 each.

Stratus says its new systems are software-compatible with the FT200. The company also announced a new version of VOS, VOS 3.0, which supports all three machines and reportedly provides a 15 percent performance improvement on the FT200. VOS 3.0 also supports SOS, a Stratus set of integrated office-management software packages that connects IBM PCs, IBM 3270 terminals and ASCII terminals to the fault-tolerant machines.

A StrataLINK local-area network (LAN) comprising as many as 32 Stratus machines performs as a single system, according to Stratus. As many as 14 Tandem systems, comprising 224 processors, can be linked in a LAN.

**Stratus sales increase**

Although Stratus has a long way to go before it can match Tandem's financial success, the company has been picking up steam. Its sales for the quarter ending April 1 were $7.6 million, compared with $3.3 million in the same quarter last year. Tandem had sales of $111.2 million for its first quarter ended March 31, up from $96 million for the same period in fiscal 1983.

**IBM influences the market**

The major obstacle facing both Stratus and Tandem in the transaction-processing market is IBM Corp.'s 4300 series mainframes, which don't incorporate fault tolerance. That difference is a major selling point for Stratus and Tandem. Stratus president William Foster says his company will do well by "complementing" IBM rather than by competing directly.

Other potential competitors in the high-end fault-tolerant market include Synapse Computer Corp., Milpitas, Calif., and Computer Consoles, Rochester, N.Y. But neither company has shipped more than a handful of systems so far.

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**Rigid disk models extend sub-4-inch, half-height markets**

**Carl Warren, Western Editor**

To meet the growing demand for rigid disk drives that match smaller desktop computers, Microscience International Corp., Mountain View, Calif., is rolling out the new 3½-inch, half-height, 10M-byte model HH-312 and the 20M-byte model HH-725, half-height, 5¼-inch model HH-725.

The 3½-inch HH-312 fills out the company's product line, says director of marketing Ron W. Schilizkus, with the drive featuring an unformatted capacity of 12.76M bytes, a data-transfer rate of 5M bits per second (ST-506 standard) and an average access time of 70 msec. The half-height, 20M-byte HH-725, designed for the future needs of desktop computers and for add-ins or replacements for systems such as the IBM PC, features an unformatted capacity of 25.5M bytes and an 80-msec. average access time. Like the HH-312, the HH-725 is ST-412-compatible.

The impetus for introducing the 3½-inch HH-312, says Schilizkus, was a demand for small Winchester disks from such desktop computer manufacturers as Compaq Computer.
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Corporation and TeleVideo Systems Inc., as well as the expected rapid growth of an add-on Winchester market for Apple Computer Inc.'s Macintosh microcomputer.

Only two manufacturers—Rodime Ltd., Glenrothes, Scotland, and Syquest Technology, Fremont, Calif.—are now supplying sub-4-inch Winchesters. Both companies' drives are slightly larger than the Microscience unit. Although Rodime and Syquest have enjoyed reasonable success with their non-standard-size drives, Schlitzkus explains, sub-4-inch Winchesters form a new niche in the disk market. Therefore, the drives must be able to compete in price. Says Schlitzkus, "5¼-inch drives are moving up in capacity and speed. There is still a very large market for 10M-byte [drives] with lower transfer rates for single-user desktop units. And, since that market is clearly growing, it needs multiple vendors and will be totally price-driven."

**Competition abounds**

Microscience expects to begin shipping the new drives in large quantities before year-end, but company officials realize they are facing stiff competition. For example, other concerns planning introductions of 3½-inch drives at the National Computer Conference this month are industry leaders Seagate Technology, Scotts Valley, Calif., Tandon Corp., Chatsworth, Calif., and Miniscribe Corp., Longmont, Colo. Start-up companies Lapine Technology, Santa Clara, Calif., and Microcomputer Memories Inc., Van Nuys, Calif., are also planning similar units.

All the 3½-inch drives sport an ST-412 interface. "This is a requirement of compatibility that the system integrator expects," says Jim Porter, a Mountain View, Calif., industry consultant and president of Disk/Trend Report. Porter agrees with Schlitzkus that the sub-4-inch Winchester will supplant low-end 5¼-inch drives in many applications.

Virtually all the contenders plan to begin shipments of evaluation or production units of the new drives by at least the fourth quarter of this year. Porter believes that, because Miniscribe can quickly manufacture the units, it may be the first to ship.

Extending Microscience's range from the opposite end is its half-height, 20M-byte HH-725. The drive, which uses a stepper motor for positioning, has a closed-loop servo that minimizes off-track errors caused by the stepper motor.

Schlitzkus points out that the HH-712 can be combined with a half-height floppy drive. "You take out a full-sized floppy and replace it with a combination of half-height floppy and an HH-725 or with twin Winchesters. The integration is easy, since the drives are made to be plug-compatible," he says.

Microscience isn't alone in the market for half-height, 5¼-inch rigid disks. Xebec Corp. and Shugart Corp., both in Sunnyvale, Calif., are preparing similar drives. The Xebec drives have an embedded controller, but Shugart is taking a more traditional approach with its two-platter model 724, which is expected to be shown at NCC. It has a closed-loop servo and a formatted capacity of 20M bytes. The company expects to begin high-quantity deliveries in the fourth quarter.

**LSI comes into play**

Another factor influencing sub-4-inch and half-height Winchesters is the availability of large-scale-integration (LSI) components. Using LSI circuitry, drive manufacturers can reduce the number of boards in the drive interface and thus reduce costs. For example, both the Microscience HH-312 and HH-725 use single-board interfaces, which decrease the number of heat-producing components.

In addition, with more than 25 manufacturers offering plated media, drive makers can provide greater areal densities—measured by multiplying tracks per inch by bits per inch—than were previously possible. "We could have taken the traditional approach on both drives and used standard oxide," says Schlitzkus, "but we expect both the HH-312 and HH-725 to end up in portable or semi-portable machines. Thus, we need a rugged media, and plated is the way to go." Further, Microscience expects greater demand for higher capacities, even for desktop systems, and plated-media capacities can be increased without adding platters.

The 3½-inch HH-312 has a 10,000-bit-per-inch (bpi) bit density, a 648-track-per-inch track density, buffered seek and microprocessor-controlled self-diagnostics. Single-unit price is $999. The 5¼-inch HH-725 offers similar specs but has a recording density of 9,680 bpi and is priced at $1,100 in single-unit quantities.
Portable display system produces high-level presentation graphics

Carl Warren, Western Editor

Aimed at providing high-level presentation graphics for office environments, the VideoShow 150, developed by General Parametrics Corp., Berkeley, Calif., provides a low-cost hardware and software solution for anyone interested in creating graphics presentations.

The goal, says company president Herbert B. Baskin, was to develop a presentation graphics system that is easy to use and doesn't require technical expertise on the part of the system integrator or end user. Thus, it was necessary to take current display methods and refine them to match perceived needs. To that end, the VideoShow 150 offers both the ability to view as many as 1,000 colors simultaneously, with fast display update, and the ease of creating graphics slide shows using General Parametrics' accompanying software package, PictureIt.

Compatible with IBM

The hardware portion of the VideoShow is a standalone unit based on an Intel 8086 microprocessor with 256K bytes of internal display RAM and a graphics display system. The unit, which can be plugged into an IBM Corp. PC or PC-compatible machine via an RS232C serial interface for slide-show development, has three outputs: National Television System Committee-compatible, red-green-blue (RGB) and digital RGB, thus supporting virtually any display monitor. The unit can also drive the display without the aid of the PC.

To display 1,000 colors at once and support six fonts in 18 styles (shadow, outline or plain), General Parametrics implemented a display method other than the standard pixel-dot technique used in most systems. "We use a look-ahead scheme to get to the next picture, so that it gives display speed," says Baskin. "But, to get the colors and definition in a display, we refined the methodology. What we do is position color in terms of the edge of a character, thus giving the impression of very high quality."

The method used in VideoShow, called horizontal positional accuracy (HPA), is a new method of putting information onto a screen. With HPA, a color is defined in terms of the horizontal element and repeating patterns that make up an object on the screen. Since intensities can be varied at each horizontal location, colors can be mixed and effects such as shadowing can be achieved. In contrast, a pixel system sets the size and attributes as functions of the pixel size, thus providing lackluster displays and poor clarity in objects such as circles, which can end up with jagged edges. HPA smooths the line much like a vector-line-drawing system, without the overhead or the need for special display tubes.

A remote device

In addition to portability, the VideoShow also features infrared remote control to move through the picture sequence much like a slide projector. Similar controls are mounted on the system.

The PictureIt software package helps keep the system as simple as possible. PictureIt allows users to create detailed graphics displays by simply filling in the blanks on fill-in formats. An accompanying manual provides detailed examples. With the VideoShow attached to a personal computer, the user can view previews during development simply by tapping a function key. Once a slide has been created, it can be saved in the desired viewing sequence.

So that developers and integrators can take advantage of the system to create other complex graphics displays such as computer-aided
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design, General Parametrics has adopted the North American Presentation Level Protocol Syntax (NAPLPS). This syntax defines the coding, storage and transmission of graphics information. “We feel we have refined the display method and want developers to add value by creating new software. The easiest way is to give them a standard format, and NAPLPS is it,” says Baskin. Besides offering a standard format for creating graphics software for the VideoShow, Baskin claims, General Parametrics provides developers with free technical assistance.

The price of the VideoShow, $3,295, includes the base unit with integrated floppy disk drive and remote control; PictureIt software sells for $595. “There are no options and nothing extra to worry about. It’s a compact system that does one thing: display high-level presentation graphics,” notes Baskin.

Winchesters combine ESDI interface with high capacity

Carl Warren, Western Editor

Micropolis Corp., Chatsworth, Calif., has unveiled a family of 5¼-inch Winchester disk drives that ranges in capacity from 85M to 170M bytes and employs the proposed enhanced small disk interface (ESDI) standard to achieve a 10-MHz transfer rate.

The family, the 1350 series, has the features of the company’s 1300 series, including a rotary positioner, a dedicated landing zone and servo surface and a mechanical brake.

Fast-access users

Although vice president of marketing Chet Baffa says single users can use the 1350 series, he contends, “Our real emphasis is on multiuser, networked and clustered systems that need fast access and high capacity at low dollars.”

The 1350 employs a rotary voice-coil positioner system that Micropolis introduced. Baffa asserts that the mounting issue—physical orientation of the drive in the system—is as important as the drive’s ability to handle data properly. “The actuator method we use is time-proven and allows virtually any mounting orientation of the drive,” he says.

Use of the ESDI standard ensures that operators in a multiuser system that utilizes UNIX will get maximum performance, according to Bob Mortensen, product requirements manager. ESDI provides the device interface to support large-system transfer requirements of 10 MHz. “With a number of ESDI chip sets becoming available, ESDI is now practical both from an implementation and cost standpoint. We have all the pieces of the puzzle and can put them together,” asserts Mortenson.

Despite the popularity of half-height drives, Micropolis has elected to stay with full-height designs. Baffa says none of Micropolis’ customers can justify the smaller footprint. “Sure,” he explains, “we’d love to make a half-height, but right now we don’t see a need for it—at least for the market we address.”

Industry consultant Jim Porter, president of the Mountain View, Calif., Disk/Trend report, concurs: “There is a place for half-height drives, and that appears to be for small desktops or portables that need only about 10M to 20M bytes. For the larger system that implies a file-server arrangement, full-height is logical. Plus the technology doesn’t have to be stretched.”

NEXT MONTH IN MMS

Two hardware profiles are featured in the August issue of Mini-Micro Systems. The first examines the impact of personal computers on systems integration. The second article reviews the popular bus standards for single-board micros.
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THE BERKELEY PORT AUTHORITY
Wafer tape drive emulates single-density floppy drive

Carl Warren, Western Editor

Designed to provide low-cost functional storage for lap-sized personal computers and electronic typewriters, the MicroWafer tape storage system, developed by Entrepo Corp., Sunnyvale, Calif., sports as much as 128K bytes of formatted data, arranged in sectors ranging from 64 to 4,096 bytes, on a wafer cartridge not much bigger than a business card.

The tape storage system is an offshoot of the Exatron Stringy floppy drive, which was developed about eight years ago. It uses the same concept as that used by Texas Instruments Inc. in its 99/4 personal computer system. However, the TI system used the Stringy floppy design. "We recognized that the older design had a number of problems in reliability and interchange," says Entrepo vice president of marketing David Osborne. "We advised TI of the difficulties, and, under our agreement with them, did and are sharing the new technology." Unlike the older design, the MicroWafer emulates a floppy disk drive by dividing the tape in sectors and by providing an interleave factor when necessary to speed data access.

The MicroWafer series—models 101 and 107—employ a data cartridge design that is optimized to resolve interchange problems. Entrepo redesigned the wafer cartridge to offset the tape reel and to provide buffers, which ensure proper tape/head compliance. Moreover, the drives' heads are wider than the tape, thus allowing full use of the 66-mil-wide media. According to Osborne, this minimizes the chances of data dropout because the tape is fully saturated.

The Entrepo MicroWafer drives are available in two models. Model 101 has a TTL-compatible interface, and model 107 has an LSI controller that provides an 8-bit bidirectional bus.

The MicroWafer drives use proven technology. For example, they employ continuous-loop tape, which means that data can be formatted in much the same manner as it is on a floppy disk. A typical 69-foot-long tape can therefore accommodate 128K bytes of formatted data or 148K bytes of unformatted data with an average access time of 32 seconds to mid-tape or 1 minute from the beginning to the end of the tape.

Because the tape used in the MicroWafer is video-grade tape that is certified for data and coated to reduce tape wear, Entrepo can provide a recording density of 1,706.7 bits per inch and a flux density of 3,413.4 flux transitions per inch.
using frequency-modulation recording. The transfer rate of 20,490 bits per second is fast enough for most applications.

Osborne envisions the Micro-Wafer being used with lap-sized computers as a low-cost media exchange. “We provide a flexible interface that easily plugs into any 8-bit bidirectional bus and a built-in command set that handles all the important functions of format, read/write, verify, seek, rewind and status.” Coupled with a file-handling system on the computer, this means that a user could create information on a lap-sized unit, unplug the Micro-Wafer and couple it to a bigger system such as an IBM PC and up-load via the parallel bus, Osborne says.

Models 101 and 107 each measure 1 by 2 by 3¾ inches and weigh 8 ounces. Model 101, a bare-bones drive, features a transistor-to-transistor-logic-compatible interface that lends itself to integration in data-collection, test-instrumentation and other specialized equipment. It sells for $20 in OEM quantities. Model 107 has a large-scale-integration interface/controller that provides a single-bit bidirectional bus with three handshake lines. Price is less than $30 in large quantities. Entrepo expects both drives to become available in high volumes in July.

Satellite software distribution looms on the horizon

Stephen J. Shaw
Washington Contributor

Two companies are developing high-flying plans for electronic distribution of computer software via satellite. Those plans will take advantage of rapid transmission over wide-bandwidth lines and move electronic distribution of software from the home into business in such applications as the transmission of software to retail store locations.

Satellite Television Corp. (STC), a subsidiary of Communications Satellite Corp. (Comsat), Washington, intends to use its proposed direct-broadcast satellite system (DBS) to carry software to home and business subscribers. Nabu Network Corp., Ottawa, hopes to attract U.S. cable television viewers to its service by offering a mix of games, educational and personal productivity software programs and a free 64K-byte home computer.

Nabu, named after a Babylonian god who served as patron of writers, was founded in July 1981 to explore the potential of satellite and cable broadband communication media to distribute software electronically. The company embarked on a two-year program to develop its own software internally, license other software and design a home computer for cable subscribers. In July 1983, Nabu began testing its network on an Ottawa cable TV system, racking up 1,500 subscribers in the first three months.

Nabu is not the first to down-load software to cable subscribers via satellite. Others, like the Jerrold Division of General Instrument Corp. with its Playable service, and a recent start-up, The Games Network, originated by The Source co-founder William Von Meister, have provided video game software with limited success.

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Like these other services, Nabu broadcasts a number of software programs that are continuously repeated. Subscribers select a program from a screen menu and enter their choice into the computer. The computer then “snags” the appropriate program from the data stream using codes incorporated into each program. Nabu’s objective is to compete the software loading within a maximum of 20 seconds from when a subscriber enters a selection.

**Plans full transponder service**

The Nabu system transmits over the Canadian Anik D-1 satellite using a quarter-transponder at 9-MHz bandwidth. The company expects to switch to either a Hughes Corp. Galaxy or an RCA Corp. Satecom communications satellite for full 136-MHz bandwidth transponder service in 1985, according to Nabu operations vice president John Hughes. Using a full transponder, says Hughes, will enable Nabu to achieve a capacity of approximately 15M bits per second (bps) and carry approximately 200 64K-bit programs simultaneously. On the cable systems, the data stream can occupy an empty video channel or can be carried beneath the video signals on several channels.

Home equipment includes a demodulator manufactured by a Hong Kong electronics company and the home computer, which was built to Nabu’s specifications by a large Korean terminal manufacturer, Samsung Electronics Co. The computer features a Zilog Inc. 8-bit Z80A microprocessor, 64K bytes of RAM and 8K bytes of ROM.

Nabu’s software transmission supports the MSX operating system used in the Samsung devices. The network also carries programming for IBM Corp.’s PCjr and Commodore Business Machine Inc.’s model
64 home computers. Among the programs offered are the LOGO educational programming language developed by the Massachusetts Institute of Technology, BASIC, under license from Microsoft Corp., and a variety of arcade-like games under license from Namco of Japan.

Nabu is attempting to do with cable-delivered software what Home Box Office (HBO) did with entertainment pay-television over cable. "We're following the HBO model very closely," Hughes says. Home subscribers can receive the

STC plans an ambitious satellite-to-home broadcast network that could include a variety of electronic information services such as remote database access, computer software down-loading and electronic publishing, as well as pay-TV programming, stereo audio and enhanced-definition video.

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THE FAST WAY TO HARD COPY.
STC aims at business

STC is scheduled to launch its DBS service this year if it can find additional partners to help fund the estimated $600 million development costs for its planned satellite system. STC is looking at a variety of electronic information services to complement its primary service of delivering entertainment television to the home. Among the secondary service offerings STC is contemplating is delivery of computer software to homes and software retail outlets.

According to Warren Zeger, STC planning and business development vice president, the DBS systems could service retail computer outlets in two ways. First, the network could be used for transporting software inventory, transmitting new programs, making updates and documenting. Zeger says STC is exploring the establishment of a computerized archival software library at STC’s program-origination facility. Second, the DBS network could download video programs into video cassette recorders at retail stores for sales training and customer displays.

Software distribution via satellite, says Zeger, offers approximately a 100-to-1 improvement over telephone distribution because of the higher bandwidth available—330K bps per satellite video channel—and enhanced error correction that reduces bit error rates to approximately 10–13.

“A 128K-bit program, for instance, could be down-loaded in 9 seconds using STC’s DBS system vs. 15 minutes at 1,200 baud over the phone lines,” Zeger estimates.

Although electronic distribution of software programs is capturing the imagination of technology enthusiasts, market prospects remain uncertain. “The skepticism about electronic software down-loading is justified,” comments Robert Wells, a telecommunications analyst and partner in Wells Communications, a consulting organization. “Retailers and consumers alike think in terms of boxes and physical inventory. Electronic distribution alters this shopping perception, and that’s a risky proposition.”
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Electronic databases move from computer center to professional use

Lawrence F. Vogel
The Office Systems Consulting Group Inc.

On-line database services are receiving much attention now, even though they are not new. Long used in libraries and computer centers, they are now sought by professionals and managers who want to use them as one-on-one tools.

The ability to access large amounts of information easily and directly can be beneficial to almost any business at almost any level, particularly in situations in which adequate information previously was not available.

Take, for example, the sales force of a medium-sized word-processing vendor. Salespeople have always had access to much industry information through the trade press and competitive analysis bulletins sent from headquarters each week. The bulletins can take as much as two to three hours to read. Salespeople find themselves pressed for time but still in need of timely information to support their sales efforts.

For these people, an electronic service that offers information on competing products and companies can be the answer. The result is a better-informed, more effective sales group. Much-needed information no longer remains the domain of a small group at headquarters. This can be transferred to many other areas of an organization, such as product planning, pricing or marketing programs.

The trend toward direct access to databases by end users, rather than filtering information through middlemen in information centers, dictates a new set of product requirements for those who supply state-of-the-art information services. These requirements, similar to those that successful office-automation vendors follow, are fairly simple:

- the service must present a solution to the business problems of the potential user, so information must be accurate and complete;
- it must be easily accessible and user-friendly;
- it must be time- and cost-justifiable.

All this must be accomplished by direct communication between the person and the computer on which the database resides.

Difficult as those objectives may be to achieve, the direct access issue provides the key to information services' future. Whether the database in question is a large public dial-up system or a small specialized system, its intrinsic value still lies in its ability to support the decisions of managers trying to achieve company-wide goals. Those wishing to provide such on-line services must keep those goals in mind.

Financings

Ibex Computer Corp., Chatsworth, Calif., has formed a $3 million limited partnership to complete research and development on its nine-track PCT-1000 streaming-tape drive....Identix Inc., a Palo Alto, Calif., manufacturer of the IDX-10 fingerprint-verification terminal for computer-system security, recently received $2.25 million in venture-capital financing. Identix says the terminal provides a higher level of security than passwords provide. A major application area should be automatic teller machines, the company predicts. Lead investors are Citicorp Venture Capital and Genesis Capital Ltd....Ridge Computers, Santa Clara, Calif., recently raised $5 million to manufacture and market its Ridge 32 32-bit personal computer. Among the financiers are Hambrecht & Quist and the Bull Group, which will market the systems in France....The Systems Center, Dallas, has secured $3 million in venture-capital funding for new microcomputer-to-mainframe networking software. Investors include
J.H. Whitney and Co. and First National Bank of Boston,...Zaisan Inc., a Houston manufacturer of voice/data workstations, garnered drivers through retail channels. Hambrecht & Quist, TA Associates and Tandon Corp. chairman one-year, $4.5 million contract to Hambrecht Inc., a Houston manufacturer of plans to market Windows device participants. Winchester disk drives to Maynard National Bank of Boston. Sirjang Tandon were among the deliver its 10M-byte half-height deals count, peripherals and software distrib....

Distribution/service deals

As its first national computer account, peripherals and software distributor Micro Distributors Inc. has chosen the Apricot portable personal computer from ACT (North America) Inc., a subsidiary of Applied Computer Techniques Plc., Birmingham, England. Applied Computer Techniques supplies the Apricot through ACT, Santa Clara, Calif....Data General Corp., Westboro, Mass., has appointed Rolm Corp. as the exclusive worldwide marketer of DG's Ada work environment software systems. The systems run on DG's Eclipse MV series minicomputers. The agreement is for applications involving substantial military-specification content, such as embedded target systems for rugged environments....Honeywell Information Systems Inc., Waltham, Mass., has signed a three-year contract worth as much as $10 million with Great Wall Industrial Co., the trading arm of China's Ministry of Space Industry. Great Wall, through the Peking Data Equipment Institute, is marketing Honeywell's DPS 6 small systems hardware and software.

Wet ink

Microsoft Corp. has selected Graphic Communications Inc., Wal...
Texas Instruments and Western Digital have entered into a license agreement that makes TI a second source for WD’s leading edge floppy disk controllers and X.25 network controllers. Under the agreement, TI plans to manufacture and market the WD177X family and WD270X family of floppy disk controllers and the WD2501/2511 X.25 packet switching network controllers. “TI is a very credible second source and this credibility is what Western Digital and our marketplace looks for in second sources of any leading edge product,” according to Terry N. Holdt, WD Executive VP and Chief Operating Officer.

Western Digital has announced a multi-million dollar contract to supply Matsushita Electric Industrial Company., Ltd. of Japan, with a custom Winchester controller board for their new IBM compatible portable computer. The portable, called the Sr. Partner, will be marketed under the Panasonic label. It includes a built-in monitor, printer, floppy disk drive and optional Winchester drive. The controller board was customized by WD to provide 64K to 512K bytes of RAM expansion, as well as control for up to two 5 ¼” Winchester.

WD has announced plans to develop products in support of the QIC-36 basic streaming tape interface. With this existing standard, established by the Quarter Inch Compatibility (QIC) group, WD can now put a read/write formatter onto a tape controller, creating an opportunity to dramatically reduce overall system costs. “WD expects the basic QIC-36 streaming tape interface to become the de-facto industry standard, driven by increasing demand from manufacturers for low-cost tape controller sub-systems,” announced Kathy A. Braun, Marketing Director, Storage Management Products.

In recognition of outstanding performance this past year in both product quality and delivery, Hewlett Packard’s Greeley, Colorado division has honored WD as one of their top vendors. WD was among several HP/Greeley vendors honored in May. Two week lead times, weekly deliveries, ship-to-stock quality levels and a very close working relationship between WD and the Greeley division were factors cited by HP in including WD in its annual vendor recognition program. WD supplies HP with both floppy disk and Winchester disk controller chips.
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CIRCLE NO. 44 ON INQUIRY CARD
Rair extends microcomputer line with 80286-based supermicro

Keith Jones, European Editor

Rair Ltd., London, based its first multiuser computer, the SuperMicro, on Intel Corp.'s 80286 processor in an effort to grab part of the worldwide supermicrocomputer market, which Rair expects to reach $128 billion by 1988. Stretching market potential even further, Rair plans to support the UNIX System V implementation that Digital Research Inc., Pacific Grove, Calif., is readying for use with the 80286. The single-quantity price of the SuperMicro starts at $15,500. Rair's U.S. subsidiary, Rair Microcomputer Corp., Santa Clara, Calif., developed and will build the product. "We expect to ship 1,000 machines this year in the United States, Britain, West Germany and France," claims Rair managing director Mark Potts. However, Potts expects Rair to be constrained for a few months, because the 80286 now is in short supply.

Potts is also waiting for the 80286 implementation of UNIX System V, which he expects Digital Research to ship during the third quarter of this year. Available now is the SuperMicro's other operating environment, Concurrent DOS, also from Digital Research and compatible with the IBM PC's PC-DOS 1.1 operating system. But the SuperMicro does not support IBM screen graphics because Rair does not specify a particular terminal for use on the system, Potts acknowledges.

Potts denies that the SuperMicro is an attempt to leapfrog IBM Corp. to market with an 80286-based machine. Industry analysts expect IBM's anticipated multiuser computer to employ the 80286. "We chose the 80286 simply because it is the most powerful microprocessor device available. Our Santa Clara development center is very near to Intel, and our people have close relations with Intel's 80286 project engineers," Potts says. A major attraction to the 80286 is its compatibility with the 8086 processor used in Rair's personal computers.

SuperMicro is more powerful

The SuperMicro is much more powerful than Rair's other products. Rair quotes a throughput of 1 million instructions per second for the machine, a performance the company attained by coupling the 80286 with the 80287 numeric co-processor. The 80286 and 80287 reside on one board with a direct-memory-access controller. The board occupies one slot in a proprietary 16-bit-wide backplane bus that also accommodates as many as four memory boards. Each memory board houses 0.5M bytes of storage, so four-board capacity totals 2M bytes. The bus can also support as many as 16 RS232C serial communications ports and one IEEE-488 parallel interface for high-speed devices such as plotters.

A peripheral bus conforming with the small computer system interface (SCSI) standard handles all data transfers involving SCSI-compatible mass-storage devices. These include the SuperMicro's one or two integral 50M-byte, 5½-inch Winchester disk drives. The SuperMicro also contains an integral 45M-byte ¼-inch cartridge-tape streamer drive for Winchester backup.

Comprising the $15,500 SuperMicro configuration are 0.5M bytes of main memory, a 50M-byte Winchester drive, eight serial ports and Concurrent DOS. System V will be priced separately at less than $1,500, according to Potts.
Tim Palmer, European Contributor

The Reagan administration’s new export rules on U.S. manufacturers may hurt system integrators in Europe if they plan to base their systems on equipment from U.S. suppliers, especially Digital Equipment Corp. DEC made headlines recently when some of its products were caught en route to the Soviet Union.

Under the new licensing rules, DEC must obtain a certification of end use for any non-VAX computer product, including CPUs, printers, terminals and other peripherals. Purchasers of DEC equipment must inform the U.S. Commerce Department of the products’ intended destination and expected use. The restrictions on VAX products are even more stringent: DEC must obtain an individual license, which DEC spokesman Dick Berube says takes four to eight weeks, for each VAX computer or peripheral destined for West Germany, Norway or Austria.

The Commerce Department suspects the three countries of being stopover points for illegal export to Communist countries (Comecon). According to Berube, however, the new regulations have so far not affected the volume of DEC’s overseas business: “In general, we’ve continued to function. The certification takes only a week or so. The government has been handling it expeditiously.”

However, with anger growing in Europe over the U.S. Commerce Department’s requirements, it is likely that DEC will soon feel the effects of the new rules. The company faces competition from Norsk Data A/S, Norway, which makes a line of powerful 16- and 32-bit minicomputers, GEC Computers Plc., Britain, which makes the popular Series 63 32-bit UNIX minicomputer, Bull-SEMS SA, France, producer of the 16-bit Mitra commercial minicomputer and the Solar industrial minicomputer, and Information Technology Ltd., Britain, which produces the fault-tolerant 32-bit Momentum 9000 commercial and industrial minicomputers. The companies would be more than happy to take DEC’s OEM business because it would allow their customers to rest assured that the details of their applications will be safe from the prying eyes of the U.S. Commerce Department.

But if their applications are legitimate, why should users object to being recorded on Commerce Department computers? Their reasons probably stem from something that happened in the 1950s, when Britain launched the first jet-engine passenger airliner, the de Havilland Comet, which had engines built into the wings. The Comet’s arrival spurred Boeing Co. to rush into production of its own models. Hungary’s Videoton Corp., which since 1978 has been building the Mitra 525 minicomputer under license from France’s Bull-SEMS, offers a VAX version that includes the DEC PDP-11 instruction set. The Mitra 525 uses Motorola Inc.’s advanced emitter-coupled-logic 4-bit slice 10800 chip, which is also the basis of the large Sperry Corp. 1100/60 and 1100/70 mainframes.

There is nothing preventing Videoton from diverting some of the French-built chips to the highly skilled computer designers in Eastern Europe.

The upshot? Any U.S. computer builder planning to offer a product in Europe should vigorously lobby Congress to persuade the Reagan administration to change its policies. There is nothing to lose, except international trade.
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Hitachi, NEC lead the way in 32-bit Japanese microprocessors

Tim Palmer
Contributing Correspondent

Having mastered high-volume, low-cost production of memory chips, Japanese semiconductor manufacturers most likely would not be content simply to second-source or reverse-engineer upcoming generation of 32-bit microprocessors. The obvious next technology for "Japan Inc." to pioneer is the upcoming generation of 32-bit microprocessors. NEC Corp. and Hitachi Ltd. have revealed plans to develop 32-bit microprocessors.

NEC was almost forced to develop an original device. The company settled a dispute with Intel Corp. in January by agreeing to stop making copies of Intel's iAPX-86 family. As a result, NEC had to lay hasty plans to develop its own parts. First up will be a real stopgap measure—a 16-bit microprocessor called the µCOM70K, which will be offered in 16- and 8-bit bus versions. The part, which should be in production by this summer, will use 2-µm.-geometry, complementary metal-oxide semiconductor (CMOS) technology. Address size will range from 64K bytes to 1M byte. The device could house as many as 200,000 transistors. The part is based on Intel's 8086 family registers and a 32-bit address, providing a maximum program size of 4.3G bytes—the same as on National Semiconductor Corp.'s planned 32132. Like National's chip, the µCOM700K will have on-chip virtual-memory management. Clock rates will be between 15 and 20 MHz, leading NEC to claim a throughput of more than 2.6 million instructions per second (MIPS). Although architecture for the device is not yet on paper, NEC plans to have the part in production by late 1986.

NEC has plenty of experience with original 16-bit microprocessors: each member of the NEAC-100 family of IBM System 34- and System 36-class machines, built and sold in the United States as the Astra line, uses one of two 16-bit microprocessors that are not offered on the market. NEC also recently agreed to second-source Zilog Inc.'s 32-bit processor. Hitachi's plans for a 32-bit chip are less original but no less challenging than NEC's. Scheduled for introduction in 1986, Hitachi's planned chip part is of interest to anyone designing in the MC68020 family of IBM. Hitachi's offering, the HD63020, is based on the MC68020. The HD63020 is basically an MC68020 implemented in CMOS. For the part, Hitachi borrowed ideas from other chip makers but added a few original ones. The result is a chip designed to offer twice the performance of and more functionality than the MC68020 while retaining software compatibility with the Motorola part.

Although Hitachi used CMOS
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when possible to limit power dissipation—the target is 1W for a 1-MIPS part—the company used N-channel MOS (NMOS) for features that require high performance. The most striking feature of the 300,000-transistor HD63020 will be the 256K-bit on-chip ROM. The CPU will also feature an on-chip cache memory to speed execution. The Hitachi part has a separate address unit with its own 32-bit registers. The microprocessor will have a 40-MHz clock and an extended instruction set to the basic design of the MC68020. Hitachi uses 1.3-µm. geometry in the 100-pin microprocessor.

Hitachi also plans to introduce several members of its HD63000, a CMOS version of the MC68000 family. All HD63000 family members incorporate 12-MHz clocks. Due this month is the HD63000. The 8-bit bus HD63008 should follow in the second quarter, and the virtual-memory HD63010 should follow in the fourth quarter. The 32-bit HD63020, rated in performance at just under 0.5 MIPS, is set for mid-1985 introduction. Motorola has no plans to second-source the Hitachi super-chip, but there is little doubt that U.S. UNIX system builders will want it so that they can remain competitive with Japanese manufacturers. One Japanese competitor, Sord Computer Corp., plans to use the part in its new UNIX machines.

Microsoft, others plan expert systems

Keith Jones, European Editor

Microsoft Corp., Kirkland, Wash., is expected to offer expert-system-construction software within the next two years. The offerings are likely to be based on Expert-Ease, a package that can generate decision-making rules from information entered in a form similar to a spreadsheet. Microsoft's products acquisitions manager, Alan Boyd, says his company will collaborate on the software with Export Software International Ltd., Edinburgh, Scotland, which markets Expert-Ease in Europe.

Emerging from another European company, Nixdorf Computer A.G., Paderborn, West Germany, are expert-system "shells" that require a UNIX host with at least 1M byte of main memory. Users can easily tailor the shells for specific applications through simple if-then instructions, according to Nixdorf's expert-system specialists.

A typical host for Expert-Ease, which runs under the UCSD p-System, is IBM Corp.'s hard disk-based microcomputer, the PC XT, with 128K bytes of RAM. Microsoft's Boyd reveals that Expert-Ease is being rewritten in C to achieve portability and a significant improvement in speed. "The existing version demonstrates that expert-systems technology can be used on a microcomputer, but [the current version] is too slow at the moment."

Export Software managing director Sandy Blackie reveals that a UNIX implementation of Expert-Ease will follow the C version and that the product could also be ported to Microsoft's XENIX. Long-term plans include a version that will make "decisions" in the form of approximations rather than precise answers.

Expert-Ease originated in the Department of Machine Intelligence at Edinburgh University in Scotland, one of the world's foremost centers of artificial-intelligence (AI) research. The British government-backed Scottish Development Agency, a shareholder in Export Software, now owns Expert-Ease. It is available in the United States.

Europeans ready Prolog, LISP implementations

While some European companies are developing easy-to-use expert systems, others are offering implementations of the two languages considered best-suited to constructing expert systems from the ground up: Prolog and LISP.

Originally confined to 8-bit machines, Micro Prolog from Logic Programming Associates (LPA) Ltd., London (MMS, September 1982, Page 103), is now available on 16-bit computers, including the IBM PC under PC-DOS and on machines that host CP/M-86. LPA joint managing director Frank McCabe notes that the company will this month launch a UNIX implementation written in C. Prolog Systems, Milford, Conn., offers Micro Prolog in the United States. The IBM PC version is priced at $295.

Metacomco Ltd., Bristol, England, is committed to making its product, Cambridge LISP, available under 32-bit operating systems including UNIX, says managing director Derek Budge. The company will probably select UNIX System V for its implementation. Budge identifies compactness as his product's biggest advantage over other LISP implementations. He says 400K bytes of main memory is sufficient to run the product. Metacomco maintains a subsidiary in Monterey, Calif., which sells Cambridge LISP running in its current environment, the multitasking, single-user TRIP0S operating system. Hosts for this implementation include the Sage IV system from Sage Computer Corp., Reno, Nev.
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from Perrone Associates Inc., San Francisco.

An expert in any field can construct Expert-Ease without assistance from an engineer—one of the biggest attractions of the product, says Microsoft's Boyd. Expert-Ease is "taught by example." A user can enter as many as 255 examples in spreadsheet-like rows, and each example can have as many as 31 attributes—either an integer or a logical entity—plus a result. From the examples, Expert-Ease generates a decision tree, which eliminates unnecessary attributes to reach a conclusion.

Microsoft's arch rival, Digital Research Inc., Pacific Grove, Calif., is also readying expert-system products, according to director of marketing Dr. Fred Cutler. The company is mainly targeting the home consumer market with products aimed at applications such as family medicine. Cutler says Digital Research's commitment to high-capacity video disk storage will provide home users with the large amounts of storage expert systems require.

Nixdorf has yet to decide whether to offer its expert-system shells only to users of its own hardware or to all UNIX users, says Bernhard Mescheder, a member of the AI team at the company's headquarters. The shells are written in Ifprolog, a UNIX implementation of the Prolog AI language from Interface GmbH, Munich, West Germany. Mescheder explains that Nixdorf will aim the shells at broad application areas such as planning and fault diagnosis. Each shell will include the Ifprolog language, and the shell's other features will be written in Ifprolog. Two key shell components are a generalized rule-generating inference mechanism and a relational database for storing attributes.

Mescheder suggests that an expert who is constructing an expert system to configure a computer system, for example, would enter the statement: "IF country of installation is West Germany THEN power is 220V." The statement is translated into Ifprolog rules and stored alongside the inference mechanism. The attributes are then copied into the mechanism's variables, thus tailoring the mechanism to the application. The expert must also load the attributes into the relational database in tabular form. When a non-expert uses the completed system as an aid, a dialogue interface incorporated into the shell asks questions and interprets answers.

Mescheder reveals that Nixdorf is interested in developing systems similar in concept to Expert-Ease. The Nixdorf systems would accept examples rather than rules. The first host for Nixdorf's shells is a machine designed by Auragen Systems Corp., Fort Lee, N.J., which Nixdorf builds and sells as the 8832.

Mescheder says his company selected Prolog rather than LISP for its expert-system shells for several reasons. They include Prolog's backtracking feature, which enables a program to try alternative strategies, and its unification facility, which lets non-numeric attributes be copied into variables by pattern matching. Another big attraction of Prolog for Nixdorf is that it is widely used in European universities.
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Hardware differences can make or break the 50 IBM PC-compatible manufacturers

Degree of PC-DOS imitation is a key strategy play

Lori Valigra, Senior Editor

Imitating a popular item, whether it be the Mona Lisa or IBM Corp.'s popular PC microcomputer, assures a certain sales success. But imitations can become a liability. Microcomputers that too closely approximate IBM's original may invite a lawsuit, as three manufacturers have discovered. However, equipment differences that don't allow even one popular program to run without alteration could break a product or a company.

As many as 50 companies are capitalizing on IBM's product success and subsequent inability to meet demand. Rod Canion, president of competitor Compaq Computer Corp., which sells an IBM-compatible portable computer, says IBM products lead in retail store sales and are purchased most by large corporate accounts, thus making IBM the "standard" to imitate.

But PC-compatible manufacturers are damned if they mimic and damned if they don't. If they don't, they almost assure themselves a limited market because of the IBM PC's success. If they do follow IBM's lead, they must adopt the PC's good features along with its limitations. For example, some of the most popular graphics programs bypass IBM's operating system and directly address IBM hardware to speed execution, so those companies wishing to have their hardware run these programs must mimic IBM's architecture. Additionally, compatible microcomputers fall prey to price pressures from other makers of compatibles and from IBM, always able to cut prices because of its economies of scale.

Among those vendors accepting IBM compatibility as their modus operandi, debate centers on which hardware and software attributes constitute compatibility. Several companies, such as Compaq, argue that compatibility means mimicking IBM's hardware and software as closely as possible, to the point of an identical keyboard layout. Other companies, such as NEC Infor-

A noticeable difference between MS-DOS and PC-DOS is the BIOS, which IBM chose to divide into hardware and firmware. MS-DOS buyers can write the BIOS all in software if desired, but many chose to implement part of it in firmware as IBM has.
mation Systems Inc., choose to imitate some features and improve others. Giving their computers MS-DOS IBM-look-alike operating systems able to run some popular IBM software packages, many such companies opted to improve execution speed or display resolution, thus sacrificing a degree of compatibility.

Market researcher Future Computing Inc., Richardson, Texas, issued a report noting the levels of compatibility of look-alike machines: the highest level, operational compatibility, enables the computers to run the most popular software for the PC. Compaq offers such a system. Functionally compatible computers cannot run PC software, but manufacturers supply their own versions of the top-selling IBM programs. Texas Instruments Inc. is one such supplier. Computers with data compatibility can read or write IBM disks but cannot transfer data between disks. Wang Laboratories Inc. supplies such a personal computer. "Incompatibility" applies to computers that can't exchange data disks with the IBM PC.

Most critical to compatibility is the basic input/output system (BIOS), the part of IBM's PC-DOS operating system that performs such functions as system checks, initializing memory and setting interrupt vectors. It writes characters to the screen, reads the keyboard, and reads from and writes to the floppy disk drive.

IBM's PC-DOS is IBM's version of MS-DOS, an operating system supplied by Microsoft Corp., Kirkland, Wash. To implement MS-DOS, purchasers must write a BIOS for their target host machine. Thus, the BIOS differs on the more than 100 licensed versions of MS-DOS. IBM chose to write part of its BIOS in firmware, which it named the ROM BIOS, and to keep another part of the BIOS in software, explains Chris Larson, MS-DOS marketing manager at Microsoft. The ROM BIOS incorporates the most hardware-dependent parts of the operating system, and forces emulators to provide an equivalent ROM BIOS, so that the operating system addresses the hardware in the same manner.

Emulators cannot copy the IBM ROM BIOS because it is protected by copyright law. IBM published—and thus copyrighted—the ROM BIOS in its technical reference manual.

IBM recently settled disputes with two top-selling

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**A case of mistaken identity: PC-DOS and MS-DOS aren't twins**

Lance Hansche
Phoenix Software Associates Ltd.

The manufacturer of a Z80-based scientific microcomputer running the CP/M operating system asked Phoenix Software Associates Ltd. to build and program an 8086 add-on board that would run the MS-DOS operating system. The goal was a machine that could run IBM PC-compatible programs even though its hardware differed dramatically from the PC's.

In seven weeks, we had five prototype printed-circuit boards and MS-DOS running in the machine. We added an 8-MHz 8086 processor and an 8087 math coprocessor, 256K bytes of RAM and a general-purpose interface bus. A version of MS-DOS 2.0 controlled all devices through the Z80.

Then disaster struck. Attracted by the portable's fast processing, the business community discovered the customer's machine, and orders began pouring in. However, before the company started shipments, it discovered that the microcomputer would not pass the ultimate test for business use: it could not run Lotus Development Corp.'s 1-2-3 integrated spreadsheet program.

Urgent calls to Lotus deepened the gloom, because we discovered it would take 10 months and a commitment of $2.5 million to get a customized version of 1-2-3.

Additionally, a quick test on the microcomputer revealed that only three of the top 10 best-selling business programs written for PC-DOS (IBM's version of MS-DOS) worked in a generic MS-DOS environment. The other seven in some way violated normal programming practice that retains PC compatibility to improve software performance or to protect the application package from piracy. The customer decided it needed PC compatibility to meet market needs, and with orders already taken, needed it fast.

Phoenix went to work, hoping the seven programs the customer wanted to run circumvented MS-DOS only by using calls equaling those in the ROM basic input/output system (BIOS) within PC-DOS documented in IBM's technical reference manual. Five of the seven programs, however, directly manipulated hardware, making it impossible to run those programs effectively on hardware that didn't mimic IBM's.

We had to emulate the full powers—and errors—of IBM's ROM BIOS, find those parts of the application programs that directly accessed hardware and emulate them in the MS-DOS BIOS we were to create. To add to the difficulty, the customer's hardware was different from IBM's. Because the customer's board was retrofitted, it accessed hardware devices only through one parallel port to the Z80. The keyboard differed greatly from IBM's, and the floppy disk drives held twice as much information as IBM's.

Emulating IBM's ROM BIOS was relatively easy, although it became clear that third-party software authors had found many ways to abuse the
compatible suppliers, Corona Data Systems and Eagle Computer Inc., as well as with Handwell Corp. (with home offices in Taiwan), alleging infringement of the BIOS. Each company has agreed not to sell the offending machines. Although none paid damages or assumed guilt, the suit caused Eagle some financial hardship, according to financial statements issued by the company during its most recent quarter. In March, Eagle stopped shipping its PC-compatible Eagle 1600 and Spirit XL personal computers containing the BIOS targeted in the lawsuit and began shipping models with a new BIOS.

Many companies probably began developing an IBM-like ROM BIOS before it became clear whether ROM could be protected under U.S. copyright law. A lawsuit settled early this year between Apple Computer Inc. and Franklin Computer Corp. questioned Franklin's right to manufacture Apple II-compatible systems using ROMs containing Apple operating systems. The case was settled out of court, but the judge was expected to rule that the ROM was protected (MMS, March, Page 79). The uncertain outcome of the Franklin/Apple case apparently kept manufacturers from changing their ROM BIOS and may also have kept IBM from suing more of them earlier.

Application developers will notice no differences between PC-DOS and MS-DOS unless they develop applications circumventing DOS and addressing hardware directly, claims Larson. He says some minor differences exist, such as how a user signs on to a host microcomputer, but they do not affect the application interface. Microsoft modified MS-DOS for IBM, including such “tidbits,” as Larson calls them, as extra code in the debugger to determine whether the display shows 80 or 40 columns, a hardware-dependent function. Thus far, says Larson, IBM has been receptive about adopt-

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"In a PC environment, graphics programs usually call the hardware or BIOS directly," says Jorge Noa, a founder of business graphics software developer Brag Systems.
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When you were a kid, did you ever try to win the Soap Box Derby? Except for the regulation wheels, there weren’t any “engineering” restrictions. You evaluated existing technologies—rope vs. rubber clothesline steering mechanisms, for example—and then built a machine you knew would take first place.

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ing any updates or changes to MS-DOS issued by Microsoft, which keeps the products on a parallel course.

Neil Colvin, president of Phoenix Software Associates Ltd., a Norwood, Mass., software house that has worked on many MS-DOS ports, notes some important differences between PC-DOS versions 1.1 and 2.0 or 2.1. All 1.1 system calls are included in 2.0 and 2.1 versions; he explains, but the software interface changed dramatically. And 2.0 and 2.1 include advanced functions similar to some available under the sophisticated UNIX operating system. Other differences in the versions include recognition of bit values.

An update notice released by Microsoft for its corresponding 2.11 version notes that to support international character sets, MS-DOS must recognize all 256 possible byte values. This means all 8 bits of a character in the MS-DOS file become important. In previous releases, MS-DOS ignored bit 7, the highest bit. Some software vendors used this unclaimed high bit, as did Ashton Tate on its popular dBASE II database manager package. To avoid problems when running under version 2.1, Ashton Tate provides a 2-byte patch to correct any problems resulting from how bit 7 is used, the Microsoft update notes.

Many application software developers write code that "talks" directly to the BIOS or to the microcomputer's hardware because the DOS is slow, explains Col-

David Wittler, Samna Corp.

Samna Corp. made a fundamental decision at the outset of designing its Samna Word word-processing program. Rather than building a "portable" word processor able to run under the DOS operating system on any PC or PC-compatible microcomputer without modification, we optimized Samna Word to take full advantage of each target machine's keyboard layout, display attributes and other key features. Modifying the program for each different implementation of MS-DOS took about a day. Modifying the program for other differences in the machines took considerably longer in some cases.

So far, versions of Samna Word II and Word III run on computers from seven companies: a PC-DOS version for IBM Corp. and MS-DOS versions for Compaq Computer Corp., Columbia Data Products Inc., Corona Data Systems, Colby Computer, Digital Equipment Corp., for the Rainbow 100 and 100+ and Texas Instruments Inc. (for the Professional).

Hardware vendors modify MS-DOS according to their product design goals. Corona and Colby, for example, have attempted to improve performance beyond that of the IBM PC. Others, such as Compaq, approximate the IBM PC blow-by-blow. Some implementations of MS-DOS require that application software developers initialize bytes or control blocks, while others do not. Other differences relate to keyboard and screen-control routines and memory consumption.

In DOS 2.0, IBM and IBM-compatible vendors provide optional American National Standards Institute standard software drivers to control the screen and the keyboard. TI is expected to do the same under MS-DOS 2.1. DEC offers both ANSI drivers and VT52 terminal compatibility under MS-DOS. Without the ANSI or VT52 drivers, it is necessary to use firmware calls or write directly to video memory to display attributes or move the cursor. Our approach was to write code directly to the screen's video memory and to write proprietary keyboard interfaces, bypassing the operating system to speed performance.

Memory consumed by the operating system varies significantly among the target machines, which affects the amount of program space available. IBM requires 12.4K bytes of memory to run PC-DOS 1.1 and 24.5K bytes to run versions 2.0 and 2.1. DEC requires 32K bytes for MS-DOS 2.05. TI requires 18.7K bytes for MS-DOS 1.25 and 35.8K bytes for MS-DOS 2.11. Samna Word III runs under PC-DOS and MS-DOS version 2.0 and higher versions and requires 320K bytes of memory on DEC and TI computers. The earlier Samna Word II package requires 256K bytes on those machines.

We encourage hardware vendors to provide software developers with as much information as possible on modifications to DOS. With that information, software developers can accommodate not just system software modifications but also hardware attributes that benefit users. This makes both hardware and software easier to sell.
There are at least two new and relatively painless ways to check if a BIOS is compatible: purchasing the BIOS or using a test package.

Graphics software suppliers generally admit they are among the worst DOS abusers. "In a PC environment, graphics programs usually call the hardware or BIOS directly," says Jorge Noa, a founder of business graphics software developer Brag Systems Inc., San Mateo, Calif. He explains that the PC's 8088 processor controls the placement of dots on the display. A primary Brag application is charting, so the company manipulates the graphics hardware through the BIOS or writes three special subroutines in the PC's hardware video memory to speed horizontal and vertical line drawing, for example. Phoenix's Colvin says using the video memory is the fastest way to bring characters to the screen. Noa agrees, noting that Brag's graphics program would require 20 times the instructions and run 20 times slower if the software used only the software BIOS.

Brag's goal is to make its programs independent of both operating systems and hardware, "but we do violate this [goal] in MS-DOS and PC-DOS," Noa admits. "One example of where we suffered a lot is realizing that, because the hardware [on different microcomputers] is different, communications calls can be different." He says that, depending on the CPU used, the system may not be able to perform all BIOS functions, such as letting a user know whether a modem is connected to the system. But, "if standard MS-DOS calls are used, functionality and portability [of applications] should be guaranteed," he says.

Richard D. Rebo, vice president of R&D at database software supplier Fox Research Inc., Dayton, Ohio, underscores communications call distinctions. He explains that some look-alike machine suppliers remapped the DOS software vectors so that they are no longer in the same place as on the PC. This may mean the call to the printer, for example, may be in a different place on different machines.

Assuring the BIOS works

There are at least two new and relatively painless ways to check BIOS compatibility—to purchase the BIOS or to use a test package. Phoenix was scheduled to release an off-the-shelf, PC-compatible ROM BIOS in late April that would sell for $90,000. Purchasers would have unlimited use of the ROM. A package with the ROM BIOS, GW BASIC (configured to look like IBM's BASICA), MS-DOS 2.11 and Phoenix's PC-DOS utilities sells for $290,000. Phoenix currently offers a $90,000 off-the-shelf software BIOS.

Another option is the PC Test package from Award Software Inc., Los Gatos, Calif., which tests a BIOS for PC compatibility. It has two sections: one tests software interrupts exercising low-level drivers, such as reading a sector from a disk or placing a character on the screen. The second checks that all semiconductors are in place and that memory is used in the same way as IBM uses it, explains PC Test developer Robert Stillman, executive vice president of Award. A companion package, DOS Test, checks for PC-DOS compatibility and prints the results. For example, it probes whether the disk drives format disks in the same way as IBM's drives do. Users get printouts of the results. The programs are priced at $6,000 each; purchased together, the price is $10,000. Award has thus far sold six packages to customers including Mitsubishi Electronics Ltd. and Fujitsu Ltd. Stillman says the programs are for software developers and sophisticated OEMs implementing IBM PC look-alikes.

Microsoft's Larson offers a last word of advice to system integrators desiring PC compatibility, especially in developing the BIOS: "Do it honestly and legitimately."
Several years ago, Digital's engineers set out to revolutionize computer performance by extending virtual address space to unprecedented proportions.

They succeeded with VAX™ architecture. A design strategy so successful, it completely revised what the world expected from 32-bit computers.

Those same engineers have been at it again. This time, compacting VAX architecture into the MicroVAX I™ system.

A micro by every measure, the MicroVAX I system nevertheless delivers all the versatility and speed you've come to expect from its larger namesakes. It guarantees both hardware and software compatibility with other VAX computer family members. It lays claim to the same treasure chest of development tools, utilities and languages. It provides access to the same impressive library of proven applications.

With the MicroVAX I system, the industry's premier 32-bit architecture has been miniaturized by VLSI technology. Along the way, Digital's engineers dramatically reduced something else: the cost.

Entry into the celebrated VAX computing family is now possible for as little as $10,000.

**THE UNCOMMON BENEFITS OF VAX ENGINEERING HERITAGE.**

A genuine VAX computer, the MicroVAX I system has been, in a sense, already proven at tens of thousands of VAX installations.

Its high bit-efficiency, for example, is achieved in true VAX architectural fashion—by accommodating data types ranging from one to 128 bits, and 21 distinct addressing modes. You can select precisely what your programs call for.

The system boasts over four gigabytes of address space, made possible by full virtual memory management.

The MicroVAX I system also inherits the elegant VAX instruction set. Some three hundred separate instructions. This gives developers exquisite control over the micro, and in turn, gives the system extraordinary applications flexibility.

Bit efficiency for speed, elegant instructions for flexibility, and consequent growth potential are the heart of VAX architectural excellence. They system sophistication means compact compilers and operating systems. Its means applications that execute with speed.

The MicroVAX I computer enters the marketplace prepared both to live up to the legendary status of its predecessors, and to make a name for itself.

**HARDWARE ENGINEERED TO GIVE YOU BIG SYSTEM PERFORMANCE.**

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The MicroVAX I system delivers over 35% of the raw power of Digital's VAX-11/780 computer. Enough to satisfy your most demanding supermicro applications. Enough to comfortably support up to five users.

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To enhance the already impressive execution speed, Digital's engineers even put in...
an eight-thousand byte direct-mapped cache memory

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While ordinary micros give you just one, often thinly supported operating environment, the MicroVAX I system gives you a choice.

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For incomparable economy, the MicroVMS operating system has been packaged by function into modules. You buy just the modules you need for your environment, then tailor the system to your application. The basic system module contains all the capabilities necessary to run applications. You can then add a program development module, a choice of networking modules, programming languages, and other optional products simply and easily. Because you never buy what you don't need, up-front investment is minimized and system overhead is reduced.

For realtime control, distributed computing and network-based multiprocessing, there is the VAXELN™ realtime programming toolkit. It gives you access to all the productivity tools of VMS. Applications developed on VMS with VAXELN software can be transported to other VAX or MicroVAX I target systems for execution. The applications do not need an underlying operating system.

The MicroVAX I system will excel in a variety of applications settings. It is a team computer in business. A network node in process control. A technical workstation. It is a compact, high-powered computer that can be taken on location for seismic, marine and field engineering applications.

**DIGITAL'S Q-BUS ENHANCED FOR HIGH PERFORMANCE I/O.**

Inexpensive and high performing, the Q-bus™ data path has become a leader in the micro world and the choice of Digital's engineers for the MicroVAX I microcomputer. The Q-bus data path now performs block mode data transfer, substantially improving its efficiency. The bus delivers transfer rates of over three million bytes per second.

There are hundreds of devices and interfaces available for it. You may already have an investment in Digital's Q-bus structure. If so, a MicroVAX I system affords an easy and economical upgrade path to 32-bit power. For design startups, it gives you ready access to a complete range of supplementary products.

**NETWORKING: YOUR WIDE-RANGING PRESENT, YOUR FAR-REACHING FUTURE.**

The MicroVAX I system is a full-fledged member of one of the broadest ranges of compatible hardware ever sold. With it, you may employ a single, consistent computing strategy from micros to huge clustered systems.

(Continued overleaf)
You can progress along this computing path with ease, transporting programs and data among systems as your needs dictate.

As your micro applications grow, for example, it is easy and cost-effective to transport programs and files from the MicroVAX I computer to larger systems. Conversely, a MicroVAX I system becomes an ideal target for programs developed on a bigger CPU. The MicroVAX I computer can communicate with all of Digital's other computing systems via DECnet™ software. As part of a DECnet network, MicroVAX I systems can also be linked with highly efficient gateways leading to IBM's SNA® networks and X.25 public packet switching networks.

Within smaller geographic areas, the MicroVAX I system connects to Ethernet (supported by DECnet software) by simply clamping onto the cable. In doing so, it becomes the first ready-to-implement microcomputer for building high-speed data communications and powerful processing into local area networks. Both MicroVMS and VAXELN software support the Ethernet connection.

**ENGINEERED-IN RELIABILITY: INCOMPARABLE SUPPORT.**

Like all of Digital's products, the MicroVAX I microcomputer is engineered for quality and produced to Digital's enviably high manufacturing standards. The MicroVAX I computer incorporates many built-in system diagnostics. The most powerful of these is a micro-code verify that performs a CPU self-test each time the computer is powered up. Many diagnostics run concurrently with normal processing, so if a failure does occur, it can be corrected quickly.

Every detail that helps assure reliability has been attended to. The system's 230-watt power supply, for instance, features thermal shutdown, overvoltage and overcurrent protection, a/c input transient suppression, and a minimum four millisecond powerdown time.

Overall, modular construction makes system service both rapid and inexpensive. The MicroVAX I system is backed by one of the industry's most experienced small system support organizations. Digital pioneered on-site service with guaranteed up-time contracts and a selection of field services, software support programs, and user training agreements so comprehensive they suit virtually every need.

No other 32-bit microcomputer in history has ever offered its users greater potential for success. While others promise performance, you'll be working with the industry standard 32-bit engine.

While others promise software, you'll have a choice of operating environments and programming tools. And while others promise support, you'll be dealing with a company that has over 475 support offices in 44 countries.

**BEST ENGINEERED MEANS ENGINEERED TO A PLAN.**

The MicroVAX I computer, like every Digital hardware and software product, is engineered to conform to an overall computing strategy. This means our systems are engineered to work together easily and expand economically. Digital provides you with a single, integrated computing strategy direct from desktop to data center, from chips to huge multiprocessiong clusters.

As its name suggests, the MicroVAX I microcomputer is the beginning of a complete system and component program based on Digital-developed VLSI technology. The MicroVAX I system is shipping now.

For additional product information or the name of your nearest Digital sales office or Authorized Industrial Distributor, call 1-800-DIGITAL, extension 225. Or write: Digital Equipment Corporation, Dept. MV1, 200 Baker Avenue, West Concord, Massachusetts 01742.

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**DIGITAL'S MICROVAX I TECHNICAL SUMMARY**

**SYSTEM CONFIGURATION**

Basic system for $9,995 (U.S. price, one only) includes: Two-board CPU, one-half Mbyte main memory (expandable), modular power supply, I/O port, and eight-slot Q-bus backplane. A disk-based system at $13,880 (U.S. price, one only) includes a 10 Mbyte fixed Winchester (expandable) and an 800-Kbyte floppy drive. Volume OEM discounts apply.

**HARDWARE OPTIONS**

- **Optional**
  - Memory: 256 KB, 512 KB with parity
  - Floppy Disks: 2 x 400 KB
  - Fixed Disks: 11 MB, 31 MB
  - Communications: 1, 4, 8 lines
- **System Maximum**
  - Memory: 4 MB
  - Floppy Disks: 4 x 400 KB
  - Fixed Disks: 62 MB

**SOFTWARE**

- Operating Environments: MicroVMS™, VAXELN™
- Supports Applications Written In: BASIC, COBOL, FORTRAN, PASCAL, PL/I, C, DSM, MACRO, LISP, OPS/5, DIBOL, RPG II.

**MECHANICAL SPECIFICATIONS**

- **Width**
  - Rack Mount: 48.3 cm x 13.3 cm x 64.8 cm
  - Floor Stand: 25.4 cm x 62.3 cm x 72.4 cm
- **Height**
  - Rack Mount: 19" x 5.25" x 25.5"
  - Floor Stand: 10" x 24.5" x 28.5"
- **Depth**
  - Rack Mount: 13.3 cm x 5.25" x 25.5"
  - Floor Stand: 15.2 cm x 6" x 27"

**WEIGHT** (chassis only): 22.68 kg (under 55 lbs.)

**OPERATING TEMPERATURE:** 15-32°C (59-90°F) at sea level.

**OPERATING HUMIDITY:** 20-80% relative humidity, noncondensing.

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*Prices apply U.S. only.
Demand for enhancements, high profits add up to windfall for IBM PC add-on suppliers

The PC after-market spawned fast-growth companies, but following in Big Blue's wake is risky

Geoff Lewis, Contributing Correspondent

Through a kind of computer Darwinism, the slots left empty within IBM Corp.'s Personal Computer have been filled with scores of products and connections that adapt the basic IBM PC to new environments ranging from laboratory instrumentation to music synthesis. Along the way, a $1 billion-plus business has mushroomed around the PC and other microcomputers that can accept IBM add-on devices.

But—as in the mainframe add-on market—IBM can turn into a predator at any time, making it possible for only the fittest and most nimble to survive. As Andrew Seybold, a Torrance, Calif., consultant and analyst puts it, "The business is sustainable to an extent, but [add-on vendors] must realize that they are riding IBM's coattails. The smart money in the add-on business knows this is a windfall and are plowing their profits into other businesses that will give them long-term growth."

Nevertheless, the immediate future is profitable indeed for established add-on suppliers, according to estimates compiled by market researcher InfoCorp, Cupertino, Calif. This year, worldwide IBM PC and PC-compatible after-market sales will amount to $3.4 billion, including $920 million in software and $615 million in printers, InfoCorp reckons. Sales of add-in memory boards, "multifunction" boards, magnetic-storage subsystems and other add-ons will total $1.4 billion, InfoCorp analyst Ralph Gilman estimates. By
1988, the whole pie will expand to $113.4 billion, dominated by software and mass-storage subsystems, he predicts.

The add-on business is driven by more than omissions in IBM's product line, analysts point out. To a large degree, the higher profits retailers reap on aftermarket hardware fuels the industry. Computer system manufacturers typically give retailers a 30 percent discount, but the discount is based on list prices. Falling prices for IBM-compatible products have meant that dealers can seldom charge their customers full list price, causing retailers' profit margins for systems to shrink.

The higher profits retailers reap on after-market hardware fuels the industry.

In contrast, retailers can sell add-ons with profit margins as high as 50 percent. "The margins on machines are getting slimmer, so it is on software and add-ons that retailers will make their money," says Kenneth Orton of Future Computing Inc., a Dallas market research concern. He estimates that the U.S. office-computer market will generate $1.4 billion in retail revenues in 1984.

"The first-time buyer typically goes back where he bought the system and buys more memory and additional software within the first year," Orton points out. "As the installed base grows, these sales will become more and more significant to retailers." Future Computing's William Ablondi estimates that the U.S. hardware after-market for IBM PC-class systems, sold through retail stores and other channels, will grow from nearly $1.8 billion this year to $7.5 billion in 1989. Sales of add-ons will represent an increasing percentage of overall hardware sales, rising from 17 percent to 24 percent over the same period.

Success rests on picking the winning machines

Despite optimistic forecasts, surviving as a supplier to the after-market is far from assured, says Dr. Martin Alpert, founder of Tecmar Inc., Cleveland, a leading supplier of boards and subsystems for IBM PCs and PC-compatibles. Success in the expanding add-on business will depend on targeting machines other than the IBM PC to support. Alpert predicts that within a few years the PC market will undergo a shakeout, eliminating all but a handful of vendors that can sell enough systems to attract add-on business. "We think there will be three major players in the market, and we will build products for them and for another two. If we choose the three correctly, we can be a $400 million to $500 million company in five years," Alpert says. He points out that microcomputer makers are starting to encourage add-ons; some manufacturers have approached Tecmar to line up add-on products before they publicly introduce new systems. To succeed in retail stores, manufacturers need hardware accessories, as well as an array of software, Alpert contends.

Apparently, Tecmar has identified Apple Computer Inc. as a survivor because Tecmar is preparing add-on products for Apple's Macintosh microcomputer. Alpert expects Apple products to account for almost 30 percent of an estimated total of $100 million in revenues for calendar year 1984. Sales of accessories for IBM and IBM-compatible systems should account for 50 percent, with the remaining 20 percent coming from a growing
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DPG-213MY

CIRCLE NO. 53 ON INQUIRY CARD
The Interpreter

The market for add-on products will grow faster than the overall market for personal computers used in business, many observers predict. Not only do most first-time buyers add to their systems within a year, but owners of older machines continue to want enhancements.

contract engineering/manufacturing operation, Alpert predicts. Although he won't discuss previous years' sales, competitors estimate them at less than $10 million for the fiscal year ending June 1983.

Founded by physician Alpert to develop computerized medical equipment, 10-year-old Tecmar skyrocketed to the top of the add-on market after management latched onto the IBM PC. Only months after IBM introduced the system in 1981, Tecmar engineers tore down a retail model and began assembling add-in boards for it. From that early start, Tecmar continued its aggressive product-development schedule, producing more than 60 boards and subsystems for the PC and PC-compatible systems, including an array of technical interfaces and controllers. Although Alpert estimates that such products give the company an 85 percent share of the scientific and industrial market for add-ons, he stresses that Tecmar derives most of its revenues from high-volume products such as the now-standard multifunction board.

Putting added memory, a real-time clock and a communications interface onto a single board—when it would require separate IBM boards to offer similar capabilities—has made the multifunction card a business unto itself. No fewer than 25 suppliers have entered the market, generating annual revenues of $100 million to $200 million.

**Success in the expanding add-on business will depend on targeting machines other than the IBM PC to support.**

**Competition drives prices down**

Competition in the multifunction-board business escalated last year after Tecmar arch-rival Quadram Corp., an Atlanta subsidiary of Intelligent Systems Inc. (ISI), slashed prices by 40 percent. "The declining price has made us take a look at margins," Alpert observes, increasing Tecmar's commitment to automation. The company has invested more than $100 million over the past few years in automatic inserters, robots and automated test equipment to cut costs in its Cleveland-area factories. Despite eroding profit margins, Tecmar recently upped the ante in the multifunction-card business by throwing in what Alpert says is $1,000 worth of "free" utility software with each board.

Quadram is probably Tecmar's closest rival in providing a broad range of after-market products. Quadram founder and ISI president Leland Strange anticipates that Quadram will contribute some $50 million to ISI's anticipated $90 million in revenues this year and an even larger chunk to the $150 million the company hopes to earn next year. Quadram was one of the first manufacturers to rush to market with a multifunction card, the Quad board, which has been the company's staple product ever since. Strange says that Quadram concentrates its efforts on supplying high-volume products that computer retailers will carry in stock, rather than arcane gadgetry that only the most sophisticated technical users require. "Tecmar will carry an analog-to-digital converter, but the retailer doesn't want to stock it," he claims.

In contrast to Tecmar, Quadram has plowed fewer resources into product development—licensing or purchasing a growing percentage of designs from other suppliers—and more into marketing. Whereas Alpert boasts of Tecmar's cost savings derived from in-house production of manuals and sales-support materials, Strange talks up Quadram's expensive national television advertising campaign and heavy investment in slick graphics and packaging he hopes will appeal to retail customers.

"We pick up small markets and make them big," Strange says of the after-market. He explains that products such as the multifunction board do not offer enough incentive for IBM and its look-alike competitors to pursue. Production of the Quad board has grown to 15,000 units a month, about half Quadram's monthly volume. The other high-volume products Quadram manufactures or distributes include monitors, printer
When was the last time

If it hasn't been recently, you've probably missed a lot of news. Like the multi-million dollar contracts we recently signed with major OEMs. Or our new small personal computer printers.

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tenance, and reduced failure rates result in the lowest line printer cost of ownership in the industry.

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Today, four of the five largest computer manufacturers* offer Centronics printers with their systems. Not just because we deliver a full line of products or help them customize interfaces. Not even because we've reduced ownership costs by designing multiple products based on common parts. Rather it's because we insist on working as a partner with our OEMs. Listening to their feedback. Incorporating their ideas into products you can count on. Dramatically increasing our commitment to research and development. To assure the quality and reliability you need today and the features and innovations your customers will demand tomorrow.

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Our color graphics will make all your pie charts beautiful.

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When was the last time you looked at us.

---


MINI-MICRO SYSTEMS / July 1984  CIRCLE NO. 54 ON INQUIRY CARD
buffers and disk drives. Like Tecmar, Quadram is counting on increasing volumes of Apple products, but Strange is banking on the anticipated IIc, not the Macintosh, to be Apple's big seller.

Strange, who characterizes his business as the "enhancement market," says he no longer fears that IBM or other manufacturers will redesign their computers and put him out of business. "Three years ago, when it was just Apple, you could make the argument that it would undo the business with its own boards or a redesign. But the business has changed. You really can't change everything on the motherboard when you've got 2 million units in the field," he argues. "Besides," he adds, "There is just a ton of things still to do [with the PC]."

A third major supplier of add-ons for the IBM PC, AST Research, Irvine, Calif., has concentrated on the multifunction board, communications and graphics, thus far staying out of the disk business. AST is hoping to quadruple its revenues to $50 million this year.

AST develops many of its products to fill requirements of popular software, says vice president of sales Thomas Stickel. For example, to support Lotus Development Corp.'s 1-2-3 integrated software package and other sophisticated spreadsheet products, AST manufactures a multifunction board that delivers 640K bytes of memory. The company makes an add-on RAM package that emulates a floppy disk to speed up operations of large programs such as the popular WordStar word-processing package. Stickel adds that graphics software packages will similarly generate demand for graphics hardware.

Although AST derives most of its revenues from multifunction cards, Stickel predicts that communications products will take on increasing importance as the number of desktop computers used in major corporations continues to grow. He claims that IBM has failed to provide cost-effective methods for tying PCs into mainframe networks or local-area networks. IBM's failure has created opportunities for technically adept add-on suppliers, he reasons.

AST manufactures boards that enable PCs to emulate IBM 3270 devices that are able to function in IBM's System Network Architecture, its overall communic-
Zetaco's newest Slot-Saver T.M. uses a touch of genius to control both disk and tape.

The ZDF-1 dual function board has dedicated microprocessors to control disk and tape drives for DG's Nova/Eclipse series. Now there is a dual function controller you can trust. Zetaco's ZDF-1 combines two well-proven products and more: our Model 295 Disk Controller and our Model 133 Magnetic Tape Coupler. Two complete controllers on a single board, with full emulation of DG's 60XX and 61XX series disk subsystems and 6021 and 6125 tape systems, enhanced to provide higher transfer rates and maximum use of your storage capacity.

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Zetaco designed the ZDF-1 as a controller to grow with. As technology advances to higher transfer rates, beyond 600 MB Wincheeters, beyond 150 ips GCR tape drives, you'll find the genius of ZDF-1 is ready. Now, and in the future.

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ZETACO G.

Controller Division, Custom Systems Inc.

MINI-MICRO SYSTEMS/July 1984

CIRCLE NO. 55 ON INQUIRY CARD
The Interpreter

sections scheme. Other AST boards allow PCs to emulate bisynchronous terminals and controllers that can work in mainframe applications. In addition, the company markets products that tie the PC to IBM's System/38 minicomputer.

Because AST's 3270 board offers more function than a similar IBM device gives, it is a popular item. It allows a PC user to download files from a host system and perform local data manipulation and printing. In contrast, the IBM version allows a PC to operate only as an interactive terminal with the host system, prompting some observers to conclude that IBM limited its function to protect terminal sales. Stickel reports that AST's product has done so well that IBM major-account salespeople occasionally recommend it.

Looking beyond IBM

Like Tecmar's Alpert, Stickel hopes to broaden the add-on business beyond dependence on IBM and its clones: "We look at ourselves as being in the add-on business for a number of target machines that are likely to include Texas Instruments Inc., Apple and Digital Equipment Corp. models." In addition, AST has developed an OEM business that accounts for nearly 13 percent of sales. It targets those manufacturers of IBM-compatible systems and IBM value-added distributors that provide specialized software and hardware.

After building a successful PC add-on business almost by accident, Tallgrass Technologies, Overland Park, Kan., is expecting to return its attention to the OEM market. Tallgrass once planned to supply makers of Winchester disk subsystems with a combined disk/tape controller that would drastically reduce the cost of incorporating disk and tape in low-end products. But Tallgrass's approach was so radical, according to president David M. Allen, that OEMs "wouldn't touch us with a 10-foot pole."

Undaunted, Allen put together a disk and tape subsystem for the IBM PC in late 1981, when Davong Systems Inc. and Corvus Systems Inc. made the only products in the hard disk PC mass-storage market. In the past three years, 40 more disk subsystem manufacturers have entered the add-on market, building the worldwide disk/tape after-market to $685 million in sales this year, according to InfoCorp estimates. Tallgrass has maintained a unique market position by virtue of its proprietary controller—undergoing custom large-scale-integration shrinkage at American Microsystems Inc. and NCR Corp.—and a newer proprietary cartridge tape head, Allen claims.

Sales should reach $80 million in calendar year 1984 if they continue at their current rate, up from $21 million in 1983, allowing Tallgrass to plot a return to the OEM market. "Only about 5 percent of the IBM PC market is available to add-on mass-storage subsystem manufacturers, so selling to computer manufacturers represents a much larger market," Allen observes.

To address OEMs, Tallgrass is working on a product that will fit into desktop systems alongside a 5¼-inch, half-height Winchester disk. Allen is also working with tape-drive manufacturers such as Archive Corp. and Wangtec to promote ¼-inch cartridge tape as a standard for data interchange on Winchester disk-based personal computers. "If computer manufacturers decide to go a different way [opting for high-capacity floppy disks, for example], we still can do a great business in the after-market. Whether or not we get out of the after-market business, we'll be successful," Allen asserts.

Davong, one of Tallgrass' major competitors in the disk and tape business, generates about 30 percent of its revenue from OEM business, according to marketing director David Jorgensen. Davong, which shed a marginal add-in board business, is targeting the external mass-storage and networking requirements of clustered personal computer systems for systems houses, OEMs and very large companies. Jorgensen reports that his company expects revenues of $40 million this calendar year.

Because he has seen the market from both the OEM and subsystem sides, Jorgensen discounts the threat posed by disk drive manufacturers' entry into the subsystem market. Although Tandon Corp. and other drive makers have moved tentatively toward the add-on PC-disk market in a quest for higher profit margins, Jorgensen believes they will find it difficult to develop the dealer network and to provide the support needed in the retail market.

Geoff Lewis is a senior editor of Electronic Business magazine, in which this article originally appeared.

Interest Quotient (Circle One)
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ERGO 201 is the first user definable block mode terminal available in this low price range. While fully emulating TeleVideo 925, VT52, Lear Siegler ADM3A, and Micro-Term's ACT-5A, the ERGO 201 also performs extremely well in most ADDS and Hazeltine environments.

Standard Equipment includes:

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• "MT" video attribute control means the ERGO 201 can display 17 combinations of reverse, underline, half, blink and blank on the same screen without using a character space.

• Custom mode allows the operator to define the terminal's control codes and escape sequences and save designations in non-volatile memory.

All these features, plus a built-in tilt mechanism, 7 x 9 character matrix, green, non-glare screen. Check the comparison chart at left and you will agree that ERGO 201 is the performance leader.

**128 Characters Standard; 256-Optional

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>ERGO 201</th>
<th>Visual 50</th>
<th>ADDS Viewpoint</th>
<th>Hazeltine Exprit II</th>
<th>Televideo 925</th>
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- Megatek
- Chromatics
- Hewlett Packard
- Raster Technology
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So half-inch became the only choice. That also meant they could assure us of something else we demanded. Reliability. For instance, they could design-in the industry's highest quality read/write half-inch heads. Meanwhile, they could make the system stream at unbeatable speeds.

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**Side One**

One of the fruits of their labors is, you get a Winchester backup that does something no other can. It scoops 190 MBytes of data onto standard half-inch tape that's housed on our Back-Pac™ four inch self-threading reel. (Which costs less than a cartridge.) That translates into the lowest cost per byte of any tape drive, anywhere. And it streams at a blazing 90 ips standard.

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Spring loaded and ball bearing tape guides.

Simple, dependable automatic tape threading.

Single capstan motor


---

**Side Two**

For your selective file-search and backup jobs, the Double Drive acts as a start/stop unit. Because it has 64 KBytes of cache memory right in its interface. That means no time loss. An optimized I/O. And apparent real-time operation for every user.

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Now, if the Double Drive sounds like it might be just what you need, here's more good news. It will fit your system. Or rather, one of our Double Drives will. Our Series 80 fits an 8" envelope, our Series 50 a 5 1/4" envelope. They'll each hold 190 MBytes of data, stored on 24 serpentine tracks. Both are available with standard industry interfaces. So one of them is right for you.

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**Unformatted capacity (MB)** | 25.52
---|---
**Formatted capacity (MB)** | 20
---|---
**Average access time (ms)** | 65

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The DX-Series is based on the field-proven technology of standard oxide media and reliable composite heads. We’ve added a completely new voice coil positioner and some very innovative engineering in both mechanical design and electronics.

The DX-Series offers capacities of 180, 240 and 300 megabytes, with ANSI and SMD interfaces to quickly and easily integrate its high performance characteristics into your system.

Move into the high end of cost-effective data storage with the proven performance and reliability of the DX-300. Write or call for complete technical data and fast and firm delivery dates.

The DX-300, 300-megabyte Winchester disk drive from PPC.
**The Integrator**

*Applying integrated systems in industry, engineering and commerce*

**Vision systems for bin-picking robots increase manufacturing options**

*New vision capabilities help system integrators and software developers use robots to perform complex factory tasks*

Dan Edson, Contributing Correspondent

Two recently introduced microprocessor-based, programmable-vision systems signal a major advance in machine vision and factory automation by enabling robots to remove objects from jumbled, disordered piles—an action known as bin picking. Supplied by General Electric Co., Syracuse, N.Y., and Object Recognition Systems (ORS) Inc., Princeton, N.J., the machine-vision systems control the first of a new class of intelligent, flexible, parts-handling robots. Unlike other vision-equipped robots, which can identify only those objects spread on a flat surface or viewed individually, bin-picking robots can recognize parts in bins and hoppers and in jumbled piles on conveyors and carts. This ability eliminates the time-consuming, costly processes of securing parts in rigid fixtures or spreading them on a surface.

GE sells its bin-picking vision system, BinVision, as part of a robot workstation. BinVision systems are in operation in GE plants in Bromont, Quebec, and Rutland, Vt. In both installations, a GE P50 process robot picks cylindrical metal turbine-blade slugs from bins and conveyors and presents them in a predetermined orientation to an assembly robot. This task is otherwise done by a person or by positioning equipment such as a shake table, which uses vibrations to reduce piles of parts into a single layer.

"As far as we know, these bin-picking robots are the first in the world performing full-time work in a factory environment," comments John Jensen, a GE engineer who designed the BinVision software. "Both robots work two shifts—16 hours each day."

ORS sells its new i-bot 1 vision system as a component. Undergoing beta tests in six U.S. factories, the i-bot 1 guides robots into bins and parts piles. Parts include automobile crankshafts, carburetor butterfly-valve shafts, electronic components and locomotive shock absorbers. In some installations, the parts pass on to processing robots; in others, the parts are placed in machine tools. The i-bot 1 system is "nearing the end of the test phase," reports John Artley, vice chairman of ORS. "We are continuing to refine i-bot 1 in response to our field tests and expect the vision system to be in production by the third quarter of this year."

Intelligent bin-picking robots can load, unload, sort, assemble and package parts in highly integrated factories and in those with little automation. Bin-picking robots could prove cost-effective wherever...
parts are stored loosely—sometimes resulting from manufacturing techniques, such as casting, extruding, forging, molding and stamping, and sometimes resulting from lack of discipline. However, the ability to operate in an undisciplined environment has sparked a heated debate. "There are other more valuable benefits of using robot vision than bin picking," states Delbert Tesar, director of the Center for Intelligent Machines and Robotics at the University of Florida, Gainesville. Tesar contends that having loose parts around encourages an inherent lack of discipline, which stands in the way of true efficiency. Other experts say a need exists for bin-picking robots and that they will be integrated into many factories.

**Bin-picking methods have contrasting features**

Bin-picking systems apply sophisticated vision techniques to evaluate the jumbled, 3-D scene in a disordered pile or bin. Many parts are in shadow and only edges or corners of some are visible. Generally, a video camera records the scene, and the image is analyzed until the system recognizes shapes it can identify. Many techniques exist to analyze a scene, including applying threshold values to the light intensity in each pixel; calculating perimeters, areas, axis lengths and other geometric parameters; counting such features as holes and corners; and determining the distance between various features. Vision systems compare data acquired in an analysis with data stored during a learning session, when key dimensions of a part were entered. To perform the extensive mathematical manipulations fast enough to control a moving robot requires a high-speed microprocessor and substantial computer memory.

**The GE BinVision robot workstation** consists of three intelligent units controlled by a programmable controller host. In addition to the vision system, the workstation includes a robot and a gripper.
High speed and high quality in one functional, compact unit. That's what Canon's Impact Matrix Printers offer you.

They print hard copy at a rapid 160 characters per second. While in the double pass mode you get an impressive, high-density 23 X18 dot matrix that gives near letter quality printing suitable for word processing.

Canon's unique technology has also dramatically reduced bothersome clatter down to a muted noise level of less than 60dB. Even at high speed.

And that, unlike many other impact matrix printers, makes them a pleasure to work with.

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The Impact Matrix Series Printers give you a convenient choice of special paper widths—the PW-1080A for 80-character column printout and the PW-1156A for 156-character column.

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Many techniques exist to analyze a scene, including applying threshold values to the light intensity in each pixel; calculating perimeters, areas, axis lengths and other geometric parameters; counting such features as holes and corners; and determining the distance between various features.

A bin-picking robot can work in one of two ways: it can identify an object, note its orientation and then pick it up, or it can pick up an object and then identify it and determine its orientation. Each method has its strengths. In the identify-orient-pick technique, complex algorithms derive detailed information from analyzing a scene. The pick-identify-orient procedure uses simpler algorithms, which reduces processing time. But the robot may have to make an intermediate stop outside the bin to identify and orient an object. In general, robots using the identify-orient-pick method are more selective because they can detect defective parts while the parts are still in a bin. Robots using the pick-identify-orient method remove all parts, including defective parts, from a bin.

Most recent research into bin picking and development of algorithms has taken place at SRI International, Menlo Park, Calif., a non-profit research group, and at the University of Rhode Island (URI) Robotics Center, Kingston, R.I. SRI is attempting to take the identify-orient-pick philosophy to its limits, writing algorithms that will determine as much information about a scene as possible, including how removing one part affects other parts. “We would like to have better understanding of the bin and the ability to handle more complex parts with fewer operator interactions,” says Bob Bolles, an SRI computer scientist.

In contrast, URI is refining the pick-identify-orient scheme, using principles the Robotics Center calls “heuristic acquisition.” Bob Kelly, director of the center, explains: “Our algorithms ask a whole series of questions of increasing complexity, such as ‘Can we discover a way to identify a place in the image with a high probability of picking something out?’ We want to get out whatever we can; if it is defective, remove and discard it, rather than fishing around it.”

BinVision employs a method similar to that researched by SRI, though GE developed its own algorithms. BinVision evaluates a scene to locate structural features, identifies viable parts and their orientations, determines which can be retrieved fastest and sends the robot to retrieve the part. In contrast, i-bot 1, based on algorithms developed at URI, searches for part geometries that the robot gripper can handle, regardless of part orientation. The vision system targets three parts; if the robot misses the first, i-bot 1 directs it to the second and then the third, if necessary. After the robot removes a part from the bin, another vision system scans the part to determine its orientation.

Robot interfaces control a variety of tasks

Because both BinVision and i-bot 1 are programmable, system integrators can use them to customize a robot for specific manufacturing operations. For instance, they could write programs that direct the vision system to perform certain tasks, such as measuring a hole diameter, after a part is retrieved. Both systems accommodate multiple cameras, so one bin might be analyzed while another is accessed.

BinVision is part of a $150,000 integrated, intelligent robot workstation, while i-bot is a $45,000 machine vision component. The BinVision robot workstation
The new Canon Handy Terminal 5000 is the portable unit that lets you gather and process information out of the office.

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Most industry observers expect the bin-picking market to be small in comparison to overall markets for machine vision and robotics.

includes a GE P50 process robot, and BinVision is also compatible with the GE A4 and A12 process robots. The i-bot 1 works with most standard industrial robots, although all the test sites use Unimation Puma 560 robots. Both systems include a camera, vision-system software, a robot controller, a vision inspection system and an intelligent gripper.

The sophisticated, interactive grippers used with both BinVision and i-bot 1 can be either pneumatic or electronic. Each has sensor feedback. In the ORS electronic gripper, for example, an infrared-beam sensor at the tip detects an object as it comes between the jaws, and a collision sensor in the gripper body detects contact. Tactile sensors also control the programmable gripping force. ORS plans to add a sensor to detect the approach of a targeted part, which will permit the robot arm to move at high speed longer than it can now. It is currently programmed to slow at the top edge of the bin.

Robot control is an important design aspect of any bin-picking vision system. Because GE manufactures both BinVision and robots, integrating the vision system with robot controls was easier than it was for ORS. In current i-bot 1 configurations, vision-control electronics are piggybacked to robot controls. In the next generation of i-bot 1 systems, ORS will offer an integrated vision and robot control package, relieving users and robot manufacturers of designing control
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interfaces. ORS intends eventually to integrate the inspection, or out-of-bin identification, with control electronics.

Theoretically, parts suitable for bin picking can be any size, shape, color, texture and reflectivity. To date, objects used by BinVision and i-bot have been simple, firm, relatively smooth and at least moderately reflective. According to ORS' Artley, i-bot 1 has successfully directed robots to pick up felt-tipped markers, gas filters, curved plier blanks, L-shaped shafts, ball bearings and "a mixture of semi-rusted, threaded and unthreaded bolts of various lengths."

Adequate light and an object's reflectivity are important but not critical, GE's Jenson explains: "In an application with severe lighting deficiencies, infrared lighting can be used." As more developed algorithms make vision systems capable of adapting to various levels of light, "lighting will become less and less of a concern," ORS' Artley contends.

Both BinVision and i-bot 1 can store data about several parts in memory. Without reprogramming, both systems can adjust to changing product lines and can work from an array of bins of different parts—a capability essential for assembly.

In the two GE applications, for example, both the bins and the conveyor hold two sizes of metal slugs. The BinVision system receives commands from a central controller to retrieve one part or the other and present it to an assembly robot. The part order is random, depending on the assembly robot's needs.

Although neither bin-picking system uses computer-aided design (CAD) data to recognize parts, it is a logical step in highly integrated facilities. However, even though CAD data describe parts in ways understandable to computers, vision systems can't use the data without conversion. SRI is configuring algorithms that automatically enhance CAD data with comprehensive, redundant lists of features. For example, a dihedral edge would appear—in memory—on lists of dihedral edges, lists of angles and lists of the features of each plane the dihedral edge defines.

Users must still manually "train" vision systems. To do this using BinVision or i-bot 1, an operator enters simple, basic parts information as instructed by a menu. The operator then places a part in a prearranged series of poses, which the system's camera records and stores. Control parameters, such as dimensional variability, can be assigned during training. Both GE and ORS claim the process is simple and brief.

Most industry observers expect the bin-picking market to be small in comparison to overall markets for machine vision and robotics. Companies in the market early will dominate it, believes Gerry Michaels of Arthur D. Little Inc., Cambridge, Mass: "The first company with equipment that works and is accepted will have a strong position." Although GE and ORS introduced equipment first, observers don't expect those companies to hold the market exclusively. Companies with machine-vision expertise stand out as other potential participants. Robot Vision Systems Inc., Melville, N.Y., for example, has been working with Lockheed-Georgia, Marietta, Ga., on a bin-picking application, and Ford Aerospace and Communications Corp., Newport Beach, Calif., is researching shape-matching for 3-D objects. Automatix, Billerica, Mass., has produced 2-D vision systems that can handle touching, overlapped and partially occluded parts—which is not a very different process from bin picking.

Growth of the bin-picking market depends on improvements in cost, reliability and capacity of the system electronics. But as machine vision in general benefits from research and factory experience, so will bin picking, says John White, director of the Material Handling Research Center at Georgia Institute of Technology: "If the only application of vision were bin picking, it would not have a sufficient market to get the price down. But the totality of all vision-based applications will." Richard Miller, a Madison, Ga., factory-automation consultant, also contends that the high cost of bin-picking systems is a temporary constraint. However, the market for bin-picking robots faces an inherent contradiction: as factories become more automated, integrated and disciplined, the demand for robots that can handle unstructured parts may begin to decrease. And bin-picking robots may become obsolete.

Dan Edson is a Cambridge, Mass., science and technology writer.

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DIGITIZERS: Integrating a microprocessor-based video digitizing system that produces high-quality images need not be expensive. A slow-scan sampling digitizer residing on one printed-circuit board can work with the host system’s processor to produce broadcast-quality images—for a total systems cost of about $10,000. Cromemco Inc.’s SDD sampling digitizer makes this technology cost-effective for many new applications and significantly lowers the cost of integrating digitizing systems. The story begins on p. 144.

GRAPHICS SOFTWARE: The trend toward establishing libraries of prewritten device drivers is causing software writers to seek a common foundation. Under scrutiny now are the Graphical Kernal System (GKS), proposed by the ANSI committee on computer graphics (X3H3) and the North American Presentation Level Protocol Syntax (NAPLPS), also proposed by ANSI in concert with the Canadian Standard Association. Some seek standard formats, but not everyone says an established standard will be easily assimilated. For more information, see p. 163.

PLOTTERS: Already a $100 million industry with more than 30 manufacturers, the desktop plotter market is expected to top $500 million by 1988. New companies such as Enter Computer Inc., Roland DG and Strobe Inc. are challenging the large manufacturers like Hewlett-Packard Co. with less-than-$1,000 plotters, creating tough buying decisions. Application requirements and plotter type need to be considered, as well as performance parameters, software availability and cost. System integrators will find that task easier if they turn to p. 185 for associate editor Dave Simpson’s plotter survey, and then to p. 199 for a manufacturers’ product list.

GRAPHICS TERMINALS: MMS presents a comprehensive product survey, starting on p. 223. Senior editor Paul Sniger provides an overview of CAD/CAM/CAE graphics display terminals, which now offer higher speeds, upward compatibility and increased performance at lower prices. A manufacturers’ product list, beginning on p. 235, surveys the entire graphics terminal market, and a directory of manufacturers appears on p. 251.

DATA COMMUNICATIONS: Callback security systems are probably the least penetrable method of protecting a computer system’s data from unauthorized access over telephone lines. The older digital systems, however, permitted an extended exchange of dialogue that enabled unauthorized callers enough time to “play” with the system. An analog secure-access-multiport (SAM) unit produced by security equipment manufacturer LeeMAH eliminates many of these limitations. See p. 257 for details.
A world of low-cost digitizing applications opens to S-100 bus systems integrators and OEMs with the new SDD video digitizing board from Cromemco, Inc.
Sampling digitizer produces broadcast-quality messages

A low-cost video digitizing system serves varied process-control, medical- and weather-imaging and typed-text applications

Chris Rook, Cromemco Inc.

Integrating a microprocessor-based video digitizing system that produces high-quality images need not be expensive. A slow-scan sampling digitizer residing on one printed-circuit board can work with the host system's processor to produce broadcast-quality images—for a total system cost of about $10,000. Sampling digitizers, such as Cromemco Inc.'s SDD board, make digitizing technology available for applications that formerly were not cost-effective and significantly lower the cost of integrating digitizing systems.

Before taking a look at a complete digitizing system, consider how a sampling digitizer works—in this case, the SDD board. The board accepts a standard National Television Standards Committee (NTSC) composite video input from sources such as a video camera, laser disk or videotape. The NTSC signal includes luminance (intensity), chrominance (color) and synchronization information, encoded in analog form. The digitizer must synchronize with the source's signal and take enough samples of the video's luminance and chrominance levels to build a complete image.

Synchronization is one of the most critical parts of the digitizing process. Because the NTSC input is in analog form, it isn't always easy to detect the synch pulses that designate the end of each scanned line or field (half a complete scanned image). This problem is especially serious with signals from sources such as videotapes and laser disks, where synch pulses can be degraded or even eliminated. The digitizer must therefore compensate for these low-quality signals by providing an accurate internal synch capability.

As the NTSC signal flows in, the digitizer separates the synch and luminance/chrominance information. Starting on the first video scan line, it samples that line's analog signal one or more times at evenly spaced intervals. It continues this process for all succeeding lines of the video image. When all lines have been sampled, the sampling process begins again, but this time the board samples pixels just to the right of those sampled on the first pass. It continues until all the image's pixels have been sampled and digitized by the board's analog-to-digital converter (Fig. 1). Because they don't sample and digitize all of an image's pixels on the first pass, sampling digitizers require that the source image remain constant until all the pixels have been processed.

Because they require fewer components, sampling digitizers are less costly to manufacture than flash digitizers that process an image in one pass. The trade-off is that they cannot work as fast as these units. Sampling digitizers' speed depends, to a certain extent,
on the host processor system and on the nature of the image being digitized. Working with 256 gray levels and 242-by-384-pixel resolution, the SDD can digitize an image in 1.07 seconds when tied to a 16-bit 68000 host microprocessor. That time doubles with an 8-bit Z80.

The host processor has a greater effect on digitizing speed when the image has more gray levels and/or colors. For example, to produce a full palette of 4,096 colors with 16 gray levels and 484-by-768 pixel resolution, a 68000 host requires 6.4 seconds compared to the Z80's 25.6 seconds.

System integrators can compensate for a host processor's inability to keep up with the digitizing process by adjusting the number of samples per line made by the digitizer. A fast host such as the 68000 allows the SDD to take 12 samples per line. At this rate, the SDD must make 64 passes through a 768-pixel horizontal resolution image to digitize it fully.

Other SDD characteristics that can be software-controlled include video tint, chrominance, input gain, level control, DC restoration of black level, gamma correction and pixel color assignments. Because control of these features is necessary to ensure a good digitized image under varying conditions, it's important to consider them in detail.

Video tint, chrominance and input gain govern the appearance of the digitized image. The controls are similar to those available on color television receivers. Tint determines the hue of the pixels and can be shifted toward red or blue to adjust the color balance. Chrominance specifies the saturation of the colors set by the tint control; removing all chrominance produces a black-and-white image. The input-gain control adjusts contrasts.

Level control compensates for image intensity and has both an automatic and a manual setting. Automatic level control (ALC) works in much the same way as its audio equivalent in a tape recorder. It enables the a previous pass (A). By sampling the video image many times, it builds a complete scene (B).

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**Fig. 1. A sampling digitizer, such as Cromemco's SDD board, uses several passes to sample a complete video image. On each pass, it samples pixels on a video scan line to the right of those it sampled in**

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DIGITIZERS

digitizer to process a wide range of source-image light levels, regardless of lighting conditions. Thus, a bright image source or a relatively dark one emerge with approximately the same overall intensity. A manual setting overrides the ALC, so that images can be adjusted to represent more accurately the varying intensity levels within a single image or in a sequence of images.

DC restoration of black level can be turned on or off via software. This feature ensures that the darkest pixels in an image are digitized as absolute black. Because the ALC, in effect, averages pixel intensities, the restoration circuit makes sure that the darkest pixels in the range are firmly anchored in black. Without this control, the video signal could drift away from a level of true black.

Another software-controlled characteristic, gamma correction, is necessary because a CRT's electron gun does not produce an increase in image intensity exactly proportional to increases in driving voltage. The SDD's gamma circuit adjusts intensity levels to compensate for the problem so that displayed image intensity corresponds to the source image's intensity.

**Color map assigns pixel values**

The assignment of colors to individual pixel values is accomplished under software control through the board's inverse-color map. A red pixel in the original scene does not have to be red in that scene's digitized version. The inverse color map can specify a blue pixel, for instance, whenever it encounters a pixel code that means red in the original scene.

Being able to assign any given color to incoming pixel values has two advantages. It provides an image-processing capability that can enhance aspects of the image. And it permits a system integrator to match the digitizer's color output to the capabilities of the video display system. If the video interface can handle only 16 colors, for example, the digitizer assigns only 16 pixel color codes to the image.

The inverse-color map uses a hardware lookup table stored in RAM. When the SDD digitizes a video image, the resulting pixel code functions as a RAM address corresponding to a unique RAM location. The contents of these locations act as the digitizer's final output. The digitizer produces pixel values directly from the source image and uses those values to address the inverse-color map, whose contents determine the digitizer's color output. Because any color value can be loaded into the inverse-color map, sampling digitizers provide complete control over an image's color.

The color-mapping procedure could be implemented in the host's memory as a software function. However,

![Image](image-url)

**Fig. 2. An inverse-color map allows the assignment of color values, not necessarily those in the original scene, to a video image. In this simplified representation, each of the 4,096 colors (pixel values) that the SDD digitizer produces is represented by a cell (and a hexadecimal pixel value) in a 16-by-16-by-16-cell cube. Each cell represents a unique mixture of the red, green and blue (RGB) color components used by an RGB color monitor for its display. The hexadecimal pixel value OFF, for example, addresses the pure yellow cell, a visual mixture of red and green.**

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**Spec summary**

- **Product:** SDD color digitizer board
- **Manufacturer:** Cromemco Inc., 280 Bernardo Ave., Mountain View, Calif. 94039
- **Input signal:** RS170A composite National Television Standards Committee color video or RS330 black-and-white video
- **Maximum input image resolution:** Images with as much as 754-by-482-pixel resolution can be digitized using standard TV camera and SDD interfaces
- **Maximum digitizing resolution:** 8 bits per pixel
- **Operating modes:** unprocessed composite video input, red video component, green video component, blue video component, composite color conversion with inverse-color map lookup
- **Sample rate:** One, three, six or 12 samples per horizontal image line
- **Processor output-control ports:** input gain level, chroma, tint, inverse-map data, digitizer operating mode and source control, strobes/line and delay setting
- **Bus:** S-100
- **Price, delivery:** $995, delivery from stock
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digitizers that use a hardware map furnish the benefits of a high-speed color assignment under software control.

Considering the color map as a 16-by-16-by-16 cube rather than a 2-D array makes the assignment of color values easier to visualize. Each pixel value (color) that can be produced by the SDD corresponds to a cell in the cube (Fig. 2). For example, a hexadecimal pixel value of OFF would address the pure yellow cell. To obtain true color, that location must be filled with an 8-bit code that produces yellow in the final display.

With a display system that handles only 16 colors at a time, the parameters of the image can be tested by trying out different color values. The mapping used depends on the application. For digitizing flesh tones, blue pixel values can be ignored. Most general imaging applications need values set for white, black, two gray levels, six bright primary colors and six dim primary colors. Assigning white and black values is straightforward; most colors require some experimentation.

The SDD board functions in systems that adhere to the IEEE-696 (S-100 bus) standard, but the board is optimized to function with the video system components shown in Fig. 3. The host processor moves data from the digitizer to the two-port graphics memory at appropriate times. Software monitors the synch signals from the SDD to determine when the digitized data is ready. Because the sampling process generates pixels out of their correct order in the sampled image, the program counts the synch pulses to recognize where a pixel fits into the final image. The system's video interface retrieves the pixels in their proper order from memory and displays them on the monitor.

Other sampling digitizers might require a different system configuration. Some units lack an internal facility for assigning pixel color values, requiring that function to be performed in software. Other digitizers incorporate their own processor and memory to simplify the host-system interface and reduce host overhead. This increases their cost, however, and, unless they also provide a direct video interface from the digitizer's memory to display memory, the system must still transfer pixel data from the digitizer's memory to the display memory.

System integrators should give careful consideration to digitizer-video interface compatibility. The pixel aspect ratios (the relationship between vertical and horizontal resolution) of the two devices must match—or at least must be made to match by software modification. For example, if a digitizer generates a 484-by-768-pixel image, and the video interface is designed to display 242-by-384-pixel images, half of the pixels must be discarded. Because the aspect ratios match, this is a simple task, even though the actual pixel counts differ.

Difficulties arise if the video interface must cope with an image of 640-pixel horizontal resolution. A software procedure could map the digitizer's 768-pixel output onto the interface's 640-pixel display, but it would be a cumbersome, non-linear procedure. It is far easier to use a compatible video interface in the first place.

**Graphics overlay live video images**

The SDD can use the system configuration (Fig. 3) to overlay computer graphics on live video images—a capability that proves useful for a variety of special effects and applications. The process uses only the SDD board's analog circuitry; the digitizing circuits are not involved.

In producing overlays, the board converts an NTSC video source into real-time red, green, blue and synch components. A two-port RAM controlled by the video interface stores the graphics to be overlaid. Synchronized with the timing signal from the SDD, the system mixes the stored graphics pixels and the real-time video images, giving priority to the graphics.

This priority is implemented using a control line from the video interface to the SDD. The line disables the SDD's real-time output whenever the interface reads a pixel color code from graphics memory that does not begin with zero (denoting a non-background color). As a result, the graphics image appears as foreground; the real-time video image, as background. Because the SDD and other components with which it works conforms to Federal Communications Commission standards, the real-time video signal with overlays can be sent directly to broadcast equipment—an important
consideration for some applications.

A cost-effective sampling digitizer system can serve a broad range of applications, including process control, medical and weather imaging and digitizing typed text. Such applications are limited only by the required digitization speed and the software needed for processing complex images.

In process-control vision-system applications, for example, a sampling digitizer permits a computer to perform automatic quality-control inspections, such as checking tolerances and counting parts on an assembly line. The trade-offs for a sampling digitizer in a manufacturing environment involve speed vs. cost vs. image quality. If the object to be digitized cannot be held stationary for the one or more seconds required for the digitizer to work, a higher-priced, faster, flash digitizer must be used.

Consider a typical inspection operation, in which fairly simple objects on an assembly line must be inspected to ensure they conform to very tight dimensional tolerances. Inspectors could measure the critical dimensions of each object by hand, but it would be a tedious task, with inherent human error. Some manufacturers achieve excellent accuracies by sighting lasers along critical dimensions. Using lasers for this type of application incurs a significant drawback, however: in addition to the objects themselves, they measure the tolerances of whatever the object is resting on. For objects on a conveyor, any variation in the conveyor's height is thus indistinguishable from variations in the object's dimensions.

A sampling digitizer can solve this problem by detecting only an object's edges, so that only the object itself is measured. The accuracy of the measurement depends on the number of scan lines covering the object. Using 400 scan lines to cover a 1-inch bolt produces a resolution of 1/400-inch.

For checking only the shared outer edges of such objects, a large number of bits per pixel specifying gray scale or color probably isn't necessary. Usually, 1 bit per pixel will suffice. In complex environments, color might be necessary to differentiate an object from its background. Detecting tolerances in joined parts requires more bits per pixel. These applications demand greater time for digitizing and processing the results in software. System integrators should therefore carefully evaluate the cost/digitizing time/image-quality trade-offs involved.

**Image quality proves important**

In other digitizer applications, digitizing speed is less crucial than high image quality. Medical applications, including standard X-rays and computer-aided-tomography scans, which can often benefit from image processing to highlight certain features of the image, are not generally real-time activities. They do, however, call for the high resolution and the large number of bits per pixel (at least 8) that a sampling digitizer can provide.

A sampling digitizer can also prove effective for weather or topographical imaging, in which quickly changing images are not the rule. The conversion of satellite or serial-photograph images into usable form is a primary application. The SDD permits a satellite image to be overlaid with outlines of geographical features, pertinent symbols and text. The entire process can be performed and broadcast live as the satellite data is received or stored on disk for later use.

Finally, consider the conversion of typed text into a form that can be read and stored on computer. Here again, digitizing speed is not a crucial parameter. Furthermore, it's inefficient to simply store a digitized image of text without converting it to machine-readable form. Even with a good compression technique, an 8½-by-11-inch sheet of paper requires at least 20K bytes of storage, compared to about 6K bytes for storing converted text.

When considering text-digitizing applications, system integrators should also keep in mind that the NTSC video standard furnishes barely enough resolution to handle an entire 8½-by-11-inch sheet legibly. When converting an image to machine-readable form, the conversion algorithm must consider gray levels as well as solid black, which complicates the process.

Engineering paper-to-computer processing applications can also benefit from cost-effective digitization. A computer-aided-design system, for example, might convert engineering drawings done by hand to a form that could be manipulated by machine. This application requires the system to analyze vectors and convert X-Y coordinates. Because engineering drawings are usually large, the system would have to digitize a drawing a part at a time and correctly reassemble the parts.

In a more speculative and specialized application, a sampling digitizer could digitize images from a telescope and compare the results with stored images of the same section of sky. Such comparisons could detect any changes among thousands of stellar objects before a human observer could achieve the same result.

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Chris Rook is product marketing manager of Cromemco Inc., Mountain View, Calif. He holds a bachelor's degree in computer science from the University of California at San Diego and a master's in business administration from the University of Santa Clara, Santa Clara, Calif.

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Graphics software schemes enhance peripheral interfacing

Graphics standards establish a middle ground to ease peripheral-to-system integration; pre-written device drivers optimize the task

Carl Warren, Western Editor

Software vendors and system integrators no longer have to be burdened with writing device-dependent drivers every time they add a new system peripheral. The reason? Libraries of optimized-shoe-box device drivers are now available from several vendors.

The trend toward establishing libraries of pre-written device drivers is causing software writers to seek a common foundation. These writers are examining the Graphical Kernel System (GKS), proposed by the American National Standards Institute (ANSI) committee on computer graphics (X3H3), and the North American Presentation Level Protocol Syntax (NAPLPS), also proposed by ANSI in concert with the Canadian Standards Association (CSA).

Tailoring the standard

Standards may prove to be the common ground, but not everyone is willing to admit that an established standard will be easily assimilated. Most developers and system integrators contend that standards are fine as long as they are used primarily as guideposts. Most vocal on this subject is Syte Information Technology Inc. president Peter J. Shaw: "Standards are great for nuts-and-bolts and technology-poor companies. They can be a hindrance to a technology-rich company and prevent it from flexing its creative muscles. I'm not saying that standards are bad; rather, they shouldn't be restrictive. It's better to view them as a common ground for systems supported by multiple vendors."

David Wilcox, vice president of sales for Graphic Communications Inc. (GCI), Waltham, Mass., says standards "have to be tailored to match the peripheral. We don't really want to sacrifice any of the capabilities of the subordinate device, so our libraries allow for a rich command set to be implemented. But we remain true to the standard as well." The standard Wilcox refers to is the Virtual Device Interface (VDI) defined in GKS and implemented by Microsoft Corp. in MS-Windows.

Currently, GCI is working closely with Microsoft to

Syte president Peter J. Shaw isn't necessarily against standards but believes they are more for technology-poor companies and can inhibit a technology-rich company from flexing its creative muscles.
Metagraphics' MetaWINDOW software is a bit-mapped tool for the IBM PC and similar computers. Fast bit-block transfers (BITBLT) are possible; a user can create icons and pull-down and pop-up menus.

Coupling fine-line graphics to the display device and outputting to a hard-copy device such as the Diablo Systems Inc. ink-jet printer, IMSI's four-point Graphics provides maximum flexibility for OEMs by offering a wide range of device drivers.

Thus, hard-copy peripheral manufacturers can implement a robust set of features without affecting the remainder of the system.

Standards prove restrictive

Software writers are not always anxious to adhere to standards. "A software writer wants to have control over the environment and not be restricted by standard rules," claims Graphic Software Systems (GSS) Inc. president Thomas B. Clarkson.

One of the trends, Clarkson contends, is to have graphics control functions decoupled from the window manager. He asserts that this is a big issue among software developers and system integrators: "Many system houses and software developers want to create their own interface to establish market differentiation. It can be as simple as a menu system or as complex as a window manager."

Even though developers are interested in creating their own environments, many are taking a building-block approach by using products that are specifically designed to handle various segments of the project. Metagraphics Corp., Mountain View, Calif., offers the MetaWINDOW graphics tool kit for $150. This package is based on the display management concepts pioneered at Xerox Corp.'s Palo Alto Research Center (PARC) and provides graphics capabilities similar to those found on Apple Computer Inc.'s Lisa or the Xerox Star computer. According to Metagraphics president Jack Davis, MetaWINDOW is a tool for developing window managers profiled for a specific system. "MetaWINDOW isn't an implementation of GKS," notes Davis. "GKS and the SIGGRAPH core proposals deal with the
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display device at a higher device-independent level. These standards are intended to facilitate a level of portability for applications but provide only for a limited set of bit-mapped graphics functions. Right now, MetaWINDOW is an optimized bit-mapped graphics tool for the IBM Corp. PC. But developers can put a GKS shell on top of MetaWINDOW.

Building blocks aid graphics

Media Cybernetics Inc., Takoma Park, Md., offers a similar product, Halo, for $150 and provides OEMs with a building block for display graphics. Like MetaWINDOW, Halo permits the creation of specialized windows or graphics capability on the IBM PC and PC-compat-

ble computers. According to a company spokesman, Media Cybernetics offers libraries of routines that are easily called from FORTRAN, BASIC, C, Pascal, APL+ and Assembly languages. With Halo, users can create 3-D graphics—a function not addressed by GKS.

One of the companies using Halo as a development tool is Datagraphic Systems Inc., Milford, Mich. Its CADMaster package uses Halo for display functions and adds output drivers for hard-copy devices such as those manufactured by Epson America Inc. and Mannesmann Tally as well as for color prism printers from Integral Data Systems Inc. The package adds output drivers to Hewlett-Packard Co. plotters as well as to most HP-compatible plotters and to those made by Houston Instrument. In addition, CADMaster supports input devices ranging from mouse pointers to digitizing pads.

Offering similar capability based on Halo is the 3Design 3CAD package by 3Design, Seattle. This package also supports a variety of hard-copy and input devices.

Standards guide technological advancement, and Graphic Software's Clarkson and others are convinced that the forerunner who establishes the standard will dominate the market. Clarkson explains that even though most software vendors have adopted VDI, implementations differ. What remains is to determine which implementation characteristics will dominate. "It's as fundamental as a cable," he says. "Once it's there, it provides the path. I see people purchasing the device driver the same as a cable—it is becoming a shoe-box technology. The one who wins is the one who supports the most devices."

Currently, Media Cybernetics, Digital Research Inc. and GSS are fighting for dominance in products shipped. Other manufacturers such as Microsoft and Metagraphics expect to capture a major share of the OEM market. Microsoft wants to establish a de facto standard with its MS-Window package.

Development times shortened

Development time can be drastically reduced using off-the-shelf device drivers. Syte Technology manager of engineering Bruce Carpenter says, "One of the
GET YOUR MESSAGE THROUGH.

EVEN WHEN YOUR MODEM SENDS IT BY WAY OF THE OKEFENOKKE SWAMP.

When you send data by telephone through nasty environments like this, it can run into problems tougher than just alligators. Problems like impulse noise. Chatter from the switchgear. Static from the atmosphere or bad weather. Distortion due to bad connections. Even with the best modem, you might find yourself running into problems tougher than other modems. Here's how we do it by creating architectural innovations in firmware, and by pushing the chip to its limit. Since it uses fewer parts, the PC:IntelliModem's no-compromise design offers higher reliability, a more compact form factor, and lower costs.

This design elegance leads naturally to more elegant performance. Take line status detection, for example. The PC:IntelliModem's adaptive, decision-directed logic monitors line status more closely than other modems. Even at weak or degraded signal levels. So it can make connections with less chance of error, by detecting signals for dial tone, remote ringback, busy and voice—some of which other modems ignore.

The PC:IntelliModem is elegantly simple. Its patented design does it all on a single microprocessor chip, with just one crystal. Other modems take two, four or more ßPs (and even more oscillators), and still accomplish less.

How do we do this? By creating architectural innovations in firmware, and by pushing the chip to its limit, close to 12 MHz. Since it uses fewer parts, the PC:IntelliModem's no-compromise design offers higher reliability, a more compact form factor, and lower costs.

Get patented modem technology. The PC:IntelliModem is elegantly simple. Its patented design does it all on a single microprocessor chip, with just one crystal. Other modems take two, four or more ßPs (and even more oscillators), and still accomplish less.

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Plan ahead with integrated voice and data.

For opening up a whole new world of integrated voice and data applications, there's nothing like the PC:IntelliModem. Literally. Its easy-to-use software package—PC:IntelliCom™—lets you switch repeatedly between talking or listening and sending or receiving data. All at the touch of a single function key. That means now both you and your computer can talk on the same line. Without having to hang up, re-dial or plug and unplug a lot of cables.

So if you're designing microcomputer datacomm products—or just looking for a PCXT modem for yourself, check out the PC:IntelliModem at your local dealer. You'll get the message. And so will they. Or contact: Bizcomp, 532 Mercury Drive, Sunnyvale, CA 94086; 408/733-7800.

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- Pulse and Tone Dialing
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Bizcomp: A history of innovation.

- 1980 Invented first command-driven modem
- 1981 Introduced proprietary line-status monitoring
- 1983 Designed first single-µP 212A-compatible modem
- 1983 Introduced first integrated voice/data modem for IBM PC
- 1983 Granted patent on command-driven modem

CIRCLE NO. 82 ON INQUIRY CARD

MINI-MICRO SYSTEMS/July 1984
Introducing the TI 855 microprinter.
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Hardware Compatible. The TI 855 microprinter is compatible with all major PC hardware. And it provides both serial RS232C subset and "Centronics-type" parallel as standard interfaces.

Software Compatible. The TI 855 uses industry standard escape sequences for compatibility with virtually all third-party software. And for those with proprietary software needs, a model is available with ANSI standard escape sequences.

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More Productivity Than Any Other Microprinter. The 855 offers both friction and tractor paper feed, to handle all types of word and data processing applications. A quick-change snap-in cartridge ribbon. Raster and mosaic graphics. And intelligence printing which maximizes document throughput — regardless of format.

Get the printer that makes for better information systems. For more information visit your nearest TI authorized dealer or write Texas Instruments Incorporated, P.O. Box 402430, Dept. DPF-00000, Dallas, TX 75240. Or call toll-free: 1-800-527-3500.
This drawing is complex in appearance but deceptively easy to create using Digital Research's DR Access10 with a simple language file.

Microsoft's MS-Windows system serves as a bridge between applications and hardware. In operation, applications call the appropriate routines either in the operating system (OS), the windows or the Graphics Device Interface (GDI) to perform a function. System integrators are responsible for creating the link between the hardware and MS-Windows via the Basic Input/Output System (BIOS), and software writers need address only the software interface provided by Microsoft.

reasons GKS is being favored is that language binding is being done. This means that a software writer can sit down and create an application in FORTRAN or C and know that he is talking the system language."

Richard Frank, chairman of Sorcim Corp., San Jose, Calif., insists that there are more important factors than providing language binding: "Essentially, when the industry moved from 8-bit machines to 16 bits, we went from a de facto software standard, CP/M, to a de facto hardware standard, the IBM PC." He adds that the architecture of the PC established a development environment that software vendors were forced to contend with. "Like everyone else, we aren't willing to be restricted by someone else's rules. We found it necessary to create our own device-independent drivers and window-management scheme."

Another package that reduces development time is Microsoft's MS-Windows tool kit, priced at $795, which combines window management, a disk operating system and a Graphics Device Interface (GDI).

The GDI capability is related directly to the GKS standard; Microsoft is working closely with GCI to provide device-specific drivers to ease implementations. According to John Butler, a Microsoft software engineer, GDI provides developers with a uniform interface to graphics and, with support of device-specific drivers, handles virtually all device technologies.

To achieve maximum ease of implementation, MS-Windows offers a modular approach: each device driver is treated as a file. Thus, drivers can be easily maintained and updated without rewriting the entire input/output system—a previous requirement in 8-bit systems.

NAPLPS may serve other segments

The GKS/VDI approach has already proven a major influence on most software vendors, but NAPLPS may spur specialized applications such as Videotex.

The NAPLPS approach is much like GKS in that it specifies device-independent data formats for encoding text and graphics and is ideal for information processing and presentation graphics. Notably, the standard is screen—thus raster—oriented and expresses coordinates as fractions of a unit screen.

Because NAPLPS is device-independent, it is expected that, with use, software vendors will be able to create single-device drivers that are compatible with any
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NAPLPS-compatible system. This means that peripheral manufacturers will have to adhere to NAPLPS rules, which those favoring the GKS approach believe could be inhibiting.

General Parametrics has accepted NAPLPS for its VideoShow 150, and software development director Pollock says the NAPLPS approach was taken to ease the development of compatible software. "We have a product that is designed to create presentation-level graphics in slide-show fashion. We wanted something that would allow us to encode frames in the smallest amount of space, and NAPLPS takes only about 3K bytes. In addition, we can provide software writers with an easy environment to write within and one that isn't beset with diverse changes." Pollock, although a member of the X3H3 committee, doesn't see GKS meeting all the needs. "Right now, there are essentially two versions of GKS: ANSI's and the International Standards Organization version, and they do differ." Pollock and Syte's Carpenter think an independent standard, partly based on GKS, will emerge.

NAPLPS is resolution-independent. Consequently, developers of low-cost presentation graphics systems may consider it ideal to maximize display performance, as did General Parametrics.

Plentiful array of software

Regardless of which standard implementation approach is used, software will be available. Already on the shelves are products from Digital Research and GSS, and Microsoft and GCI expect to have a large library this year. Companies such as Sorcim and newly formed Softway, San Francisco, are working on libraries of device drivers for OEMs. Sorcim's Graphic Control System (GCS) is not an OEM product. It was developed as an in-house product. According to company chairman Richard Frank, "We were once a tool factory; now, we make spreadsheets. We may consider going back in the tool business, and we do have the ability to create that type of product." Softway is a software tool company. Its first product, Matis ($175), is a BASIC language extension that adds graphics capability on the creation of window management and device handling. Softway plans to offer a full set of library routines for OEMs.

Some peripheral companies are helping software vendors develop products for their devices. Enter Computer Inc., San Diego, offers the Sweet P plotter system, which uses the HP Graphics Language (HPGL) and the Sweet P Graphics language (SPGL) as command sets, thus easing the creation of both device drivers and application software.

Michael Manchee, product specialist, explains that, by using a rich command set, the plotter can perform complex plots with little effort on the part of the user. "Most plotters have their own command set and don't adhere to GKS. It is up to the software writer or system implementor to provide the proper driver," he says. In most cases, this is simply a serial or parallel device driver that can handle ASCII strings. For example, a simple command to pick up the pen is coded as "PU" and can be implemented even in BASIC. "We take care of processing the commands, and in many cases that is 90 percent of the burden," says Manchee.

The model 84 plotter from California Computer Products (Calcomp) Inc., Anaheim, Calif., allows the system integrator or software writer to create easy-to-use applications. GCI has made its Graphwriter software available for use with the Calcomp plotter. This software package, when coupled with the plotter, allows the creation of complex graphics and line texturing, primarily by taking advantage of the device's rich command set.

The Pixy 3 microplotters by Mannesmann Tally, Kent, Wash., offer similar capabilities. A company spokesman explains that numerous software vendors are taking advantage of the plotter's ease of integra-
The Firebreathers from Gould blast the competition into oblivion.

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tion. For example, a range of Apple-compatible software is available, as are Chartmaster and Signmaster from Decision Resources Inc., Westport, Conn.

Houston Instrument, Austin, Texas, is touting compatibility to 79 packages, many of which are GKS-compatible. The company is anxious to provide robust command sets to improve plotter functions. Therefore, it is interested in having device drivers that support its products.

Printers are hard to handle

GSS's Clarkson points out that one of the most difficult devices to handle is a printer. "Virtually every printer manufacturer has a method of handling the device and a different command set. It makes it difficult to create a generic software package, so you need to have very specific drivers," he says. As a result, GSS has developed a series of packages that are built around the GKS kernel and VDI implementation.

Among the products available from GSS are those bound either into the operating system or those that serve as modules that users can adapt. These include GSS-Solutions, which comprises GSS-Chart and GSS-Terminal. The two programs can serve as standalone products or can be bound into a full system. The terminal program permits the migration of applications from a mainframe to a minicomputer or microcomputer. Because the package is compatible with the Tektronix Inc. 4010 family, software created in this environment can be down-loaded and manipulated using Chart. This package allows for full cut-and-paste and a full array of charts and graphs.

To allow OEMs to implement full graphics capability on 8- or 16-bit systems, GSS offers the Toolkit, which includes a kernel system. According to Clarkson, this represents the first implementation of GKS in a microcomputer environment, thus providing full graphics functions as defined by the standard. The Toolkit's plotting system takes advantage of the kernel and lets users develop sophisticated charts and graphs. The modular Window Manager permits the creation of windowing systems that can be controlled by a multitude of input devices.

The key element in GSS's list may be the device drivers, however. Paying careful attention to the standards, GSS has extended the VDI proposal found in GKS. The GSS-Driver contains a protocol converter at the device—hardware—level. The software receives the generic graphics requests, such as "draw a line," and then does the necessary conversion to make the device perform the function.

Notably, GSS hasn't limited itself to physical device drivers specified by VDI. Rather, the company offers a metafile driver for pseudo device drivers and an NAPLPS driver for videotex applications. The NAPLPS driver is important for storing information transmitted over phone lines or for NAPLPS-oriented devices. GSS provides language binding to aid the software writer.

Documentation comes on diskette

All the packages are bundled as a kit, which includes the software and documentation on diskette. The GSS-Terminal and the GSS-Chart sell for $20,000 each. GSS-Driver is priced at $10,000 for a full set. The language binding is $4,000 more. Prices of GSS-Plot and the metafile interpreter are $12,000 and $10,000, respectively. GSS adds a royalty structure based on hardware or software shipped.

Another company offering software for OEMs is International Microcomputer Software Inc. (IMSI), San Rafael, Calif. Its four-point Graphics ($195) creates smooth animation and allows easy manipulation of objects. The technique is an NAPLPS-line implementation. To support a variety of printers and plotters, IMSI offers device-specific drivers for $29.95 each.

Of the companies that are developing graphic software and specifically GKS-compatible products, Digital Research has established a significant posture. Work-
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A very pretty picture indeed. What’s more, you get easy interface to our color hardcopyer. Programmable function keys. A user-definable look-up table. And user-definable hardware anti-aliasing.

But hardware technology notwithstanding, you also get a powerful software story with the 2414. For instance, it’s compatible with the TEK 401X instruction set and Plot 10 package. So you can save a lot of time and aggravation implementing graphics software. Upgrade quite painlessly. And eliminate costly re-learning curves.

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ing originally with GSS, Digital Research integrated one of the first implementations of the SIGGRAPH core into CP/M. It has also implemented metafile for storing pictures in an encoded format for Videotex applications.

Like Microsoft and GSS, Digital Research has developed an extensive library of end-user and OEM software geared for graphics. Specifically, it offers the GSX-86 programmer's tool kit for $350. This package includes peripheral drivers and is compatible with CP/M-86, Concurrent CP/M and PC-DOS. In addition, the company provides language binding for the full family of Digital Research products.

Graphics System Extension (GSX), an implementation of GKS developed in tandem with GSS, has made it possible for Digital Research to offer such graphics packages as DR Draw ($400), DR Access10 ($500) and DR Graph ($295). According to Fred Langhorst, director of Digital Research's graphics division, the packages represent a comprehensive set of graphics tools that are easily modified to fit specific applications.

According to Langhorst, the GSX system comprises two major components: the Graphics Device Operating System (GDOS) and the Graphics Input Output System (GIOS). The GDOS is device-independent and is based on the emerging ANSI VDI standard. This portion intercepts calls from the applications and interprets them for the device-dependent GIOS. The GIOS is designed to be very device-specific, and, like Microsoft’s implementation, it is designed to be hung into the system as modules. One of the companies that has adopted Digital Research’s method is Digital Equipment Corp. for the Rainbow series of computers.

Although Precision Visuals Inc., Boulder, Colo., offers the DI-3000 integrated system of 200 user-callable graphics subroutines, which are developed in accordance with SIGGRAPH core and GKS, company president Jim Warner issues a warning: “Graphics standards are important, but they tend to be outpaced by new equipment. The standards are a result of give-and-take and don’t always consider the marketplace.”

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David Simpson, Associate Editor

The demand for small business or office-related graphics output has created a $100 million desktop plotter industry that will top $500 million by 1988, according to Future Computing Inc., a Richardson, Texas, market research company. More than 30 manufacturers currently offer desktop plotters. And, although Hewlett-Packard Co. commands over 70 percent of the market, new companies such as Enter Computer Inc., Roland DG and Strobe Inc. are challenging the large manufacturers with less-than-$1,000 plotters. System integrators have plenty of products from which to choose, but the buying decision remains tough. A variety of factors have to be matched with application requirements, including the type of plotter, technology, performance parameters, software availability and cost.

Choosing the right technology

Pen plotters are the dominant desktop graphics output devices, outselling all other technologies combined. The fastest-growing segment centers on the less-than-$2,000 category. According to Dataquest Inc., a Cupertino, Calif., market research company, U.S. shipments of less-than-$2,000 pen plotters totaled 100,000 units in 1983. This number is expected to reach 155,000 in 1984, and at a 40 percent compound annual growth rate, will exceed 300,000 in 1986. Of 1983 shipments, 65 percent were for technical applications and 35 percent were for business applications.

Plotters for business applications should steadily gain market share over the next few years. Creative Strategies International, a San Jose, Calif., market research concern, projects a 51.2 percent compound annual growth rate for unit shipments of business graphics-based pen plotters, from 34,900 units in 1982 to 275,700 in 1987 (Fig. 1).
There are three types of pen plotters: flatbed, drum and hybrid (Fig. 2). Flatbed plotters generally provide high precision and allow an operator to remove and replace plots with little loss of accuracy. With flatbed plotters, the paper remains stationary while the pen plots the X and Y axes. Drum plotters are usually less expensive and can accommodate continuous-roll paper. The drum moves the paper vertically while the pens move across the paper horizontally. Hybrid plotters operate like drum plotters, plotting the X axis via pen movement and the Y axis by moving the paper vertically with pinch, or grit, wheels that hold the edges of the paper. Hybrid plotters are usually less expensive than drum plotters.

Pen plotters provide proven technology, low cost and high quality. In addition, there is an abundance of graphics software for pen plotters, most of which can be easily implemented by inexperienced users. But pen plotters are relatively slow, especially when printing text, and sometimes require user intervention. In addition, they are usually limited to producing fewer than eight colors. Consequently, a trend in the graphics output arena is aimed at raster-based dot-matrix devices, as opposed to vector-based pen plotters. Raster devices use technologies such as impact dot matrix, ink jet, electrostatic and thermal transfer. These newer units—called printer/plotters—are exhibiting performance improvements but probably won't cut into pen-plotters market share for another two to three years.

**Color impact dot-matrix printer/plotters** use multi-colored ribbons and standard dot-matrix print heads that employ solenoid-driven print hammers. They can use serial or line-printer techniques. Some serial units make one horizontal pass for each color; others shift the ribbon as required, which allows printing all colors in one pass. Line printers produce an entire row of dots simultaneously, printing a page in one color, then going back up the page to print another color.

As with other raster-based output devices, it is sometimes difficult to distinguish between a dot-matrix printer and a dot-matrix printer/plotter. Some manufacturers point to resolution; others, to graphics software support. Lear-Siegler Inc.'s Versaprint model 520, for example, has a resolution of 150 dots per inch (dpi) horizontally by 144 dpi vertically. Although this falls short of the 240 dpi required for letter-quality output, it's sufficient for most business graphics applications.

Graphics software support is weak for many dot-matrix units, but a few printer/plotters handle most of the graphics application packages written for popular microcomputers. For example, Printronix Inc.'s MVP supports all major IBM PC-compatible graphics application packages.

Most graphics application packages generate images via a list of vector commands. Pen plotters accept those commands without the need for translation. Raster-based devices, on the other hand, require vector-to-raster conversion because they create images by selectively turning dots on and off in a fixed matrix. Raster-based output devices must translate vector information into a raster or bit-mapped image, which typically requires conversion hardware, software or firmware. Although terminal manufacturers, plotter manufacturers, applications software suppliers, OEMs or system integrators can supply conversion functions, supplying such functions usually involves extra money or time.

An exception is Envision Technology Inc.'s VectorPrinter, which has a built-in vector-to-raster conversion system. The dot-matrix printer/plotter incorporates two 8088 microprocessors; one controls the print mechanism, and the other controls the host interface and command interpretation. Because the 8088s work in parallel, processing of subsequent windows—or plots—can continue while earlier plots are printed. The VectorPrinter sells for $3,495, prints on plain paper or transparencies and plots in eight colors.

The primary advantage of impact dot-matrix printer/ plotters is speed. When mixing text and graphics, pen plotters are very slow, usually around 3 characters per second (cps), making them impractical in word- or data-processing applications. Impact dot-matrix units such as Printronix's $3,745 MVP and Trilog Inc.'s
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MINI-MICRO SYSTEMS/July 1984

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$6,900 TIP 302, on the other hand, can print text at 150 and 300 lines per minute (lpm), respectively.

Lear Siegler's director of printer engineering, Herb Craft, claims his company is capturing pen-plotter market share because "more and more people are mixing text and graphics, such as spreadsheets, pie charts, etc." The Versaprint supports Lotus Development Corp.'s 1-2-3 and other popular application packages. "We're concentrating on developing more compatibility with the IBM PC/XT," says Craft, a strategy voiced by many dot-matrix printer/plotter manufacturers.

*Ink-jet printer/plotters* have print heads that spray a continuous stream of ink drops toward the paper. An electromagnetic field between the print head and the paper determines whether the dots will reach the paper or be electrically deflected. More recent ink-jet printer/plotters use drop-on-demand techniques, in which the print head controls the ink-drop flow, so that ink drops are emitted only when the print head fires (Fig. 3).

The major advantages of ink-jet plotters are speed, color capabilities and dual-mode operation. For example, Advanced Color Technology Inc.'s ACT II and Printacolor Corp.'s TC 1040 produce an 8½-by-11-inch plot in 90 seconds, regardless of the complexity of the plot. Whereas desktop pen plotters are usually limited to about eight colors, the ACT II can produce 125 shades, and the TC 1040 can produce almost 5,000 hues. Both units can print on paper or transparencies.

The disadvantages involve resolution, price and vector-to-raster conversion software, but improvements are coming quickly. Whereas 240 dpi is generally considered letter quality, most ink-jet printer/plotters currently hover around 120 dpi. However, according to Printacolor vice president of marketing Philip Frick, his company will introduce a 240-dpi desktop printer/plotter within a year.

In the cost controversy, Diablo Systems Inc. is countering with its $1,295 Series C150 ink-jet printer/plotter (MMS, January, Page 223). The unit uses continuous-stream or drop-on-demand techniques and has 120-dpi vertical and horizontal resolution. Other manufacturers are also pushing price decreases. "Our main competition is the technology itself," says Chuck Stires, marketing manager at Advanced Color Technology. "The idea is to lower prices to keep in line with the decreasing prices for systems and terminals, more than to compete quality-wise with other technologies."

---

*Fig. 3. Advanced Color Technology's ACT II ink-jet printer/plotter employs drop-on-demand technology, in which electrical impulses control the flow of ink drops to the paper. The print head has 12 jets arranged in three groups of four jets each. The ACT II uses the three subtractive primary colors: yellow, magenta and cyan. As the print head moves across the page, the compression of piezoelectric crystals ejects the ink drops. The color in each pixel is produced by mixing ink drops, allowing as many as eight solid colors or 125 shades.*
Like other raster-based devices, ink-jet printer/plotter manufacturers require vector-to-raster conversion software to run vector-based application programs. A software driver usually performs this translation. Most ink-jet printer/plotter manufacturers supply drivers for the popular microcomputers. Advanced Color Technology, for example, supplies drivers on floppy disk for more than 40 systems.

Electrostatic printer/plotter have only recently entered the desktop market with the introduction of Versatec Inc.'s black-and-white V-80 unit. Like other electrostatic devices, Versatec's printer/plotters produce hard copy by applying programmed voltage to an array of densely spaced nibs arranged on a stationary writing head. In response to digital commands, the nibs create electrostatic dots on the paper or film passing over the writing head. The plotter then exposes the media to liquid toner, producing an image.

Although Versatec is the only supplier of a desktop electrostatic printer/plotter, color versions are in development at other companies and may be available next year. According to Versatec's Dale Richmond, product manager for the V-80, the company is working on a small-format (desktop) color electrostatic printer/plotter, but completion date is uncertain.

The major advantages of electrostatic units are high speed, high resolution, quietness, reliability and dual-mode operation. The V-80 operates in text mode at 1,000 lpm and 1.2 inches per second in plot mode. It has a resolution of 200 dpi, providing 40,000 points per square inch, and a mean time between failures (MTBF) of 3,000 hours. The V-80 requires dielectrically coated paper, which costs about 1½ cents per page.

Richmond admits to competition from ink-jet and impact dot-matrix units, but says Versatec will meet it with faster, higher-resolution color units. On the down side, the raster-based V-80 requires vector-to-raster conversion software to run vector-based application programs. This is available in the Versaplot package, which adds a few thousand dollars to the price. Versa-plot for Digital Equipment Corp.'s VAX, for example, sells for $3,500; a PDP-11 package, $2,000.

The electrostatic-output device market was worth $138 million in 1981 and $178 million in 1982, according to Creative Strategies. In 1982, Versatec had 66.3 percent of the market, Benson Inc. had 21.3 percent, and Calcomp-Sanders Associates Inc. had 12.4 percent.

Thermal-transfer technology uses a thermal print head with nibs that, when heated, melt dots of pigment onto the paper or transparency. An ink-sheet roll, positioned over a paper-transport roll, contains three bands of yellow, cyan and magenta. The medium makes one pass under the print head for each of three colors.

The major drawbacks to thermal printer/plotter are resolution and cost. Seiko Instruments U.S.A. Inc.'s CH5201B, for example, has a resolution of 150 dpi and a price tag of $11,950. Most analysts believe that thermal-transfer output devices will not have much impact in the desktop, high-quality graphics area until prices come down and resolution improves.

<table>
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<tr>
<td>A2</td>
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<td>A3</td>
<td>297 x 420 B</td>
</tr>
<tr>
<td>A4</td>
<td>210 x 297 A</td>
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Fig. 4. Paper sizes are often indicated according to American National Standards Institute (ANSI) or International Standards Organization (ISO) standards.

Measuring pen-plotter accuracy

Hewlett-Packard Co. defines accuracy as the exactness with which a plotter can position one endpoint with respect to another endpoint. Most applications do not require perfect accuracy, but if an application calls for exact spacing between parallel lines or if precise measurements will be taken from the plot, the buyer should be aware of the plotter's accuracy level. Two related specifications are important: repeatability and resolution.

Repeatability measures how closely a plotter returns a pen to a plotted point, describing the ability to join new elements to those previously plotted. HP considers good repeatability to be within one-third of a line width. Most desktop plotters have 0.001- to 0.008-inch repeatability. Low-cost plotters, such as Mannesmann Tally Corp.'s Pixy 3 Microplotter ($795) and Radio Shack's FP-215 ($895), have lower repeatability specifications (0.012 inch).

Mechanical resolution is the smallest move a plotter can make in any direction. The shorter the mechanical resolution, the smoother the line. Good mechanical resolution reduces the "stair-stepping," or jagged-line, effect. Addressable resolution is the smallest pen move a user can specify programmatically. According to HP, the human eye cannot distinguish between moves smaller than 0.001 inch, so addressable resolution need not be finer than 0.001 inch. Because it would be useless to have a smaller addressable resolution than mechanical resolution, mechanical resolution is generally more important. The accompanying survey chart notes re-
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peatability and mechanical resolution for most desktop pen plotters.

Other performance parameters important in choosing a plotter are the type and size of media that the plotter will accept (Fig. 4), plotter speed, pen actualization and acceleration and the number of available character sets and colors. Pen actualization is the time it takes the plotter to select and position a pen, and pen acceleration, measured in G's, is the time it takes for the pen to reach top speed. An increasingly important area of consideration is software (see "Graphics software schemes enhance peripheral interfacing," Page 163).

Micro boom pushes plotter market

According to Future Computing, unit shipments of office-based desktop plotters were 90,000 in 1983 and will exceed 700,000 in 1988, representing a compound annual growth rate of 40 percent. Revenues will jump from $110 million in 1983 to about $500 million in 1988 for a 35 percent compound annual growth rate (Fig. 5). Some research companies, such as Dataquest, predict that total revenues for less-than-$2,000 pen plotters will jump from $110 million in 1983 to about $500 million in 1988 for a 45 percent compound annual growth rate in terms of units shipped and at a 35 percent growth rate for total revenues.

The U.S. market for office-based desktop plotters is expected to increase at a 45 percent compound annual growth rate in terms of units shipped and at a 35 percent growth rate for total revenues.

Fig. 5. The U.S. market for office-based desktop plotters is expected to increase at a 45 percent compound annual growth rate in terms of units shipped and at a 35 percent growth rate for total revenues.

The driving forces behind the need for desktop plotters are the office-based microcomputer boom and the graphics demands of popular application packages such as Lotus' 1-2-3 and Sorcim Corp.'s SuperCalc III. When asked what the major trends will be, many analysts respond, "Watch HP." HP has the lion's share of the installed base, its plotters are generally considered state-of-the-art, its introductions spawn me-too products, and it is able to price products competitively due in large part to economies of scale. HP's recently announced $595 ink-jet printer is a good indication of what the company can do price-wise. "In addition," says Future Computing's John Hoper, "plotters are seen as specialty items in the retail market. Retailers don't handle a lot of brands," which makes it difficult for start-ups to establish a foothold.

But the need for low-cost graphics output has created a new market niche—the less-than-$1,000 plotter. Several start-up companies have entered this arena within the last year and are now showing significant success. Examples of low-cost pen plotters are C. Itoh Electronics Inc.'s four-pen CX4800 ($695); Enter Computer's single-pen, 12-color Sweet P model 100 ($699); Mannesmann Tally's eight-pen Fixy 3 Microplotter ($795); Roland DG's eight-pen DXY-800 ($995); Strobe's eight-pen M260 ($995); and Yokogawa Corp. of America's four-pen PL-1000 ($995). Yokogawa supplies Apple Computer Inc. with the model 410 color plotter, which Apple sells for $779.

Other manufacturers have responded predictably to the influx of low-cost plotters. About a year ago, HP slashed 30 percent off the price of its two-pen 7470A to $1,095 and introduced the six-pen 7475A at $1,895. Calcomp-Sanders, traditionally a manufacturer of large-format plotters, introduced the eight-pen, $1,995 model 84. In a similar move, Houston Instrument went from a predominantly engineering-based product line to personal-computer-based plotters priced at less than $1,000.

Pricing competition from non-pen-plotter technologies is expected to drive pen-plotter prices downward over the next five years. For example, Diablo Systems' Series C150 ink-jet printer/plotter is competitively priced at $1,295, as is Lear Siegler's $2,195 model 520 impact dot-matrix printer/plotter. Although thermal and electrostatic printer/plotter prices are currently too high to compete effectively at the low end, prices will drop over the next two or three years as manufacturers smooth technology wrinkles and reach high-volume production.

Future Computing predicts that prices for low-end desktop plotters will plummet 50 percent over the next four years for units targeted at floppy disk-drive-based systems and 30 percent for units aimed at Winchester disk-drive-based systems. The market for less-than-$2,000 plotters is expected to increase tenfold by 1988.
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## DESKTOP PLOTTERS

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<td>14½ roll, tractor feed</td>
<td>horiz: 85-140 dpi vert: 85 dpi</td>
<td>ACT supplies drivers for IBM PC, Apple Iie, S-100; drivers available for Chromatics, Lundy, Vetrix, Megatek, others</td>
<td>serial, parallel, RS170</td>
<td></td>
<td>767</td>
</tr>
<tr>
<td>ALPHA MERICS CORP.</td>
<td></td>
<td>open-bed</td>
<td>fiber tip, wet ink</td>
<td>paper, film, mylar</td>
<td>drafting</td>
<td>18 x 30</td>
<td>2</td>
<td>.00125</td>
<td>.00125</td>
<td>Hewlett Packard, HPGL compatible</td>
</tr>
<tr>
<td>AlphaPlot 1</td>
<td></td>
<td>open-bed</td>
<td>fiber tip, wet ink</td>
<td>film, paper</td>
<td>24 x 34</td>
<td>2</td>
<td>.00125</td>
<td>.00125</td>
<td>Hewlett Packard, HPGL compatible</td>
<td>RS232C</td>
</tr>
<tr>
<td>AMDEX CORP.</td>
<td></td>
<td>flatbed</td>
<td>felt tip</td>
<td>paper, film</td>
<td>11 x 17</td>
<td>1</td>
<td>.002</td>
<td>.004</td>
<td>many packages available on Apple and IBM; Lotus driver supplied</td>
<td>RS232C, Centronics</td>
</tr>
<tr>
<td>APPLE COMPUTER</td>
<td></td>
<td></td>
<td>felt tip</td>
<td>6</td>
<td>8</td>
<td>paper, film</td>
<td>11 x 17</td>
<td>.008</td>
<td>Apple Business Graphics; PSS Graph; Graph + Calc Chartmaker, Apple writer; Apple Logo; CAD Apple, CAD 1 Micrograph</td>
<td>RS232C</td>
</tr>
<tr>
<td>CALCOMP-SANDERS</td>
<td></td>
<td>flatbed</td>
<td>liquid ink, nylon</td>
<td>paper, film</td>
<td>8½ x 11</td>
<td>6</td>
<td>.004</td>
<td>.004</td>
<td>over 30 commercial software packages available</td>
<td>RS232C, IEEE-488, Centronics</td>
</tr>
<tr>
<td>Model 84</td>
<td></td>
<td>drum</td>
<td>liquid balpoint, nylon</td>
<td>paper, film</td>
<td>8½ x 11, 11 x 17</td>
<td>1</td>
<td>.08</td>
<td></td>
<td></td>
<td>RS232C, IEEE-488, Centronics</td>
</tr>
<tr>
<td>C. ITOH ELECTRONICS</td>
<td></td>
<td>printer/plotter; pen plotter</td>
<td>water-based balpoint</td>
<td>4</td>
<td>4.8</td>
<td>paper</td>
<td>10</td>
<td>.008</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chart includes pen plotters and representative printer/plotters

MINI-MICRO SYSTEMS: July 1984
## DESKTOP PLOTTERS

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Pens</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMREX INTERNATIONAL</strong></td>
<td></td>
<td>grit wheel</td>
<td>paper,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fiber tip 1</td>
<td>transparency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>8½ x 11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.004</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IBM-PC, Apple, Epson, Kaypro, Osborne, Vector, Zenith</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RS232C, parallel</td>
</tr>
</tbody>
</table>
|                   |           |              | Price: $695  
| **DIABLO SYSTEMS** |           | printer/plotter | paper, film   |
|                   |           | ink jet 4 color cartridges, 100 + mixtures | 8½ x 11 |
|                   |           | 120 dpi      | Many commercially available graphics programs |
|                   |           | 19           | RS232C        |
|                   |           | .004         | 695           |
|                   |           |              | Centronics   
|                   |           |              | 1,295         |
| **ENTER COMPUTER INC.** |         | grit wheel    | paper,        |
|                   |           | fiber tip 6   | transparency film |
|                   |           | 14           | 8½ x 11       |
|                   |           | .004         | .004          |
|                   |           |              | Over 27 commercially available graphics programs |
|                   |           |              | Centronics   
|                   |           |              | 1,095         |
| **ENVISION** |           | printer/plotter | paper, film   |
|                   |           | impact dot matrix | 5–13 |
|                   |           |              | 2 as a plotter; 6 as a printer |
|                   |           |              | .069 (vert) .0027 (horiz)  |
|                   |           |              | emulates Diablo 630, HP 7475 |
|                   |           |              | RS232C, Centronics    |
|                   |           |              | 3,495          |
| **FACIT DATA PRODUCTS** |         | printer/plotter | pinfeed only  |
|                   |           | dot matrix 2  | 2–17.8        |
|                   |           |              | 11            |
|                   |           |              | 72 dpi        |
|                   |           |              | (vert) 140 dpi (horiz) |
|                   |           |              | opt. Plot-10 graphics |
|                   |           |              | parallel,     
|                   |           |              | RS232C, IEEE-488 |
|                   |           |              | 3,995         |
|                   |           |              | 695           |
| **HESTAIR DATALINE LTD.** |       | printer/plotter | pinfeed only  |
|                   |           | dot matrix 4  | 2–17.8        |
|                   |           |              | 11            |
|                   |           |              | 72 dpi        |
|                   |           |              | (vert) 140 dpi (horiz) |
|                   |           |              | opt. Plot-10 graphics |
|                   |           |              | includes driver |
|                   |           |              | parallel, IEEE-488 |
|                   |           |              | 4,695         |
| **MINI-MICRO SYSTEMS / July 1984** |       | drum          | water-or-oil-based fiber tip |
|                   |           | 4            | 10 x 15       |
|                   |           | .003 .01     | optional graphics ROM |
|                   |           |              | Centronics, RS232C    |
DATA GENERAL'S MV/FAMILY-TOP PERFORMANCE, NOT TOP DOLLAR

Forget VAX.™
Data General's ECLIPSE® MV/Family of 32-bit computers brings you the best price/ performance available for engineering applications—while running some of the best electronics engineering software.

TWICE AS FAST AS VAX
Consider the price/performance graph shown below. On the basis of dollar-per-MIP,

Data General's MV/10000™ gives you twice the performance of the VAX 11/780—at a lower price.

Now compare the MV/8000® to the VAX 11/780. Same performance. But the MV/8000® is half the price. The same holds true when you compare the MV/4000® to the VAX 11/750. And our recently announced OEM MV/8000 C offers almost twice the performance of the VAX 11/750. But it's the same price.

RUNS THE MOST WIDELY-USED SOFTWARE
You can run all of the best software on our ECLIPSE MV Series, including TEGAS®, NCA/DVS®, MicroSet-86®, ECAD's DRACULA, and Mentor's CADISYS®.

And Data General keeps you a generation ahead by bringing you comprehensive service plans and industry standard software development environments.

CALL NOW
For more information on Data General's ECLIPSE MV/Family, call 1-800-554-4343 and ask for Operator 06F.

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UNIX™ System V from AT&T can help you close a sale, as well as open up new markets. It's another reason why good business decisions are based on UNIX System V from AT&T.

More and more of your customers will be demanding multi-user and multi-tasking systems. The benefits of UNIX System V—portability, reliability, flexibility—make it the ideal software system for this lucrative market.

In addition, AT&T will support UNIX System V with the service, training, and documentation resellers need to prosper.

More choices, more opportunities

UNIX System V is virtually hardware independent. So you'll be able to configure systems using equipment from a variety of vendors.

You can use the flexibility of UNIX System V as a real selling point to customers who want to add hardware that is compatible with the machines they already have.

And over the long term, UNIX System V offers continuing opportunities to upgrade and expand your customers' systems. End-user flexibility translates into market opportunity for the reseller.

Software that sells

UNIX System V offers
another real sales opportunity in
the area of customized software.
You'll be able to sell software
for a wider range of configura-
tions. You'll have more software
to offer, too. Your programmers
can concentrate on developing
new packages instead of rewrit-
ing old ones.
For more information, send
in the coupon for a copy of our
free booklet, "Why Good
Business Decisions are Based on
UNIX System V."

UNIX System V. From AT&T.
From now on, consider
it standard.

AT&T
## DESKTOP PLOTTERS

### HEWLETT-PACKARD CO.
3030 Hanover St.
Palo Alto, CA 94306
(415) 857-1501

<table>
<thead>
<tr>
<th>Company</th>
<th>Pens Type</th>
<th>Pens</th>
<th>No. of Pens</th>
<th>No. of Colors</th>
<th>Plotting Speed</th>
<th>No. of Characters Available</th>
<th>Mechanical Resolution</th>
<th>Resolvability</th>
<th>Компактный размер</th>
<th>Price ($)</th>
<th>Circle No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEWLETT-PACKARD CO.</td>
<td>roller grip fiber tip</td>
<td>2</td>
<td>15</td>
<td>paper, overhead transparency film</td>
<td>8½ x 11</td>
<td>5</td>
<td>.001</td>
<td>.004</td>
<td>Hewlett Packard, Apple II, Ile, III, DEC Professional, IBM PC/XT</td>
<td>RS/232C, HP-IG</td>
<td>1,095</td>
</tr>
<tr>
<td>HEWLETT-PACKARD CO.</td>
<td>roller grip fiber tip</td>
<td>6</td>
<td>15</td>
<td>paper, overhead transparency film</td>
<td>8½ x 11, 11x17</td>
<td>19</td>
<td>.001</td>
<td>.004</td>
<td>Hewlett Packard, Apple II, Ile, III, DEC Professional, IBM PC/XT</td>
<td>RS/232C, HP-IG</td>
<td>1,895</td>
</tr>
<tr>
<td>HEWLETT-PACKARD CO.</td>
<td>roller grip w/ sheet feeder fiber tip</td>
<td>6</td>
<td>15</td>
<td>paper, film</td>
<td>8½ x 11, 11x17</td>
<td>19</td>
<td>.001</td>
<td>Hewlett Packard, Apple II, Ile, III, DEC Professional, IBM PC/XT</td>
<td>RS/232C</td>
<td>3,900</td>
<td></td>
</tr>
</tbody>
</table>

### HOUSTON INSTRUMENTS
P.O. Box 15720
Austin, TX 78753
(512) 833-0900

<table>
<thead>
<tr>
<th>Company</th>
<th>Pens Type</th>
<th>Pens</th>
<th>No. of Pens</th>
<th>No. of Colors</th>
<th>Plotting Speed</th>
<th>No. of Characters Available</th>
<th>Mechanical Resolution</th>
<th>Resolvability</th>
<th>Компактный размер</th>
<th>Price ($)</th>
<th>Circle No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPS-20</td>
<td>drum Pentel, ballpoint, drafting, fiber tip</td>
<td>8</td>
<td>4.2</td>
<td>fan fold, roll chart, vellum, polyester film</td>
<td>11 x roll</td>
<td>up to 5</td>
<td>.005</td>
<td>.005</td>
<td>DM/PL, incremental parallel, Centronics</td>
<td>3,995</td>
<td></td>
</tr>
<tr>
<td>CPS-30</td>
<td>drum Pentel, ballpoint, drafting, fiber tip</td>
<td>8</td>
<td>4.2</td>
<td>fan fold, roll chart, vellum, polyester film</td>
<td>22 x roll</td>
<td>up to 5</td>
<td>.005</td>
<td>.005</td>
<td>DM/PL, incremental parallel, Centronics</td>
<td>5,995</td>
<td></td>
</tr>
<tr>
<td>DMP-29, 29-3</td>
<td>flatbed plastic nib</td>
<td>8</td>
<td>22</td>
<td>heavy bend, polyester film</td>
<td>11 x 17</td>
<td>5</td>
<td>Hewlett Packard, Apple II, Ile, III, DEC Professional, IBM PC/XT</td>
<td>RS/232C, HP-IG, Centronics</td>
<td>2,995-2,790</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMP-40, 40-2</td>
<td>drum plastic nib, ballpoint, film ink</td>
<td>1,2</td>
<td>4.2</td>
<td>bond, vellum, polyester film</td>
<td>11 x 17</td>
<td>5</td>
<td>.005</td>
<td>.005</td>
<td>Hewlett Packard, Apple II, Ile, III, DEC Professional, IBM PC/XT</td>
<td>RS/232C</td>
<td>995</td>
</tr>
</tbody>
</table>

### IBM INSTRUMENTS INC.
Orchard Park
P.O. Box 332
Danbury, CT 06810
(203) 796-2444

<table>
<thead>
<tr>
<th>Company</th>
<th>Pens Type</th>
<th>Pens</th>
<th>No. of Pens</th>
<th>No. of Colors</th>
<th>Plotting Speed</th>
<th>No. of Characters Available</th>
<th>Mechanical Resolution</th>
<th>Resolvability</th>
<th>Компактный размер</th>
<th>Price ($)</th>
<th>Circle No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>XY/749</td>
<td>flatbed fiber tip, nylon tip, ceramicroc dip, steel tip</td>
<td>8</td>
<td>13 or 18</td>
<td>paper, vellum, transparencies</td>
<td>8½ x 11</td>
<td>6</td>
<td>.04</td>
<td>.04</td>
<td>Hewlett Packard, Apple II, Ile, III, DEC Professional, IBM PC/XT</td>
<td>RS/232C, IBM 488</td>
<td>1,955</td>
</tr>
<tr>
<td>XY/750</td>
<td>flatbed fiber tip, liquid ink</td>
<td>8</td>
<td>13</td>
<td>paper, transparencies</td>
<td>11 x 17</td>
<td>5</td>
<td>.04</td>
<td>.04</td>
<td>Hewlett Packard, Apple II, Ile, III, DEC Professional, IBM PC/XT</td>
<td>RS/232C, IBM 488</td>
<td>4,500</td>
</tr>
<tr>
<td>7371</td>
<td>felt tip</td>
<td>2</td>
<td>15</td>
<td>paper, transparencies</td>
<td>8½ x 11</td>
<td>5</td>
<td>.001</td>
<td>.004</td>
<td>Hewlett Packard, Apple II, Ile, III, DEC Professional, IBM PC/XT</td>
<td>RS/232C, IBM 488</td>
<td>1,100</td>
</tr>
<tr>
<td>7372</td>
<td>felt tip</td>
<td>6</td>
<td>15</td>
<td>paper, transparencies</td>
<td>8½ x 11, 11 x 17</td>
<td>19</td>
<td>.001</td>
<td>.004</td>
<td>Hewlett Packard, Apple II, Ile, III, DEC Professional, IBM PC/XT</td>
<td>RS/232C, IBM 488</td>
<td>1,900</td>
</tr>
</tbody>
</table>

### LEAR SIEGLER INC.
714 N. Brookhurst St.
Anaheim, CA 92803
(714) 774-1010

<table>
<thead>
<tr>
<th>Company</th>
<th>Pens Type</th>
<th>Pens</th>
<th>No. of Pens</th>
<th>No. of Colors</th>
<th>Plotting Speed</th>
<th>No. of Characters Available</th>
<th>Mechanical Resolution</th>
<th>Resolvability</th>
<th>Компактный размер</th>
<th>Price ($)</th>
<th>Circle No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Versaprint Model 520</td>
<td>printer</td>
<td>dot matrix</td>
<td>4</td>
<td></td>
<td>16</td>
<td>9</td>
<td>150 dpi (horiz), 144 dpi (vert)</td>
<td>.003 dot resolution</td>
<td>Lotus 1-2-3, BPS, other major PC pkgs.; OEM-supplied drivers</td>
<td>current loop</td>
<td>1,395</td>
</tr>
</tbody>
</table>

MINI-MICRO SYSTEMS: July 1984
"We bought an IBC Middi Cadet because no other system could do the job."

Sue Kardas
Director of Career Training
Burlington Area Vocational-Technical Center

When the Burlington Area Vocational-Technical Center needed a multi-user system for student training, we considered many multi-user systems, but in demo after demo there was too much of a user delay.

Then IBC contacted us, and offered to demonstrate the Middi Cadet's multi-user capabilities—we were skeptical, but we gave it a try.

First, the Middi Cadet ran 9 users doing word processing without any delays. As a second test, we had the Middi operating 3 terminals each on word processing, accounting and BASIC programming. Again, no user delay. This was the multi-user, multi-tasking system we had been looking for.

With the Middi Cadet, we got a higher speed Z80B processor, a very fast hard disk drive and enough memory to do the job (512K Bytes).

On top of that, we felt that we got a very good price from an excellent vendor. Our system was delivered and installed two weeks later. Since then we've been so pleased with the Middi that we're planning to buy another. With two systems providing 18 stations we will be equipped to offer training in all aspects of information processing."

The Middi Cadet is a 10 user system that includes a 6MHz, Z80B CPU; 256 to 512K Bytes of RAM memory; a 20 MB, 5¼" hard disk drive and a one megabyte 5¼" floppy disk drive.

For more information on the Middi Cadet, see your local IBC dealer.

To locate the dealer nearest you, call or write:

OUTSIDE THE USA
Integrated Business Computers
21592 Marilla Street
Chatsworth, CA 91311
(213) 882-9007 TELEX NO. 215349

WITHIN THE USA
Integrated Business Computers
1140 36th Street, Suite 212
Ogden, Utah 84403
(801) 621-2294

Circle No. 192 for DEALERS.
The first thing ISI International put on this new Multibus card was 2 megabytes...

And that was just the beginning.

Squeezing 2 megabytes of memory onto a single Multibus card is quite an accomplishment in itself. But we believe it takes more than just memory to meet the increasing needs of today's systems. That's why our new MCB-2X Multibus card is designed with a number of significant special features. And why ISI International is truly a leader in Multibus memory products.

Superior Dynamic Memory Relocation.
The new MCB-2X can relocate up to eight 64K or 256K blocks independently - making it a very powerful tool for "RAM disk," graphics display or multiple table look-up applications.

Expanded Error Correction Logic.
All single bit errors are automatically scrubbed during refresh cycles without system interruption. And thanks to the automatic memory initialization feature, software doesn't have to be preconditioned.

Flexible Addressing Capabilities.
Board addresses starting on any 4K boundary can be mapped to cross 1 and 4 megabyte boundaries. The MCB-2X can also occupy a continuous 512K or 2048K memory space within its 16 megabyte range.

Look into ISI International's new MCB-2X. You'll find all the features you need... plus up to 2 megabytes of memory for the largest capacity available on a single card. Or, for non-volatile CMOS requirements, see our MCB-364 and MCB-332 modules. For simpler dynamic requirements, investigate our MCB-512.

Since 1970, ISI International has shipped over 10 billion bytes of memory cards, giving us a level of experience that's hard to match. Put it to work for you. For systems needs just call us in the West at (408) 743-4442, in the East (201) 272-3920, or in the Midwest call (513) 890-6450. For off-the-shelf products, contact your nearest ISI International distributor: Alliance, Anthem, Arrow, Future Electronics, R.A.E., Quality Components or Schwebec.

* Multibus is a Trade mark of Intel Corp.

MINI-MICRO SYSTEMS / July 1984
## DESKTOP PLOTTERS

<table>
<thead>
<tr>
<th>Company Corpo</th>
<th>Model</th>
<th>Plotter Type</th>
<th>Pens</th>
<th>Media</th>
<th>Paper Size (in)</th>
<th>Mechanical Resolution (dpi)</th>
<th>Compatible Software</th>
<th>Price (d)</th>
<th>Circle No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANNESMANN TALLY CORP.</td>
<td>PIXY 3 Microplotter</td>
<td>flatbed</td>
<td>water, oil-based fiber tip</td>
<td>8</td>
<td>paper, film</td>
<td>8½ x 11</td>
<td>003</td>
<td>RS232C, parallel</td>
<td>795</td>
</tr>
<tr>
<td>NICOLET ZETA CORP.</td>
<td>ZETA 8</td>
<td>drum</td>
<td>nylon tip liquid roller, film; liquid ink, ballpoint</td>
<td>8</td>
<td>translucent vellum, glossy bond, clear ink film, acetate film</td>
<td>11 x 50, 11 x 120</td>
<td>.001</td>
<td>Nicolet Zeta's proprietary software including FPS, Functional, Typset, ZCHART</td>
<td>5,950</td>
</tr>
<tr>
<td>NUMONICS</td>
<td>Model 5412</td>
<td>grit roller</td>
<td>fiber tip, ballpoint, liquid ink</td>
<td>1</td>
<td>cut sheet film, mylar</td>
<td>10 x 36</td>
<td>.005</td>
<td>RS232C, IEEE-488, Centronics</td>
<td>1,295</td>
</tr>
<tr>
<td>PANASONIC INDUSTRIAL CO.</td>
<td>VP-6801P</td>
<td>flatbed</td>
<td>oil-, water-based fiber tip, water-based plastic tip, water-based ballpoint</td>
<td>6</td>
<td>paper, transparency</td>
<td>7.2 x 10</td>
<td>.003</td>
<td>Apple Business Graphics, BPS, ChartMaster, GrafTalk, Curve II and others</td>
<td>1,565</td>
</tr>
<tr>
<td>PRINTACOLOR CORP.</td>
<td>TC 1040</td>
<td>printer/plotter</td>
<td>ink jet</td>
<td>4913</td>
<td>bond, high intensity paper, transparencies</td>
<td>85 dpi or 100 dpi (horiz) 85 dpi (vert)</td>
<td>16-20 drivers written for most popular models</td>
<td>RS232C, Centronics</td>
<td>5,495</td>
</tr>
<tr>
<td>PRINTRONIX INC.</td>
<td>MVP</td>
<td>printer/plotter</td>
<td>dot matrix</td>
<td>b&amp;w</td>
<td>paper</td>
<td>8½ x 11</td>
<td>IBM-PC software</td>
<td>RS232C, Centronics, Dataproducts</td>
<td>3,745</td>
</tr>
</tbody>
</table>
An open-and-shut case for making MiniFrame™ your first choice in low-cost OEM systems.

**Impressive CPU Speed.** Running the AIM™ Benchmark, MiniFrame is as fast as a VAX-11/750. The MiniFrame's MC68010 microprocessor operates at 10MHz, with no wait states.

**Virtual Memory Management.** MiniFrame's custom MMU provides unique demand-paged implementation of UNIX™ System V...with 3.5 Mbytes of address space per process.

**Runs as Many as 8 Terminals.** Convergent PT and/or GT, or standard ASCII. Multidrop RS-422 communications line operates at 307 Kbit/sec.

**Communications Expansion.** LAN capability via optional high-speed Ethernet interface module, and/or 8 additional RS-232 ports.

**Economical Memory Expansion.** MiniFrame provides ½ Megabyte of RAM standard; up to three boards can be added for system expansion to 2 Mb.

**One to Eight Users.** MiniFrame can be configured for up to 50 Megabytes of integral mass storage: 5¼" Winchester fixed disks of 13, 26 or 50 Mb.
MiniFrame: another first from Convergent Technologies. Super-minicomputer power at PC prices.

OEMs can now meet the needs of small to medium-sized organizations for low-cost, high-performance systems capable of handling large UNIX-based applications.

The MiniFrame system—which effectively opens a whole new market for you—is unique not just for its price/performance advantages. It also provides complete flexibility in meeting requirements ranging from single-user “personal UNIX systems” to eight-terminal data-processing installations.

Convergent Technologies achieved this breakthrough by adapting the innovative hardware and software developed for its MegaFrame multiprocessor.

The result is a powerful, compact and expandable unit priced to give you the maximum opportunity of capitalizing on a rapidly growing UNIX market.

There are, of course, many other unique benefits of the MiniFrame system.

Convergent provides foundation software for office applications—including a powerful, Wang keystroke-compatible word processor, an advanced financial spreadsheet and complete electronic mail facility.

The Window Manager permits viewing and manipulating of up to four applications running simultaneously on Convergent's PT or GT terminal screens.

Major performance increases result from utilizing these terminals with the MiniFrame. At only slightly higher cost than standard "dumb tubes", our PT or GT terminals offer high-speed communications plus built-in processor with enough memory to execute key portions of the system code.

Programming languages include industry-standard High Level COBOL and BASIC, full FORTRAN-77, Pascal and C.

OEM prices for the MiniFrame start at less than $5,000; an eight-user MiniFrame can be configured for under $10,000. Prices like these make it an open-and-shut case for choosing the MiniFrame.

Graceful upgrade path to the MegaFrame.

The MegaFrame, Convergent Technologies' revolutionary super-minicomputer system, utilizes multiple processors; has expansion potential to 128 users, 8 MIPS and gigabytes of disk storage. It enables OEMs to handle today's growing demand for computing services without discarding a single piece of hardware...or being forced into expensive CPU upgrades.

Applications software can be transported—unchanged—from the MiniFrame to the MegaFrame whenever the workload requires it. The two systems are object-code compatible, allowing OEMs to provide a complete family of systems.

MegaFrame: proof that if anyone can build a UNIX system the way it should be built—it's Convergent Technologies.
# DESKTOP PLOTTERS

<table>
<thead>
<tr>
<th>Company, Model</th>
<th>Plotter type</th>
<th>No. of pens</th>
<th>Plotting speed (ips)</th>
<th>Paper size (in.)</th>
<th>No. of characters available</th>
<th>Media type</th>
<th>Price (FY)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RADIO SHACK</strong></td>
<td>FP-215</td>
<td>flatbed</td>
<td>fiber tip</td>
<td>1</td>
<td>4</td>
<td>paper</td>
<td>10 x 14</td>
</tr>
<tr>
<td></td>
<td>CGP-115</td>
<td>platen</td>
<td>ballpoint</td>
<td>4</td>
<td>2½'</td>
<td>paper</td>
<td>4 inch roll</td>
</tr>
<tr>
<td><strong>RICOH OF AMERICA INC.</strong></td>
<td>GP-1</td>
<td>ballpoint</td>
<td>felt tip</td>
<td>4</td>
<td>4</td>
<td>7</td>
<td>continuous feed, cut roll paper</td>
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<tr>
<td><strong>ROLAND DG.</strong></td>
<td>DXY-800</td>
<td>flatbed</td>
<td>felt tip</td>
<td>8</td>
<td>7.5</td>
<td>bond, acetate</td>
<td>11 x 17</td>
</tr>
<tr>
<td></td>
<td>DXY-101</td>
<td>flatbed</td>
<td>felt tip</td>
<td>1</td>
<td>7.5</td>
<td>bond, acetate</td>
<td>11 x 17</td>
</tr>
<tr>
<td><strong>SANYO BUSINESS SYSTEMS CORP.</strong></td>
<td>PR 100 XY</td>
<td>modified</td>
<td>flatbed</td>
<td>4</td>
<td>4</td>
<td>paper</td>
<td>10 x 15</td>
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<tr>
<td><strong>SEIKO INSTRUMENTS U.S.A. INC.</strong></td>
<td>CH5201B</td>
<td>thermal ink</td>
<td>transfer</td>
<td>8</td>
<td>(8½ x 11 image takes 60 sec.) paper</td>
<td>transparencies</td>
<td>8½ x 11</td>
</tr>
<tr>
<td><strong>SHARP ELECTRONICS CORP.</strong></td>
<td>CE150</td>
<td>printer/plotter</td>
<td>ballpoint</td>
<td>4</td>
<td>1</td>
<td>roll paper</td>
<td>2.16</td>
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<tr>
<td></td>
<td>CES15P</td>
<td>printer/plotter</td>
<td>ballpoint</td>
<td>4</td>
<td>2</td>
<td>bond, transparencies</td>
<td>8.5</td>
</tr>
<tr>
<td><strong>SOLTEC DISTRIBUTION</strong></td>
<td>RY-1MZ</td>
<td>flatbed</td>
<td>ballpoint, fiber tip</td>
<td>6</td>
<td>15.75</td>
<td>paper, vellum</td>
<td>8½ x 11</td>
</tr>
</tbody>
</table>

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**MINI-MICRO SYSTEMS/July 1984**
ABLE's ATTACH customers enjoy their spaghetti in the dining room, not the computer room.

ABLE's ATTACH, the breakthrough multi-host terminal switching system for DEC UNIBUS computers that eliminates the spaghetti-like mess of cables in your computer room.

One ATTACH host board and a single cable replaces 16 DEC interfaces, and their associated "spaghetti." And it still supports up to 128 terminals on your system without the endless tangle of cables that tie up your computer room.

One ATTACH host board does the work of many multiplexers. The immediate advantage is a dramatic reduction in mounting space and expansion cabinetry, resulting in significant cost savings. And ATTACH can be located up to a kilometer away from your computer room.

Cook up a system to meet your present data communication requirements with ATTACH. At the touch of a keyboard, terminals can be dynamically switched among any combination of VAX and PDP-11 UNIBUS systems. And, ATTACH is compatible with RSX, RSTS/E, VMS and UNIX operating systems.

Expanding your capabilities, or adding terminals is easy with ATTACH. As your requirements grow simply add modular ATTACH units to your system.

Whether you have 28, or 128 or more terminals, ATTACH has the right recipe for cost-effective connectivity. ABLE Computer's ATTACH is the most efficient terminal interconnection system on the table.

Contact the ABLE representative near you, or call ABLE toll-free at 800-332-2253.

The communication specialists
For the first time, you can get three types of computer communications systems from just one company. Quadram.
Now Quadram Makes Communications as easy as 1, 2, 3.

When it comes to enhancement products for IBM® PCs and other personal computers, no one can beat Quadram. In fact, if you use spreadsheets or large databases, you're probably using a Quadram product already.

Now Quadram applies their expertise to communication devices. Not just modems, but a complete range of products that you can do anything from networking to enhancing your system. And both have call progress monitoring to automatically determine and compensate for different types of phone systems and transmission status (human voice, busy signal, data or dial tones). Of course, both plug directly from your computer into your phone jack.

Get the moderns with the name for quality. Quadram®. Fully compatible with Bell 103/212A dial-up modems and the most popular modem brands.

1. Quadmodem™
From your home or office, reach out and touch something.

Just because your computer is all alone, that doesn't mean it has to be lonely. Not when you've got Quadmodem.

Quadmodem is a complete intelligent modem package, including an integral or standalone modem with supporting documentation. Each modem comes with QuadTalk—a powerful communications software package plus an introductory offer from The Source.

Just pick the model that's right for you and your computer.

The Integral Unit drops into an IBM PC, XT, PCjr or Apple IIe. The Stand Alone is an intelligent modem that connects to your system through an RS-232 port.

Both have enhanced diagnostic capability to troubleshoot not only your system, but the system at the other end of the phone line. And both have call progress monitoring to automatically determine and compensate for different types of phone systems and transmission status (human voice, busy signal, data or dial tones). Of course, both plug directly from your computer into your phone jack.

Get the moderns with the name for quality. Quadram™. Fully compatible with Bell 103/212A dial-up modems and the most popular modem brands.

2. Quad3278™
Let an IBM PC communicate with an IBM mainframe.

To integrate your PC into a mainframe environment, look to Quadram first.

Because now you can have all the features of the IBM PC (mass storage and peripherals) plus the incredible power of a mainframe right at your desk. All it takes is Quadram's 3278 emulation package which includes hardware, software, even cabling.

To make your IBM PC emulate the 3278 Display Work Station, get the Quad3278.®

Once you're on-line the IBM mainframe sees you as just another 3278 terminal. Little does it know that you're actually a high-performance, intelligent work station, with all the functions of the Personal Computer. With mainframe support you can download data, process it on your PC, even store it on your own disk for later reference.

Make the connection from micro to mainframe. And back it up with Quadram quality. It's the logical step for the future.

3. Quadnet™
Turns your IBM PC's into a Local Area Network.

Local Area Networking (LAN) is one of the most interesting and useful ideas to come down the pike. Basically, it allows you to interlink a group of computers together so they can share information and peripherals with each other.

And now with Quadnet, you don't have to compromise your system to fit our system. Instead, you can easily link as few as two, or as many as 255 IBM PCs together in a hard-wired network. And you can configure them almost any way you want. They can work independently of each other or share resources and peripherals.

The possibilities are endless. But the important thing to remember is that Quadnet gives you a choice with four different Network Systems. Choose the one that meets your price and performance needs.

Quadnet grows as you grow. Yet the user commands stay the same, thanks to the upward compatibility of the Quadnet operating software.

Whichever version you hook on to, you get a complete package (hardware, software, and documentation). And most importantly, you get Quadram's reputation for quality.

QUADRAM QUALITY

At Quadram, we don't make personal computers. We just make them better. So insist on the Quadram name. It's your assurance that you're buying from one of the most established and involved companies in the microcomputer field. Ask your dealer about us.

MINI-MICRO SYSTEMS July 1984
THE BEST AD FOR THE EPM IS ONE IT PRINTS ITSELF

DIABLO FROM HAMILTON/AVNET

The print quality and speed of Diablo's new Electronic Printing Machine is approaching laser. But its price certainly is not. With our quantity pricing (for more than 10 units) it doesn't cost much more than a daisywheel printer.

The resolution of the EPM is 200 x 200 dots per inch. Yet it's extremely fast (up to 6 pgs per minute depending on mix of graphics and text) because it achieves high resolution without multiple passes. As you can see, it prints graphics, and text, including large type sizes. It's office-quiet, at less than 52 dBA, and interfacing is easy, even if you want it to be used by a whole group of personal computer users.

The EPM also fits in at a factory. It is ideal for printing such things as bar codes, because it doesn't overheat the gummed backs of labels. Its high speed and reliability are also very suited to the factory environment.

Call our Computer Product Specialists for evaluation and applications assistance. And be sure to ask about our leasing services, as well as our other computer products.
<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Penser Type</th>
<th>Pens</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>RY-10MZ</td>
<td>flatbed</td>
<td>ballpoint, fiber tip</td>
<td>10</td>
<td>paper, vellum 11 x 17</td>
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<tr>
<td>RY-1003</td>
<td>flatbed</td>
<td>ballpoint, fiber tip</td>
<td>4</td>
<td>paper, vellum 17 x 22</td>
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<tr>
<td>STROBE INC.</td>
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<tr>
<td>897-5A Independence Ave.</td>
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<tr>
<td>Mountian View, CA 94043</td>
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<td></td>
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<tr>
<td>(415) 969-5130</td>
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<td></td>
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<tr>
<td>M200</td>
<td>drum</td>
<td>felt tip (Pilot razor point)</td>
<td>1</td>
<td>paper, film 8 1/2 x 11</td>
</tr>
<tr>
<td>M260</td>
<td>drum</td>
<td>felt tip</td>
<td>8</td>
<td>paper, film 8 1/2 x 11</td>
</tr>
<tr>
<td>TEKTRONIX INC.</td>
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<tr>
<td>P.O. Box 500</td>
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<tr>
<td>Beaverton, OR 70777</td>
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<tr>
<td>(503) 627-7111</td>
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</tr>
<tr>
<td>4662 option 31</td>
<td>flatbed</td>
<td>plastic nib, liquid ink</td>
<td>8</td>
<td>paper, vellum, mylar, acetate, preprinted forms 11 x 17</td>
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<tr>
<td>4663</td>
<td>flatbed</td>
<td>fiber tip, hard nib, liquid ink</td>
<td>2</td>
<td>paper, mylar, acetate 17 x 22</td>
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<tr>
<td>VERSATEC</td>
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<tr>
<td>2770 Walsh Ave.</td>
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<tr>
<td>Santa Clara, CA 95051</td>
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<tr>
<td>(408) 986-2600</td>
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<tr>
<td>V-80</td>
<td>printer/plotter</td>
<td>electrostatic</td>
<td>15</td>
<td>paper, transparencies, films, vellum 11 x roll</td>
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<tr>
<td>WESTERN GRAPHTEC INC.</td>
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<tr>
<td>12 Chrysler St.</td>
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<tr>
<td>Irvine, CA 92714</td>
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<tr>
<td>800-854-3335</td>
<td></td>
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<tr>
<td>MP1000</td>
<td>flatbed</td>
<td>water-, oil-based or ink</td>
<td>6</td>
<td>paper, film A3 several</td>
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<tr>
<td>WX4731</td>
<td>drum</td>
<td>ballpoint, fiber tip</td>
<td>4</td>
<td>paper 11.3 width roll several</td>
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<tr>
<td>WX4630 Series</td>
<td>flatbed</td>
<td>ballpoint, fiber tip, ink drafting pens</td>
<td>1, 2, or 10</td>
<td>paper, film A3 several</td>
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<tr>
<td>DA8400</td>
<td>flatbed</td>
<td>ballpoint, fiber tip</td>
<td>6</td>
<td>paper, film A4 several</td>
</tr>
<tr>
<td>YOKOGAWA CORP. OF AMERICA</td>
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<tr>
<td>2 Dart Rd.</td>
<td></td>
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<tr>
<td>Shenandoah, GA 30265</td>
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<td></td>
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<tr>
<td>(404) 253-7000</td>
<td></td>
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</tr>
<tr>
<td>PL-1000</td>
<td>grit wheel</td>
<td>plastic tip, fiber tip</td>
<td>4</td>
<td>paper, mylar 10 x 15</td>
</tr>
<tr>
<td>PL-1000 (with Business Graphics EM)</td>
<td>grit wheel</td>
<td>plastic tip, fiber tip</td>
<td>4</td>
<td>paper, mylar 10 x 15</td>
</tr>
</tbody>
</table>
## DESKTOP PLOTTERS

<table>
<thead>
<tr>
<th>Company/Model</th>
<th>Plotter Type</th>
<th>Pens</th>
<th>Media</th>
<th>Price (£)</th>
<th>Circle to</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL-2000</td>
<td>flatbed</td>
<td>ceramic</td>
<td>paper, mylar</td>
<td>7 x 10</td>
<td>2.050 (Centronics)</td>
</tr>
<tr>
<td>PL-2000 (with Business Graph ROM)</td>
<td>flatbed</td>
<td>ceramic</td>
<td>paper, mylar</td>
<td>7 x 10</td>
<td>2.210 (Centronics)</td>
</tr>
</tbody>
</table>

### Single Board Computer

**6 MHz Z80**

**Fast, Powerful and Compact Microcomputers**
- 4 or 6 MHz Z80* CPU
- 2K to 64K ROM or EPROM
- Expandable RAM from 64K to 256K
- DMA for Floppy and Hard Disk Data Transfers
- 2/4 RS-232 Serial Ports
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CIRCLE NO. 108 ON INQUIRY CARD

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### Solid-State Disc Replacement

Dramatic increases in throughput. Outstanding reliability.

- Capacities to 80 megabytes
- 10 megabytes in 7-inch chassis
- Interfaces to most minicomputers
- Battery back-up

When used as a disc replacement, the high speed, non-rotating MegaRam provides the software compatibility of a disc with the performance of main memory. Ideal for swapping, scratch files, overlay storage, process control, telecommunications, graphics, data acquisition, array processing, etc.

Let us show you how the MegaRam can enhance the performance of your computer while providing outstanding reliability.
Confused about which Local Network to choose? You're not alone. In today's personal computer environment, new LANs seem to pop up daily, adding even more choices. And more questions.

Questions about performance, Price, Security, Expandability. And software availability. It isn't hard to see that multiple choice has become multiple guess.

We Provide The Answer. At Novell, we offer a unique new approach. An approach which answers the multiple choice question. We've taken our field-tested network operating system and made it work on all of today's LANs. ARCnet, Ethernet, OMNINET, proNET, PNet, G-NET. Even tomorrow's Anynet.

We call it NetWare™.

NetWare is designed to bring the user and software supplier together for maximum performance, security and functionality. No matter which LAN hardware you choose.

Software, Software And More Software. Because each LAN is different, today's leading software companies view NetWare as the single unifying answer to the multiple choice question. Many have become NetWare "Do It Once and For All" affiliates, adapting their software for application in multiuser NetWare environments.

Quickly. Easily. Uniformly. And only once for all LANs.

Novell Means Service. To serve the LAN market better, we've initiated a series of benchmark tests on all the major LAN configurations—both with the supplier's native operating system and with NetWare. The results are available now.

Interested? Give us a call to order your copy of the "LAN Benchmark Report." It's free. We'll also try to answer any questions you might have about personal computer networking. Call us at 1-800-LANKIND.
Information is power. So you can afford to speak softly when you rely on CDI/100, the powerful information management system.

CDI/100 includes a database management system with variable length fields and an open-ended file structure. You get tailored formatting and recordkeeping that's virtually limitless.

Our dynamic menu system leads you through the steps. You can create, access and retrieve files — even generate customized reports. Suddenly you’re handling vast quantities of information with ease.

Infact, CDI/100 even allows you to use a host of existing application programs, which protects your software investment while maximizing your
computer's usefulness and effectiveness.

And since all of these features are combined in just one package, CDI/100 is priced very competitively. Ask for a demonstration today, wherever you buy software.

**Exceptional New Software Concept**
- Everyone's Filing System
- English-like Inquiry Language
- Dynamic Menu System
- Integrated Help Features
- Relational Data Management
- Enhanced Basic Compiler
- Dictionary Supported Data Base
- Task Master

MINI-MICRO SYSTEMS/July 1984
TELEVIDEO MULTI-
TO EACH HIS OWN.

If you’ve had your share of sharing a personal computer, TeleVideo® Multi-User Computers mean the end of the line. From two users to 16, and even more, our systems offer the expandability and power to meet your growing needs.

OUR SYSTEMS GROW WITH YOUR BUSINESS.
And with TeleVideo it’s easy, inexpensive and controllable. You can add users to the systems with plug-in simplicity, when and where you need to. Secretaries and bosses can all share the same system without sharing the same computer. And by simply adding to your system as your business grows, your original investment is always protected.

3,000 SOFTWARE PROGRAMS AND MAIN-FRAME COMMUNICATION.
Our systems support industry standard software, so you’ll have access to nearly 3,000 very productive programs. And by emulating IBM® 3270 and 3780 terminals with additional TeleVideo software, you can even communicate with IBM mainframes.

However large or small your business, or department, TeleVideo offers a variety of multi-user computers that offer each user all the conveniences of a personal computer. And all the power of a computer network.

THE LOWEST COST PER USER.
The all-in-one system that’s the one for all, the TS 804 is completely integrated into a single desktop enclosure. The system can support up to four users and a wide selection of peripherals. And it’s all available for the lowest cost-per-user on the market: under $1500.

TO EACH HIS OWN PROCESSOR.
A powerful desktop micro computer system, the TS 806 offers all the conveniences of the TS 804 and even more throughput. With the ability to

The TS 816: Up to 16 users

IBM is a registered trademark of International Business Machines Corp.
provide true multi-user capabilities for up to six stations, any combination of TeleVideo 8 and 16-bit personal computers can be supported by the TS 806.

UP TO 16 USERS AND 16-BITS.
Up to 16 workstations can be used with the TS 816, creating a flexible multi-tasking system. Any combination of 8 and 16-bit personal computers can be supported, with or without local storage.

THE WORLD'S LEADING MANUFACTURER.
TeleVideo is the leader in multi-user computers and the number one independent manufacturer of terminals. And from systems to peripherals to service and support, only TeleVideo offers you the convenience of a single-vendor solution.

For more information, call 800-538-8725 (in California, 800-345-8008).

TeleVideo Multi-User Computers. To each his own.
A lot of terminal manufacturers have tried to copy our ergonomic design

In 1980 when Tandberg Data introduced the TDV 2200 family, they were the first and only terminals in the world meeting the stringent specifications of the 1985 German Ergonomic Standard—a standard set to protect the safety, health and comfort of the operator. The TDV 2200 includes such features as tilt, swivel, height adjustment, ultra-low profile, detachable keyboard for comfort of operation, non-reflective surfaces, and anti-reflex tube for screen clarity. Since its introduction and as a testimonial to its innovative design, over 50,000 units have been installed. Today, there are a lot of “me-too” terminal manufacturers who have tried to copy our ergonomic design and that’s certainly a plus for the industry. But, with our new TDV 2200S, an even improved version, it will be a lot tougher to copy our performance.

The TDV 2200S can emulate virtually any popular terminal and protocol. It can be equipped with up to 56k bytes of memory and some models will store up to eight pages of data. It has superb communications capabilities including networking; up to 1024 different characters in a single terminal; optional high resolution business graphics; a 70Hz refresh rate for flicker-free viewing; and a 15” screen and big letters for easy readability.

Like its predecessor, the TDV 2200S also features sixteen soft switches called PUSH keys that recall previously stored words, phrases or code sequences; a simplified menu protocol that cuts set-up time in half; and character, page, block or line/field transmission. No other terminal on the market today can match all of these features. But, they are probably trying.

So, you can wait while they try to catch up with us, or you can go with the terminal that sets the pace for the industry.

Tandberg Data, Inc., P.O. Box 99, Labriola Court, Armonk, N.Y. 10504. Phone: (914) 273-6400. Telex: 137357 Tanberg Arnk.
Mid-range CAD/CAM/CAE systems dominate graphics display terminals

Falling prices and increased performance help trigger increased demand for mid-range CAD/CAM/CAE systems

Paul Sniger, Senior Editor

Computer-aided design (CAD), computer-aided manufacturing (CAM) and computer-aided engineering (CAE) with all their ramifications—from solids-modeling to robotics—represent rapidly growing uses of graphics. New CAD/CAM/CAE systems in the high-, mid- and low-range are offering higher speed, upward compatibility and increased performance at lower prices. Industrial applications currently provide the best target for graphics terminals and particularly for color graphics terminals.

Defining the field

System integrators purchase CAD/CAM/CAE systems to aid either in system integration or to resell the systems after adding value to the hardware or software. CAD/CAM/CAE systems permit the modeling, design, drafting and manufacture of products under computer control. For example, CAD systems use computers and graphics display terminals, allowing designers to create, draft, analyze and manipulate products on a screen in 2-D or 3-D. CAE systems do more than CAD; they include computational and modeling capability. CAE systems simulate entire systems or products in the computer, whereas CAD/CAM systems address only the physical description of a product. By using a system model, CAE iteratively analyzes and tests functional characteristics such as noise, shelf life and vibration. This analysis minimizes the need for engineering and manufacturing prototypes.

According to Kenneth Bosomworth, president of research company International Resource Development (IRD) Corp., Norwalk, Conn., there are about 20 CAE workstations on the market. But more companies are rapidly entering the CAE market. “When you

By year-end, IBM will surpass Computervision in market share by a slight margin, Daratech estimates. Revenues from CAD/CAM/CAE are expected to hit $2.4 billion this year, $3.4 billion in 1985 and $4.2 billion in 1986.
consider that the average engineer is making $45,000 to $55,000 per year,” says Bosomworth, “and that his work is increasing in complexity, the need for CAE is becoming stronger.” Bosomworth points out that CAE workstations are sold in standalone configurations, and all have some communication support, although some require connection to a larger computer. The companies having extensive in-house CAE experience, says Bosomworth, are IBM Corp., Digital Equipment Corp. and Hewlett-Packard Co., “and this will give them an edge.”

CAM systems oversee the work flow in manufacturing facilities and control production machinery, thus speeding the design-to-production cycle. These systems may be categorized in several ways.

Proponents of large-scale engineering computation use terminals remote from a host mainframe. This setup provides the integrated ability to support design, drafting and heavy computation. The output results are then delivered to manufacturing. Automatic drafting system integrators use CAD/CAM systems as minicomputer- or microcomputer-based drafting/design aids with standalone capability.

However, implementations of large-scale engineering computation are often single-function, department-level solutions to short-term problems rather than part of a corporate overall long-range plan. “As a result, 80 percent of CAD systems are used for drafting,” states Alan Christman, general manager of the Computer

Integrated Manufacturing Division of Control Data Corp. (CDC), Minneapolis. “In fact, CAD is so often thought of as a drafting tool that the acronym CAD is often read as ‘computer-aided drafting’ rather than ‘computer-aided design.’”

CAD/CAM application categories include mechanical design and manufacturing and architecture, engineering and construction (AEC). New CAD/CAM application categories are growing and include fields such as education and graphics design.

Systems are segmented into three price categories: the low range, which includes mostly IBM PC- and Apple Computer Inc.-based systems priced at less than $20,000; the mid-range, which includes minicomputer-based systems priced at $20,000 to $60,000; and the high range, which generally includes mainframe-based systems priced at $60,000 to more than $1 million.

The low end—personal-computer-based systems selling for less than $20,000—is experiencing the most rapid growth. Systems in this category are usually limited to 2-D capability and to drafting applications. Mid-range systems that sell for less than $60,000 are workstation-based, with the processor in the station. These systems were previously limited to drafting; however, the newer 32-bit workstations provide greater performance. The mid-range category is experiencing the most activity and is even eroding the high end. The more sophisticated high-end systems are often integrated into host-based systems traditionally found
What's the best recommendation you can make when you're asked about business graphics?

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MINI-MICRO SYSTEMS/July 1984
Why buy a **VISUAL 102** instead of a DEC VT102?

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The new **VISUAL 102** gives full DEC VT102* performance and more features at a much lower price. Plus, when you need it, a Graphics Option card turns the VISUAL 102 into a 768 x 293 resolution graphics terminal emulating the Tektronix 4010/4014. Just insert the card and immediately you have high resolution graphics compatible with a variety of available software packages.

VISUAL 102. The low cost, DEC VT102 compatible terminal that lets you graph now or graph later.

The UL listed VISUAL 102 exceeds FCC Class A requirements and U.S. Government standards for X-ray emissions.
in automotive and aerospace applications. Their prices typically include workstations, computers, plotters and software.

**Workstations standardize**

CAD/CAM workstations and graphics displays in particular entail user/system interaction. A workstation consists of a high-resolution, direct-view storage or raster-scan CRT; a keyboard; user-programmable function keys; and input units such as light pens, voice synthesis, mice, track balls, control disks, thumb wheels and digitizer pads.

The CAD/CAM industry is in the midst of change. CAD/CAM manufacturers are broadening their lines, and companies that once specialized in mid-range systems are offering high-end systems. Meanwhile, traditional high-end system makers are moving downward. One example is Applicon, Burlington, Mass., which traditionally sold only high-end systems priced in the $100,000 to $1 million range. Recognizing the growth opportunities in mid-range systems and the need to round out its line in the face of a trend toward integrated systems and compatibility, Applicon is offering new systems at around $50,000. However, the company is not neglecting the power of its line.

Applicon's recently introduced 32-bit Bravo! system includes application software that allows interactive solids, surface and finite-element modeling as well as flat-pattern and numerical-control tool-path generation. The software is offered unbundled to DEC-supplied VAX-11/780 users; Applicon's use of DEC software signals a departure from Applicon's traditional turnkey operation.

Another trend in the industry is toward **graphics software standardization**. Because value added is typically taking the form of algorithms for software modeling and shaded-color 3-D images, software is becoming more of a concern to users. System users worry that they will lose their software equity when acquiring new systems because graphics software is in a state of flux.

Thus, graphics standards are needed. The 2-D Graphical Kernel System (GKS) software and the Virtual Device Interface (VDI) standards are a start. However, GKS fails to address some developments in solids modeling and shaded-color surfaces.

Typifying the trend toward graphics standard operating systems, Lundy Electronics & Systems Inc., Glen Head, N.Y., provides full GKS functionality on monochrome and color graphics terminals in its 6100 series. Megatek Corp. and Spectragraphics Corp., both in San Diego, provide partial GKS implementations.

Another trend is toward **user friendliness and simple training**. Reliable training programs are expensive. In 1982, CAD/CAM training for basic operating skills required an industry investment of $200 million in

---

**CAD/CAM/CAE market growth accelerates**

After a depressed 28 percent annual CAD/CAM/CAE market growth rate in 1982 and early 1983, '83 finished with a 32 percent rate; in fact, total 1983 revenues exceeded $1.7 billion. According to Daratech Inc., a Cambridge, Mass., research company, it is likely that the 1984 growth rate will exceed 40 percent. These statistics demonstrate that the number of vendors selling CAD/CAM/CAE systems in the United States increased dramatically—up from only 20 in 1980 to more than 100 in 1983, and companies are entering the field almost weekly.

Although projections differ slightly, other market research companies unanimously confirm this dramatic growth. International Data Corp., Framingham, Mass., for one, predicts that CAD/CAM/CAE sales will approach $2 billion in 1984 and $3.48 billion by 1986, and most of those will be color systems. Ray Barger, vice president of marketing and sales at Spectragraphics Corp., San Diego, states, "The number of color terminals in use just for solids modeling and robotics applications should grow between 35 percent and 40 percent per year."
### MAGNETIC TAPE OF COMPLETE DATABASE

For those marketers who wish to receive all the information and be able to generate their own analysis, the complete database is available on magnetic tape. Data includes:

- **1983 Expenditures** for minicomputers, microcomputers, peripherals, and software.
- **1984 Estimated Expenditures** for minicomputers, microcomputers, peripherals, and software.
- **Geographical Regions**
- **Type of Organization**
- **Minicomputers/Microcomputers purchased in 1983 and those installed in prior years:**
  - Vendor name and model number
  - Units acquired
  - Major applications
- **Minicomputers/Microcomputers planned 1984 purchases:**
  - Vendor name and model number
  - Units planned to be acquired
  - Major applications
  - Sites planning to change major vendor
  - Fail-safe computer operations
  - Electronic office functions

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- **Northern California & Northwest (408) 243-8838**
- **Southeast (404) 955-6500**

### PRESELECTED LISTS AND MAILING LABELS

All selections are available as a listing or as cheshire or pressure sensitive labels. Cross tabulations of categories are also available.

**Site Selection**  
**Site Count**

- Total sites surveyed: 8,511
- Sites by planned 1984 expenditure levels:
  - $50,000-99,999: 4,829
  - $100,000-249,999: 3,582
  - $250,000-499,999: 2,218
  - $500,000 or more: 1,403
- Sites planning to install integrated electronic office functions in 1984: 1,642
- HOT PROSPECTS...Sites planning to change major vendors in 1984: 1,085
- Value-added OEMs and third parties: 3,110
- Value-added user sites: 4,813

### 13th ANNUAL MINI-MICRO COMPUTER MARKET REPORT

All data is available in a 200-plus page bound report for $495. In addition to an executive summary, the report's tables include:

- 1983 Unit expenditures
- Type of Organization
- Geographical Regions
- Current Computer Vendors
- 1984 plans for:
  - Switching vendors
  - Unit expenditures
  - Fail-safe computer operations
  - Electronic office functions

For more information on prices, list selections, and the MINI-MICRO SYSTEMS Market Report, fill out and send the coupon below.

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For whatever system you're designing, there's already an advanced color graphics system to go with it. Either the economical, easy to use VX128A or the versatile VX384A with its 16.8 million color palette and 512 simultaneously viewable colors.

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The Vectrix VX128A and VX384A, part of an expanding line of products that do the job better, including the Midas System for the IBM PC XT and the Vectrix Paint Program.

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A third dimension.

Which means now you can buy 3D Megateknology starting for under $12,000. For instance, the Whizzard 1600 desktop design terminals with color or monochrome capabilities, very high resolution and VT-100™ compatibility.

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Then there's the ultimate computer graphics system: the Whizzard 7200. It guarantees remarkable speed and flexibility, modular architecture that supports high resolution and real-time dynamic color raster displays, and unmatched interactive graphics capabilities.

Plus, with every one of our products you get Megateknology—our longstanding trademark of innovative design, quality and high reliability.

There's a whole new dimension to our Whizzard family, thanks to the latest in 3D Megateknology.

Watch it add more dimension to your creativity.

That's Megateknology.™

See us at SIGGRAPH, Booth 606, July 24-26.
salaries. CDC expects the training cost to exceed $500 million next year.

To simplify training, the Graphics Processor from Telesis Corp., Chelmsford, Mass., replaces complicated I/O devices, computer languages and esoteric commands with simple English commands. The Graphics Processor, which was introduced late last year, sells for less than $70,000 and offers easy-to-use advanced functions such as roam, zoom, world window and user-definable color priority. Located just below the workstation is a proprietary function screen that appears as an array of squares. By touching these squares with a light pen, users can simulate a velocity joystick. Thus, users can rapidly or slowly roam about the stored picture. A zoom-control feature permits single, double or quadruple magnification, permitting detailed editing. The world-window feature permits users to switch within ½ second between a window and a world view of the picture, with the window highlighted in the world-view mode. To aid visualization in such applications as printed-circuit board design, users can assign various colors to different layers of a design.

CAD systems are typically based on second-party processors. Two companies, Auto-Trol Technology Corp., Denver, and Calma Co., Santa Clara, Calif., base their products on Apollo Computer Inc.'s color workstations. But developing application-specific software is growing more costly, and hardware from small CAD makers is becoming more sophisticated. These two developments are sparking a trend among CAD system software developers toward designing their own hardware.

Color graphics resolution increases

A growing factor in the CAD/CAM/CAE market is IBM, a newcomer that has chalked up impressive gains. Its limitations in solids modeling and electronic design notwithstanding, IBM's model 3250 workstation captured a 19.2 percent 1983 market share, and IBM may surpass industry leader Computervision Corp. this year, according to research company Daratech Inc., Cambridge, Mass.

A major force in the emerging market for terminals with 1,024-by-1,024-pixel and higher resolution, IBM's 5080 graphics system is a high-performance raster-scan intelligent workstation that can display 256 color hues or gray shades simultaneously.

Increasing screen resolution from 512 by 512 to 1,024 by 1,024 pixels meant that IBM had to increase processing power fourfold. This increase grows as colors are added and resolution increases. Keeping large amounts of data in a host computer or a networked Winchester drive thus becomes less satisfactory because of speed limitations in transferring bulk data rapidly across RAM or hard disk interfaces that handle serial processing.

According to Hiram French, vice president of marketing for Megatek, terminal makers will offer products that significantly increase the resolution of color graphics beyond the current maximum of 1,024 by 1,024 pixels with 16 colors out of a palette of 4,096 colors. This trend is producing more standalone capability.

In addition, terminals are becoming more powerful and self-reliant. Ray Barger, vice president of marketing and sales for Spectragraphics, agrees with French and adds, "Host-dependent terminals will eventually die out. The economics of putting the computer within the workstation will cause that to happen." Another trend, says Barger, is that individual users will increasingly want their own computing capability: "This will be another factor in the demise of the less-powerful terminals." French believes there are performance and color trade-offs in designing color terminals. Adding colors to a terminal's color palette does not provide certain high-performance features, he says, adding that "Megatek opted to increase performance via rapid refresh rates instead of by adding colors."

As for IBM, Charles Foundyller, president of Daratech, says that "IBM is moving to become a major OEM supplier of computers and workstations in the CAD/CAM/CAE industry and is moving into a market previ-
Serious problems plague system integrators and users, however. Newcomers find CAD/CAM difficult to learn and use. It involves costly training programs, steep learning curves and endless training: systems become obsolete so rapidly that ongoing programs are required even for experienced users. Furthermore, universities typically cannot afford to buy up-to-date CAD/CAM systems to train users. Thus, it falls to the CAD/CAM companies to pay for training users and system integrators, who are in short supply.

Users and system integrators, wary of incompatibility problems, won't commit massive capital funds to systems they don't understand and are afraid may go underused. The proliferation of databases and systems from different vendors plus a lack of communications between systems and software have resulted in expensive and time-consuming inefficiencies. Many companies claim to offer integrated capabilities but merely use sophisticated file-transfer systems.

There are exceptions, however, such as Applicon's Bravo! system with its common, integrated database that offers users the ability to link design, analysis, drafting and manufacturing. This integrated-database approach ensures consistency and security, so that created data can be used for engineering applications.

One example of the trend toward increased functionality and integration is Computervision's recently introduced CDS 3000, which offers a high degree of interaction with applications and databases residing on larger systems. CDS 3000 interacts with central CAD/CAM/CAE systems, including technical publications, facilities management and graphics and text distribution to the factory floor. "CAD/CAM/CAE workstation users require a mix of graphics applications and non-graphics functions," states Computervision president James Berrett.

Computervision has revitalized its R&D and is looking outside the company for software, hardware and expertise to shorten development time. Prices of Computervision's IBM 4300-based CDS 4000 Version 2 high-performance multiuser system start at $250,000; the single-user CDS 3000 starts at $35,000. The CDS 4000 is another example of Computervision's new direction: it was developed jointly with Sun Microsystems Inc., Mountain View, Calif.

Another totally integrated solution is CDC's integrated computer-aided engineering and manufacturing (ICEM) approach. ICEM tailors CAD/CAM consulting, training, support, services and systems to each manufacturer's needs. Rather than simply sell systems, ICEM provides total support, offering users immediate access to sophisticated CAD/CAM at CDC application centers in major U.S. cities.

Because CDC has extensive manufacturing experience, its consultants can assist users in the design and manufacture of products. The advantages are that users lacking in-house CAD/CAM systems or capability can become immediately involved in CAD/CAM. In addition, system integrators seeking to acquire CAD/CAM capability can do so without committing themselves to massive capital expenditures. Furthermore, users with their own terminals or workstations can gain access to a full range of powerful ICEM programs through the Cybernet data services network.

As the volume, complexity and growth of CAD/CAM requirements increase, ICEM provides a natural growth path. As users progress and the shift to acquisition becomes cost-justifiable, they can begin purchasing what they need. For example, the ICEM 120-40 entry-level design/drafting system sells for less than $50,000; the system can interface with Cybernet for added capability.

The total integrated approach is proving successful with users and system integrators. According to Dara-tech, CDC's CAD/CAM/CAE system and service sales in 1983 grew 46.4 percent over the previous year, with 1984 expected to exceed that rate.

---

**WORKSTATION PRICES TAKE A TUMBLE**

In 1980, the prices of workstation-based systems ranged from $80,000 to $100,000. This year, the price range is expected to be $20,000 to $80,000. In 1988, prices are projected to be $2,500 to $20,000.

Interest Quotient (Circle One)

High 834 Medium 835 Low 836
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Data Sentry logs all attempted contacts for audit trails and analysis of users. Its security set-up is locally controlled by a master password that is accessible only to authorized personnel. And its design includes high-reliability components, the latest LSI circuitry, plus Autodial 300/1200 baud full-duplex communications, with auto ranging for incoming data.

Data Sentry will deal with your toughest security problems.

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<table>
<thead>
<tr>
<th>FEATURE COMPARISON</th>
<th>VISION 2200</th>
<th>VISION 2200</th>
</tr>
</thead>
<tbody>
<tr>
<td>VT220 Command Set</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>Function System Memory</td>
<td>256</td>
<td>1024</td>
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<tr>
<td>Programmable Functions (PF)</td>
<td>16</td>
<td>64</td>
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<td>PF in VT100 Mode</td>
<td>0</td>
<td>64</td>
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<td>Data Routing From Function Keys</td>
<td>NO</td>
<td>YES</td>
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<td>Non-Volatile Function Memory</td>
<td>NO</td>
<td>YES</td>
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<td>Four-Page Memory</td>
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<td>Eight-Page Memory Option</td>
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<td>Bi-Directional Printer Port</td>
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<td>Dual Set Up Tables</td>
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<td>Dual Host Support</td>
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<td>YES</td>
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<tr>
<td>Composite Key</td>
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<td>YES</td>
</tr>
<tr>
<td>Graphics Option</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
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**PRICE QUANTITY ONE**

|            | $1295 | $1245 |

* Based on latest information supplied by manufacturer. ** Not applicable.
# GRAPHICS DISPLAY TERMINALS

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Display (diagonal)</th>
<th>Display resolution</th>
<th>Alpha numerics screen no.</th>
<th>Memory (max)</th>
<th>Interface (protocols)</th>
<th>Emulations</th>
<th>Unit Price (U.S.)</th>
<th>Notes, Features, Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADAGE INC.</td>
<td>3000</td>
<td>19-inch, 16M-color palette</td>
<td>1024x1024</td>
<td>program-</td>
<td>DMA interfaces to most minicomputers (PIO, DMA, NTSC)</td>
<td>18,200</td>
<td></td>
<td>Model 4115 is a 2D model, models 4135 and 4145 are 3D models</td>
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<tr>
<td></td>
<td>4100 Series</td>
<td>21-inch, blue</td>
<td>22x3000</td>
<td>program-</td>
<td>DMA interfaces to most minicomputers</td>
<td>42,920</td>
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<tr>
<td>ADVANCED ELECTRONICS DESIGN INC. (AED)</td>
<td>1024</td>
<td>19-inch, 256-color with 16.7M-palette</td>
<td>1024x768</td>
<td>85x69 (5x6, 7x9, 10x12, 14x18)</td>
<td>RS232C, DMA, RS170 (X-on/X-off)</td>
<td>anti-aliasing, reference grid; opt. rack-mount</td>
<td>7,495</td>
<td>opt. rack-mount version with 19-inch screen</td>
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<tr>
<td></td>
<td>512</td>
<td>13-inch, 256-color with 16.7M-palette</td>
<td>512x483</td>
<td>85x69 (5x7, 7x9)</td>
<td>RS232C, DMA, RS170 (X-on/X-off)</td>
<td>opt. rack-mount version with 19-inch screen</td>
<td>9,995</td>
<td>anti-aliasing, reference grid; opt. rack-mount version with 19-inch screen</td>
<td></td>
</tr>
<tr>
<td>AMALGAMATED WIRELESS LTD.</td>
<td>8602V</td>
<td>14-inch, monochrome, green, amber, white or 8-color</td>
<td>640x480</td>
<td>80x25 (7x9)</td>
<td>RS232C, RS422, current loop (X-on/X-off, bissync)</td>
<td>DEC VT100, Honeywell VIP7700, Univac U200, Datapoint 8227</td>
<td>2,995</td>
<td>opt. 19-inch, rack-mount</td>
<td></td>
</tr>
<tr>
<td>ASEA INDUSTRIAL SYSTEMS</td>
<td>TESSELATOR 8100, 8300, 8400</td>
<td>13-, 19-, 25-inch, 64-color</td>
<td>720x336</td>
<td>120x56 (user-defined)</td>
<td>RS232C, RS422, RS449, current loop (ECMA-24, X.25/2)</td>
<td>on board modems, Intl character sets; zoom, pan, bar graph, windowing, multichannel support</td>
<td>3,995</td>
<td>scaled and clipped windows, display list storage and management; opt. 16 programmable function keys</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AYCON 17</td>
<td>13-inch, 8-color</td>
<td>560x336</td>
<td>80x48 (5x5, 5x7, 7x14, 6x16)</td>
<td>RS232C (TTY, Bissync)</td>
<td>Intecolor 8001G</td>
<td>2,995</td>
<td>opt. 19-inch, rack-mount</td>
<td></td>
</tr>
<tr>
<td>CHROMATICS INC.</td>
<td>4200</td>
<td>13-inch, 16-color with 4096-color palette</td>
<td>512x384</td>
<td>85x48 (5x7)</td>
<td>RS232C, opt. parallel, RGB (X-on/X-off)</td>
<td>scaled and clipped windows, display list storage and management; opt. 16 programmable function keys</td>
<td>6,995</td>
<td>scaled and clipped windows, display list storage and management; opt. 16 programmable function keys</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4300</td>
<td>13-inch, 16-color with 4096-color palette</td>
<td>1024x768</td>
<td>170x96 (5x7, 10x14)</td>
<td>RS232C, opt. parallel, RGB (X-on/X-off)</td>
<td></td>
<td>1,895</td>
<td>simulated pan and zoom, split screen</td>
<td></td>
</tr>
<tr>
<td>CIE TERMINALS</td>
<td>CIT414</td>
<td>12-inch, green</td>
<td>640x480</td>
<td>80x34 (7x9)</td>
<td>RS232C, current loop (X-on/X-off, RTS/CTS)</td>
<td>Tektronix 4010, 4014, 4016</td>
<td>2,995</td>
<td>simulated pan and zoom, split screen</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CIT467</td>
<td>12-inch, 8-color</td>
<td>570x480</td>
<td>132x24 (7x9, 9x9)</td>
<td>RS232C, current loop (X-on/X-off, RTS/CTS)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td>1,895</td>
<td>simulated pan and zoom, split screen</td>
<td></td>
</tr>
<tr>
<td>CIFER</td>
<td>2841</td>
<td>12-inch, green, orange</td>
<td>1024x256</td>
<td>128x32 (7x7, 9x9)</td>
<td>dual RS232C (X-on/X-off, DTR/CTS)</td>
<td>Tektronix 4010</td>
<td>screen dump, reprogrammable keyboard, non-volatile storage of keyboard, character set and communications parameters</td>
<td>2,995</td>
<td></td>
</tr>
</tbody>
</table>

MINI-MICRO SYSTEMS: July 1984 235
### GRAPHICS DISPLAY TERMINALS

#### COLORGRAPHIC COMMUNICATIONS

<table>
<thead>
<tr>
<th>Company Model</th>
<th>Model</th>
<th>Display (diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode screen format</th>
<th>Graphics characters</th>
<th>Interconnect (protocols)</th>
<th>Equivalents</th>
<th>Unit Price ($)</th>
<th>Notes, accessories, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVI-100, model 113</td>
<td>13-inch, 8-color</td>
<td>160x240</td>
<td>80x48 (7x9)</td>
<td>RS232C, (X-on/X-off)</td>
<td>ADDS Regent 40, IBM 3101, Hazeltine 1510, Lear Siegler ADM-3</td>
<td>2,750</td>
<td>split screen, scaling, multiple pages, rack-mount, 128 ASCII line drawing character set</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MVI-100, model 119</td>
<td>19-inch, 8-color</td>
<td>160x240</td>
<td>80x48 (7x9)</td>
<td>RS232C, (X-on/X-off)</td>
<td>ADDS Regent 40, IBM 3101, Hazeltine 1510, Lear Siegler ADM-3; DEC VT52, VT100</td>
<td>3,250</td>
<td>split screen, scaling, multiple pages, rack-mount, 128 ASCII line drawing character set</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MVI-100, model 813</td>
<td>13-inch, 8-color</td>
<td>160x192</td>
<td>80x48 (7x7)</td>
<td>RS232C, (X-on/X-off)</td>
<td>ISC 8001G, DEC VT100, VT52</td>
<td>3,000</td>
<td>process control character set, 24 programmable function keys, 4 split screens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MVI-100, model 819</td>
<td>19-inch, 8-color</td>
<td>160x192</td>
<td>80x48 (7x7)</td>
<td>RS232C, (X-on/X-off)</td>
<td>ISC 8001G, DEC VT100, VT52</td>
<td>3,500</td>
<td>process control character set</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MVI-100, model 489</td>
<td>19-inch, 8-color</td>
<td>640x480</td>
<td>80x48 (7x9)</td>
<td>RS232C, DEC VT100, VT52; ADDS Regent 40, IBM 3101, Hazeltine 1510, Lear Siegler ADM-3</td>
<td>5,500</td>
<td>clipping, scaling, windowing, rack-mount; opt. RGB output</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MVI-7</td>
<td>13-inch, 8-color</td>
<td>720x288</td>
<td>80x24 (7x9)</td>
<td>RS232C, RS422, current loop (X-on/X-off)</td>
<td>ADDS Regent 40, IBM 3101, Hazeltine 1510, Lear Siegler ADM-3; DEC VT52, VT100</td>
<td>3,500</td>
<td>4 split screens, clipping, scaling, windowing; opt. RGB output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MVI-7, model 719</td>
<td>18-inch, 8-color</td>
<td>720x288</td>
<td>80x24 (7x9)</td>
<td>RS232C, RS422, current loop (X-on/X-off)</td>
<td>ADDS Regent 40, IBM 3101, Hazeltine 1510, Lear Siegler ADM-3; DEC VT52, VT100</td>
<td>4,000</td>
<td>4 split screens, clipping, scaling, windowing; opt. RGB output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XL-13</td>
<td>13-inch, 8-color</td>
<td>640x480</td>
<td>80x48 (7x9)</td>
<td>RS232C, (X-on/X-off)</td>
<td>DEC VT52</td>
<td>3,000</td>
<td>clipping, scaling, windowing, rack-mount; opt. RGB output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XL-19</td>
<td>19-inch, 8-color</td>
<td>640x480</td>
<td>80x48 (7x9)</td>
<td>RS232C, (X-on/X-off)</td>
<td>DEC VT52</td>
<td>3,500</td>
<td>clipping, scaling, windowing, rack-mount; opt. RGB output</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### CYBERNEX LTD.

<table>
<thead>
<tr>
<th>Model</th>
<th>Display (diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode screen format</th>
<th>Graphics characters</th>
<th>Interconnect (protocols)</th>
<th>Equivalents</th>
<th>Unit Price ($)</th>
<th>Notes, accessories, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1014</td>
<td>14-inch, green</td>
<td>1024x780</td>
<td>146x780 (5x7)</td>
<td>dual RS232C, Centronics</td>
<td>Tektronix 4010, 4012, 4014, 4015</td>
<td>2,685</td>
<td>supports Microsoft mouse, Summagraphics bit pad</td>
<td></td>
</tr>
</tbody>
</table>

#### DATAMEDIA CORP.

<table>
<thead>
<tr>
<th>Colors Model</th>
<th>Display (diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode screen format</th>
<th>Graphics characters</th>
<th>Interconnect (protocols)</th>
<th>Equivalents</th>
<th>Unit Price ($)</th>
<th>Notes, accessories, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colors Model 10 graphics</td>
<td>12-inch, 64-color</td>
<td>640x240, 640x480</td>
<td>132x24 (7x9)</td>
<td>RS232C, CCITT-V.24 current loop (X-on/X-off)</td>
<td>DEC VT52, 100; Tektronix 4027, 4010</td>
<td>polygon fill, circle/pie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colors Model 30 graphics</td>
<td>12-inch, 64-color</td>
<td>640x240, 640x480</td>
<td>132x24 (7x9)</td>
<td>RS232C, CCITT-V.24 current loop (X-on/X-off)</td>
<td>Lear Siegler ADM-3A, Hazeltine 1420, ADDS Regent 25, Tektronix 4027, 4010</td>
<td>polygon fill, arc/pie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colors Model 60 graphics</td>
<td>12-inch, 64-color</td>
<td>640x240, 640x480</td>
<td>132x24 (7x9)</td>
<td>RS232C-C, CCITT-V.24, opt. current loop (X-on/X-off)</td>
<td>DEC VT52, 100, 131, 132, Tektronix 4027, 4010</td>
<td>polygon fill, circle/pie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colors Model 70 graphics</td>
<td>12-inch, 64-color</td>
<td>640x240, 640x480</td>
<td>132x24 (7x9)</td>
<td>RS232C-C, CCITT-V.24, opt. current loop (X-on/X-off)</td>
<td>Data General 6055, 6053, Dashier 100, 200, Tektronix 4027, 4010</td>
<td>polygon fill, circle/pie</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### DATA TYPE LTD.

<table>
<thead>
<tr>
<th>Model</th>
<th>Display (diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode screen format</th>
<th>Graphics characters</th>
<th>Interconnect (protocols)</th>
<th>Equivalents</th>
<th>Unit Price ($)</th>
<th>Notes, accessories, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>XK19</td>
<td>19-inch</td>
<td>1024x1024</td>
<td>132x24 (10x13)</td>
<td>RS232C, (X-on/X-off, DTR)</td>
<td>DEC VT100, Tektronix 4014, TeleVideo 925</td>
<td>random pattern fill mode by seeding, auxiliary I/O ports</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### DATAVUE CORP.

<table>
<thead>
<tr>
<th>Model</th>
<th>Display (diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode screen format</th>
<th>Graphics characters</th>
<th>Interconnect (protocols)</th>
<th>Equivalents</th>
<th>Unit Price ($)</th>
<th>Notes, accessories, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>DV132C</td>
<td>13-inch, green</td>
<td>1056x240</td>
<td>132x24 (5x9)</td>
<td>RS232C, (X-on/X-off, bsync)</td>
<td>DEC VT100</td>
<td>1,795</td>
<td>opt. rack-mount</td>
<td></td>
</tr>
<tr>
<td>215</td>
<td>13-inch, 8-color with 64-color palette</td>
<td>640x409</td>
<td>132x24 (7x18)</td>
<td>RS232C, (X-on/X-off, DTR/CTS)</td>
<td>DEC VT100, Tektronix 4014</td>
<td>3,450</td>
<td>opt. mouse, RGB output</td>
<td></td>
</tr>
</tbody>
</table>
More professional software is duplicated on FORMASTER than any other system.

All the best known software publishers have chosen FORMASTER systems for diskette duplication and piracy protection because they're fast, flexible, and easy to use. Plus, they are proven reliable and cost effective.

Copies over 300 per hour
FORMASTER systems duplicate up to 326 fully verified copies per hour. That's ten times faster than a microcomputer. And with a FORMASTER jam-proof automatic loader, you can cut handling time by up to 90%.

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Easy, reliable operation
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The first choice
FORMASTER has the complete solution for software production: handling, duplicating and labeling. So, for more about the diskette duplicators that have become the first choice of all the best known software publishers, contact the sales department at FORMASTER Corporation, 1983 Concourse Drive, San Jose, CA 95131. Telephone (408) 942-1771.

INTERMEC introduces SQUARE MATRIX label printing.

WITH THE NEW INTERMEC SQUARE MATRIX PRINTER YOU GET SUPERIOR PRINT QUALITY AND TOTAL FORMAT FLEXIBILITY AT DOT MATRIX PRICES.

The new SQUARE MATRIX 8625 prints bar code and human readable text from a series of tight fitting squares. These squares virtually eliminate the gaps, ragged edges and grayness so common to dot matrix printing. Since the 8625 SQUARE MATRIX is a thermal printer, variations in image density are eliminated giving you superior printing quality with every label. The result: The SQUARE MATRIX 8625 gives you bar code labels with optimum scanning performance plus maximum print format flexibility.

ONE UNLIMITED FORMAT, SQUARE MATRIX 8625 DOES THE WORK OF 10 PRINTERS.

The 8625 gives you the ability to print multiple bar codes in up to 10 different formats: two are pre-programmed and eight are user programmable.

SQUARE MATRIX 8625 PRINTS ANYTHING, ANYWHERE, ANY SIZE.

Print any height label up to 3 1/4” high. Bar code height can vary up to the full height of the label. Three different text fonts, special graphics, lines, boxes and logos can be printed in any direction or magnification any place on the label.

SQUARE MATRIX 8625 PRINTS THE MAJOR BAR CODES.

CODE 39, CODE 93, Interleaved 2 of 5, 2 of 5, CODE 11, and Codabar, all with high density capability, are pre-programmed within the 8625. Even UPC/EAN is printed in most popular densities.

USER FRIENDLY PROMPTING MAKES SQUARE MATRIX LABEL FORMATS EASY TO DEVELOP.

Anybody can do it. Just plug it in and the user friendly prompting menu allows even untrained personnel to design custom formats quickly. Using standard interfaces, the 8625 operates with most mini computers and CRT terminals.

THE SQUARE MATRIX 8625 PRINTS LABELS ON DEMAND.

The 8625 delivers single labels as needed or in batches in straight through or spooled form with no paper waste.

SQUARE MATRIX PRINTERS OFFER BEST RELIABILITY.

With only one active moving part, a stepper motor, the 8625 eliminates mechanical trouble spots. The 8625’s printhead is warranted up to five years when using INTERMEC’s quality DURATHERM™ label stock.

SMALL SIZE, SMALL PRICE, UNLIMITED FLEXIBILITY AND QUALITY MAKE SQUARE MATRIX THE LOGICAL CHOICE.

The compact 8625 takes very little space at a work station and even less from your budget. To find out more, contact INTERMEC Corporation, 4405 Russell Road, P.O. Box 360602, Lynnwood, WA 98036-9702. Call 206/743-7036. TELEX: U.S. 152447, Int’l (ITT) 4740080.

INTERMEC
The industrial bar code experts.

For Literature, Circle Number 193.
For Demonstration, Circle Number 194.
<table>
<thead>
<tr>
<th>Company/Model</th>
<th>Display (diagram)</th>
<th>Display resolution</th>
<th>Additional screen font character set</th>
<th>Interface protocols</th>
<th>Emulations</th>
<th>Unit price ($)</th>
<th>Key features optional</th>
</tr>
</thead>
<tbody>
<tr>
<td>220</td>
<td>13-inch, 16-color with 4096-color palette</td>
<td>640x480</td>
<td>132x24 (7x18)</td>
<td>RS232C, (X-on/X-off, DTR/CTS)</td>
<td>DEC VT100, Tektronix 4014</td>
<td>4,950</td>
<td>opt. mouse, graphics tablet, RGB output</td>
</tr>
<tr>
<td>230</td>
<td>13-inch, 16-color with 4096-color palette</td>
<td>640x409</td>
<td>132x24 (7x18)</td>
<td>RS232C, (X-on/X-off, DTR/CTS)</td>
<td>DEC VT100, Tektronix 4014</td>
<td>6,950</td>
<td>mouse, graphics tablet, opt. RGB output</td>
</tr>
<tr>
<td>239</td>
<td>19-inch, 16-color with 4096-color palette</td>
<td>640x480</td>
<td>132x24 (7x18)</td>
<td>RS232C, (X-on/X-off, DTR/CTS)</td>
<td>DEC VT100, Tektronix 4014</td>
<td>9,450</td>
<td>mouse, graphics tablet, RGB output</td>
</tr>
</tbody>
</table>

**FALCO DATA PRODUCTS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display</th>
<th>Resolution</th>
<th>Additional font character set</th>
<th>Interface</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAME 100</td>
<td>12-inch, green, amber</td>
<td>640x285</td>
<td>132x24 (6x10)</td>
<td>RS232C, opt. RS422, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td>1,195</td>
<td>split screen; opt. 14-inch screen</td>
</tr>
<tr>
<td>TS100/132G</td>
<td>12-inch, green, amber</td>
<td>640x285</td>
<td>132x24 (6x10)</td>
<td>RS232C, opt. RS422, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td>1,095</td>
<td>split screen</td>
</tr>
</tbody>
</table>

**GENISCO COMPUTERS CORP.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display</th>
<th>Resolution</th>
<th>Additional font character set</th>
<th>Interface</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-1000</td>
<td>19-inch, b&amp;w</td>
<td>1024x792</td>
<td>146x66 (7x12, 8x13, 12x20, 13x22)</td>
<td>RS232C</td>
<td>DEC VT100, Tektronix 4014</td>
<td>9,950</td>
<td>area delete, erase, programmable keys; opt. alphanumeric overlay</td>
</tr>
<tr>
<td>G-2200</td>
<td>19-inch, 16-color with 4096-color palette</td>
<td>1024x792</td>
<td>146x66 (7x12, 8x13, 12x20, 13x22)</td>
<td>RS232C, RS422 (X-on/X-off)</td>
<td>Tektronix 4014, DEC VT100</td>
<td>12,950</td>
<td>area delete, erase, programmable keys, overlay</td>
</tr>
</tbody>
</table>

**GRAPHON**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display</th>
<th>Resolution</th>
<th>Additional font character set</th>
<th>Interface</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>GO-140</td>
<td>12-inch, green</td>
<td>512x390</td>
<td>80x24 (9x12)</td>
<td>RS232C, (X-on/X-off, DTR)</td>
<td>DEC VT100; Tektronix 4010, 4012, 4013</td>
<td>1,995</td>
<td>4 pages of memory</td>
</tr>
</tbody>
</table>

**GRINNELL SYSTEMS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display</th>
<th>Resolution</th>
<th>Additional font character set</th>
<th>Interface</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>2800 SERIES</td>
<td>19-inch, up to 16M-color palette</td>
<td>512x512, 480x512, 512x640, 480x640</td>
<td>(16x16)</td>
<td>RS232C, DMA interfaces to DEC LSI-11, PDP-11, VAX, and most other minis</td>
<td>DEC VT100, Tektronix 4027, IBM 3278, 3270, RJE, SNA</td>
<td>30,000–60,000</td>
<td>joystick, mouse, graphics tablet, 19-inch rack-mount, 24 card slots</td>
</tr>
<tr>
<td>270 SERIES</td>
<td>19-inch, up to 16M-color palette</td>
<td>480x512, 512x512</td>
<td>(5x7, 7x9)</td>
<td>DMA interfaces to DEC LSI-11, PDP-11, VAX, and most other minis</td>
<td>DEC VT100, Tektronix 4010, 4012, 4013</td>
<td>10,000–60,000</td>
<td>joystick, mouse, 19-inch rack-mount, 12 card slots in chassis</td>
</tr>
</tbody>
</table>

**HMW DATA SYSTEM GMBH**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display</th>
<th>Resolution</th>
<th>Additional font character set</th>
<th>Interface</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>14-inch, 4096-color palette</td>
<td>1024x1024</td>
<td>80x48 (9x14)</td>
<td>RS232C, current loop, Centronics (X-on/X-off)</td>
<td>DEC VT100, Tektronix 4027, IBM 3278, 3270, RJE, SNA</td>
<td>opt. 19-inch display</td>
<td></td>
</tr>
</tbody>
</table>

**HMW ENTERPRISES INC.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display</th>
<th>Resolution</th>
<th>Additional font character set</th>
<th>Interface</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>9081</td>
<td>19-inch, 8-color</td>
<td>480x384</td>
<td>90x48 (5x7, 5x14)</td>
<td>RS232C, current loop (X-on/X-off, DTR)</td>
<td>DEC VT100, ISC 8001G</td>
<td>5,000</td>
<td>opt. rack-mount slides</td>
</tr>
<tr>
<td>9083-S</td>
<td>13-inch, 8-color</td>
<td>480x384</td>
<td>80x48 (5x7, 5x14)</td>
<td>RS232C, current loop (X-on/X-off, DTR)</td>
<td>DEC VT100, ISC 8001G</td>
<td>4,045</td>
<td>opt. RS170 output, current loop port, second RS232C port</td>
</tr>
<tr>
<td>9203</td>
<td>13-inch, 8-color</td>
<td>480x384</td>
<td>80x48 (5x7, 5x14)</td>
<td>RS232C, current loop (X-on/X-off)</td>
<td>DEC VT100, ISC 8001G</td>
<td>oil, dust and watertight housing, membrane keyboard; opt. 16 programmable function keys, special graphics characters</td>
<td></td>
</tr>
<tr>
<td>9204</td>
<td>13-inch, 8-color</td>
<td>480x384</td>
<td>90x48 (5x7, 5x14)</td>
<td>RS232C, current loop (X-on/X-off, DTR)</td>
<td>DEC VT100, ISC 8001G</td>
<td>7,995</td>
<td>opt. 32K byte RAM, 32K byte ROM</td>
</tr>
</tbody>
</table>

**HUMAN DESIGNED SYSTEMS INC.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display</th>
<th>Resolution</th>
<th>Additional font character set</th>
<th>Interface</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept GVT +</td>
<td>12-inch, amber, green, white</td>
<td>250x512</td>
<td>132x25 (5x9, 7x11)</td>
<td>RS232C, current loop (X-on/X-off, DTR/CTS)</td>
<td>Tektronix 4010, DEC VT100</td>
<td>1,895</td>
<td>46 programmable function keys, non-volatile memory</td>
</tr>
<tr>
<td>Concept GVT-AFL +</td>
<td>12-inch, amber, green, white</td>
<td>250x512</td>
<td>132x25 (5x9, 7x11)</td>
<td>RS232C, current loop (X-on/X-off, DTR/CTS)</td>
<td>DEC VT100, Tektronix 4010, 4013</td>
<td>2,095</td>
<td>46 programmable function keys, non-volatile memory</td>
</tr>
</tbody>
</table>

MINI-MICRO SYSTEMS: July 1984
## GRAPHICS DISPLAY TERMINALS

<table>
<thead>
<tr>
<th>ID SYSTEMS CORP.</th>
<th>Display Size (diagonals)</th>
<th>Display Resolution</th>
<th>Alpha Mode Screen Font</th>
<th>Interface (Protocol)</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Notes, Features, Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID-100VB SP</td>
<td>12-inch, 8-color</td>
<td>608x480</td>
<td>RS232C, RS170, TTL levels, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td>4,895; 4,995</td>
<td>split-screen capabilities, screen dump</td>
<td></td>
</tr>
<tr>
<td>ID-100VE LP</td>
<td>14-inch, 8-color</td>
<td>1280x480</td>
<td>RS232C, RS170, TTL levels, current loop, NTSC (X-on/X-off, RTS/CTS)</td>
<td>DEC VT100; Tektronix 4010, 4014, 4027</td>
<td>3,895</td>
<td>eight viewports, four independent plane controls, 64K-bytes display list memory, all keys redefinable, screen dump</td>
<td></td>
</tr>
<tr>
<td>ID-100 MVA</td>
<td>12-inch, 8 shades of gray</td>
<td>512x256</td>
<td>RS232C, RS170, TTL levels, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td>2,895</td>
<td>split-screen capabilities, screen dump</td>
<td></td>
</tr>
<tr>
<td>ID-100 VA</td>
<td>12-inch, 8-color</td>
<td>512x256</td>
<td>RS232C, RS170, TTL levels, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td>3,895</td>
<td>split-screen capabilities, screen dump</td>
<td></td>
</tr>
<tr>
<td>IMLAC</td>
<td>8000</td>
<td>19-inch, green</td>
<td>RS232C (X-on/X-off)</td>
<td>Tektronix 4014</td>
<td>1,735</td>
<td>calligraphic, bit-pad, opt. light pen, multibus</td>
<td></td>
</tr>
<tr>
<td>INDUSTRIAL DATA TERMINALS</td>
<td>2200</td>
<td>19-inch, 8-color</td>
<td>512x512</td>
<td>RS232C, parallel, current loop (X-on/X-off)</td>
<td>11,995</td>
<td>rack-mount, color printer interface</td>
<td></td>
</tr>
<tr>
<td>INDUSTRIAL DATA TERMINALS</td>
<td>2250</td>
<td>19-inch, 8-color</td>
<td>512x512</td>
<td>RS232C, parallel, current loop (X-on/X-off)</td>
<td>16,595</td>
<td>rack-mount, color printer interface</td>
<td></td>
</tr>
<tr>
<td>INTECOLOR</td>
<td>2427</td>
<td>13-inch, 8-color</td>
<td>RS232C, opt. current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010</td>
<td>1,995</td>
<td>opt. 12 function keys, RS232C printer port</td>
<td></td>
</tr>
<tr>
<td>VHR-19</td>
<td>19-inch, 8-color</td>
<td>1024x768</td>
<td>RS232C, opt. RS343A, current loop</td>
<td>DEC VT100; Tektronix 4010, 4014, 4014-1</td>
<td>3,995</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E8001G</td>
<td>19-inch, 64-color</td>
<td>180x192</td>
<td>RS232C, opt. current loop</td>
<td>2,745</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E8001 R</td>
<td>19-inch, 64-color</td>
<td>480x384</td>
<td>RS232C, opt. current loop</td>
<td>3,975</td>
<td>bit-mapped graphics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTERGRAPH CORP.</td>
<td>19-inch, 256-color</td>
<td>1280x1024</td>
<td>RS232C, RS432 (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010</td>
<td>28,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITHACA INTERSYSTEMS INC.</td>
<td>GRAPHOS I</td>
<td>13-inch, 16-color</td>
<td>640x480</td>
<td>RS232C (X-on/X-off, DTR)</td>
<td>DEC VT100; Tektronix 4010</td>
<td>6,995</td>
<td>16 independent display windows, reference grid</td>
</tr>
<tr>
<td>ITHACA INTERSYSTEMS INC.</td>
<td>GRAPHOS II</td>
<td>13-inch, 16-color</td>
<td>640x480</td>
<td>RS232C (X-on/X-off, DTR)</td>
<td>DEC VT100; Tektronix 4010</td>
<td>3,995</td>
<td>16 independent display windows, reference grid; 19-, 25-inch screens</td>
</tr>
<tr>
<td>ITHACA INTERSYSTEMS INC.</td>
<td>GRAPHOS III</td>
<td>13-inch, 16-color</td>
<td>640x480</td>
<td>RS232C (X-on/X-off, DTR)</td>
<td>DEC VT100; Tektronix 4010</td>
<td>4,995</td>
<td>16 independent display windows, reference grid; opt. 19-, 25-inch screens</td>
</tr>
<tr>
<td>ITHACA INTERSYSTEMS INC.</td>
<td>GRAPHOS IV</td>
<td>13-inch, 256-color</td>
<td>640x480</td>
<td>RS232C (X-on/X-off, DTR)</td>
<td>DEC VT100; Tektronix 4010</td>
<td>16</td>
<td>16 independent display windows, reference grid; opt. 19-, 25-inch screens</td>
</tr>
<tr>
<td>JAPAN COMPUTER CORP.</td>
<td>NJC-M1000</td>
<td>12-inch, green, amber</td>
<td>640x486</td>
<td>RS232C, Centronics (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td>3,995</td>
<td>selective erase, screen dump, mixed text and graphics</td>
</tr>
</tbody>
</table>

MINI-MICRO SYSTEMS July 1984
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<table>
<thead>
<tr>
<th>Company/Model</th>
<th>Display size</th>
<th>Display resolution</th>
<th>Alpha ch/Color</th>
<th>Interconnect (protocol)</th>
<th>Emulations</th>
<th>Unit price (US)</th>
<th>Notes/Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJC-M1401 II</td>
<td>14-inch, green, amber</td>
<td>1032x780</td>
<td>86x30 (12x26)</td>
<td>RS232C, Centronics, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td></td>
<td>three graphics pages, selective erase, screen dump, mixed text and graphics</td>
</tr>
<tr>
<td>NJC-C2022</td>
<td>19-inch, 16-color with 27-color palette</td>
<td>1024x780</td>
<td>84x30 (9x15)</td>
<td>RS232C, Centronics, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td></td>
<td>selective erase, screen dump, mixed text and graphics, color table manipulation</td>
</tr>
<tr>
<td>NJC-M1414</td>
<td>14-inch, green, amber</td>
<td>1032x780</td>
<td>86x30 (12x26)</td>
<td>RS232C, Centronics, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td></td>
<td>screen dump, mixed text and graphics, windows</td>
</tr>
<tr>
<td>NJC-C1441</td>
<td>14-inch, 8-color with 27-color palette</td>
<td>1024x780</td>
<td>84x30 (12x26)</td>
<td>RS232C, Centronics, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td></td>
<td>screen dump, mixed text and graphics, color table manipulation, selective erase</td>
</tr>
<tr>
<td>NJC-C1431</td>
<td>14-inch, 16-color with 27-color palette</td>
<td>1024x780</td>
<td>84x30 (9x15)</td>
<td>RS232C, Centronics, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td></td>
<td>selective erase</td>
</tr>
<tr>
<td>NJC-C1421</td>
<td>14-inch, 16-color with 27-color palette</td>
<td>1024x780</td>
<td>84x30 (9x15)</td>
<td>RS232C, Centronics, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td></td>
<td>selective erase</td>
</tr>
<tr>
<td>KEL INC.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J1014</td>
<td>14-inch, green</td>
<td>1024x780</td>
<td>146x65 (5x7, 10x14)</td>
<td>RS232C, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td></td>
<td>selective alpha and graphics erase, supports Japanese Katakana; opt. printer</td>
</tr>
<tr>
<td>J1014C</td>
<td>14-inch, 8-color</td>
<td>1024x780</td>
<td>146x65 (5x7, 10x14)</td>
<td>RS232C, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td></td>
<td>selective alpha and graphics erase, supports Japanese Katakana; opt. printer</td>
</tr>
<tr>
<td>J1019C</td>
<td>19-inch, 8-color</td>
<td>1024x780</td>
<td>146x65 (5x7, 10x14)</td>
<td>RS232C, current loop (X-on/X-off)</td>
<td>DEC VT100; Tektronix 4010, 4014</td>
<td></td>
<td>selective alpha and graphics erase, supports Japanese Katakana; opt. printer</td>
</tr>
<tr>
<td>LEAR SIEGLER INC., DATA PRODUCTS DIV.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADM-3AG</td>
<td>12-inch, green, amber, b&amp;w</td>
<td>512x250</td>
<td>80x24 (5x7)</td>
<td>RS232C, opt. current loop</td>
<td>Tektronix 4010</td>
<td></td>
<td>selective erase, write through mode, block fill</td>
</tr>
<tr>
<td>ADM-5G</td>
<td>12-inch, green, amber, b&amp;w</td>
<td>512x250</td>
<td>80x24 (5x7)</td>
<td>RS232C, opt. current loop</td>
<td>Tektronix 4010, ADM-3A</td>
<td></td>
<td>selective erase, write through mode, block fill</td>
</tr>
<tr>
<td>ADM-11G</td>
<td>12-inch, green, amber</td>
<td>512x250</td>
<td>80x25 (7x10)</td>
<td>RS232C, opt. current loop, RS422 (X-on/X-off, DTR)</td>
<td>Tektronix 4010, 4014; Lear Siegler ADM-3A, ADM-5</td>
<td></td>
<td>4 programmable function keys, graphics printer output; opt. 14-inch monitor</td>
</tr>
<tr>
<td>ADM-12G</td>
<td>12-inch, green, amber</td>
<td>512x250</td>
<td>158x25 (7x10)</td>
<td>RS232C, opt. current loop, RS422 (X-on/X-off, DTR)</td>
<td>Tektronix 4010, 4014; Lear Siegler ADM-3A, ADM-5, ADM-31, ADM-32</td>
<td></td>
<td>16 programmable non-volatile function keys, graphics printer output, block mode; opt. 14-inch screen</td>
</tr>
<tr>
<td>LEXIDATA CORP.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2400</td>
<td>19-inch, white</td>
<td>1280x1024</td>
<td>160x85 (7x9, 14x18, 21x27, 28x36)</td>
<td>RS232C</td>
<td>Tektronix 4014</td>
<td>9,900</td>
<td>12 programmable function keys, 4 variable-sized workspaces</td>
</tr>
<tr>
<td>2410</td>
<td>19-inch, 16-color with 4096-color palette</td>
<td>1290x1024</td>
<td>160x85 (7x9, 14x18, 21x27, 28x36)</td>
<td>RS232C</td>
<td>Tektronix 4014</td>
<td>13,600</td>
<td>12 programmable function keys, 4 variable-sized workspaces</td>
</tr>
<tr>
<td>LYNWOOD INTERNATIONAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alpha Colour</td>
<td>15-inch, 4096</td>
<td>400x396</td>
<td>100x30 (7x11, 10x14)</td>
<td>RS232C (X-on/X-off, bisync)</td>
<td>DEC VT100; Tektronix 4010, IBM 3274, 3279</td>
<td></td>
<td>character sets — 544 total characters available</td>
</tr>
<tr>
<td>Alpha Graphic</td>
<td>15-inch, green</td>
<td>1000x396</td>
<td>100x30 (7x11, 10x14)</td>
<td>RS232C</td>
<td>Tektronix 4014</td>
<td></td>
<td>character sets — 544 total characters available</td>
</tr>
<tr>
<td>MATROX ELECTRONIC SYSTEMS LTD.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GXT-1000</td>
<td>19-inch, 16-color with 256-color palette</td>
<td>1024x1024</td>
<td>84x30 (12x26)</td>
<td>RS232C, RS449, parallel</td>
<td>Tektronix 4113</td>
<td>13,345</td>
<td>rackmount or desktop versions; supports as many as 64 independent viewports and four dialog areas</td>
</tr>
<tr>
<td>Company</td>
<td>Model</td>
<td>Display (inches)</td>
<td>Display resolution</td>
<td>Alpha mode</td>
<td>Graphics format</td>
<td>Interface (protocol)</td>
<td>Emulations</td>
</tr>
<tr>
<td>--------------</td>
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<tr>
<td>MEGATEK CORP.</td>
<td>3355</td>
<td>19-inch, 16-color with 4096-color palette</td>
<td>1024x1024</td>
<td>113x75 (36x54)</td>
<td>RS232C, IEEE-488</td>
<td>DEC VT100, Tektronix 4014</td>
<td>opt. video output, hardcopy device</td>
</tr>
<tr>
<td></td>
<td>7250</td>
<td>19-inch, 16-color with 4096-color palette</td>
<td>512x512</td>
<td>85x56 (48x72)</td>
<td>RS232C, IEEE-488, DEC Unibus (X-on/X-off)</td>
<td>Tektronix 4014</td>
<td>opt. video output, hardcopy device</td>
</tr>
<tr>
<td>MEMOREX CORP.</td>
<td>2079</td>
<td>15-inch, 4- and 7-color</td>
<td>132x27 (9x12)</td>
<td>bissy, SNA/SELG;</td>
<td>IBM 3279 all models</td>
<td>IBM graphics and software</td>
<td></td>
</tr>
<tr>
<td>PDS TECHNOLOGIES INC.</td>
<td>2150</td>
<td>15-inch, green</td>
<td>768x585</td>
<td>80x24 (7x11)</td>
<td>RS232C, current loop (X-on/X-off, DTR)</td>
<td>DEC VT52, VT100; Tektronix 4010, 4014; Lear Siegler ADM-3A</td>
<td>parallel port, ruggedized and sealed for use in industrial environments</td>
</tr>
<tr>
<td>PHOENIX COMPUTER GRAPHICS INC.</td>
<td>768-TM</td>
<td>19-inch, 256-color with 16.8M-color palette</td>
<td>768x1365</td>
<td>96x48 (8x8)</td>
<td>RS232C, RS422, Centronics, IEEE-488, (X-on/X-off, bissy)</td>
<td>Tektronix 4010</td>
<td>four- or eight-plane image memory, anti-aliasing; opt. zoom and pan</td>
</tr>
<tr>
<td></td>
<td>1024-TM</td>
<td>19-inch, 256-color with 16.8M-color palette</td>
<td>1024x1024</td>
<td>80x64</td>
<td>RS232C, RS422, Centronics, IEEE-488, (X-on/X-off, bissy)</td>
<td>Tektronix 4010</td>
<td>four- or eight-plane image memory, anti-aliasing; opt. zoom and pan</td>
</tr>
<tr>
<td>PSITECH</td>
<td>319</td>
<td>19-inch, 8-color</td>
<td>512x512</td>
<td>85x48 (5x7)</td>
<td>dual RS232C (X-on/X-off)</td>
<td>DEC VT52, VT100; Tektronix 4010; Lear Siegler ADM-3</td>
<td>variable character size, 32 programmable function keys</td>
</tr>
<tr>
<td></td>
<td>329</td>
<td>19-inch, 16-color with 4096-color palette</td>
<td>512x512</td>
<td>85x48 (5x7)</td>
<td>dual RS232C (X-on/X-off)</td>
<td>DEC VT52, VT100; Tektronix 4010; Lear Siegler ADM-3</td>
<td>variable character size, 32 programmable function keys</td>
</tr>
<tr>
<td></td>
<td>214</td>
<td>14-inch, 8-color</td>
<td>512x512</td>
<td>85x48 (5x7)</td>
<td>dual RS232C (X-on/X-off)</td>
<td>DEC VT52, VT100; Tektronix 4010; Lear Siegler ADM-3</td>
<td>variable character size, 32 programmable function keys</td>
</tr>
<tr>
<td></td>
<td>224</td>
<td>14-inch, 16-color with 4096-color palette</td>
<td>512x512</td>
<td>85x48 (5x7)</td>
<td>dual RS232C (X-on/X-off)</td>
<td>DEC VT52, VT100; Tektronix 4010; Lear Siegler ADM-3</td>
<td>variable character size, 32 programmable function keys</td>
</tr>
<tr>
<td></td>
<td>314</td>
<td>14-inch, 8-color</td>
<td>512x512</td>
<td>85x48 (5x7)</td>
<td>dual RS232C (X-on/X-off)</td>
<td>DEC VT52, VT100; Tektronix 4010; Lear Siegler ADM-3</td>
<td>variable character sets, 32 programmable function keys; opt. 60K-bytes RAM</td>
</tr>
<tr>
<td></td>
<td>419</td>
<td>19-inch, 8-color</td>
<td>512x512</td>
<td>85x48 (5x7)</td>
<td>dual RS232C (X-on/X-off)</td>
<td>DEC VT52, VT100; Tektronix 4010; Lear Siegler ADM-3</td>
<td>buried Winchester disk storing up to 160 pages, variable character size, 32 programmable function keys</td>
</tr>
<tr>
<td>QUME CORP.</td>
<td>QVT211GX</td>
<td>14-inch, green</td>
<td>644x288</td>
<td>80x24 (7x9)</td>
<td>RS232C; opt. current loop (X-on/X-off, DTR)</td>
<td>Tektronix 4010, 4014, 4027; DEC VT125</td>
<td>split-screen; opt. amber</td>
</tr>
<tr>
<td>RAMTEK</td>
<td>6211</td>
<td>13-inch, 16-color with 94-color palette</td>
<td>640x480</td>
<td>80x24 (8x10)</td>
<td>RS232C, Centronics (X-on/X-off, bissy, DTR)</td>
<td>DEC VT52</td>
<td>RGB output, opt. rack-mount, 640x512 display resolution</td>
</tr>
</tbody>
</table>
UNIX IS A DINOSAUR
CP/M® & MS-DOS™ ARE TOYS

MULTI SOLUTIONS PRESENTS
THE WORLD'S FIRST
4th GENERATION
OPERATING SYSTEM

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• NETWORKING
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• VSAM
• B-tree
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• FULL SCREEN EDITING
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MINI-MICRO SYSTEMS/July 1984
The only reason you're not using Pioneer's disk drive tester already.

If you still haven't seen the Pioneer hard disk drive tester in action, it's time to take a look. And judge for yourself.

Beginning with the price tag, every aspect of the Pioneer Qualifier™ is designed to meet your requirements for pocketbook and performance.

It's the only tester to interface with any and all SMD drives.

It's the only one with a hefty 20-megabit per second capability. Even at triple the price.

It's the only one that can read and transfer Fujitsu's error map right into your computer. In seconds.

It's the only one that will format to your custom specs. And it does it at one megabyte per second. Over five times faster than by computer.

It pinpoints your errors to a specific media sector. And separates the correctable from the uncorrectable. So you can detect and log either set.

Have you ever seen a tester that does all that?

And also checks the address mark capability of your drive? And isolates intermittents in the output? And works with embedded servos? And can be multiplexed to test four drives at once?

The Pioneer Qualifier does all those things. And easily, at that.

It's almost turnkey. It's totally programmable through the simplified keyboard. And you can input a custom set of drive characteristics with no EPROMS to modify or boards to change.

Plus, there's even a standard RS232 port for remote operation, data printout, uploading and downloading.

Call Pioneer for a demonstration today. It's an eye opener.

Pioneer Research, 1745 Berkeley St., Santa Monica, CA 90404.
(800) 233-1745 (outside California).
(800) 848-1745 (in California). Rep opportunities available.
<table>
<thead>
<tr>
<th>Company Model</th>
<th>Display (Diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode (8 characters)</th>
<th>Interface (Protocols)</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Notes, features, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>6221</td>
<td>13-inch, 16-color with 64-color palette</td>
<td>640x480</td>
<td>132x48 (8x10)</td>
<td>RS232C (X-on/X-off, DTR)</td>
<td>DEC VT100</td>
<td>5.995</td>
<td>RGB output; opt. rack-mount</td>
</tr>
<tr>
<td>6411</td>
<td>19-inch, 16-color with 4096-color palette</td>
<td>1280x1024</td>
<td>80x51 (8x10)</td>
<td>RS232C (X-on/X-off, bisync, DTR)</td>
<td></td>
<td>14.995</td>
<td>opt. 256-color with 16M-color palette</td>
</tr>
</tbody>
</table>

**RASTER TECHNOLOGIES INC.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display (Diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode (8 characters)</th>
<th>Interface (Protocols)</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Notes, features, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>One/25-S</td>
<td>19-inch, 16.7M-color</td>
<td>512x512</td>
<td>128x66 vector character defaults to (5x7)</td>
<td>RS232C; IEEE-488; opt. DMA to DEC PDP-11 VAX and most hosts (X-on/X-off)</td>
<td>Tektronix 4014</td>
<td>20,000–23,000</td>
<td>display list, local segments, local clipping, solids modeling primitives, rack-mount</td>
</tr>
<tr>
<td>One/40</td>
<td>19-inch, 64-color with 16.7M-color palette</td>
<td>1024x1024</td>
<td>128x66 vector character defaults to (5x7)</td>
<td>RS232C; IEEE-488; opt. DEC Unibus, VAX bus (X-on/X-off)</td>
<td>Tektronix 4014</td>
<td>10,000–17,000</td>
<td>display list, local segments, local clipping, rack-mount</td>
</tr>
<tr>
<td>One/60</td>
<td>19-inch, 64-color with 16.7M-color palette</td>
<td>768x576</td>
<td>128x66 vector character defaults to (5x7)</td>
<td>RS232C; IEEE-488; opt. DEC Unibus, VAX bus (X-on/X-off)</td>
<td>Tektronix 4014</td>
<td>10,000–17,000</td>
<td>local clipping, display list, rack-mount</td>
</tr>
<tr>
<td>One/80</td>
<td>19-inch, 256-color with 16.7M-color palette</td>
<td>1280x1024</td>
<td>128x66 vector character defaults to (5x7)</td>
<td>RS232C; opt. DEC Unibus, VAX bus and other DMA (X-on/X-off)</td>
<td></td>
<td>14,000–33,000</td>
<td>local clipping, rack-mount</td>
</tr>
<tr>
<td>One/10</td>
<td>14-inch, 16- or 256-color with 16.7M-color palette</td>
<td>640x480</td>
<td>128x66 vector character defaults to (5x7)</td>
<td>RS232C; DEC Unibus, VAX bus (X-on/X-off)</td>
<td>DEC VT100, Tektronix 4014</td>
<td>6,000–8,000</td>
<td>local clipping, display list</td>
</tr>
<tr>
<td>One/25</td>
<td>19-inch, 16.7M-color</td>
<td>512x512</td>
<td>128x66 vector character defaults to (5x7)</td>
<td>RS232C, DEC Unibus, VAX bus (X-on/X-off)</td>
<td>Tektronix 4010</td>
<td>10,000–20,000</td>
<td>local clipping, display list, rack-mount, RS170; opt. interfaces: Multibus, Data General, Perkin-Elmer, Gould/SEL, IBM, DACU, IEEE-488</td>
</tr>
</tbody>
</table>

**SCION CORP.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display (Diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode (8 characters)</th>
<th>Interface (Protocols)</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Notes, features, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>SuperScreen</td>
<td>19-inch, white</td>
<td>1024x768</td>
<td>128x102 (6x10 up to 16x16)</td>
<td>four RS232C, 32-bit parallel, 16-bit parallel (X-on/X-off)</td>
<td></td>
<td>640K RAM, 80K EPROM, 5 graphics and 1 text plane, multiple-window management firmware.</td>
<td></td>
</tr>
</tbody>
</table>

**SEIKO INSTRUMENTS USA INC.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display (Diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode (8 characters)</th>
<th>Interface (Protocols)</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Notes, features, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1104</td>
<td>14-inch, 8-color with 512-color palette</td>
<td>1024x780</td>
<td>80x48 (11x13)</td>
<td>RS232C, Centronics (X-on/X-off, ENQ/ACK, DTR)</td>
<td>Tektronix 4010</td>
<td>5,950</td>
<td>fan, mark, pixel, grid graphics primitives, 16 user-definable function keys</td>
</tr>
<tr>
<td>2412</td>
<td>20-inch, 7-color with 35-color palette</td>
<td>1024x780</td>
<td>132x64 (7x9, 10x13)</td>
<td>RS232C (X-on/X-off, ENQ/ACK, DTR)</td>
<td>Tektronix 401X</td>
<td>12,950</td>
<td>anti-aliasing, display list, RGB output</td>
</tr>
<tr>
<td>2414</td>
<td>20-inch, 1024-color with 32-, 768-color palette</td>
<td>1280x1024</td>
<td>132x64 (7x9, 10x13)</td>
<td>RS232C (X-on/X-off, ENQ/ACK, DTR)</td>
<td>Tektronix 401X</td>
<td>18,950</td>
<td>hardware anti-aliasing, console mode overlay, multiple logical surfaces</td>
</tr>
</tbody>
</table>

**SPERRY COMPUTER SYSTEMS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display (Diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode (8 characters)</th>
<th>Interface (Protocols)</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Notes, features, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>UTS 60</td>
<td>14-inch, 16-color.</td>
<td>512x375</td>
<td>80x25 (9x15)</td>
<td>RS232C</td>
<td>Sperry Uniscope</td>
<td>4.533</td>
<td>2 logical terminals with dual page, full editing capabilities; 8 language selections, COBOL programmable</td>
</tr>
<tr>
<td>UTS 60</td>
<td>14.6-inch, 16-color</td>
<td>512x375</td>
<td>80x24 (9x15)</td>
<td>RS232C</td>
<td>Sperry Uniscope, UTS 400; TTY</td>
<td>opt. 5.25-inch diskette subsystem, disk subsystem, multi-pen plotter</td>
<td></td>
</tr>
</tbody>
</table>

**SUMMIT CAD CORP.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Display (Diagonal)</th>
<th>Display resolution</th>
<th>Alpha mode (8 characters)</th>
<th>Interface (Protocols)</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Notes, features, options</th>
</tr>
</thead>
<tbody>
<tr>
<td>XT-PC 68000</td>
<td>19-inch, 16-color with 4096-color palette</td>
<td>1024x1024</td>
<td>160x48 (8x7)</td>
<td>RS422, RS232C (SNA)</td>
<td>IBM 3270, Tektronix 40XX</td>
<td>22.007</td>
<td>runs IBM PC, XT software, second monitor in station is 13-inch with 640x400 resolution</td>
</tr>
</tbody>
</table>
## GRAPHICS DISPLAY TERMINALS

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Display (inch), Type</th>
<th>Display Resolution</th>
<th>Alpha Mode, Color, Character (256K Bytes)</th>
<th>Interface (Fontcode)</th>
<th>Emulations</th>
<th>Unit Price ($)</th>
<th>Notes, References</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUPERSET INC.</td>
<td>CD-3</td>
<td>19-inch, 8-color</td>
<td>1024x768</td>
<td>current loop (X-on/X-off)</td>
<td>Tektronix 4010, DEC VT100</td>
<td>3,995 (Q1)</td>
<td>generates NTSC, sync. on any external video signal; overlays graphics on any video signal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>with 263K-color</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAB PRODUCTS CO.</td>
<td>132/15-G</td>
<td>15-inch, green, amber, white</td>
<td>512x384</td>
<td>current loop (X-on/X-off)</td>
<td>Tektronix 4010</td>
<td>2,795</td>
<td>vector, point plot, incremental point plot</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>13-inch, 480x360</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEKTRONIX INC.</td>
<td>4105</td>
<td>13-inch, 64-color</td>
<td>480x360</td>
<td>current loop (X-on/X-off)</td>
<td>Tektronix 4010</td>
<td>3,995 (Q1)</td>
<td>includes German, French characters, 60 Hz refresh</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4107</td>
<td>13-inch, 64-color</td>
<td>640x480</td>
<td>three RS232C ports, Centronics</td>
<td>Tektronix 4014, DEC VT100</td>
<td>6,950 (Q1)</td>
<td>includes German, French, Japanese characters; 256K-bytes of display memory, 60 Hz refresh</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4109</td>
<td>19-inch, 64-color</td>
<td>640x480</td>
<td>three RS232C ports, Centronics</td>
<td>4014 and DEC VT100 with 4113 graphics</td>
<td>9,950 (Q1)</td>
<td>includes German, French and Japanese characters; 256K-bytes of display list memory, 60 Hz refresh</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4114B/4114B30</td>
<td>19-inch direct view storage</td>
<td>4096x3120</td>
<td>current loop, RS422</td>
<td>Tektronix 4010</td>
<td>17,900</td>
<td>full programmability, CP/M, Fortran, 16 alphanumeric character sizes; opt. keyboard fonts, color enhanced refresh</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4115B/4115B4116B/4116B30</td>
<td>19-inch direct view storage</td>
<td>4096x3120</td>
<td>current loop, RS422</td>
<td>Tektronix 4010</td>
<td>22,400</td>
<td>full programmability, CP/M, Fortran, 16 alphanumeric character sizes; opt. keyboard fonts, color enhanced refresh</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>19-inch, 64-color</td>
<td>1280x1024</td>
<td>current loop, RS422</td>
<td>Tektronix 4010</td>
<td>19,950</td>
<td>32-bit addressability; standard 4 bit planes, 288K RAM, self-test, autoconverged display; opt. DMA, integrated graphics tablet, dual floppy disks, local operating system and languages</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>19-inch, 64-color</td>
<td>1280x1024</td>
<td>current loop, RS422</td>
<td>Tektronix 4010</td>
<td>19,950</td>
<td>full programmability, CP/M, Fortran, 16 alphanumeric character sizes; opt. keyboard fonts, color enhanced refresh</td>
<td></td>
</tr>
<tr>
<td>TELERAY INC.</td>
<td>16-GRE</td>
<td>15-inch, green, amber, white</td>
<td>240x640</td>
<td>current loop, RS422</td>
<td>Tektronix 4010, 4014</td>
<td>26,750</td>
<td>variable character size, 4 pages of memory, 32 programmable function keys; opt. 12-, 15-inch display, 8 pages of memory, rack-mount</td>
<td></td>
</tr>
<tr>
<td>TELPAR INC.</td>
<td>801</td>
<td>12-inch, 8-color</td>
<td>160x96</td>
<td>current loop</td>
<td>Lear Siegler ADM-2A</td>
<td>3,200</td>
<td>16 function keys; opt. RS170 output, 2 pages of memory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>802</td>
<td>12-inch, 8-color</td>
<td>160x192</td>
<td>current loop</td>
<td>ISC 8001G</td>
<td>3,850</td>
<td>16 function keys, one page of memory; opt. rack-mount</td>
<td></td>
</tr>
<tr>
<td>TRANSIAC CORP.</td>
<td>TR1024</td>
<td>15-inch, green</td>
<td>1024x780</td>
<td>current loop</td>
<td>Tektronix 4010, 4014</td>
<td>3,650</td>
<td>supports as many as 4 image planes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15-inch, green</td>
<td>1024x780</td>
<td>current loop</td>
<td>Tektronix 4010, 4014</td>
<td>3,600</td>
<td>supports as many as 4 image planes</td>
<td></td>
</tr>
<tr>
<td>VECTROR AUTOMATION INC.</td>
<td>Graphicus-80</td>
<td>21-inch, green, white</td>
<td>4096x4096</td>
<td>current loop</td>
<td>DEC VT100, Tektronix 4014</td>
<td>26,750</td>
<td>local 50 dynamics, local windowing, 5,000 readable characters</td>
<td></td>
</tr>
<tr>
<td>VERTICOM</td>
<td>PLP100</td>
<td>13-inch, 16-color</td>
<td>640x480</td>
<td>current loop</td>
<td>DEC VT100, Tektronix 4010</td>
<td>5,650</td>
<td>tilt and swirl; opt. 19-inch screen</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PLP200</td>
<td>13-inch, 16-color</td>
<td>640x480</td>
<td>current loop</td>
<td>DEC VT100, Tektronix 4010</td>
<td>6,450</td>
<td>rubber-banding, tilt and swirl; opt. Multibus compatible slots, 19-inch screen</td>
<td></td>
</tr>
<tr>
<td>VISUAL TECHNOLOGY</td>
<td>500</td>
<td>14-inch, green</td>
<td>768x585</td>
<td>current loop</td>
<td>DEC VT52, Lear Siegler ADM-3A, Hazeltine 1500, DG 200</td>
<td>2,495</td>
<td>separate alphanumeric and graphic memory, block transmission and editing capability; opt. foreign languages</td>
<td></td>
</tr>
<tr>
<td></td>
<td>550</td>
<td>14-inch, green</td>
<td>768x585</td>
<td>current loop</td>
<td>DEC VT100, Tektronix 4010</td>
<td>2,495</td>
<td>opt. foreign languages</td>
<td></td>
</tr>
</tbody>
</table>
Emulex zooms into the fast lane, with two new controllers for VAX users that can handle bigger disk drives and high-bit density GCR tapes.

The single-board SC7000 lets you mix up to four different types of industry-standard removable or Winchester SMD drives with capacities of 80 MBytes on up. Serial transfer rates are as fast as 1.8 MBytes per second. So the SC7000 is perfect for new-generation, high-density drives such as the 825-MByte CDC 9771 drive. And like all Emulex controllers, the SC7000 is totally transparent to DEC system software and diagnostics when running on standard size drives.

What's more, the SC7000 has a special switch that allows you to change from the VAX-11/750 to the VAX-11/780 configuration.

Of course, Emulex hasn't left tape users by the side of the road. Our new TC7000 tape coupler lets you move up to the higher densities and transfer rates of state-of-the-art GCR transports. Depending on the formatter, you can use any tape density, including 800-bpi NRZI, 1600-bpi PE or 6250-bpi GCR. And a single TC7000 can handle up to four STC-type transports or eight reel-to-reel units with Pertec-type interfaces with data transfer rates up to 1.5 MBytes per second.

Kick your VAX into high gear. Call toll-free: (800) 854-7112. In California: (714) 662-5600. Or write: Emulex Corporation, 3545 Harbor Blvd., P.O. Box 6725, Costa Mesa, CA 92626.

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<table>
<thead>
<tr>
<th>Company Name</th>
<th>Address</th>
<th>Phone Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDS Technologies Inc.</td>
<td>2000 Black Rock Turnpike, Fairfield, CT 06430</td>
<td>(203) 366-4089</td>
</tr>
<tr>
<td>Tab Products Co.</td>
<td>2000 Black Rock Turnpike, Fairfield, CT 06430</td>
<td>(203) 366-4089</td>
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<tr>
<td>Verticom</td>
<td>1400 Page Mill Rd, Palo Alto, CA 94304</td>
<td>(415) 852-2400</td>
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<tr>
<td>Phoenix Computer Graphics Inc.</td>
<td>12310 Pinecrest Rd, Reston, VA 22091</td>
<td>(703) 476-6100</td>
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<tr>
<td>Scion Corp.</td>
<td>12310 Pinecrest Rd, Reston, VA 22091</td>
<td>(703) 476-6100</td>
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<td>Teledyne Research</td>
<td>Box 746, Reston, VA 22091</td>
<td>(703) 476-6100</td>
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<tr>
<td>TeleRay Research</td>
<td>Box 746, Reston, VA 22091</td>
<td>(703) 476-6100</td>
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<tr>
<td>Sperry Computer Systems</td>
<td>5400 W 4000 S, Salt Lake City, UT 84116</td>
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<tr>
<td>Summit Cad Corp.</td>
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<td>SuperSet Inc.</td>
<td>5400 W 4000 S, Salt Lake City, UT 84116</td>
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<tr>
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<table>
<thead>
<tr>
<th>Programmable Function Keys</th>
<th>4 (Shiftable to 8)</th>
<th>16 (Shiftable to 32)</th>
<th>16 (Shiftable to 32)</th>
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<tr>
<td>Non-Volatile Function Keys</td>
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<td>Standard</td>
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<tr>
<td>Function Key Legends on 25th Line</td>
<td>From Host</td>
<td>From Host</td>
<td>Standard</td>
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<tr>
<td>No. of Pages of Display Memory</td>
<td>1</td>
<td>2</td>
<td>4</td>
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<tr>
<td>Display Memory Configurations (Plus 25th Message/Status Line)</td>
<td>24 Lines by 80 Characters</td>
<td>(2) 24 x 80 or (1) 48 x 80 or (1) 24 x 158</td>
<td>User Definable up to 96 x 80</td>
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<tr>
<td>Scrolling</td>
<td>Standard Scrolling</td>
<td>Smooth, Jump or Horizontal Scrolling</td>
<td>Smooth or Jump Scroll</td>
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<tr>
<td>Transmission Mode</td>
<td>Conversation Mode</td>
<td>Conversation or Block Mode</td>
<td>Conversation or Block Mode</td>
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<tr>
<td>Editing</td>
<td>Limited</td>
<td>Full Editing &amp; Protected Fields</td>
<td>Full Editing &amp; Protected Fields</td>
</tr>
<tr>
<td>Visual Attributes: Reduced Intensity, Blank, Blank and Reverse Video, Underline &amp; cursor also on ADM 12 and ADM 24E</td>
<td>3 Embedded, 1 Non-Embedded</td>
<td>4 Embedded, 1 Non-Embedded or All Non-Embedded, plus Full Screen Reverse Video</td>
<td>5 Embedded, 1 Non-Embedded or All Non-Embedded, plus Full Screen Reverse Video and Highlight</td>
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<tr>
<td>OEM Flexibility</td>
<td>Modifiable</td>
<td>Modifiable Set-Up and Characteristics</td>
<td>Modifiable Set-Up and Characteristics &amp; Personality</td>
</tr>
<tr>
<td>Terminal Compatibility</td>
<td>ADM 3A, ADM 5, ADDS Viewpoint &amp; Regent 25, Haezeline 1400, 1420 &amp; 1500, DEC VT-52</td>
<td>ADM 3A, ADM 5, ADM 31, ADM 32</td>
<td>ADM 3A, ADM 5, ADM 31, ADM 32, ADM 42</td>
</tr>
</tbody>
</table>

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MINI-MICRO SYSTEMS /July 1984  CIRCLE NO. 120 ON INQUIRY CARD
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Callback security system prevents unauthorized computer access

Analog unit overcomes limitations of digital devices

Jim Smith, Omnicom Engineering

Callback security systems are probably the least penetrable method of protecting a computer system's data from unauthorized access over telephone lines. Designed to prevent an unauthorized user from gaining access to a computer's communications channels, the system will hang up and "call back" a telephone number at a pre-programmed, authorized location. Security equipment manufacturer LeeMAH's modular secure-access-multiport (SAM) unit, placed between the computer modem and the telephone lines, eliminates many of the limitations of digital security devices situated between the modem and a computer's I/O ports. It also furnishes priority call routing, can be hard-wired or remotely programmed and generates an

---

**Unauthorized Caller**

1. Unauthorized person at an unauthorized location calls dial-up port and enters an illegally obtained location identification number (LIN) code.
2. SAM sends back an acknowledgment tone and disconnects (even if the unauthorized person does not hang up).
3. After searching the LIN directory, SAM dials the telephone number of the authorized location, warning of the unsuccessful intrusion attempt.

---

**Authorized Caller**

1. User calls dial-up port from authorized location. SAM answers without acknowledgment tone.
2. User enters LIN.
3. After receiving an acknowledgment tone, user hangs up and SAM disconnects.
4. Searching the LIN directory to find the telephone number of the authorized location, SAM dials back.
5. A one-digit connection code permits entry to the data base through the modem.

---

Fig. 1. Responding to authorized or unauthorized callers, SAM calls back only telephone numbers at authorized locations, thwarting unauthorized callers who might have obtained location-identification numbers (LINs). The callback also alerts the authorized location to the unsuccessful attempt at intrusion.
audit trail of telephone transactions.

**Providing better security**

When first developed, callback security systems were installed between the computer's I/O ports and the modem interfacing the telephone network. Because they prompted callers for further exchange of dialogue, these early digital systems were vulnerable to the intrusions of unauthorized callers, permitting them enough time to "play" with the system.

Second-generation callback systems—including Lee-MAH's secure-access unit (SAU) and SAM device—are more secure and cost-effective and offer advantages over widely used password or encryption systems. Passwords are easily decoded or deduced. If they are complex, they are likely to be written down near a terminal so as not to be forgotten, thereby defeating their purpose. Encryption protects data only when it is transmitted. Moreover, encryption systems can be costly, requiring installation of hardware at both ends of a data-transmission connection.

Developed for use by telephone companies, the single-port SAU prevents unauthorized use of remote computer diagnostic ports. Because both the SAU and SAM reside between the modem of a computer and the telephone network and talk only in analog terms, they can reject modem-handshake requests. The units interface with originate or answer modems, including the Racal-Vadic Inc. 34XX series and the Bell Laboratories 212 series. In contrast, most digital port protectors need originate-mode auto-dial modems to function.

**LIN code protects computer access**

The SAU and SAM operate in a similar manner. After a call to the data center is answered, they remain

---

**Fig. 2. The basic callback system** uses as many as 16 dual-line cards to handle 32 telephone lines and modems. An expansion unit furnishes access to as many as 32 additional phone lines. Memory-expansion cards enable the unit to store a maximum of 2,304 authorized callback locations.

**Fig. 3. Computer-access-protection unit components** indicate the scope of SAM functions from the first call to the computer center to the final connection with the computer's dial-up ports.
Analog callback security systems, placed between the modem and the telephone dial-up network, avoid the limitations of digital systems situated between the modem and the host computer’s access ports. Operating only with originate-mode modems and prompting callers for passwords, digital systems can be vulnerable to programmer tampering.
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CIRCLE NO. 131 ON INQUIRY CARD
silent and do not emit the handshake or acknowledgement tone of most handshake systems, thus masking the fact that a computer access point has been reached. Only if the correct six-digit location-identification number (LIN) code is entered by the caller does the system answer with an acknowledgement tone. It then immediately hangs up. If the LIN code matches an entry in a 256-number callback directory (as many as 2,304 telephone numbers in a 32-port system), the SAM calls back the pre-programmed telephone number at the authorized location, usually within 15 seconds. Only then are both the computer modem and the terminal modem allowed to handshake. Because the system calls back only the location identified with the entered LIN code, it thwarts callers who have the proper LIN code but are not at the authorized location (Fig. 1).

The SAM system is compatible with modem communications networks operating at speeds as high as 9,600 baud and with any computer protocol. System integrators can modularly expand the basic system from two to 32 ports using as many as 16 dual-line PC cards corresponding to the number of lines to be handled (Fig. 2). An expansion unit can provide as many as 32 additional lines for a total of 64. The non-volatile LIN directory is stored on electrically-erasable, programmable ROMs (EEPROMs).

When it detects the ring voltage of an incoming call, one of the SAM's dual-line cards passes the information on to the controller card, which sequentially scans each line card. The controller then assigns an idle, dual-tone multifrequency (DTMF) or Touch-Tone receiver (connected to the tone receiver card) to the incoming line. The tone receiver can handle as many as four simultaneous incoming calls. If more than four calls are received at the same time, the overflow is queued until the next receiver channel becomes available.

A tone receiver is usually occupied for approximately 30 seconds, but, because there are four receiver channels, maximum wait time is 15 seconds (5.5 rings), even under the heaviest traffic conditions. A call is answered within 2 seconds 95 percent of the time.

After a receiver has been assigned to the incoming call, the line card goes off-hook, remaining silent to mask the computer from unauthorized callers. If the caller enters a valid LIN code on the Touch-Tone telephone keys, SAM performs a directory search for a matching LIN entry. If a match is found, the system directs the callback in the callback directory, according to a pre-configured scheme (see “Implementing programmable call routing,” below).

### IMPLEMENTING PROGRAMMABLE CALL ROUTING

System integrators can configure the secure-access-multiport (SAM) system for maximum effectiveness by pre-programming its operating parameters to match computer-site requirements. One of the most important of these parameters is the callback method used by the system. SAM recognizes two types of routing: same group routing (SGR) and least group routing (LGR). The first digit of a caller's location-identification number (LIN) code indicates the routing of his return call. When a LIN code is configured for SGR, the primary outgoing group of lines is selected for callback. If a LIN code is configured for LGR, the callback is prioritized and assigned a digit from 0 to 9 (lowest to highest priority). SGR directs all return calls according to the programmed priority. With LGR, however, a callback request will be directed to a group 0 line first, a group 1 line next and so on, until the line group number exceeds the first digit of the user's LIN code. Thus, a caller with a LIN that starts with the digit 0 will receive a callback only over a group 0 line; a user with a LIN that starts with 9 can be called back on any available outgoing line.

LGR allows system managers to control all computer traffic according to priority, equipment used (e.g., private branch exchange extension), communications route (local or national networks), least-cost considerations (wide-area telephone service lines or non-American Telephone & Telegraph Co. long-distance services) and other factors. Someone with a vital time-dependent task to perform would be given a higher-priority number. LGRs can also be used to permit port selection for the correct routing to a particular modem or protocol-conversion unit.

The time-control function uses the first or second digit of the LIN code to reference a table with as many as 16 entries, the current day of the week and a real-time counter to determine whether a caller can be called back. This allows six on/off cycles per week for each of 10 groups of callers.

### PROGRAMMABLE SAM PARAMETERS

- **Telephone lines.** Any of 32 (or 64) lines can be designated to receive an incoming call, originate an outgoing call or both.
- **Modem characteristics.** The type of modem (auto-answer or originate) interfacing the protected computer port can be pre-programmed.
- **Return-call routing.** The LIN code's first digit indicates the callback routing.
- **Time control.** A real-time clock and time-clock control table in non-volatile memory can be programmed to deny a return call at certain hours and days of the week.
Behind the action, pageantry and spectacle of the 1984 Olympic Games is one of the most extensive data communications systems ever built.

The Electronic Messaging System—12 computers, 1,700 terminals, 300 printers—was created for the 1984 Olympics by AT&T. And tied together with Infotron networking equipment. The EMS is designed to replace the old system of hand-carried reports in the world's first multi-site Olympics. It does everything from displaying event results, to providing schedules, qualifying information and personal messages to the participants themselves.

The system's true complexity lies in the numbers of people it serves: the 50,000 officials and reporters, coaches and athletes of the Olympic family. But the demands placed on it are very much like the demands all Infotron customers place on their networks.


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DATA COMMUNICATIONS

However, if there is no directory match for the LIN code, the incoming call is immediately disconnected without an acknowledgement tone.

Finding an available line

When it finds an idle line for the return call, the common control card directs the tone card to send a 1-second, 697-Hz acknowledge tone. If an idle line is not available, SAM checks the incoming line to determine if it can be used for the return call. If it can be used, the tone card sends a ¼-second, 941-Hz tone, followed by a ¼-second, 697-Hz tone, indicating to the caller that the same line will be used for the callback.

If the call cannot be returned on the same line, 15 ¼-second-on/¼-second-off, 941-Hz tone bursts signal an all-lines-busy condition, and the incoming call will be

Unauthorized access to computer systems—the crime that security devices such as LeeMAH's secure-access-multiport (SAM) unit are designed to prevent—can result in significant losses to the companies involved. One study estimates the annual cost of computer-related abuse at $300 million, with an average loss per incident of $45,000. A report from the federal government's General Accounting Office estimates total "computer-related crimes in federal programs" at $2.2 million, with an average loss per incident of $44,110.

In the absence of federal computer-crime laws, computer-related crimes currently fall under state criminal statutes. However, several bills relating to computer abuse have been introduced in Congress. One, H.R. 1092, the Federal Computer Systems Protection Act (see Table, below), has 108 cosponsors in the House and might have reached the floor of the House when this article appears. But, despite considerable media attention and the rush to introduce legislation in Congress, there is no consensus among legal experts or in the computer industry that current state laws are adequate to deal with the problem or that new federal legislation is required.

"To the extent we are talking about classical criminal conduct—theft, fraud, embezzlement—where intention to do wrong is the element, whether a computer is involved or not makes no difference," asserts Dan Brooks, a Virginia attorney specializing in computer law. "There shouldn't be a great distinction between computer crime and other types of crime." Brooks advocates caution in drafting new legislation and applying criminal sanctions to conduct that is not clearly and unequivocally criminal. He thus supports clarifications of criminal statutes "to make sure they apply appropriately to traditional crimes perpetrated with computers and crimes against computers and assets related to computers."

Brooks sees problems in the borderline area of computer "hackers" who gain access to computer data banks. "I have great difficulty with the concept of taking these people and throwing them into a special category of 'crook' without some consensus that this sort of 'fiddling around' is their problem and not the database operator's problem," he argues. "We can identify extremes at which we can reach a reasonably clear consensus that conduct is criminal or not. But, in the larger area between these extremes, there really isn't enough experience so that people can be held to understand that what they are doing is criminal or not."

Brooks also wants the problem to be seen in proper perspective in relation to other crimes. "We are talking about jail," he notes, not merely a slap on the wrist for offenders. And he is skeptical about further straining an overburdened criminal-justice system. "We are talking about public prosecutors who are concerned with rapes, murders, the interstate transportation of God knows what and diverting that scarce resource to the prosecution of whatever the perpetrators have done."

The members of one broad-based computer industry group, the Association of Data Processing Service Organizations (ADAPSO), have not indicated strong support for new computer-crime legislation, contends David Sturdivant, ADAPSO director of public relations. "There is not any great push in our membership for new legislation at this time. The feeling is that the laws on the books can handle anything that comes up." Members see the protection against unauthorized access afforded by security devices, encryption, passwords and other measures as the first line of defense against computer crime, Sturdivant says. "Overall, the attention to that area is very strong among our members."

J.V.

PROVISIONS OF FEDERAL COMPUTER SYSTEMS PROTECTION ACT

- Applies to: Computers "owned by, under contract to or operated for or on the behalf of" the U.S. government, federally guaranteed financial institutions and companies with interstate computer networks.
- Penalties: Fines of as much as $50,000 or twice the value of the property stolen, whichever is greater, and/or as much as five years imprisonment for "whoever uses or attempts to use" a computer "with intent to execute a scheme" to defraud or to obtain property by false or fraudulent means or to "embezzle or steal" such property. Fines of as much as $50,000 and/or imprisonment for five years for criminal damage to covered computers and for computer tampering with intent to deny access to authorized users.
- Property covered: "Anything of value," including tangible or intangible personal property; "computer processed, produced or stored data"; transmitted information; computer operating or application programs.

CONTROLLING COMPUTER CRIME

Unauthorized access to computer systems—the crime that security devices such as LeeMAH's secure-access-multiport (SAM) unit are designed to prevent—can result in significant losses to the companies involved. One study estimates the annual cost of computer-related abuse at $300 million, with an average loss per incident of $45,000. A report from the federal government's General Accounting Office estimates total "computer-related crimes in federal programs" at $2.2 million, with an average loss per incident of $44,110.

In the absence of federal computer-crime laws, computer-related crimes currently fall under state criminal statutes. However, several bills relating to computer abuse have been introduced in Congress. One, H.R. 1092, the Federal Computer Systems Protection Act (see Table, below), has 108 cosponsors in the House and might have reached the floor of the House when this article appears. But, despite considerable media attention and the rush to introduce legislation in Congress, there is no consensus among legal experts or in the computer industry that current state laws are adequate to deal with the problem or that new federal legislation is required.

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Fig. 4. Audit-trail printouts log the telephone lines used for calling the computer center (In) and the callback (Out), if different from the incoming line, tracking attempts to gain access to the computer. Status numbers indicate the receiver processing the call; the letters in the status column indicate rerouting data.

terminated, with the understanding that the caller must try again later. The all-lines-busy signal is also given if the time-clock control function denies computer access.

**Making the final connection**

Under normal circumstances, the SAM returns calls within 10 to 15 seconds. After the SAM's callback, the final computer connection is established in one of three ways. Under full automatic control, the caller's data set connects directly to the line. The connection can also be made after the data set issues a valid carrier tone or after the caller enters a Touch-Tone connection code—usually the [*] key—and connects the data set to the line directly or acoustically. Both the dual-line card and common-control card continue to monitor the line until the call is terminated. After the audit trail record is printed, the idle line is freed to wait for another call (Fig. 3).

SAM is usually programmed through a hard-wired terminal. A system integrator or an end user can also employ a remote terminal for programming. For remote programming, a single-port SAU protects the terminal, and the programmer must use the same callback protocol as required by the SAM.

After properly accessing the SAM's programmable port, programmers can read and re-configure several system parameters to meet changing requirements. For example, they can change any entry in the return-call directory, including a library of the 16 most-often-used return-call numbers. They can also display system status and system and line configurations, as well as alternate group routings. Finally, programmers can alter such information as current real-time data, audit-trail records, passwords, memory locations and pre-configured menus.

**Generating an audit trail**

An audit trail is one of the most effective means of tracing authorized and unauthorized user activity and analyzing important system parameters. SAM begins to generate its audit trail after it first detects an incoming call, storing the information in the system's printer memory buffer. Monitored data includes the day, date and time of the call; the incoming and outgoing telephone lines used; the number of authorized locations called back and the caller's identity; and the time the call is disconnected (Fig. 4). In contrast, digital callback systems stop monitoring the caller as soon as the computer connection has been established. SAM can thus record all systematic unauthorized attempts to access the computer system as well as information on uncompleted calls, including queuing data, all-lines-busy information, invalid codes, modem and line malfunctions and return calls not answered. Additional audit-trail functions can be provided.

Jim Smith is president of Omnicom Engineering, San Jose, Calif.

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<th>Interest Quotient (Circle One)</th>
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MINI-MICRO SYSTEMS: July 1984

265
Designing a 67-Megabyte, File-Addressable, Back-up Storage System Is as Easy as...

1 Choose Your Interface.

Whether you're talking SASI, RS-232, RS-422, S-100, GPIB (IEEE-488), PERTEC, Q BUS or IBM PC protocol, we've got your board. Name your format, and one-third of your design job is done. Instead of spinning your wheels, or taking time to reinvent one, you can take advantage of what ADIC has already accomplished. Namely, developing a high-performance, high-capacity back-up device that gives designers the choices and the capabilities they need.

We've built it around the compact, reliable HCD-75 1/4" cartridge back-up system from 3M. We use the 3M drive and 3M preformatted data cartridges with tape designed specifically for this application. It's a winning combination, and it's ready to go to work for you.

2 Pick Your Packaging.

Decisions, decisions, decisions. Will you be needing a desktop-style housing with UL, FCC and CSA approvals? A standard rackmount? A portable? Or would you prefer the understated elegance of bare metal, ready to drop into a package of your own? Whatever you choose, we'll gladly deliver. And we're always willing to talk about other options.

3 Call ADIC for Answers.

We're basically back-up experts, so we know a good thing when we see one. Like the 3M hardware with file addressability that has been proven in more than 20,000 installations. Like software developed for us by people like Tim Paterson, author of DOS 1.1 for the IBM PC. ADIC has put together all the ingredients for OEM users who've got bigger problems to solve.

So go ahead, give us a call. The worst it can do is simplify your life.

CIRCLE NO. 133 ON INQUIRY CARD
Minicomputers achieve 10-MIPS performance

The Concept 32/97 computers, the three newest members of the company's Concept/32 family of compatible 32-bit minicomputers, incorporate an emitter-coupled-logic-ECL-technology CPU with a 75-nsec. cycle time, instruction unit/executive unit CPU architecture, a four-way set associative cache memory, a hierarchical memory system, an alterable-control storage and a four-stage instruction pipeline. The computers feature a 16M-byte task-addressing capability with field upgrading via modular performance options including a multiply accelerator (MACC), cache memory, shadow memory and a dual-processor internal processing unit (IPU).

Depending on the modular performance enhancements that are included, the Concept 32/97 computers provide a performance of 4.67 million instructions per second (MIPS) as measured by the whetstone benchmark. In its basic configuration, which includes one CPU, 4M bytes of main memory and 32K bytes of cache memory, the Concept 32/9705 computer provides performance as high as 4.67 MIPS. The system's performance increases to 5.6 MIPS with the addition of the optional MACC. The Concept 32/9780 multiprocessor configuration, which features the IPU, provides performance as high as 8.4 MIPS. When the optional MACCs are added to the CPU and IPU, the Concept 32/9780's performance increases to 10.08 MIPS.

The Concept 32/97 product line uses the company's proprietary real-time operating system, MPX-32, and languages such as FORTRAN 77+. The computers also support UTX/32, the company's implementation of UNIX Berkeley BSD 4.2 with Bell System V enhancements.

Prices for the Concept 32/97 computers range from $245,000 for a basic 32/9705 to $495,000 for a fully configured 32/9780 with two MACCs and 128K bytes of cache memory. All basic systems include 4M bytes of main memory. Delivery is 90 days after receipt of order.


Circle No 300

Portable computer has LCD, printer, modem

The 17-pound STM PC transportable computer comes with a 16-line-by-84-character LCD with 540-by-200-pixel graphics resolution. An MS-DOS 2.0 software-compatible 80186 microprocessor drives the unit. The product features 256K bytes of RAM and has dual 1M-byte floppy disk drives. It includes a 300- to 1,200-baud, auto-dial/auto-answer direct-connect modem, a 40-column thermal printer and a detachable, low-profile, 94-key keyboard. Integrated software with word-processing, spreadsheet, database-management and graphics functions is also standard. $3,000. STM Electronics, 530 Middlefield Rd., Suite 250, Menlo Park, Calif. 94025, (415) 326-6226.

Circle No 301

Portable offers operating system choices

The user-configurable and -expandable M3000 transportable computer is built into a water-resistant, dust-proof aluminum case. A basic configuration includes CP/M Plus running on a Z80A microprocessor with 64K bytes of RAM. Options are MS-DOS or CP/M-86 running on an optional STD-88A processor card and UNIX running on an optional STD-68000A processor card. Optional expansion card cages include the STD bus with four open slots, the VME bus with two open slots and the S-100 bus with two open slots. The basic model includes one 376K-byte, double-sided, double-density, 5½-inch floppy disk drive. Options include dual 376K-byte, 5½-inch floppy disk drives or a combination of a 10M-byte, 5½-inch Winchester disk drive and a 376K-byte floppy disk drive. The computer has a detachable, 93-key, IBM-style keyboard with 14 programmable function keys and an 18-key calculator pad. The system incorporates a 9-inch green CRT that displays 80 characters by 25 lines. Prices start at $1,645. MicroStandard Technologies Inc., Box 319, New Lebanon, Ohio 45345, (513) 687-1395.

Circle No 302
Portable micro runs IBM PC software

The Ivy 3000 series transportable computers are compatible with IBM PC software. They employ Intel's 6-MHz 80186 microprocessor and run the IBM PC-DOS-compatible IDOS operating system. The series is available in two versions, which both come with 256K bytes of RAM. Model 3001 has two half-height, 5¼-inch, 320K-byte floppy disk drives; model 3002 has one half-height, 5¼-inch 320K-byte floppy disk drive and one half-height, 5¼-inch, 10M-byte Winchester disk drive. The computers incorporate a 9-inch amber screen that displays 25 lines by 80 columns. Two RS232C ports, one of which can be software-configured for synchronous network communications, and one Centronics-compatible port are also standard. Other features include a detachable keyboard and a battery-powered time-of-day clock. Model 3001: $2,995, model 3002: $3,995. Ivy Microcomputers Corp., 220 Ballardvale St., Wilmington, Mass. 01887, (617) 657-8268.

Circle No 303

MINI-MICRO SYSTEMS /July 1984
Announcing Codex’s 2230 Series dial modems.
Now you can get 2400 bps productivity with the reliability you expect at 1200 bps.

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There’s even a model with programmable auto call. So you can send data unattended at night when rates go down. Each 2230 Series model is fully Bell 212 compatible. Each accommodates all communications protocols and meets the CCITT international 2400 bps dial standard. You can integrate Codex 2230’s into your network gradually or all at once, without putting your system in turmoil.

Then, there’s Codex’s worldwide service and support organization, ready to answer any question or solve any problem. Plus very attractive options to buy or lease.

To get the complete story on Codex’s advanced 2230 Series dial modems, dial 1-800-821-7700, ext. 881. Or write: Codex Corporation, Dept. 707-81, 20 Cabot Boulevard, Mansfield, MA 02048.
A hard disk and cartridge tape controller together on one board? Magic! Not really. It's Teletek's HD/CTC. The hard disk and cartridge tape drive controller provide the support necessary to interface both rigid-disk drives and a cartridge tape deck to the S-100 bus.

- A Z-80A CPU (optionally Z-80B) providing intelligent control of the rigid-disk and cartridge tape drives.
- Support of 5½" rigid-disk drives with transfer rates of 5 megabits per second. Minor changes of the on-board components allow the support of other drive types/sizes and transfer rates up to 15 megabits per second. (Interface to disk drive is defined by software/firmware on-board.)
- Controller communications with the host processor via 2K FIFO at any speed desirable (limited only by RAM access time) for a data block transfer. Thus the controller does not constrain the host processor in any manner.
- Two 28-pin sockets allowing the use of up to 16K bytes of on-board EPROM and up to 8K bytes of on-board RAM.
- Individual software reset capability.
- Conforms to the proposed IEEE-696 S-100 standard.
- Controller can accommodate two rigid-disk drives and one cartridge tape drive. Expansion is made possible with an external card.

Teletek's HD/CTC Offers A Hard Disk Controller, Plus Cartridge Tape Controller, All On One Board.

TELETEK

4600 Pell Drive Sacramento, CA 95838 (916) 920-4600 Telex #4991834 Answer back - Teletek

CIRCLE NO. 135 ON INQUIRY CARD
System executes programs concurrently

The four-user, multiprocessor CompuPro 10 microcomputer system concurrently executes 8- and 16-bit software. Based on a closely-coupled master/slave architecture, the product uses a dedicated 8088 processor with 768K bytes of RAM to handle system resources and overhead such as disk, printer and communication links, while four Z80B processors with 64K bytes of RAM each act as individual task processors. In the standard configuration, each user terminal has access to its own Z80B processor and dedicated memory for running 8-bit application programs. The central 8088 processor and its main memory are dynamically allocated to each user, the Z80B acting as a terminal handler for running 16-bit tasks. Standard features include seven serial ports, a Centronics printer port, as much as 512K bytes of solid-state disk memory and dual 5¼-inch, 1M-byte floppy disk drives. Price is approximately $1,800 per workstation. CompuPro, 3506 Breakwater Court, Hayward, Calif. 94545, (415) 786-0909. Circle No 305

Computer implements NuBus technology

The Nu Machine computer system implements 37.5M-byte-per-second, 32-bit, processor-independent NuBus technology. The product comes with a 10-MHz 68010 processor with a 4K-byte, 45-nsec. cache memory and a memory-management system implemented in hardware. The machine also features an 800-by-1,024-pixel, 15-inch, 60-Hz, non-interlaced, black-and-white display and bit-mapped graphics controller. An optional Multibus subsystem allows use of a wide variety of peripherals and controllers. A high-bandwidth translator provides the interface between the NuBus and the Multibus systems. The Nu Machine runs a UNIX-derived operating system. A windowing system provides capabilities for multiple virtual terminals on the product’s display. FORTRAN and C programming languages are available. The office model, configured with a 68010 CPU, 512K bytes memory, an 84M-byte Winchester disk drive, a ¼-inch cartridge-tape drive, a display, a keyboard and a mouse, is priced at $36,240 (25 units). Texas Instruments Inc., Data Systems Group, P.O. Box 402430, Dallas, Texas 75240, (800) 527-3500. Circle No 306

PLUG THIS IBM-COMPATIBLE 9-TRACK TAPE SYSTEM INTO JUST ABOUT ANY PORT

The IBEX Model TS-110 Magnetic Tape system is immediately compatible with any micro- or mini computer, mainframe, modem or special device having a standard port—RS-232, RS-422, or GPIB/HP1B. It appears to that device as a buffered printer or terminal. Simple, transparent ASCII control codes provide tape drive control for any number of functions.

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- IBM-standard format compatibility
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CIRCLE NO. 137 ON INQUIRY CARD
Modem combines auto-dialing, multiplexing

The CDS 224 Superduplex modem offers a statistical multiplexer with ARO error correction and auto-dial features. Designed for interactive and batch traffic requiring error-free data transmission, the product connects multiple asynchronous devices to a standard two-wire switched telephone for 2,400- or 1,200-bit-per-second transmission. The modem's statistical multiplexer provides three RS232C ports, which users configure via their terminal keyboards for baud rate, character format and flow control. Each port supports 14 asynchronous speeds ranging from 50 to 9,600 bps, or users can select an auto-baud feature that automatically matches port speed to the speed of the user's device. The modem features x-on/x-off and CTS flow control and an adaptive prioritizing technique. The ARO error-recovery feature uses a bit-synchronous protocol. The modem's automatic dialing feature supports touch-tone and rotary (pulse) dialing systems. $1,695. Concord Data Systems Inc., 303 Bear Hill Road, Waltham, Mass. 02154, (617) 890-1394.

Circle No 307

Network incorporates twisted-pair wiring

The AST-PCnet II LAN requires no dedicated print and file servers, includes a print-spooling capability, and simplifies installation with its twisted-pair wiring and RJ11 modular connectors. The distributed-bus system runs on IBM PC XT computers. Print spooling allows queuing of print jobs on disk for as many as three shared printers on the network. The system links two or 32 personal computers on a 500-foot trunk cable without repeater circuitry. The network includes tape boxes and 15-foot drop cables and operates transparently to users. Each PC can be designated as a shared PC or as a user PC. The network uses standard PC-DOS commands to access remote disk drives and printers. It transmits data at 500 kbps, uses a CSMA/CA protocol and provides file/record locking. $1,290 for the starter kit, including two controller cards, cabling and software. AST Research Inc., 2121 Alton Ave., Irvine, Calif. 92714, (714) 863-1333.

Circle No 308

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MINI-MICRO SYSTEMS/July 1984
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So if you're after OEM's and systems integrators, be at a Mini/Micro. For complete information, call toll-free: 800-421-6816. In California, 800-262-4208.

Meet OEM's and systems integrators where they live.

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Sponsored by regional chapters of IEEE and the Electronic Representatives Association

CIRCLE NO. 141 ON INQUIRY CARD
New Products

Printers

Printer prints in seven colors

This color graphics printer produces hard copy in seven colors directly from a CRT, a video monitor or a CPU using thermal-transfer technology. It is offered in two versions: a video interface and a digital version. The RS170-compatible model CP-80V accepts RGB signals with or without separate sync and can print a full, 640-by-480-dot page in as little as 45 seconds. The Centronics-compatible model CP-80C is 0.027 inches. Operators can select a maximum of 136 print positions at 10 cpi and as many as 233 print positions at 17.1 cpi. Vertical spacing is operator-selectable at 3, 4, 6 or 8 lpi. An adjustable tractor pin-feeds forms from 3- to 16-inches wide. The printer offers ASCII-B, EBCDIC and international character sets are offered. Buffer sizes range from 960 to 3,564 characters. $7,200. 

Telex Computer Products Inc., 6422 E. 41st St., Tulsa, Okla. 74135, (918) 627-1111. Circle No 313

Printer features movable ruby wire guide

The Hermes model 612 matrix printer operates at 400 cps in data-processing mode and at 100 cps in near-letter-quality mode. The printer uses an 18-wire matrix print head featuring a movable ruby wire guide. All printing is done in a single-pass mode—132 cpi at 10 cpi. Four character sets are resident, and eight versions are standard: U.S., U.K., French, German, Danish, Norwegian, Swedish/Finnish, Italian and Spanish. A Centronics-compatible parallel interface is also standard; an RS232C/V24-compatible serial interface is optional. The printer includes a tractor feed for continuous forms and can also handle single sheets. $2,650. 

Singer Data Products Inc., 2351 E. Devon Ave., Elk Grove Village, Ill. 60007, (312) 800-6500. Circle No 309

Band printer includes power stacker

The 132-column LP1200 band printer produces hard-copy output on standard single-sheet or six-part, multiple-copy, fan-fold paper and comes with an automatic power paper stacker. The printer, which plugs into any P-E Series 3200 computer, provides a typical throughput of 1,200 lpm when a 64-character set is used. A 96-character set and German and U.K. character sets are also available. A touch-sensitive control panel allows switch-selectable 80- or 132-column printing. Standard vertical spacing is switch-selectable at 6 or 8 lpi. A horizontal forms-adjustment system simplifies formatting of special forms with as many as 63 lines per page. $29,500. 

Perkin-Elmer Corp., Data Systems Group, 2 Crescent Place, Oceanport, N.J. 07757, (201) 870-4768. Circle No 310

Printer has parallel/serial interfaces

The Compumate 2100 daisy-wheel printer incorporates a Centronics-compatible parallel interface and an RS232C serial interface. The unit prints at 20 cps and outputs 115 cpl at 10 cpi, 135 cpl at 12 cpi and 172 cpl at 15 cpi. It accepts cut-sheet or continuous-feed, fan-fold paper and has a 256-character print buffer. The printer emulates the Diablo 630 command set and is WordStar-compatible. $649. 

Swintec Corp., 23 Poplar St., P.O. Box 421, East Rutherford, N.J. 07073, (201) 935-0115 or (800) 225-0867. Circle No 311

Matrix printer offers IBM compatibility

The model 387 table-top matrix printer features 400-cps throughput and plug compatibility with an IBM 3274/3276 or a Telex control unit. The product's standard print mechanism forms an 8-by-7 dot matrix and can print six-part forms with a total thickness of .004 inches. 

Yokogawa Corp. of America, 2 Dart Road, Shenandoah, Ga. 30925, (404) 253-7000. Circle No 312

Full-page printer fits in less than half a briefcase

The battery-powered, full-page ThinPrint 80 thermal graphics printer weights 4 pounds and measures 2.5 inches high by 7.5 inches deep by 11.5 inches wide. It features 40-cps bidirectional printing, a 2,048-character buffer memory, 80 or 136 cpl, an RS232C or Centronics interface and single-sheet or roll feeding from its internal paper compartment. The printer provides a dot-addressable graphics resolution of 960 by 7 dots per line. $279 including rechargeable batteries, an AC adapter and an 80-page paper roll. 

Axonix Corp., 471 Wakahara Way, Salt Lake City, Utah 84108, (800) 821-7093. Circle No 313

Plotter provides multicolor graphics

The PL 1000 x-y plotter prints on DIN A3-sized paper and incorporates such plotting functions as circles, arcs, coordinate axes, symbols and various lines. The plotter automatically switches between four pens to provide multicolor graphics. Using oil-based, felt-tipped pens, the plotter can draw on OHP film. Resolution is 0.004 inches; maximum pen speed is 4 lps. The plotter comes with 8-bit parallel or RS232C interfaces. Prices start at $991. 

Yokogawa Corp. of America, 2 Dart Road, Shenandoah, Ga. 30925, (404) 253-7000. Circle No 315
In considering Daisy M45 as your next printer look beyond the striking European styling. Look at its value-packed quality and performance. You’ll be impressed.

Daisy M45 advanced daisywheel printers deliver true bi-directional printing at an incredible speed of 45 characters per second. You get crisp letter-quality output from printwheels interchangeable in a wide variety of type styles.

Daisy’s M45 is compatible with all computer systems, mini and micro. You get a choice of eight different interchangeable interface modules for the hardware/software combination you choose — no need to be concerned about compatibility.

And it’s quiet. Very quiet. Daisy’s designers scored a breakthrough with a minimum of moving parts — 35% fewer than other conventional daisywheels. Considerable research went into its automatically controlled “long-life”, impact hammer. Plus it uses Daisy’s "multistrike" cartridge to further optimize ribbon life.

Daisy M45 has earned a great deal of respect throughout the world — not only as a reliable and durable office printer — but also one sensibly priced with more features for your money. Like programmable carriage motion, pitch and proportional spacing, 5760 points per square inch plotting resolution — and many operator controls and indicators built-in.

Extensive office use in every major country in the world has proven Daisy’s enviable record of dependability.

Call today or send coupon for more details.

The World’s Finest Printers

Daisy Systems Holland

Daisy Systems Holland BV, Nieuweweg 270, P.O. Box 126, 6800 AG Wilthen, The Netherlands, Tel: (31-8684)-18170, Telex 48281

SEE US AT NCC CIRCLE NO. 142 ON INQUIRY CARD
Winchesters store as much as 51M bytes

The 2306H and 2312H half-height Winchester disk drives store 6M and 12M bytes of unformatted data, respectively, on 5¼-inch plated or oxide media. The drives provide 85-msec. average access times using closed-loop stepper-motor accessing. They employ an ST506/412 interface and achieve 625K-byte-per-second data-transfer rates. The full-height, 5½-inch Winchester disk drive models 5612H, 5624H, 5636H and 5650H store from 12M to 51M bytes (unformatted). They also use the ST506/412 interface and have 625K-byte-per-second data-transfer rates. The 5600H series employs a stepper-motor actuator design and provides 49-msec. average access times. 2300H series prices start at $535 each for 500 units; 5600H series prices start at $625 each for 500 units. International Memories Inc., 10381 Bandley Drive, Cupertino, Calif. 95014, (408) 446-9779.

Mass-storage subsystem packs 40M bytes

Packaged in the standard CompuPro disk enclosure (approximately 22 by 5½ by 18 inches), the H40 hard disk subsystem provides 40M bytes of mass storage for use with the company's IEEE 696-S-100 bus-compatible microcomputer systems. The subsystem features a Quantum Q540 5¼-inch hard disk, the vendor's Disk 3 DMA disk controller and the CP/M-80 and CP/M-86 operating systems. It also includes a double-sided, double-density Quantum Track 842 8-inch floppy disk drive that stores 2.4M bytes and accepts single- or double-density, single- or double-sided media. $5,495. CompuPro, 3506 Breakwater Court, Hayward, Calif. 94545, (415) 786-0909.

Winchesters feature 25-msec. average seek time

The 1320 series of 5¼-inch Winchester disk drives offers a 25-msec. average seek time, including settling. Models 1323, 1324 and 1325, which comprise the series, provide capacities of 42.6M, 63.9M and 85.2M bytes, respectively. The products support the ST506/412 interface.
Every department, every person in our organization is dedicated to one goal—to deliver the finest in disk memories.

At Century Data Systems, we see quality as a pervasive, company-wide attitude. And our customers share this perspective. Leading OEMs continue to rely on Century Data Systems disk memories for superb reliability, year after year. That's the real payoff from our total approach to quality.

At Century Data Systems, quality is much more than a memory. It's a living company commitment. And it can work to your advantage. Write or call for specifics.

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Marketing Communications
1270 N. Kraemer Boulevard
Anaheim, California 92806
(714) 999-2660
Rigid but not fixed

It wasn’t easy to design a rigid disk drive that you can remove like a floppy, but has the capacity and performance of a Winchester. In fact, Amcodyne engineers had to make removability work before they could even think about capacity and performance.

A dynamic head-loading system was developed so that heads can be retracted from the removable cartridge. Eliminating head-disk contact improves reliability so much that we are using it on our fixed-only drives as well.

A clean air system was developed to keep cartridge surface dirt out of critical areas. It works so well, our fixed/removable drives are cleaner (Class 50 or better) than most Winchester.

An embedded servosystem was developed for adapting the drive’s mechanics to minute variations in interchangeable cartridges. Not only were disk runout problems eliminated, we got the kind of fast, reliable access that you would expect of a Winchester drive.

Now that it’s done, it’s all very simple—simple to build, to install, to use, and to maintain. Reliability of the Arapaho 7110 is field-proven, and we are producing them in OEM volume.
New Products

DISK/TAPE

Magnetic-tape subsystems work with SCSI bus

This trio of ½-inch tape subsystems for the SCSI bus use an intelligent controller and furnish programmable data-block sizes in read-and-write mode to a maximum of 32K bytes. All tape subsystems can use 7-, 8½-, and 10-inch standard reel sizes and can store as much as 40M bytes of data on a 2,400-foot reel of 1.5-mil tape. The model TD1012/SCSI supports nine-track, 1,600-bpi recording in the start/stop mode operating at 12.5 ips and/or streaming mode at 100 ips. Data-transfer rate is 20K bytes per second in start/stop mode and 160K bytes per second in streaming mode. The model TD1050/SCSI supports seven- or nine-track, dual-density, 800-bpi (NRZI) and 1,600-bpi (PE) recording in a start/stop mode operating at 45 ips. Data-transfer rate is 72K bytes per second. The model TD1750/SCSI supports nine-track, dual-density, 800-bpi (NRZI) and 1,600-bpi (PE) recording in a start/stop mode operating at 75 ips. Data-transfer rate is 120K bytes per second. TD1012/SCSI: $4,550, TD1050/SCSI: $5,150, TD1750/SCSI: $5,950, all in 100-unit quantities. Data Technology, 4060 Morena Blvd., P.O. Box 178160, San Diego, Calif. 92117, (619) 270-3990. Circle No 320

Subsystems enhance MDX development systems

The model 740 series cartridge-disk subsystems for Intel MDX development systems are available in four versions with various combinations of 10M-byte removable cartridge disk drives and single-sided, double-density floppy disk drives. The cartridge disk drives have 1.12M-byte-per-second transfer rates and 35-msec. average access times. Because the MDX systems are compatible with the CP/M-80 operating system, the cartridge disk subsystems allow a user to swap ISIS- and CP/M-formatted disks in the drive. Because the controller/interface in the model 740 series subsystems is ISIS-compatible in single density and double density simultaneously, a user can copy a file from a single-density disk to a double-density disk or vice versa. The subsystems’ single-board controller/interface simultaneously emulates the Intel SBC-201, SBC-202 and SBC-206. $7,172 to $8,692. Zendex Corp., 6644 Sierra Lane, Dublin, Calif. 94568, (415) 828-3900. Circle No 319

Subsystem provides 10M bytes of storage

The DataSafe-16, a 5½-inch Winchester disk subsystem for Intel Systems, provides 10M bytes of formatted storage and three directories. Compatible with Intel’s ISIS-II operating system, the subsystem has 78,336 available blocks allocated in three directories—F0, F1 and F2. Data-transfer rate is 625K bytes per second, and average access time is 85 msec. The Z80A microprocessor-based controller includes 32-bit ECC with transparent 11-bit burst error correction. The DataSafe-16 fits on top of the Inteltec and includes a Multibus adapter card that occupies one slot in the host chassis and conforms to IEEE 796 specifications. $6,500. Winchester Systems Inc., 14 Laurel Hill, P.O. Box 545, Winchester, Mass. 01880, (617) 933-8500 or (800) 325-3700. Circle No 321
Atron Announces A State-of-the-Art Advance in Debugging Software on the IBM PC

PC PROBE

- REAL TIME HARDWARE BREAKPOINT
- REAL TIME TRACE
- 8 CHANNEL LOGIC ANALYZER
- SYMBOLIC DEBUGGING
- HIGH LEVEL LANGUAGE SUPPORT
- PROGRAM PATCHING
- ENHANCED HUMAN INTERFACE
- FULL SPEED EXECUTION
- PROGRAM CRASH RECOVERY

PC PROBE IS AVAILABLE NOW. SO WHY WASTE TIME. CALL US TODAY. (408) 741-5900

New Products

TERMINALS

Terminal operates in graphics, APL modes

The model 16GRF/APL, an ANSI X3.64-compatible terminal, offers presentation graphics, APL capability and text editing. In graphics mode, the terminal is Tektronix 4010/4014 and Plot 10-compatible, with 240-by-640-dot bitmap display resolution. The terminal has a transparent printer port through which data are transmitted in LA120/LA34 format. In addition to APL, the terminal has four resident character sets: line drawing, mosaic, superscript/subscript and ASCII. Its 8K-byte display memory is normally configured as four 24-line-by-80-column pages. A 25th line displays setup, status and messages. The terminal's 312-character function memory can be expanded to include any unused display memory and accepts as many as 32 programmable functions. 12-inch model: $2,940; 9- and 15-inch styles with amber, green or white phosphors are also available.

Teleray Division of Research Inc., 6425 Flying Cloud Drive, Eden Prairie, Minn. 55344, (612) 941-3300.

Circle No 322

Graphics terminal features 512-by-480 resolution

The GTC314 color graphics terminal features a 512-by-480 bit-mapped display. Using Tektronix 4027-compatible protocol, the terminal can display arcs, circles, pies, vectors, bars and polygons. It can perform polygon fills in color or patterns. The terminal offers three character sets. The standard character set provides a display of 85 cpl with 48 lines on the terminal's 14-inch monitor. Two programmable sets permit users to define font and cell sizes as large as 256 by 128 pixels. The product's detachable keyboard uses a DEC VT100-style layout, and all keys are user-programmable. The terminal also furnishes two RS232C ports that operate at speeds as high as 19.2K baud. $2,395. PsiTech, 16902 Von Karman, Irvine, Calif. 92714, (714) 863-0981.

Circle No 323

Graphics terminal suits scientific applications

The ergonomically designed G-2200 terminal for CAD/CAM, CAE, scientific and business applications has a detachable keyboard and a 19-inch color monitor. The bit-mapped graphics terminal features 1,024-by-792-pixel resolution, a 60-Hz refresh rate, zoom, scroll, roam, alphanumeric and graphics overlays, selective erase and built-in support for a mouse, a tablet and a printer. The unit displays as many as 16 colors simultaneously from a palette of 4,096 hues. It is software-compatible with the Tektronix 4014 and is supported by third-party software such as ANVIL, Template, DI-3000 and BARDS. It also emulates the DEC VT100 for text editing and data entry. $12,950. Genisco Computers Corp., 3545 Cadillac Ave., Costa Mesa, Calif. (714) 556-4916.

Circle No 324

Low-cost unit replaces TeleVideo 925 terminal

The Challenger 525 video terminal, an alternative for TeleVideo 225 users, features 40 reprogrammable function keys (the first 22 are factory set with codes emulating the 925); pass-through and page printing; blink, blank, reverse and underline video attributes; a screen...
A saver; an RS232C or current-loop interface capable of communicating at speeds as high as 38,400 baud; and keyboard setup with the Softstart non-volatile storage package. The keyboard styling combines an IBM Selectric layout with a row of 21 single-stroke function keys, an isolated numeric pad and a cursor-control key cross pattern. The terminal's 12-inch green screen furnishes an 80-column-by-25-line display. $895. Soroc Technology Inc., 161 Freedom Ave., Anaheim, Calif. 92801, (714) 992-2860.

Circle No 325

ASCII terminal operates in IBM 327X environment

Designed for the IBM 327X environment, the Fame 78 ASCII terminal features an IBM 3278-style keyboard with 24 pre-set function keys and a green phosphor, 24-line-by-80-column display with a 25th status line. It includes a 12-inch, tilt-and-swivel screen, a microprocessor-controlled logic board and a CRT control circuit for a separate sync/video CRT monitor. The product offers two bidirectional RS232C ports with user-selectable baud rates from 300 to 9,600. $995. Falco Data Products Inc., 1286 Lawrence Station Road, Sunnyvale, Calif. 94089, (408) 745-7123.

Circle No 327

SONEX kills disk drive hum.

SONEX acoustical foam's absorption coefficient is four times that of conventional materials. Send for the tests, charts, specs, and color examples from 3800 Washington Ave. N., Minneapolis, MN 55412, or call 612/521-3555.

CIRCLE NO. 148 ON INQUIRY CARD
New Products

SOFTWARE

CAD electronic software runs on personal computers

The Electronic Design Automation software line turns an IBM PC or PC-compatible microcomputer into a specialized electronic-design workstation. The software integrates the engineering and layout portions of printed-circuit-board design. The PC-CAPS schematic-capture system uses a hierarchical design methodology and handles as many as 1,000 components and 1,000 nets at each level of hierarchy. It operates in as many as 16 colors with 50 layers. The PC-CARDS layout package creates printed-circuit boards and performs real-time checking of circuit signals for shorts and continuities. Like PC-CAPS, PC-CARDS is menu-driven and has rubber-band-line and real-time dragging capabilities. PC-CARDS can handle as many as 2,000 nets, 500 components and 10,000 component pins in as many as 15 colors and 50 layers. The PC-LOGS 12-state, event-driven logic simulator handles as many as 5,000 elements. The three packages share a common database, the Integrated Intelligent Database, that tracks electrical and logical connections and device attributes. Together the three packages sell for $9,000. Personal CAD Systems Inc., 981 University Ave., Building B, Los Gatos, Calif. 95030, (408) 354-7193.

Circle No 328

Software package includes application developer

The Aura integrated-software package features an application developer; menu operations; and integrated database, spreadsheet, word-processing and graphics modules. The package runs on IBM PC XT and PC-compatible microcomputers and requires 256K bytes of memory. Aura’s database manager executes report, sort, select, edit and index functions through a menu-driven, fill-in-the-blanks user interface. Data from this module can be included in spreadsheets, graphs or word-processing documents. Aura’s electronic spreadsheets can measure as large as 255 rows by 63 columns. The spreadsheet module offers more than 50 functions including statistical, financial, logical, mathematical, date and text operations. It includes a zoom feature for inspecting supporting data in related spreadsheets. Aura’s word-processing documents can include database information, spreadsheets or graphs. The program can concurrently edit several files and perform text-block operations that also allow moves between documents. Aura’s business graphics element offers free-draw graphics as well as the ability to alter prepared graphics dynamically and automatically.Aura also allows graphs to be included in word-processing documents. $495. Softrend Inc., 2 Manor Parkway, Salem, N.H. 03079, (603) 898-1777.

Circle No 329

Cross assembler supports 8086/8088 microprocessors

The ASM186 cross assembler system implements the structured assembly language specified by Intel for the Intel 8086/8088 and 80186/80188 microprocessors. The system also includes floating-
Those who know, pick Pacific

However it’s defined, quality has a way of being recognized.

For some of our customers, it might be product versatility. Two years ago we began making a 68000-based 16/32 bit CPU board that could operate with or without the popular UNIX operating system, depending on whether the customer had system- or real-time needs.

For others, performance is important. We designed a memory management unit that protects multiuser programs with no wait states. That’s when we discovered that performance and versatility become interconnected.

For instance, Congress needed some method of debugging the networking system currently used by the Members’ staffs. We packaged our CPU board with the necessary peripherals, and from this computer system we discovered even more applications. Our board now helps the U.S. Geological Survey analyze minor quakes from the Atlantic seafloor, while across the ocean the Prime Minister’s Office uses the same product to edit correspondence.

To increase performance even further we later designed a feature known as “dual porting”. This allows two or more processors to work together in tandem. Like a bicycle pedaled-by-two, the speed is impressive. So too is its versatility.

M.I.T. uses our new “D” board to study astronomy; General Electric uses it to control a robot for welding jet turbines.

Versatility and performance aside, we like to think that our list of “Who’s Who” is most attracted to us by our unique brand of personal service.

Pacific sales representatives provide pre-sales consultation and we pride ourselves on our post-sales service and support . . . no matter who you are.

For additional information, contact Sherrell Harper
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Cardiff, California 92007
(619) 436-8649

CIRCLE NO. 150 ON INQUIRY CARD
In one independent competition after another, UNIFY has proved itself the fastest UNIX data base management system. No wonder it's been selected by more computer manufacturers than all other UNIX data bases combined.

UNIFY speeds you through development and expedites program execution with some of the most powerful utilities of all, including:

- Fully menu-driven design.
- A powerful screen handling package that helps you format screens quickly, with no coding required.
- Raw I/O, that lets you bypass the UNIX file system for up to 40% faster performance in large data bases.
- Built-in optimizers that select the fastest of four data access methods.
- Industry standard IBM SQL query language, plus our powerful report writer, for easy access by end-users.
- Ninety subroutines for advanced program development... the most complete package of its kind.
- UNIFY's integrated design links program modules like screens, query language and report writer to help you quickly create complete, friendly, easily expandable applications.

Horsepower for the long run.
Unlike other data bases, UNIFY won't slow down under the weight of additional data or multiple users. It's built with the power to support new features later.

Judge for yourself. Send for our 300-page tutorial and 500-page reference manual—yours for only $95—that show you how to build virtually any application. Contact UNIFY, Dept. MMS-7, 9570 S.W. Barbur Blvd., Portland, OR 97219, 503/245-6585.
New Products

SOFTWARE

Software-development tool is language-independent

FORMIX for IBM PC and PC-compatible microcomputers is a CICS-like screen-management system composed of a run-time executive and a set of interactive screen forms-development tools. For creating screens, FORMIX provides screen-layout capability with which both the positioning and edit/validation criteria of all screen elements are defined interactively in a paint-the-screen mode. Customized, on-line help-screen, message and screen prompts are integrated with each application process. For programming, FORMIX provides language interfaces so that application programs written in standard programming languages such as BASIC, Pascal, C or COBOL load a defined screen form and call the FORMIX run-time executive. The run-time executive handles the screen I/O, message and data editing and validation. $495 for the BASIC version.

MCSI, 9531 W. 78th St., Eden Prairie, Minn. 55344, (612) 944-5220.

Circle No 331

Workstation software has window manager

CA-Executive software consists of integrated business applications, a microcomputer-to-mainframe link and communications facility and a window manager. The software runs on IBM PC XT and compatible microcomputers and requires 256K bytes of memory. The business applications include database-management, spreadsheet, word-processing, editing, graphics and forms-generation programs. Multiple programs can be displayed and processed concurrently through windows. Data can be retrieved, received, moved, manipulated and transmitted from one window to another or back and forth between the PC workstation and the mainframe. CA-Executive is also equipped with several utility windows including PC-DOS, directory, printspool, clock, notepad and help windows. 7665 (51 units).


Circle No 332

APL programming system runs under PC-DOS

The APL*Plus/PC System is an extended APL language that runs under PC-DOS on the IBM PC with 196K bytes of RAM and on various IBM PC look-alikes. The latest release features a full-screen editor for modifying programs and character data, scrolling display screens, support for the DOS 2.0 operating system, graphics primitives for screen and printer, an on-line help facility and English-like keywords. $585.

STSC Inc., 2115 E. Jefferson St., Rockville, Md. 20852, (301) 984-5123.

Circle No 333

Communications package sends messages over Telex

The SofGram electronic communications package allows users to create, send and receive messages over the Telex, TWX and DDD networks. The software provides a full menu-and-forms-driven user interface and a filing system. Users can create messages using the screen editor supplied with SofGram or with their own editor or word processor. The package works with commercially available modems and runs on computers that use the UNIX operating system. $500.

SofTest Inc., 555 Goffle Road, Ridgewood, N.J. 07450, (201) 447-3901.

Circle No 334

Modula-2 operates on VAX/VMS computers

The Modula-2 VAX/VMS compiler is a full implementation of the Modula-2 language as defined in the Modula-2 Report. The compiler generates VAX native object code. The VAX/VMS linker links separately compiled Modula-2 modules. The VAX/VMS symbolic debugger can be used to debug Modula-2 programs. All debugger commands are available, including examination of variables, setting of breakpoints and stepping through the program line-by-line. The Modula-2 compiler also provides features specific to the VAX/VMS environment, such as four floating data types. Through foreign-definition modules, the compiler provides access to routines written in languages different from Modula-2, such as VMS operating-system services and run-time library procedures. $1,500 per year.

Logitech Inc., 165 University Ave., Palo Alto, Calif. 94301, (415) 326-3885.

Circle No 335

Cross assemblers facilitate program development

The XMAC series of relocating cross assemblers enables any MS-DOS or PC-DOS microcomputer to serve as a development station for the Zilog Z8, the RCA 1802/4/6, the Fairchild F8/3870, the National Semiconductor 8070, the Intel 8051 or the TI TMS7000 or 9900 series microprocessors. The XMAC systems include a relocating macro assembler, a text editor, a cross-reference generator and off-loading facilities. The relocating macro assembler features macro and conditional assembly and can chain a series of source files during a single assembly. The two-pass linking loader produces an absolute Intel hex file. Members of the XMAC series share a common operational structure with uniform procedures for program entry, modification, assembly and disk-file handling. $250 each.

Allen Ashley, 385 Sierra Madre Villa, Pasadena, Calif. 91107, (213) 795-5748.
New Products

SUBASSEMBLIES

Package allows STD bus software development

With the Series 8800 Prototype Development System (PDS), IBM PC users can perform STD bus software development. The package includes software, the STD-8088 target system and documentation. The software allows users to write, compile and down-load programs to the target STD-8088 system as well as debug target-system-resident code from the operator console of the IBM PC. The debugged code can then be sent back to the PC, saved and burned into PROM. The STD-8088 target system includes an eight-slot card cage, a 10A power supply, a ZT 8812 processor board with an 8088 microprocessor, an Intel 80130-6 interrupt processor with counters and timers, two memory boards and a quad serial board for communications with the PC. PDS software consists of two packages: PC/STD 88, which provides file preparation and loading/debugging capabilities, and DBG 88, a PROM-based monitor program. $2,800. Ziatech Corp., 3433 Roberto Court, San Luis Obispo, Calif. 93401, (805) 541-0488. Circle No 337

Package simulates CP/M on HP minicomputers

The HP Bridge virtual CP/M microcomputer system for HP2600 series minicomputers running the MPE operating system includes a user-installable coprocessor board, software utilities for translating and transferring data and a license for CP/M. The Bridge software runs as a normal task under the MPE operating system and appears to a user to work as a standard CP/M microcomputer. The z-Board accelerator, which operates with the Bridge software, features four Z80 microprocessors, 256K bytes of RAM, eight serial I/O ports and a bit-slice machine that handles the bus and microprocessor arbitration. The z-Board allows as many as four users to access CP/M at once, each operating independently and using one Z80 cell, 64K bytes of RAM and two serial I/O ports. $5,000 for the hardware, $5,000 for the software. Virtual Microsystems, 2150 Shattuck Ave., Suite 720, Berkeley, Calif. 94704, (415) 841-9594. Circle No 338

Controller emulates DEC UDA-50 Unibus adapter

The model S35/U disk controller emulates the functions and operations of the DEC UDA50 Unibus disk adapter on the PDP-11 Unibus or on the VAX Unibus. The controller can operate with as many as four SMD disks with serial data rates as high as 15M bps. Any combination of drive sizes and speeds can be mixed on the same controller, which provides several forms of redundancy and reliability enhancement. The UDA-50 performs error detection and correction on all information read from the disk as well as on-board formatting, supports dual-port capability and contains automatic self-test diagnostics. $6,800. Dataram Corp., Princeton Road, Cranbury, N.J. 08512, (609) 799-0071. Circle No 339

Tape controllers are DEC-compatible

The TFC 825 and TFC 925 DEC TS11-compatible tape controllers come in three versions, according to the type and speed of the drive selected. The controllers work with LSI-11, PDP-11 and VAX-11 processors using 800-, 1,500-, 2,200- and 6,250-bpi tape drives with Pertex or STC interfaces. The first version works with industry-standard (Pertex) streaming and formatted start/stop drives that are front- and top-loading. The second works with low-speed, STC-compatible, GCR start/stop drives (50 ips). The third works with high-performance, STC-compatible, GCR start/stop drives (125 ips). The TFC 825, a Unibus-compatible, single-hex-sized board, which is embedded in one SPC slot, is software-transparent to DEC and UNIX operating systems. It uses a microprocessor for data-buffer management and tape-drive control and has a 16K-byte speed-matching buffer. The TFC 925, a Q-bus-compatible single-quad card controller, has the same characteristics as the TFC 825, with 22-bit addressing and block-mode DMA transfer capabilities. $1,850 to $2,950. Aviv Corp., 26 Cummings Park, Woburn, Mass. 01801, (617) 933-1165. Circle No 340

Prototyping board aids circuit development

The eZ Board experimenter system includes an epoxy printed-circuit board mounted with a set of solderless breadboarding units for building circuits. The package includes four distribution buses with 50 tie points each that can be used for power, ground, clock lines and reset commands. A four-position on-board DIP switch aids development and analysis of experimental circuits. Each switch position connects to a set of tie-point block sockets on either side, and a flat ribbon cable connects the board to a computer's bus-expansion slot. The breadboard area consists of 1,440 tie points with a capacity of 16 14-pin DIPs. Components with lead diameters as large as 0.032 plug in and can be connected with ordinary hookup wire. $174.95. Sabadia Export Corp., P.O. Box 1132, Yorba Linda, Calif. 92686, (714) 630-8335. Circle No 341

MINI-MICRO SYSTEMS: July 1984
New Products

**SUBASSEMBLIES**

**Plasma panel displays 2,000 characters**

The PlasmaGraphics 120 flat-panel display uses AC and DC plasma-discharge display technology. The product provides 120,000 addressable pixels arranged in 480 columns by 250 rows. When addressed by a 5-by-7 character matrix, the panel can display 25 lines of 80 characters. All the electronics to address and time the display are housed on an integral panel driver board. Less than $1,000 in OEM quantities. Plasma Graphics Corp., P.O. Box 4903, Warren, N.J. 07060, (201) 757-5000. Circle No 342

**Controller, host adapters increase I/O performance**

The ACB—5580 SMD hard disk controller board has SASI/ANSI SCSI support and two intelligent host adapters for S-100 and Multibus host buses. The board is aimed at improving the I/O performance of multitasking microcomputer systems. It supports as many as seven host CPUs through the SCSI bus and as many as four SMD drives. The board drives either 8- or 14-inch, 9.6M-bps SMD disk drives. It features disconnect/reconnect, file sharing and non-interleaved operation. The AHA-1510 for the S-100 bus and the AHA-1530 for the Multibus intelligent host adapters function between the host bus and the SCSI bus as I/O processors working with the operating system's I/O supervisor. Both host adapters support DMA at 1.5M bytes per second from the SCSI bus to the host's local memory. They handle as many as eight concurrent I/O requests. ACB-5580: $880; AHA-1510: $425; AHA-1530: $460. Adaptec Inc., 580 Cottonwood Drive, Milpitas, Calif. 95035, (408) 946-8600. Circle No 347

**Processor card is 68000-based**

The DVME 102 single-board microcomputer is based on a 68000 microprocessor and incorporates a 68451 memory-management unit. The board provides 256K bytes of dual-ported dynamic RAM with parity, two 28-pin boot sockets, two dual-ported RS232C channels and three programmable counter/timer channels. The memory array accommodates a 256K-by-1 RAM chip and offers memory expansion to 1M byte. The dual-channel USART supports programmable bit rates from 300 to 19,200 bps in asynchronous mode and as high as 1M bps in synchronous mode. The processor card also provides system clock, bus time-out, single-level arbiter, reset push-button and programmable-status LED indicators for system control. $3,000. DY4 Systems Inc., 888 Lady Ellen Place, Ottawa, Ontario K1Z 5M1, (613) 728-3711. Circle No 343

**Product supports micro development**

The MDS-68K package provides development support for Motorola's 68000 microprocessor in Intel's Intellec series of microprocessor-development systems. It includes a Motorola-compatible assembler, a linker/loader, a symbolic debugger, a plug-in circuit board and documentation. The plug-in board furnishes an 8-MHz 68000 CPU, a memory-management subsystem, 256K bytes of RAM and 64K bytes of ROM firmware. The firmware contains a monitor and the MDS-68K ISIS I/O interface. The board also has two serial I/O ports for use with 68000 hardware emulators. The symbolic debugger permits debugging of assembly, as well as high-level language modules, using programmer-defined symbols and statement numbers. $5,995. Language Resources Inc., 4885 Riverbend Road, Boulder, Colo. 80301, (303) 449-8087. Circle No 346

**CP/M micro board mounts on minifloppy drives**

The Little Board single-board CP/M computer screws directly into the mounting holes of a 5¼-inch minifloppy disk drive. The board combines a 4-MHz Z80A CPU with a printer port and floppy disk controller. The board comes with the CP/M 2.2 operating system and utility programs for formatting and copying data. It has two RS232 ports that feature software-controlled baud rates—75 to 38,400 baud for one and 75 to 9600 baud for the other. The parallel I/O port has a Centronics-compatible printer pin-out. The unit's disk I/O capability includes support for as many as four single- or double-density, single- or double-sided, 48- or 96-tpi minifloppy disk drives. $349. Ampro Computers Inc., 67 E. Evelyn Ave., P.O. Box 390427, Mountain View, Calif. 94090, (415) 982-0230. Circle No 345

**Protocol converter supports color terminals**

The Defender II/IIs protocol converter allows asynchronous ASCII terminals to communicate with an IBM or equivalent host computer using SNA/SDLC or BSC protocols. It features full-screen mapping, menu-driven setup capabilities and backup memory, maintains an internal image buffer, operates remote full-screen applications at low baud rates and supports terminals with color and extended highlighting features. When installed in the Defender II/IIs chassis, the product is available in an eight-port configuration. $5,500. Digital Pathways Inc., 1060 E. Meadow Circle, Palo Alto, Calif. 94303, (415) 493-5544. Circle No 344

**Product supports micro development**

The MDS-68K package provides development support for Motorola's 68000 microprocessor in Intel's Intellec series of microprocessor-development systems. It includes a Motorola-compatible assembler, a linker/loader, a symbolic debugger, a plug-in circuit board and documentation. The plug-in board furnishes an 8-MHz 68000 CPU, a memory-management subsystem, 256K bytes of RAM and 64K bytes of ROM firmware. The firmware contains a monitor and the MDS-68K ISIS I/O interface. The board also has two serial I/O ports for use with 68000 hardware emulators. The symbolic debugger permits debugging of assembly, as well as high-level language modules, using programmer-defined symbols and statement numbers. $5,995. Language Resources Inc., 4885 Riverbend Road, Boulder, Colo. 80301, (303) 449-8087. Circle No 346
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Handbooks list product specifications

This eight-volume set of handbooks contains product specifications of the vendor’s product line. The handbooks cover software, memory components, microcontrollers, telecommunications, microsystem components, military products, development systems and OEM systems. $75, including a free, 112-page 1984 Product Guide. Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051, (408) 496-9604.

Circle No 348

Directory lists computer graphics suppliers

The Third Edition of the S. Klein Directory of Computer Graphics Suppliers: Hardware, Software, Systems and Services lists more than 500 supply sources. Entries in the 224-page directory provide basic product information and business backgrounds of each company, including ownership, top management, company size, sales volume, year founded, addresses, phone numbers, telex or TWX and contact persons. The edition also contains a five-page brief on the considerations and trade-offs encountered when buying computer graphics products. $60. Computer Graphics Suppliers, Directory Manager, 750 Boston Post Road, P.O. Box 89, Sudbury, Mass. 01776, (617) 443-4671.

Circle No 349

Resource profiles hardware, software firms

The second edition of Microcomputer Marketplace profiles companies that provide hardware, software, supplies and services to microcomputer users. The edition contains 2,300 new entries, for a total of 4,000. The companies include 2,000 software publishers; 150 distributors; 250 magazines and newsletters; 750 manufacturers of systems, peripherals and supplies; and 300 specialty companies. The first chapter identifies and describes approximately 2,000 publishers of microcomputer software and includes the companies’ names, addresses, telephone numbers, products, application areas and operating and microcomputer systems. In the book’s index chapters, software is grouped according to applications and compatibilities. Company profiles are arranged according to distributors and manufacturers of microcomputer systems, peripherals and supplies. The publication also furnishes directories of periodicals, associations, on-line database services and special services. 517 pages, $75. Gale Research Co., Book Tower, Detroit, Mich. 48226, (313) 961-2242.

Circle No 350

Report details market for integrated software

The Integrated Software report focuses on integrated application-software packages that combine more than one application function in a program that moves and transfers data between functions. The report also covers “mouse-and-window” operating environments typified by Apple’s Lisa and VisiCorp’s Visi™. The report predicts that sales of integrated application-software packages and the new operating environments will reach $6.5 billion by 1988. The report also analyzes industry economics, market forces, distribution, potential market entrants and the competitive environment, including company profiles and market shares. $1,450. Creative Strategies International, 4340 Stevens Creek Blvd., Suite 275, San Jose, Calif. 95129, (408) 249-7550.

Circle No 351

Catalog lists engineering standards

The 1984 EIA and JEDEC catalog lists more than 600 standards and publications for electronic components and equipment. It also includes interim standards and engineering bulletins; proceedings of nationwide technical conferences and workshops sponsored by the EIA engineering department committees; and the EIA’s Joint Electron Device Engineering Council standards, publications and semiconductor registration lists. The catalog gives prices and ordering information. $5. Electronic Industries Association, 2001 Eye St., N.W., Washington, D.C. 20006, (202) 487-4891.

Circle No 353

Directory lists computer dealers

The 1984 Directory of 22,368 Computer Dealers lists business names, addresses, zip codes, telephone numbers and franchise information. The information is a compilation of 4,800 Yellow Pages telephone directories in the United States. The reference organizes information alphabetically by state and city. $369. American Business Directories Inc., P.O. Box 26347, Omaha, Neb. 68127, (402) 331-7293.

Circle No 354

Book features operating systems


Circle No 352

Multiplexer directory provides specifications

This directory provides specifications and pricing information on 140 multiplexers for general-purpose data-transmission applications. The directory also provides information on how multiplexers operate and discusses the relative merits of various multiplexing techniques. Each model description defines the multiplexer type and applications and provides information on data-channel and composite-link parameters, diagnostics capabilities and visual indicators and support. Model descriptions are arranged alphabetically by vendor. $39. Data Decisions, 20 Brace Road, Cherry Hill, N.J. 08034, (609) 429-7100.

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### New Products

#### LITERATURE

**Software guide lists packages for HP plotters**

This guide describes eight graphics software packages that enable Apple personal computer users to produce charts and graphs on HP 7470A and HP 7475A graphics plotters. The guide includes data sheets, sample graphics plots and hardware requirements. The guide also provides information on connecting the HP graphics plotters to the Apple IIe and Apple III, including recommended system configuration, connection instructions and communication verification. Hewlett-Packard Co., 1820 Embarcadero Road, Palo Alto, Calif. 94303.

Circle No 356

**Catalog describes customized systems**

This 60-page product catalog describes the company’s DEC-, NCR- and UNIX-compatible customized systems and software. Chapters detail the company’s offerings in DEC and UNIX operating systems and layered products; integrated Q-bus, Unibus and Multibus systems and components; mass-storage and tape drive subsys-

tems; terminals and printers; and hardware- and software-support services. Cambridge Digital Systems, P.O. Box 586, 65 Bent St., Cambridge, Mass. 02139, (617) 491-2700, (800) 343-5504.

Circle No 357

**Literature details CAD systems**

This literature details the ICON 2000 series integrated, computer-aided design systems based on DG’s Desk Top Generation computers. ICON systems suit applications in the architectural, engineering, construction and printed-circuit board markets. The literature explains the expandable system’s features, provides a system overview and details important software functions and hardware components. The literature also provides operating specifications and lists available options. Summographics Corp., 777 State St. Extension, P.O. Box 781, Fairfield, Conn. 06430, (203) 384-1344.

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**Mini-Micro Systems**

*Covers the Value-Added Market*

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MINI-MICRO SYSTEMS /July 1984

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JULY

17-20 "Microprocessor Software, Hardware & Interfacing" Workshop, Los Angeles, sponsored by Integrated Computer Systems. Contact: Ruth Dordick, Integrated Computer Systems, 6305 Arizona Place, P.O. Box 45405, Los Angeles, Calif. 90045, (213) 417-8888, (800) 421-8166 (outside California) or (800) 352-8251 (in California). Also to be held on July 24-27 in Washington.


23-25 Summer Computer simulation Conference (SCSC '84), Boston, sponsored by Simulation Councils Inc. Contact: Charles Pratt, Simulation Councils Inc., P.O. Box 2228, La Jolla, Calif. 92038, (619) 459-3888.


JULY 31-AUG. 3

AUGUST

13-17 "Database '84" Course, Wang Institute of Graduate Studies, Tyngsboro, Mass., sponsored by the Wang Institute of Graduate Studies. Contact: Roberta Wesley, Coordinator of Special Programs, Wang Institute of Graduate Studies, Tyng Road, Tyngsboro, Mass. 01879, (617) 649-9731.

15-16 Telecommunications Seminar, New York, sponsored by The Yankee Group. Contact: Lisa Caruso, Seminar Director, The Yankee Group, 89 Broad St., Boston, Mass. 02110, (617) 542-0100. Also to be held on Aug. 22-23 in San Francisco.


SEPTEMBER

5-7 National Software Show, Anaheim Convention Center, Anaheim, Calif., produced by Raging Bear Productions Inc. Contact: Philip J. Russell, National Software Show, Raging Bear Productions Inc., 21 Tamal Vista Drive, Suite 175, Corte Madera, Calif. 94925, (415) 924-1194 or (800) 732-2300.

11-13 Midcon '84 High-Technology Electronics Exhibition and Convention, Dallas, produced by Electronic Conventions Inc. Contact: Nancy Hogan or Kent Keller, Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, Calif. 90045, (213) 572-2965.

11-13 Mini/Micro Southwest '84 Computer Conference and Exhibition, Dallas, produced by Electronic Conventions Inc. Contact: Nancy Hogan or Kent Keller, Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, Calif. 90045, (213) 572-2965.


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