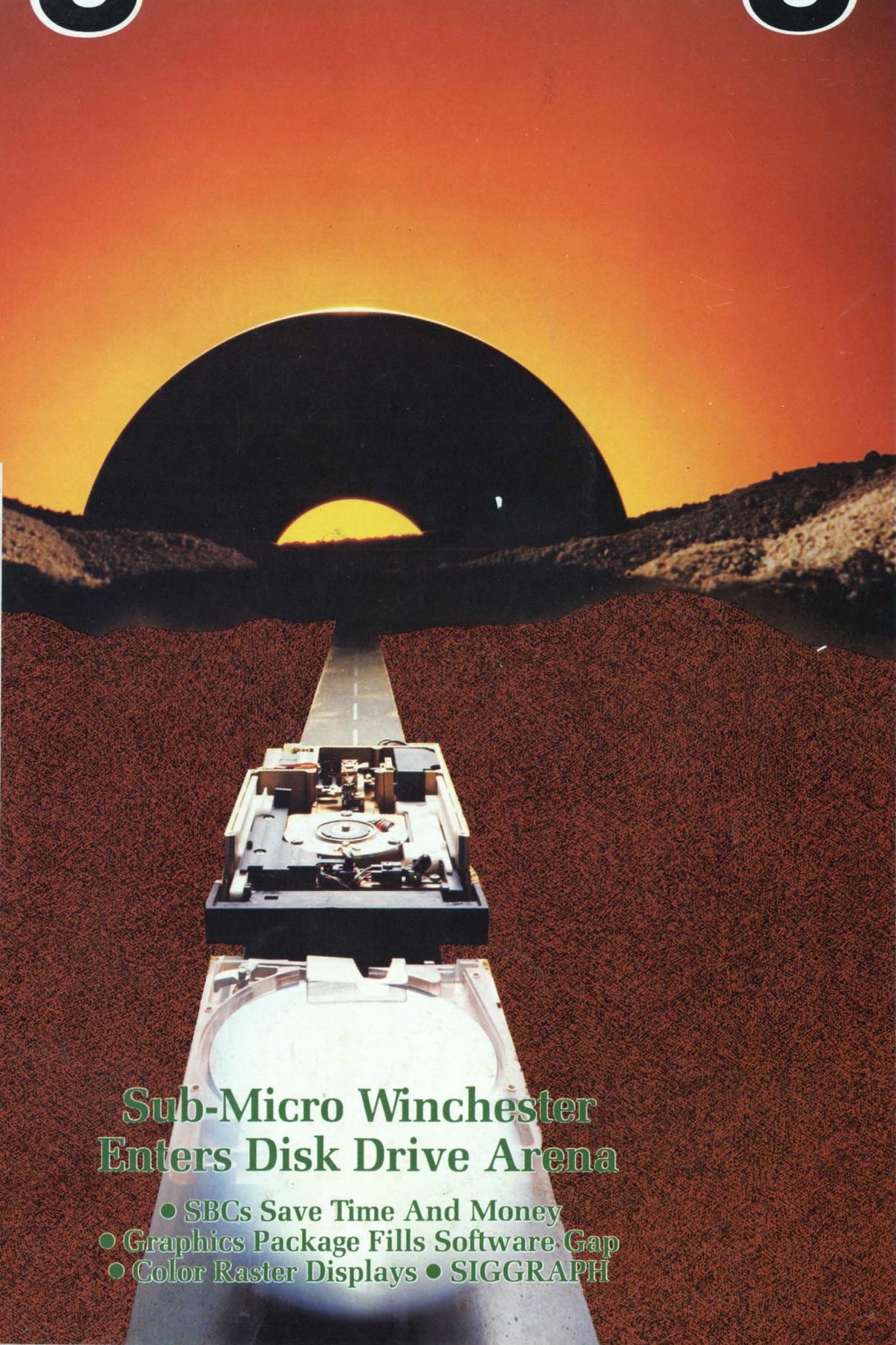


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How quiet is "silent"? We've designed the Silent/Scribe series to operate at less than 55dBA at a distance of three feet. This means that from across the room in the average office you may have to look at it to tell whether it's printing.

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Standard Features	Char. per Inch	DP-9000A	DP-9500A	DP-9001A	DP-9501A	DP-9620A
Printing Speed (Char. per Sec.)	10	150	150	120	120	200
	12	180	180	—	—	120
	12.5	—	—	150	150	—
	13.3	200	200	—	—	—
	15	—	—	180	180	150
	16.4	—	—	200	200	164
Enhanced	10	—	—	—	—	100
Expanded Print (Double Width)		Yes	Yes	Yes	Yes	Yes
Dot Addressable Graphics (Dot/In., H/V)		60/72	60/72	75/72	75/72	72/72
Max. Line Width (In.)		8.0	13.2	8.0	13.2	13.2
Audible Alarm		Opt.	Opt.	Opt.	Opt.	Yes
Out-of-Paper Sense		Yes	Yes	Yes	Yes	Yes
Ribbon, Continuous Loop Cartridge (Yds)		30	30	30	30	30
Interfacing:						
Parallel Cent. Comp.		Yes	Yes	Yes	Yes	Yes
RS-232-C Serial		Yes	Yes	Yes	Yes	Yes

To select a Silent/Scribe printer for your specific needs and wallet is easy. They come with a variety of printing speeds, fonts and line widths. Some models provide both draft and enhanced quality copy; so you can print out your engineering reports, complete with charts and graphs.

Regardless of which Silent/Scribe model you select, certain underlying features and a value-engineering point of view extend throughout the entire product line. The results? Standard dot-addressable graphics; sophisticated communications controls and protocols; flexible and easy-to-use operator controls; quick-change continuous loop ribbon cartridge; and universal interfaces that work with virtually any minicomputer or system.

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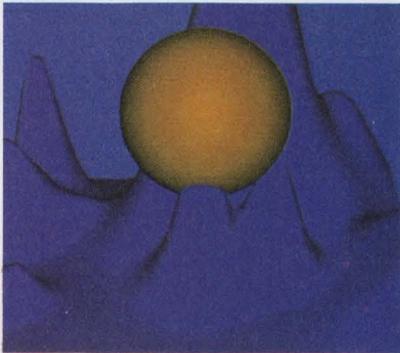
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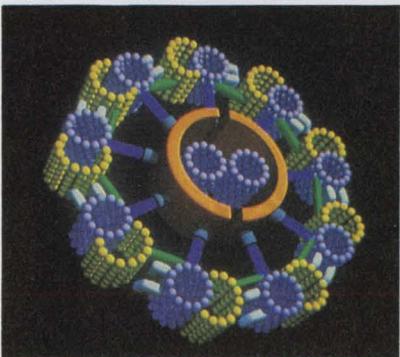
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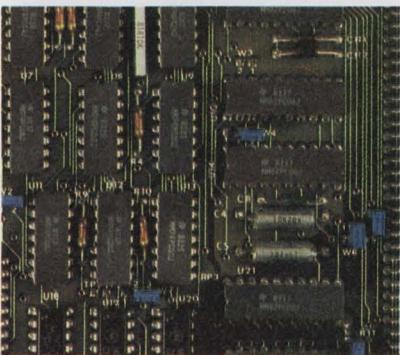
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Cover

Signifying a new round in the battle for mass storage supremacy, SyQuest's new 3.9" removable Winchester is aimed squarely at the burgeoning desk-top computer market (story on page 56; cover courtesy of SyQuest Technology).

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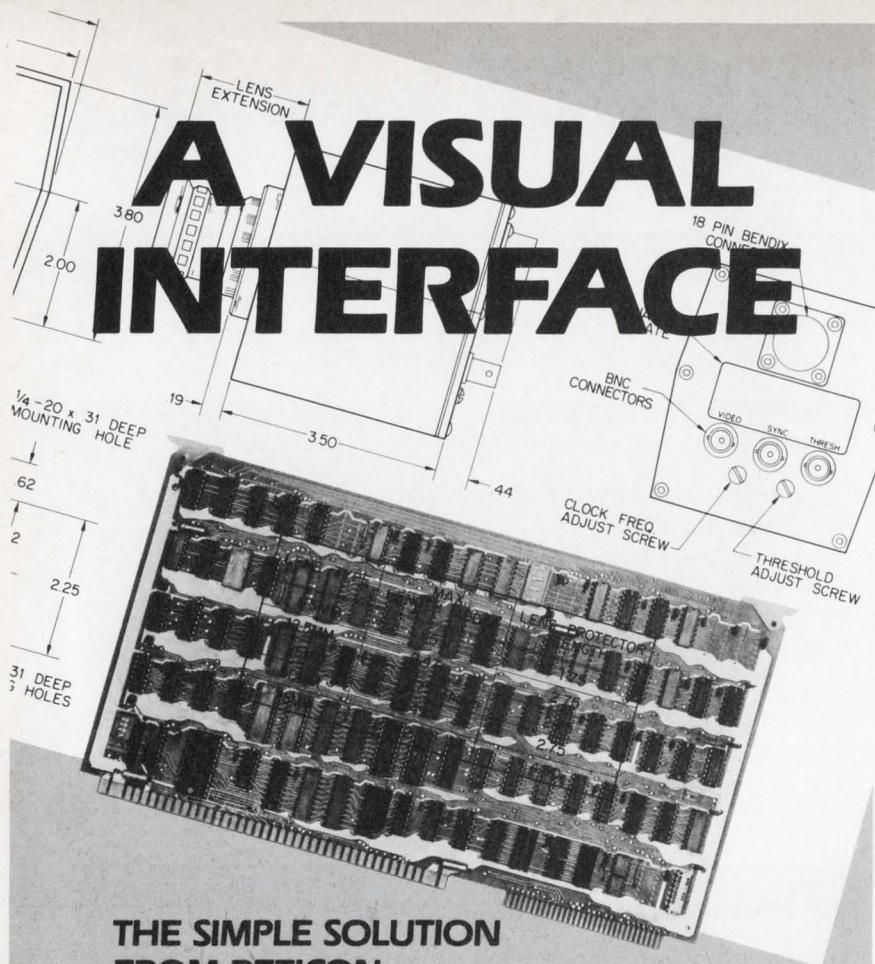
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Da Vinci would have traded all his notebooks for this new AED767 graphics terminal.

Today, Leonardo da Vinci's notebooks are priceless objets d'art. They also contain many unique engineering concepts, like the one shown above of the iron framework he designed to reinforce the head and neck moulds for 'Il Cavallo', the horse. Although da Vinci worked periodically on 'Il Cavallo' for 16 years, the gigantic bronze statue, which was to stand some 26 feet tall, never materialized.

AED 767's unique anti-aliasing feature



On



Off

Instead, his patron, the Duke of Milan, used the casting bronze for canons in a war against France.

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Editor, *Digital Design*, 1050 Commonwealth Ave., Boston, MA 02215.

Conditioning Devices

Dear Editor:

John Waterman, Jr. made some good points in his April article on selection of power conditioning devices for computers. I particularly concur with his advice to use instrumentation to find out what type of power problems exist before making a selection.

Perhaps shortness of his article prevented mentioning the importance of determining whether disturbances come from the line or are load-induced. Interaction between load current and power source impedance can be a significant source of unwanted line voltage changes, wave distortion, transient disturbances and noise.

Some power conditioning devices have a relatively high internal impedance compared with a typical utility power source. When computer loads have high harmonic current content or large peak values, the additional source impedance increases rather than decreases the magnitude of load-induced line voltage distortions and disturbances.

I have seen marginally operating systems become much worse or completely inoperative after installation of a poor choice of power conditioner. There was nothing wrong with the conditioner. It was merely the wrong type or the wrong KVA size for the application.

Source impedance and load-induced disturbance magnitude can often be reduced by selecting a conditioner with a larger KVA capacity. However, this increases cost of the conditioner and energy losses during its useful life. Choosing the type and capacity of a power conditioner often requires experienced judgement and compromise when choosing between technical and economic considerations.

John F. Kalbach
920 Alta Pine Drive
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Cryptography and Data Security. Palo Alto, CA. Also in Los Angeles, CA November 3-5. Contact: Hellman Assoc., 299 California Ave, Palo Alto, CA 94306; 415-328-4091.

August 9-13

AOS System Programming. New York, NY. Contact: Kathy Hamson, Data General, 4400 Computer Dr, Westboro, MA 01580; 617-485-7270.

August 9-13

Spread Spectrum Communications System. Washington, DC. Provides participants with a better understanding of the concepts and applications of spread spectrum systems. Contact: Continuing Engineering Education Program, George Washington University, Washington, DC 20052; 202-676-6106.

August 15-17

Interactive Integration of Text and Pictures. Andover, MA. Contact: Institute for Graphic Communication, 375 Commonwealth Ave, Boston, MA 02215; 617-267-9425.

August 15-19

ASME Second International Computer Engineering Conference and Show. San Diego, CA. Contact: Irwin Berman, Foster Wheeler Development Corp., 12 Peach Tree Hill Rd., Livingston, NJ 07039.

August 16-18

Encapsulation of Electronic Devices & Components; Interconnection Wiring and Cabling; and Modern Industrial Transformer Practice. All three courses held in NJ. Contact: The Center for Professional Advancement, Dept. NR, PO Box H, E. Brunswick, NJ 08816; 201-249-1400.

August 16-20

INFOS II Data Structures Under AOS. New York, NY. Contact: Kathy Hamson, Data General, 4400 Computer Dr, Westboro, MA 01580; 617-485-7270.

August 17-19

Computerized Pictorial Typesetting. Andover, MA. Contact: Institute for Graphic Communication, 375 Commonwealth Ave, Boston, MA 02215; 617-267-9425.

August 19-21

Internecon/Semiconductor International Exposition. Singapore. Electronic packaging and production equipment, tools, hardware materials and test instruments. Contact: Cahners, Exposition Group, 222 W. Adams St. Chicago, IL 60606; 312-263-4866.

August 21-27

15th International Congress on High Speed Photography and Photonics. San Diego, CA. Contact: SPIE, PO Box 10, Bellingham, WA 98227; 206-676-3290.

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Advances in Impactless Printing. Carmel, CA. Contact: Institute for Graphics Communication, 375 Commonwealth Ave, Boston, MA 02215; 617-267-9425.

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August 23-25

Computer Vision: Representation and Control. Rindge, NH. Contact: R. Haralick, VPI & SU, Dept. of Electrical Engr., Blacksburg, VA 24601; 703-961-6819.

August 23-26

Electromagnetic Compatibility Engineering. NJ. Contact: The Center for Professional Advancement, Dept. NR, PO Box H, E. Brunswick, NJ 08816; 201-249-1400.

August 24-25

Indycon '82. Indianapolis, IN. A micro-computer and electronic components conference with technical papers and exhibits. Contact: F. Schechter, Show Manager, 8326 Trace Circle, Indianapolis, IN 46260; 317-875-7711.

August 24-27

1982 International Conference on Parallel Processing. Bellaire, MI. Contact: Dr. Tse-yun Feng, Dept. of Computer and Information Science, The Ohio State University, 2036 Neil Ave. Mall, Columbus, OH 43210; 614-422-1408.

August 30-Sept 1

Robotics. NJ. Contact: The Center for Professional Advancement, Dept. NR, PO Box H, E. Brunswick, NJ 08816; 201-249-1400.

August 30-Sept 3

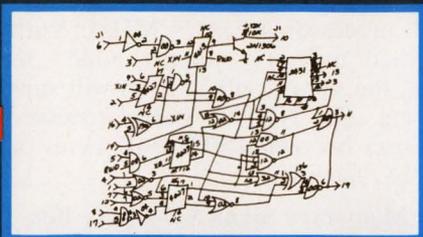
11th International Symposium on Mathematical Foundations of Computer Science—MFCS '82. Gdańsk, Poland. Contact: Witold Lipski, Jr., MFCS '82, Institute of Computer Science, Polish Academy of Sciences, PO Box 22, 00-901 Warsaw, PKiN, Poland.

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NET001	U1 1 1 A1
NET002	U1 2 1 A1
NET003	A2 1 1 A1
NET003	U1 2 1 A1
NET003	U2 2 1 A1
NET004	U1 3 1 A1
NET004	U2 3 1 A1
NET005	U2 8 1 DF
NET005	U2 13 1 C2
NET005	U11 13 1 D3
NET005	U2 7 1 D2
NET005	U4 18 1 C3
RWD	U2 5 1 C1
RWD	U3 8 1 B1
XIN	U3 11 1 A2
XIN	U6 4 1 D1
XIN	U4 3 1 D1

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2	12	054-002	SN7402N
3	8	054-6080-87	RESISTOR 1.5K 1/2W 5%
4	2	079-5784-1	ZENER DIODE 1N821 6.2L

REFERENCE DESIGNATOR	PART NUMBER	DESCRIPTION
CR1	079-5784-1	ZENER DIODE 1N821 6.2L
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U1	054-4000	SN7404N
U2	054-002	SN7402N

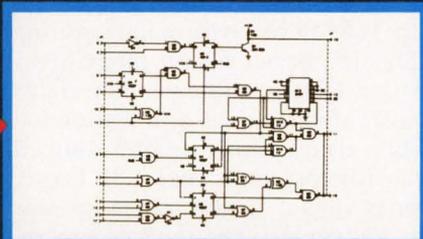
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"DS1" interfaces to P.C.B. Routers, Wire Wrap, Simulation and Test Programs.

UPDATED SCHEMATIC



"DS1" performs Back-Annotation from a "Was-To" list derived from the P.C. Router. "Back-Annotation" automatically updates the schematic to agree with the circuit board component placement.

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News Update

Vocabulary Development Software

Signal Technology, Santa Barbara, CA now offers a speech processing software package designed specifically to support the new GI Orator speech synthesizer chip.

According to Dr. Larry Pfeifer, Signal Technology's vice president, the new software package permits users to perform vocabulary generation in-house.

The package is composed of a subset of Signal Technology's ILS signal processing package. It contains tools for speech labeling, waveform editing and display, speech analysis and synthesis, formant tracking, digital filtering and spectral analysis.

Intel And Burroughs Enter Into IC Agreement

Intel Corp and Burroughs Corp have entered into an agreement under which Intel's silicon foundry will become Burroughs' high-volume manufacturing source for proprietary MOS ICs. Under the agreement, Burroughs will design, prototype, assemble and test the proprietary circuits; Intel will sell silicon wafers to Burroughs through its silicon foundry. The agreement is a result of a previous Burroughs decision to discontinue high-volume wafer manufacturing and concentrate on design and prototype fabrication. Intel will begin supplying wafers to Burroughs during 1982 for circuits already designed by Burroughs. Also under the agreement, Intel will provide technical information to allow Burroughs to design circuits compatible with Intel's advanced HMOS and CHMOS processes.

North Star Computers Can Convert to Multi-processor, Multi-terminal Systems

MuSYS Corporation, Tustin, CA, has announced the availability of a new CP/M compatible operating system and slave processors that convert single-user North Star Horizon computers to multi-processor, multi-terminal systems. The new operating system is enhanced TurboDOS, a CP/M compatible system being distributed by MuSYS Corporation under license from Software 2000. Most application software written for CP/M2.x can be run on TurboDOS. With TurboDOS and MuSYS NET/82 S-100 slave processors, the North Star Hori-

zon can support up to 8 terminals, each running at full processor speed (4 MHz). With bank switched memory support added to TurboDOS, the same configuration will support 16 users. The NET/82 slave processor gives each user his own Z80A, 64K bytes of RAM and I/O facilities.

Computer Memories Signs \$4M Pact For 5 1/4" Drives

Computer Memories has signed an agreement with Dynabyte Corporation which will represent more than \$4M over a 2-year period. The contract calls for shipment of Computer Memories' 12 and 19 Mbyte 5 1/4" Winchester disk drives. Dynabyte will incorporate the drives into their Series 5505, 5605, and 5710 business computers which are marketed by a worldwide network of distributors and dealers.

Seagate Technology 105% Guarantee

Seagate Technology has guaranteed that every Seagate disk drive will pass incoming inspection or the customer will receive a 5% rebate on the failed disk drive. Seagate is providing to qualified customers, a comprehensive incoming test program that includes a disk test system, on-site training for customer QA personnel, system certification every ninety days, and a "gold standard" reference drive. The guarantee is available, under written contract, to volume purchasers of Seagate disk drives. To qualify, the customer must purchase a minimum of 500 drives per year for US delivery, and install Seagate's incoming test program.

California Devices And Telmos Form Cross-Licensing Pact

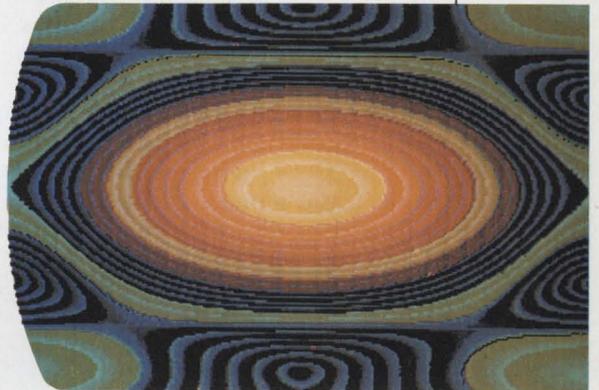
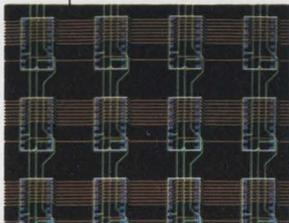
California Devices, San Jose, CA, and Telmos, Santa Clara, CA, have announced completion of a cross-licensing agreement under which Telmos receives manufacturing rights to CDI's HC Series silicon gate CMOS gate arrays and CDI acquires similar rights to the Telmos TM6000 Series of linear/digital silicon CMOS arrays. Also second-sourced by American Microsystems and LSI Logic, the HC Series digital arrays range in size from 300 to 1780 gates. The devices can replace from 20 to more than 50 individual TTL or CMOS circuits. The Telmos TM6000

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Modular in design, configurations are available ranging from single board B/W graphics to full color image display systems at resolutions from 512 X 512 to 1024 X 1024.

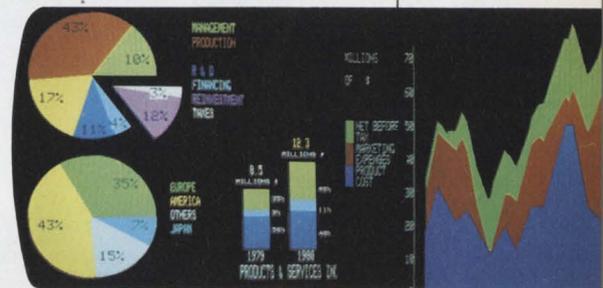


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News Update

Series extends the digital gate array concept by integrating general purpose linear CMOS elements on the same circuit as the digital gates, permitting integration of entire analog/digital functions on the same circuit.

Corvus Continues Dramatic Growth

The sales of Corvus Systems have tripled and net income has quadrupled for the first nine months of the current fiscal year when compared to the same period of the previous fiscal year. Sales for the nine months ending February 27, were \$17.9 M from the year-earlier \$5.9 M, and net income was \$1.45 M from the year-earlier \$347,000. During this period, net income per share increased from \$0.10 to \$0.19, adjusted to reflect an increase in the number of outstanding shares as a result of the company's public offering of October, 1981.

Taurus Software Launches CP+

Taurus Software Corp., San Francisco, CA, will sell CP+, a product that enhances Digital Research's popular CP/M operating system for 8-bit μ Cs. CP+ was conceived by John Simpson, President of Taurus, after he had worked in marketing and sales positions for Digital Equipment Corp. and Burroughs Corp. "I saw a lot of frustrated, first-time CP/M users confused by complex commands, and addressed that frustration by creating CP+," said Simpson. "CP+ eliminates the need to learn complex commands by using English language commands. The result is a friendlier system that features benefits such as timesharing of computer resources and increased productivity," added Simpson. CP+ is available through distributors, computer store dealers and directly from Taurus for \$150.

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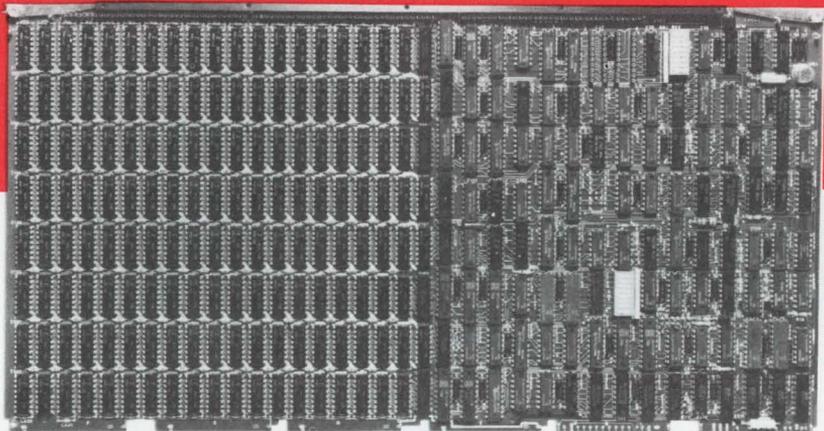
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LSI-11	DR-113S	quad	256 KB
LSI-11	DR-213S	quad	1.0 MB
PDP [®] -11	DR-114S	hex	256 KB
PDP-11	DR-114SP	hex	256 KB
PDP-11	DR-214SP	hex	1.0 MB
PDP-11	DR-144S	hex	256 KB
PDP-11	DR-244S	hex	4.0 MB
VAX [®] -11/750	DR-175S	hex	256 KB
PDP-11/70			
VAX-11/780	DR-178S	extended hex	512 KB
DECSYSTEM 2020 [®]	DR-120S	extended hex	512 KB
PDP-8/A	DR-118S	quint	128 K x 12

DEC, DECSYSTEM 2020, PDP and VAX are registered trademarks of Digital Equipment Corporation.

Dataram also provides core add-ins, core and semiconductor add-ons, memory system units, memory management, and a wide range of memory-related accessories for DEC users.

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First Lithium "Paper" Batteries Feature High Capacity

A family of flat, super-thin, "paper" lithium batteries available from the Battery Sales Div. of Panasonic Industrial Corp., officially designated as "Lithium Paper Batteries," represent a significant breakthrough in manufacturing technology of lithium cells. They can be made as thin as 0.8 mm (about 0.031") in any shape that might be desired—square, rectangular, triangular, semicircular—for portable electronic equipment, and stand-by memory back-up systems.

Unlike previous "paper" batteries, these lithium units offer considerable capacities. Thus a unit measuring just 70 mm (2.76") by 94 mm (3.7") by 1.8 mm (0.071") has a capacity of 1.5 ampere-hour. Even a tiny "chewing gum stick" lithium paper battery measuring only 20 mm (0.79") by 70 mm by 1.8 mm offers a capacity of 80 mAh. Since these capacities are at a nominal "lithium" voltage of 3Vdc, the new units boast the world's highest energy densities.

Lithium Offers Safety

The cells are inherently safe. As the battery discharges, the original battery materials—lithium-polycarbon-monofluoride—are converted to two harmless and stable compounds: carbon and lithium fluoride. The formation of carbon within a cell lowers the internal cell resistance. Thus, voltage remains at a constant level longer.

During long-term storage, no gas generation occurs, which minimizes self-discharge and the associated loss of capacity. Capacity deterioration occurs at 0.5% per year. Such a cell will retain about 95% of its original capacity after ten years of storage.

Other Advantages

1. Long operating and shelf life—no other battery systems can compete with lithium when it comes to life. In fact, at this time there is no actual test data on how long a lithium cell might "live." Certain early cells at Matsushita Electric

Corporation that were placed on test in 1971 are still going strong today.

2. High energy density—in volumetric efficiency, a lithium cell outstrips the conventional carbon-zinc (Leclanche) cell five to ten times. With portable devices of all kinds growing in popularity, this is important.

3. The ability to store and operate at low temperatures—since the electrolyte in a lithium cell contains no water, conductivity remains high even at very low temperatures.

As for size, lithium paper bat-

teries can be made in a variety of shapes and sizes. The three most popular sizes are half post card, small business card, and chewing-gum stick size, which are respectively: 70 × 94 × 1.8 mm, 43 × 70 × 1.8mm, and 20 × 70 × 1.8mm. Nominal shelf life for each is three years at 20°C. Nominal voltage is the same for all three, 3.0 Vdc. Capacity differs, and is, respectively: 1500, 350 and 80 mAh. Short circuit current is 3, 1.3 and 0.2 A. Internal resistance is: 2, 4 and 11 ohms. Capacity was measured by discharge to 2.0 Vdc into a 500Ω load.

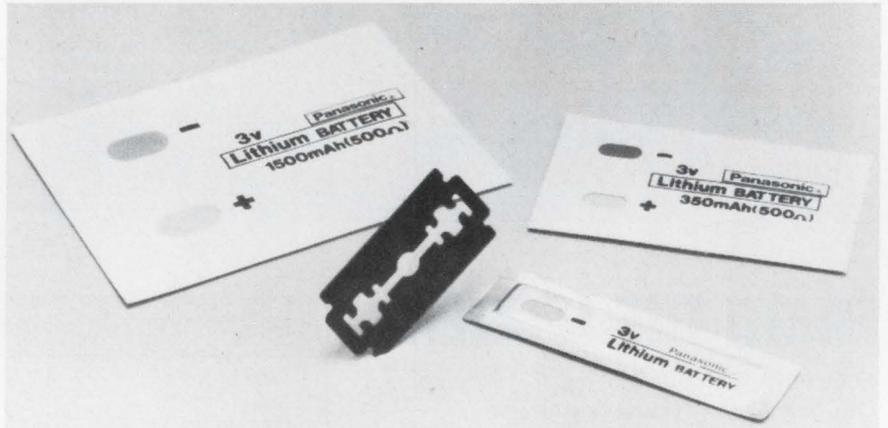


Figure 1: Lithium batteries, manufactured in thin "sheets" like this fit into small and portable units as a primary power source or for battery backup.

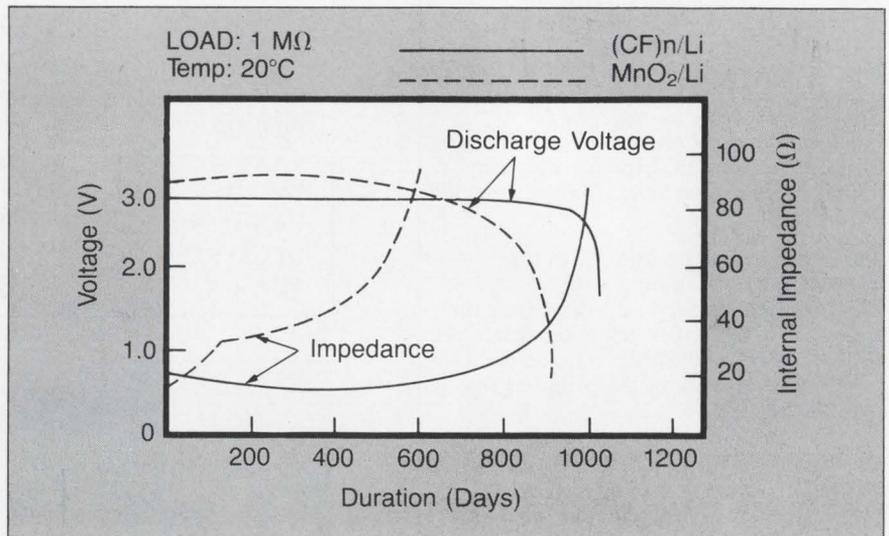


Figure 2: Graph compares characteristics of a $Li(CF)_n$ cell with those of another solid-cathode cell using MnO_2 . One reason for a flat characteristic of the monofluoride cell is that its internal resistance remains constant.

New Directions In US Telecom Power Market

Evolving market conditions are changing the once staid telecom power equipment market, with shifting user requirements and technological advances in power designs as the driving forces of change. These changes mean opportunities for some suppliers, and trouble for others. Traditional telecom power equipment suppliers must either adjust to a changing market or risk losing business, warns a new study from Northern Business Information.

New technologies—digital switching and transmission, fiber optics, satellite communications—have been instrumental in changing end user power needs, as has the trend to large PBXs with integrated voice/data capabilities. At the same time, the incorporation of semiconductor technology in power supply design, combined with increased use of μ Ps for remote monitoring and control, are changing the nature of telecom power products.

By 1985, the market is expected to reach \$387 million, in constant

dollars, up from \$278 million in 1980. While the Bell System now dominates the market, the fastest growing segments in the future will be independent telcos and other users, including specialized common carriers, interconnects and OEMs.

The real action in the market by 1985 will be in two areas: low end DC power equipment and AC systems. The best prospects will be for small power plants, single phase rectifiers and power supplies. Strong demand for power equipment will result from a corresponding increase in demand for small digital COs and remote switching systems, lightwave (fiber optic) repeaters, digital carrier microwave systems and satellite earth stations. Demand for voice/data PBXs, key telephone systems and intelligent terminals will also buoy the market for power equipment.

The study predicts that high frequency or switchmode designs will form a substantial portion of shipments of single phase rectifi-

ers and power supplies up to 5,000 W by 1985; in addition to reduced size and weight, and higher efficiencies, switchmode designs can be produced at 25–30% lower cost than low frequency equivalents. Controlled ferrononant regulators, on the other hand, will meet high power, single and three phase specifications over the long term.

The outlook is good for DC to AC inverters and uninterruptible power systems (UPS); single and three phase units of all sizes will power an increasing number of processor-based systems and peripherals which must operate from noise-free, continuous electrical power. While telecom AC power demand will remain steady, the big money is in data processing (DP) applications. Here the best news, according to Northern, is that the market for AC systems will escalate as telecom and information processing functions merge and voice/data networks become homogeneous.

Further information on this report may be obtained from Northern Business Information at 66 West Broadway, New York, NY 10007; telephone (212) 732-0775.

Intelligent Videodisk Systems To Fuel Growth In CAI Markets

After less than spectacular growth over the past few years, the computer-aided instruction (CAI) market will expand rapidly, at a compound annual rate of 40% to reach \$13 billion by 1987. This includes the aggregate hardware systems, software, courseware, and related services. Intelligent videodisk systems—an important new vehicle for CAI that interfaces μ Cs with videodisks for interactive random-access video routines—will be a vital key to this growth, according to a new market analysis just released by Creative Strategies International (CSI).

According to CSI, the private industry sector will grow the most rapidly, spurred by the critical need to train workers quickly, ef-

fectively, and cost efficiently. In the personal/professional segment of the market, special-interest potential for CAI is virtually limitless. Each occupation category is a market; each interest group is a

Despite the educational market's reputation for being a hard sell, competition is keen. μ C vendors are already doing \$460 million.

market.

The new intelligent videodisk will substantially increase the educational power of the μ C based CAI machine, and is a promising catalyst for the computerized educational boom that failed to materialize earlier. By linking μ Cs and videodisks, forming a system whose high-quality sound and images are controlled by an interactive software routine running through the μ C, engineers have developed the ideal hardware for computer learning.

Unlike previous CAI systems, which are inflexible, unable to vary speed or approach to needs of the individual learner, intelligent videodisks can store effective sound and color video packages and play them back in sequences

determined by the user's responses. While the interaction has been available for years, interactive video has not.

Courseware will be the key to success in this dynamic marketplace. Although the intelligent videodisk system has removed the obstacles of system inflexibility, prohibitive pricing, and other problems that have plagued the industry, the CAI market still suffers a lack of innovative courseware that has the power to break some of the remaining acceptance barriers. The need for exciting courseware leaves open a wide market window, and imaginative courseware that combines the best of education with the best of interactive computer and video technology could turn the market upside down.

The report points to μ Cs as a key growth area; unit shipments of μ Cs will grow at a compound annual rate of 45%. Special CAI units will grow even more rapidly. Courseware revenues are expected to grow at a compound annual

rate double that of hardware systems' revenues. Throughout the forecast period, software/courseware will take an increasingly larger market share, and will attain over half of the total market in 1987 for CAI hardware, software/courseware, and services.

Despite the educational market's reputation for being a hard sell, competition is keen. μ C vendors are already doing \$460 million in CAI markets, some large computer makers have well-protected niches, and many more entrants—from publishing houses to video giants—are ready to move into the market. New entrants attracted to the field of CAI range from billion-dollar conglomerates such as Sony and Panasonic, to technology leaders such as Honeywell, to new start-up companies such as Wicat, Allen Communications, and Video.

Creative Strategies' report, *Microcomputers And Videodisks In Educational Markets*, focuses on the development, marketing, and impact of the new intelligent vi-

deodisk system, as well as other major elements of the CAI market. The study assesses the potential for CAI in four major segments, (formal education, private industry, government, and personal/professional). Forecasts through 1987 are presented for hardware (μ Cs minicomputers mainframes, large mainframes, special CAI units, video cassette recorders, videodisk players, and videodisk player/recorders), software, courseware, and services.

Microcomputers And Videodisks In Educational Markets, which is available for \$1450, also discusses pricing and distribution, and evaluates the competitive environment, including market share analyses and profiles of key competitors.

For further information, contact Creative Strategies International, 4340 Stevens Creek Blvd., Suite 275, San Jose, California 95129, (408) 249-7550; or CSI/London at Banda House, Cambridge Grove, London, W6 OLN, (01) 741-4767.

Small Systems Packaged Software Market To Hit \$6.3 Billion By 1986

A dramatic compound growth rate of 35.6% per year for the next 4 years is projected for the small systems packaged software market in a report published by International Data Corporation.

Today there are over 14 million small businesses, about 2.5 million self-employed professionals, and over 15 million managers in large corporations who are current or potential users of small systems.

Analysts have predicted that about one-fourth of the industry's sales in 1981 in this marketplace were attributable to software; but by 1990 the percentage of software to hardware sales will increase to almost three-fourths. There are presently 8,000 to 9,000 software products in existence, over 400 producers of identifiable

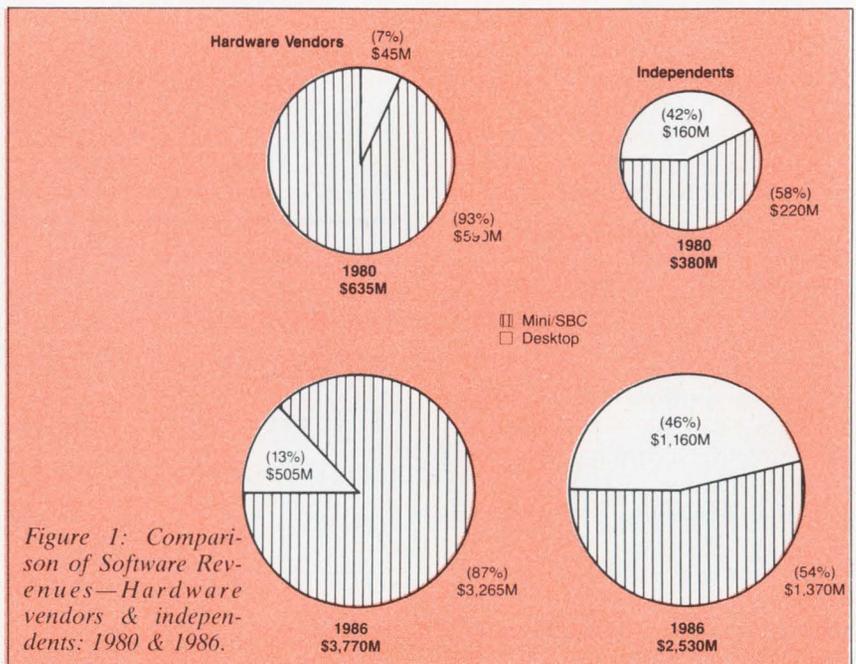


Figure 1: Comparison of Software Revenues—Hardware vendors & independents: 1980 & 1986.

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Our software package, LX/GPI, supports a 31-bit precision Object Data Structure™ (ODS) consisting of graphics primitives and functions for defining and changing the bit-

map memory. The ODS is a high-level mathematical description of the graphics database maintained in a World Coordinate space. Like a display list, the ODS is kept in vector format; however, the

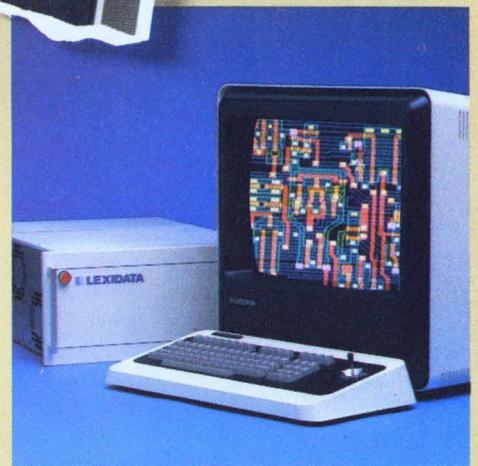
Incorporating System 8000 hardware into your graphics environment ensures a strong processor balance, where no one element is consistently the bottleneck. System 8000 software assures that all elements are equally efficient, leading to high

performance and cost effective use of all the hardware in the interactive computer graphics system.

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local World Coordinate description allows multiple viewing operations of the database or sections of the database without requiring the host to redefine the objects. In addition, all graphics transformations are performed locally. Therefore, you can redraw the display quickly, without host processing or data retransmission. Unlike conventional display lists, ODS processing is proportional to the number of vectors being viewed, not the length of the display list.



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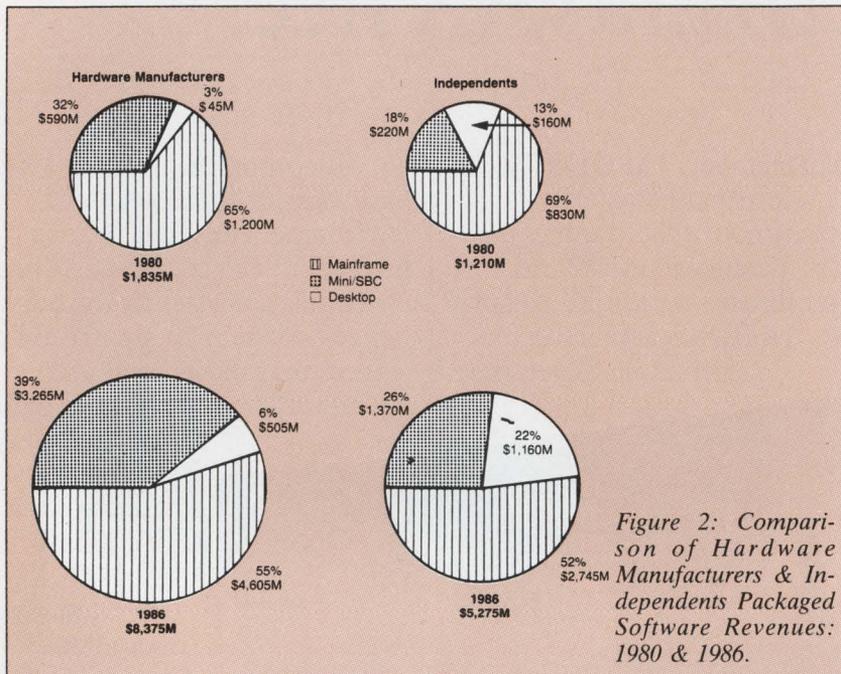


Figure 2: Comparison of Hardware Manufacturers & Independents Packaged Software Revenues: 1980 & 1986.

products and more of each on the horizon.

IDC's report, identifies the companies which are offering small systems packages (always an elusive figure because of the huge number of small OEMs and independents), and presents market shares, with projections, by processor type.

In the race for the expanding software dollar, the independent software vendors are coming on strong in small systems, even though hardware manufacturer revenues from total software—\$1,835 million in 1980—still overshadow the \$1,210 million revenues of the independents.

The report pinpoints market growth by breaking down the 1980 small systems software revenues by processor (mainframe, mini, SBC) and by vendor (108 companies in total)—and includes projections for each through 1986. Listed are revenues of:

- The major hardware vendors (top 21 companies).
- The top 23 independent companies (revenues of \$10 million or more).
- The 21 new companies IDC identifies as ones to watch in mini and desktop markets (revenues of \$8 to \$10 million).

One hundred and eight companies in total are broken out by processor type, some broken out even further by product use (system/utility/application).

With reason, hardware manufacturers are beginning to take even more aggressive steps to increase the percentage of their revenues derived from packaged software.

The report includes a detailed exploration of the major hardware manufacturers' software policies—summaries of their strategies for increasing percentage of revenue from software sales. Some of the methods being employed:

- Increase internal development, which means allocating larger percentages of R&D budgets for software (50% is not uncommon).
- Acquire software packages from an external developer in a desired market area or application.
- Act as software publishers, that is request submissions from third party sources, edit, reproduce and distribute the software, making royalty arrangements with the developer, who will also provide support and maintenance for the package.

(IBM, Data General, DEC, Texas Instruments, and Apple have all recently made announcements about third party ties.)

- Set up joint marketing agreements with independents already marketing a successful product, taking a cut from the sale usually completed by the independent. (IBM, Data General, Hewlett-Packard, and Texas Instruments have already announced joint marketing arrangements with independent software houses.)
 - Request that third party sources develop packages specifically for their machines and aid in the marketing of these packages. (This recently happened between IBM and Peachtree Software for IBM's new personal computer.)
 - Engage in joint development projects with independents. (IBM and Microsoft jointly developed the disk operating system for IBM's personal computer.)
 - Actually acquire software companies.
- The report also identifies and analyzes some of the major issues propelling the growth of the desktop software industry today including:
- The availability of user-friendly software like VisiCalc.
 - The availability to use packages on a variety of machines, made possible by the introduction of portable operating systems like CP/M and Unix.
 - The development of software publishing which centralizes package distribution (report gives profiles of the 2 leading publishing companies, Personal Software and Lifeboat Assoc.).
- The 151-page report, *Small Systems Packages Software: An Overview*, is available from International Data Corporation's Software and Services Information Program for \$2,500. Separate versions of the report on Desktop only and Mini/SBC only are available for \$1,500 each. For further information call (617) 872-8200.

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TRW's OMICRON-B™* makes the MPY 112K the fastest (20 MHz — video rate) 12x12-bit multiplier available.

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THE LEGEND LIVES!



PHOTOGRAPHED BY GREG GUIRARD

The most ancient of all legends, the appearance of the Phoenix is said to herald great events. On only five occasions in history has the bird appeared. The legend lives again, this time to announce the coming of a new age in computer graphics . . . **The Phoenix 1024** high resolution color graphics system.

The legendary bird is considered a favorable sign and **The Phoenix 1024** continues that tradition by rewarding the user with its own state of the art technology, through high performance, high resolution (true 1024 X 1024 viewable), local intelligence and anti-aliasing.

While this mysterious bird derived its beautiful plumage from a blending of five colors, **The Phoenix 1024** provides 256 simultaneously displayable colors to create over 16 million color combinations.

Like the bird of fable, **The Phoenix 1024's** appearance is also a sign of prosperity. The price/performance features of **The Phoenix 1024** coupled with its competitive pricing provide the user with capabilities generally more costly, which means critical cost savings without sacrificing performance or resolution. So prosperity comes to the user from **The Phoenix 1024** by bottom line reduction, increased productivity and creativity.

The bird of legend, with a five-colored plume, a call of five sweet, harmonious notes and the ability to raise its beautiful tail to a height of six feet, would be quite proud of its namesake. **The Phoenix 1024** offers keyboard, trackball, digitizers, plotters, hard and soft disk drives, high level command sets for graphic manipulation and high speed host interfaces.

For details, call or write to where that legend lives.

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Phoenix Computer Graphics Inc.

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318-234-0063

A Simple Programmer For The 8748

The Intel MCS-48 family of μ Cs are single-chip processors especially designed to be efficient, low-cost controllers. These devices contain all of the features needed for a complete, if simple, computing system—CPU, ROM, RAM, clock-timer and I/O. One member of this family, the 8748, is of special interest for small quantity applications. The 8748 contains all of the features of the 8048 family, but with the 8048's ROM replaced by EPROM. The low price of the 8748 makes it economical for jobs which formerly required a card full of integrated circuits.

However, the cost of a dedicated development system often is a barrier to the use of these microcontrollers. For simple applications, a simple programming system for the EPROM may suffice. This article describes such a programmer which enables an S-100 based computer to program and verify an 8748's memory. The hardware and the Basic software used to program the 8748 are briefly described below.

Hardware

The hardware is functionally divided into three sections: I/O buffering, port decoding, and programming interface circuitry. The schematic of the programmer circuitry is given in **Figure 1**.

The first section of the circuitry provides S-100 I/O buffering. The three octal buffers, U1, U2, and U3 provide buffering for the lower 8 address lines and the two data busses (note that the S-100 data busses are unidirectional). Chip U4 buffers and inverts the port input and output strobe signals SINP and SOUT.

The next section of the hardware, consisting of U5 through U8, decodes the port address and produces the four strobe signals used to latch the three input registers and the output buffer. During a port read or write instruction,

```

10 REM          8748-PRO.BAS          VERSION OF 10 NOV 81
20 REM  BASE ADDRESS IS SET TO 40
30 REM ***** SET THE INITIAL CONDITIONS *****
40 OUT 43,3 : REM SET Vpp TO FLOAT {5 volts}
50 REM SET THE OTHER CONDITIONS
60 REM TO=1,BUS CONTROL=1, EA=1 (5 VOLTS),RESET=0,Vdd=1 (5 VOLTS)
70 X=232 : OUT 42,X
80 INPUT "INSERT THE 8748 IN ITS SOCKET",I$
90 INPUT "APPLY +25 VOLT SUPPLY",I$
100 INPUT "DO YOU WANT TO CHECK FOR PROPER ERASURE, Y OR N? ",I$
110 IF I$ = "N" THEN GOTO 440
120 REM ***** VERIFY THAT THE EPROM IS ERASED *****
130 FOR PAGE = 0 TO 3
140 FOR ADR = 0 TO 255
150 X=(X AND 247) : REM SET T0=0 {SELECT PROGRAM MODE}
160 OUT 42,X
170 X = (X AND 191) :REM SET EA=0 (23 VOLTS) {ACTIVATE PROGRAM MODE}
180 OUT 42,X
190 X=(X OR PAGE) : REM APPLY THE TWO MS ADR BITS TO P20 & P21
200 OUT 42,X
210 X=(X AND 127) : REM ENABLE THE BUS TO 8748--PORT 42 BIT 7 = 0
220 OUT 42,X
230 OUT 41,ADR : REM SEND THE ADDRESS
240 X=(X OR 16) : REM LATCH THE ADDRESS (RESET=1)
250 OUT 42,X
260 X=(X OR 128) : REM DISABLE THE BUS DRIVER BY SETTING PORT 42 D7=0
270 OUT 42,X
280 X=(X OR 8) : REM SET T0=1 (5 VOLTS) {VERIFY MODE}
290 OUT 42,X
300 Z = INP(40) : REM READ THE BUS OF THE 8748 {BYTE = 0 IF ERASED}
310 IF Z <> 0 THEN GOTO 410
320 X=(X AND 247) : REM SET TO=0
330 OUT 42,X
340 X=(X AND 239) : REM RESET = 0
350 OUT 42,X
360 PRINT "ADDRESS ",(256*PAGE + ADR)," CONTENTS ",Z
370 NEXT ADR
380 NEXT PAGE
390 PRINT "EPROM PROPERLY ERASED"
400 GOTO 430
410 PRINT "EPROM NOT ERASED AT ADDRESS ";(256 * PAGE + ADR)
420 GOTO 10
430 INPUT "PRESS <CR> TO CONTINUE",I$
440 REM ***** BEGIN THE PROGRAMMING MODE *****
450 INPUT "MANUAL (M) OR AUTOMATIC (A) OF CODE FILE ENTRY?",J$
460 IF J$ = "M" THEN GOTO 580
470 IF J$ <> "A" THEN GOTO 450
480 INPUT "NAME OF FILE FROM WHICH PROGRAM IS TO BE TAKEN ",I$
490 OPEN "I",1,I$+".DTA"
500 DIM ADDRESS(1024), CODE(1024)
510 FOR X = 1 TO 1024
520 CODE(X) = 0 : REM FILL THE CODE ARRAY WITH 'NOP' CODE OF 00
530 NEXT X
540 FOR COUNT = 1 TO 1024 : REM GET THE DATA FROM FILE
550 IF EOF(1) THEN 580
560 INPUT#1, ADDRESS(COUNT), CODE(COUNT)
570 NEXT COUNT
580 REM ***** BEGIN THE ACTUAL PROGRAMMING OF THE EPROM *****
590 FOR PAGE = 0 TO 3
600 FOR ADR = 0 TO 255
610 IF J$ <> "M" THEN GOTO 650
620 PRINT "ENTER DATA BYTE IN DECIMAL FOR ADDRESS ";(256*PAGE +ADR);
630 INPUT PDATA
640 GOTO 660
650 PDATA = CODE(256*PAGE + ADR)
660 X = 128 : REM SET T0 = 0,BUS CONTROL=1{SELECT PROGRAM MODE}
670 OUT 42,X
680 X = (X AND 191) : REM SET EA=0 {ACTIVATE PROGRAM MODE}
690 OUT 42,X
700 REM PAGE IS MOST SIGNIFICANT 2 BITS, 0-3 {APPLY P20, P21}
710 X=(X OR PAGE)
720 OUT 42,X
730 OUT 41,ADR : REM ADR IS LEAST SIGNIFICANT 8 ADDRESS BITS

```

Table 1 continued on page 24.

Applications Notebook

REF DES	IC TYPE	# PINS	+5	GNDS
U1-3	74LS244	20	20	10
U4	74LS04	14	14	7
U5	74LS138	16	16	8
U6	74LS86	14	14	7
U7	74LS32	14	14	7
U8	74LS20	14	14	7
U9-11	74LS374	20	20	10
U12	7406	14	14	7
U13	8748	40	40	20
U14	LM317T	{TO-220}		
S1	DIP switch	8	—	5-8
RP1	899-1-R2.2K	14	14	—

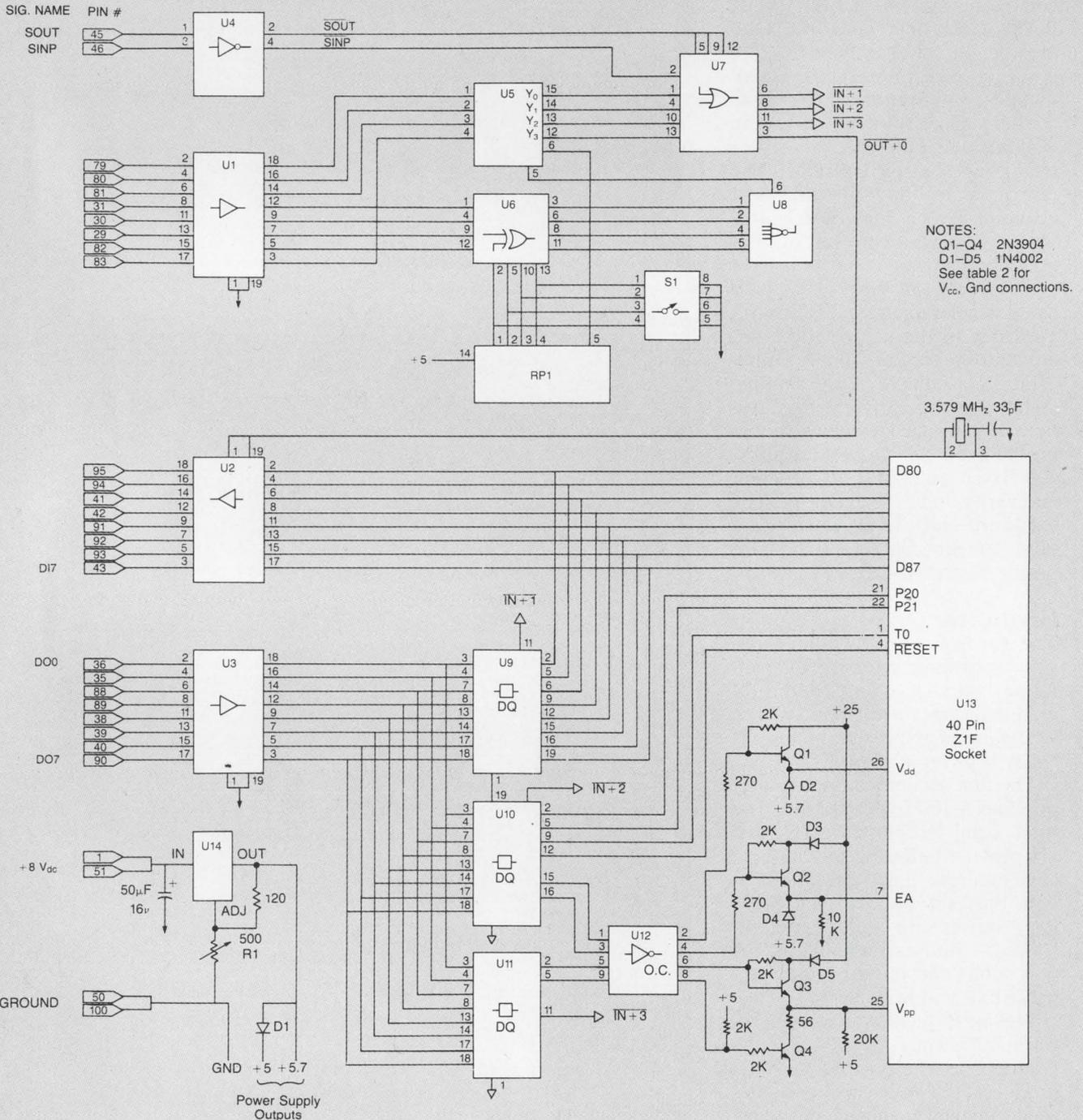


Figure 1: A schematic of the S-100 8748 programmer circuitry.

cont'd. from page 22.

```

740 X=(X AND 127) : REM ENABLE THE BUS TO THE 8748
750 OUT 42,X
760 REM LATCH ADDRESS IN 8748 BY SETTING RESET = 1 (5 VOLTS)
770 X=(X OR 16)
780 OUT 42,X
790 OUT 41,PDATA : REM {DATA TO BE ENTERED AT ADDRESS JUST LATCHED}
800 X = (X AND 223) : REM SET VDD TO 0 ( 25 VOLTS )
810 OUT 42,X
820 OUT 43,1 : REM SET VPP TO ZERO VOLTS
830 OUT 43,2 : REM SET VPP TO 23 VOLTS FOR 50 TO 60 MS
840 REM PULSE LOOP REGULATES THE Vpp TIME
850 FOR PULSE = 1 TO 42 : REM 51 MS PULSE {4 MHZ Z-80} 5 NOV 81
860 NEXT PULSE
870 OUT 43,1 : REM SET VPP=0 VOLTS
880 OUT 43,3 : REM LET VPP FLOAT
890 X = (X OR 128) : REM DISABLE THE BUS OUTPUT
900 X=(X OR 40 ) : REM SET VDD = 5 VOLTS & T0 = 5 VOLTS {VERIFY MODE}
910 OUT 42,X
920 REM READ THE DATA ON THE 8748 BUS
930 Z=INP(40)
940 IF Z <> PDATA THEN GOTO 970
950 PRINT "PROGRAMMING SUCCESSFUL AT ADDRESS ";(256*PAGE + ADR)
960 GOTO 1000
970 PRINT "PROGRAMMING NOT CORRECT AT ADDRESS ";(256*PAGE + ADR)
980 STOP
990 GOTO 10
1000 X = (X AND 247) : REM SET T0 = 0
1010 OUT 42,X
1020 X = (X AND 239) : REM SET RESET = 0
1030 OUT 42,X
1040 NEXT ADR
1050 NEXT PAGE
1060 GOTO 10
1070 END
    
```

Table 1: The control program, written in Basic, closely follows the flow diagram in Figure 2.

the port address appears on the lower 8 address lines, A0 through A7. If this address corresponds to a port selected for this programmer by switch S1, one of the four outputs of decoder U5 will go low. U7, an OR gate, provides a final masking of the four strobe outputs. One of the lines from U7, OUT+0, strobescs the output buffer to send data from the 8748 to the main computer's CPU. The other three strobe lines are direct control inputs to the 8748 socket.

The last section of the hardware consists of latches to hold data sent to the programmer board and driver circuitry to switch the high-level programming voltages needed to write data to the 8748's EPROM. Register U9 stores data to be sent to the 8748's bidirectional data bus. U10 and U11 drive other inputs on the 8748. The inverting buffer, U12, has high-voltage open collector outputs used to control the transistors which switch the 23V and 25V required at the Vdd, EA

and Vpp inputs to the 8748.

The on-board power supply uses an adjustable voltage regulator, U14, to provide 5.7V from the 8V power supplied by the S-100 mainframe. The 5.0V supply to drive the TTL integrated circuits is produced from the 5.7V supply by passing it through a series diode. The 25V required to program the EPROM must be supplied by an external power supply.

Thus, the hardware is designed to decode and store data sent from the CPU so that the sequence of steps to program the 8748 may be performed.

Software

The overall software flow chart is shown in Figure 2. The control program, Table 1, was written in Basic and closely follows this flow diagram. In the interest of clarity no truncating of the program was attempted; each control step is performed and executed with its own OUT instruction. Execution

speed is not the object here, successful EPROM programming is the goal.

Conclusions

This programmer is a useful, low-cost tool for the development of simple controllers which use the 8748. It can be used in conjunction with an 8048 cross-assembler or with hand-assembled instructions.

This programmer has other potential applications as well. It can be used to read the ROM contents of a mask-programmed 8048 if the external supply is reduced to 12V, and with some modifications it could program the 8755 peripheral device, which is a 2K-byte EPROM with 16 I/O lines and control interfaces.

Reference

1. "MCS-48 Family of Single Chip Microcomputers User's Manual." Intel Corporation, 1979.
Terry Hinshaw, 4558 Margery Dr, Fremont, CA 94538.

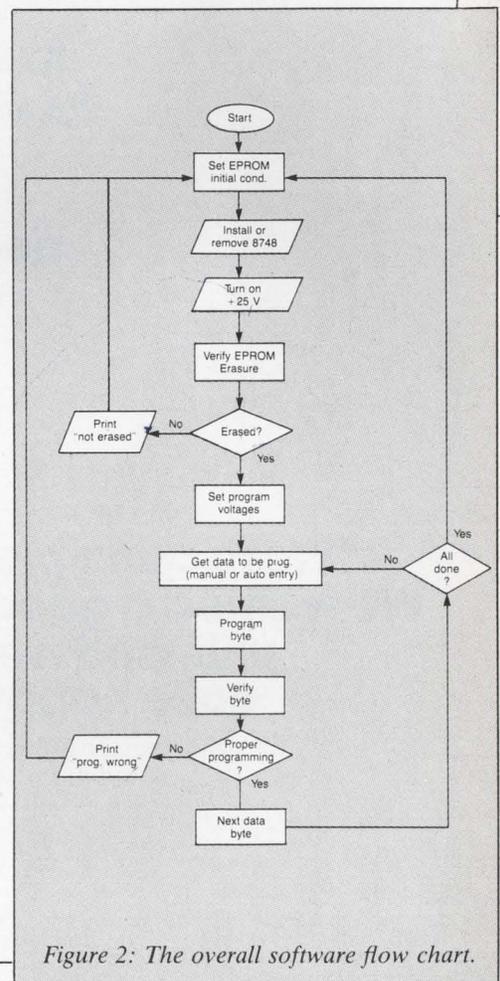


Figure 2: The overall software flow chart.

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Nabra Enterprises



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John Spaulding, Project Manager
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TeleVideo Systems, Inc.
Dept. 220A
1170 Morse Avenue
Sunnyvale, CA 94086

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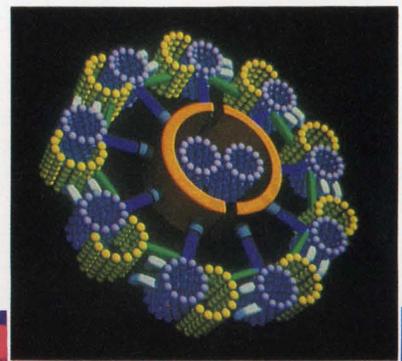
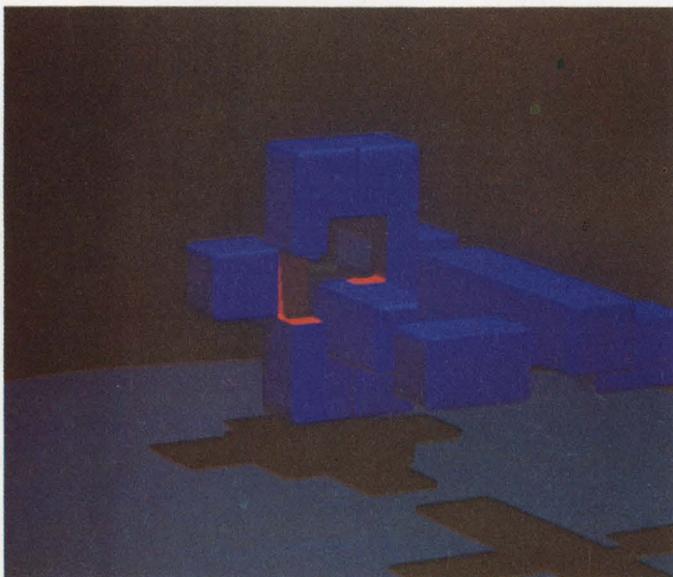
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Write 9 on Reader Inquiry Card

Color Raster Display Terminals

Greater creative freedom is a primary advantage of raster scan. Of the graphics display technologies—direct view storage, vector refresh, plasma panel and raster-scan—only the raster-scan can be used in both imaging and line-drawing applications. Other advantages include fast interactivity, unlimited-hue palette and variable-intensity screen.

The use of color will play an increasingly important role in the computer-graphics industry. In an article by Lawrence Elliott (Color Penetrates Computer-Graphics Industry, **Digital Design**, November 1981, pp. 34-50), he states that: "As a result of display and design improvements, the products whose technologies provide color will dominate DTS (displays, terminals and systems) revenue shares by 1984. Color raster-scan



The above four photos are courtesy of Raster Technologies Inc.

Built-In Anti-Aliasing

The AED 767 is a graphics/imaging terminal including keyboard, color monitor, service and parallel data interface. Uses include business graphics, CAD/CAM, Command and Control, graphic arts, imaging, simulation and TV applications. Specs include: 256 displayable colors from a palette of 16.8 million, 1024 x 1024 x 8 planes with a 768 x 575 display which can be panned over the memory, and flicker free refresh at 90 frames/sec 2:1 inter-

laced which can be stepped down to 60 frames/sec 2:1 interlaced for TV compatibility. Anti-aliased capability solves the problem of jagged lines for higher resolution and more lifelike drawings. Other features include blue-line grid 8 memory planes with R/W masks; pan; up to 42 Kbytes of RAM/ROM; support of two serial RS-232 ports and one parallel interface; Tektronix emulation; and user definable symbols. Options include tablet, hard copy, LSI-11/23 with

Winchester and floppy disks, and 2D CORE software interface. \$22,000; \$17,600 in quantity.

Advanced Electronics Design Inc,
440 Potrero Ave, Sunnyvale, CA
94086. **Write 210**

Variety of Screen Sizes

The UCD-19 is one of a family of ultra high resolution, precision in-line RGB color monitors designed for the most exacting datagraphics applications. They are available in cabinet, rack mount and chassis only versions. In addition to the 19" diagonal screen size, 9", 13" and 25" versions are available. Specs include: 50 MHz signal bandwidth (8 ns rise/fall time); 5 ms horizontal retrace; 550 ms vertical retrace time; 15.750-40 KHz scan rate (programmable). Interfaces are Analog R, G, B, sync. Other features include linear signal processing, digital sync processing and built-in test generator. \$3500.

Amtron Corp, 5624 Freedom Blvd,
PO Box 1150, Aptos, CA 95003.

Write 211

Upgradable CAD/CAM Systems

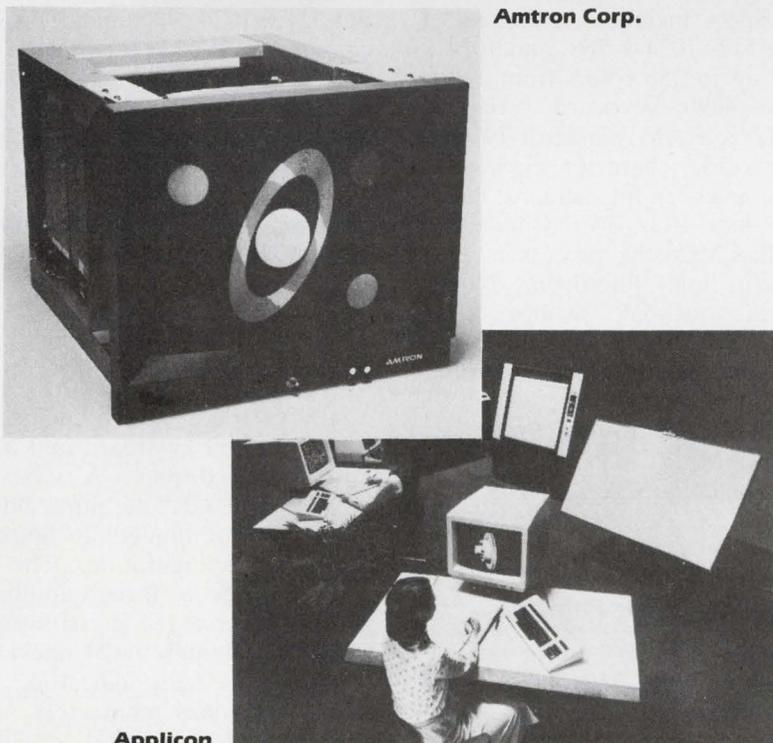
The Series 4000 workstations feature state-of-the-art electronics and ergonomic design. The 4640 offers a 19" B&W display and the 4650 offers a 19", 8-color display. Both provide high-resolution raster graphics with inking, tracking, scaling and rotation. Each supports up to 1/2 Mbyte of μ P memory for generation and manipulation of graphics, and both support selective erase. Other features include an optional PERL (Perception-Enhanced Resolution Logic) which minimizes the stairstepping effect through an anti-aliasing capability; support of 256 color-shaded graphics; and ergonomic design. A variety of hardware and software packages are available including three Graphics Processing Facilities based on DEC 16 and 32 bit systems. Over 100 specialized applications software packages are also available. The 4650 color workstation is approximately \$70,000.

Applicon, 32 Second Ave, Burlington,
MA 01803. **Write 212**

devices, already representing one-third of DTS's \$285-million sales in 1979, will total three-quarters of DTS's \$1.4-billion in 1984."

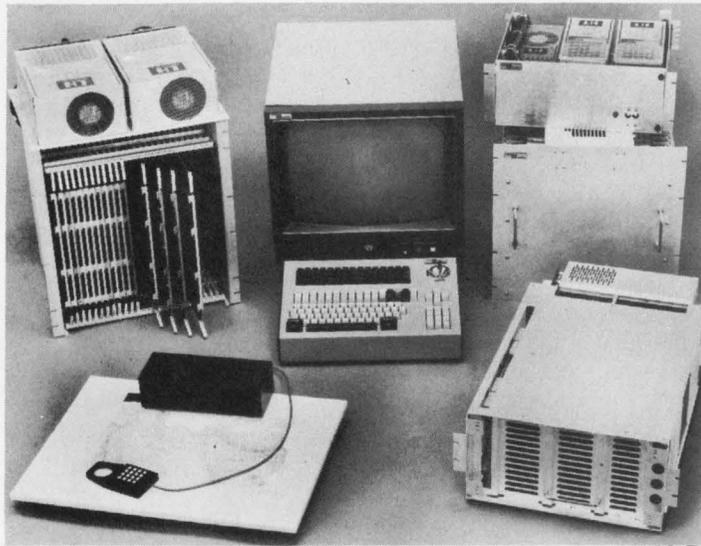
"Equipment offering color raster technology shall overwhelm DTS unit-shipment shares in 1984. Color raster product shipments will increase to 87% of 1984's 250,000 DTS units, from 47% of 1979's 32,300."

This showcase includes a representative product from the major color raster display terminal manufacturers who responded to our questionnaire by publication date. Beyond the particular products listed here, most of the companies offer an entire line of systems. Further information may be obtained by using the Write Numbers and Reader Inquiry Card.



Amtron Corp.

Applicon



Aydin Controls

California Computer Products



2D and 3D Graphics

The AYCON 16/Series Display Computer, based on the Aydin 5216, has applications in SCADA, process monitoring and control, CAD/CAM/CAE, 2D or 3D graphics and simulation, business presentation graphics, TV broadcast graphics, etc. It features separate processor bus (AYBUS) and refresh memory bus (MEMBUS); low and high speed serial I/O, including HDLC compatibility; versatile graphics firmware including zoom, pan, scroll and fill functions. Specs are: viewable display resolution up to 1024 x 1024 pixels; addressable display data base up to 64K x 64K pixels; variety of video modules, with or without lookup tables; up to 65,536 simultaneously displayable colors from a palette of up to 16 million; 80 x 48 character A/N overlay option; multiple 16 bit μ Ps—up to 14 per controller; and high speed parallel DMA interface to DEC, HP, SEL minis and others. Options include: vector generator; interactive devices; cartridge, floppy and Winchester disk; plus multiple workstations, up to 4 per controller. From \$15,000.

Aydin Controls, 414 Commerce Dr, Ft. Washington, PA 19034.

Write 213

Choice of Resolution

The Vistagraphic 4000 line of monochrome and color raster displays offer hardware and software compatibility to assure continued product dependability and productivity as graphics needs grow. Suitable for applications such as process control, CAD/CAM, mapping, engineering analysis, simulation and training, and command and control. Specs include: resolutions of 640 x 512, 1024 x 768, and 1024 x 1024; up to 256 colors from a palette of 4096; keyboard, serial I/F and 128K RAM standard; 19" display; vector, character, circles, ellipses, and area fill standard; direct pixel data I/O; overlay/underlay; and dual MC68000 processors. Options include photopen, tablet, joystick, trackball, memory to 1 Mbyte, floppies, hard disk, Pascal and Fortran. From \$9950; from \$6965 in quantity.

California Computer Products, (CALCOMP), 2411 W. La Palma Ave, Anaheim, CA 92803.

Write 214

16 Million Color Palette

The CGC 7900 is a color graphic computer with MC68000 16-bit Motorola processor and the ability to display 256 colors simultaneous-

ly from a color palette of over 16 million colors. Designed for stand-alone operation or may be connected via serial or parallel ports to a host computer. An 8 color overlay utilizes character cell graphics to overlay an image on a bit map graphics picture, unaffected by the graphics roll, pan or zoom of the underlying image. Specs include 19" display, 1024 x 768 viewable resolution with a graphics memory of 1024 x 1024, 96 standard ASCII characters, 151-key keyboard, 128 Kbytes of user RAM, and 8 bezel keys. Options include Idris, C, Pascal, Fortran, joystick, and 10Mbyte or 40Mbyte fixed disk drive. \$25,000.

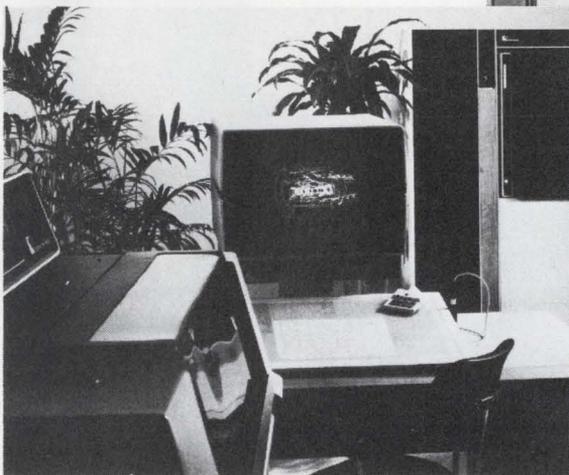
Chromatics Inc, 2558 Mountain Industrial Blvd, Tucker, GA 30084.

Write 215

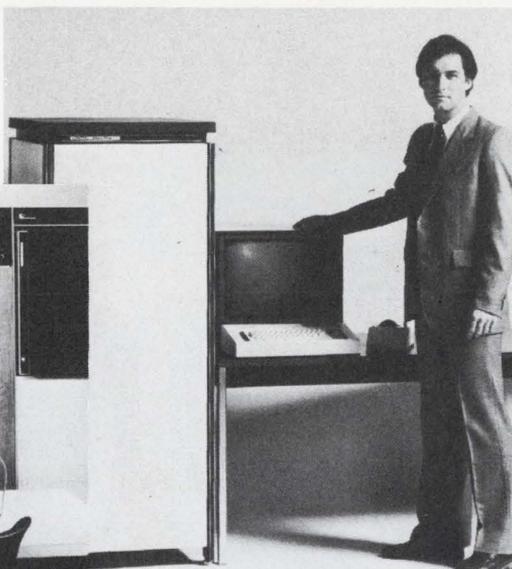
Software Compatibility

The MVI 100 is human engineered with detached keyboard and a rotating/tilting display. A series of monochrome CRT terminal emulators allow for immediate hook-up to existing configurations. The display features 8 foreground/background colors, 13" pre-converged CRT, 80 columns by 24 lines, status line plus fault indicators, 128 ASCII standard characters, and vertical and horizontal scrolling.

Comtal Corp.



Computervision Corp.



The keyboard is an 87-key detachable unit with 24 programmable function keys and auto repeat. Functions include insert and delete character and line, erase line and page, cursor addressing, 4 split screens horizontal and vertical, and self-test and diagnostics. Communications specs are: RS-232C, full or half duplex, 110 to 19,200 baud, and auxiliary port. From \$2200 to \$2750 depending on quantity.

Colorgraphic Communications Corp., 2379 John Glenn Dr, PO Box 80448, Atlanta, GA 30366.

Write 216

Distributive Processing Terminal

The 427 minimizes mainframe operations by performing front end processing at the point of data collection. Up to 4 CRT stations and 4 I/O devices may be operated from one 427 terminal. It can be either desk mounted or on a telescoping stand for various viewing heights. The unit contains: 19" color monitor; two cursors (one under characters and one on the video display); one color for characters and another for the pictures; 64 characters by 20 lines standard, up to 80 char./line x 20 lines; user specified color for the drawing; 512 x 512 pixels; detached keyboard will full ASCII and 11 key numer-

ics, 5 key cursor controls and 5 key functions; 2K buffer for text information; and 32 lines with roll and picture. It uses Tektronix 4014 protocol with RS-232C or IEEE 488 interface. Options include up to 8 colors available and video expandable to 1024 x 512 pixels. \$9650.

Computer Talk Inc., 2800 S. Rooney Rd, PO Box 148, Morrison, CO 80465.

Write 217

Full Screen Graphics

The Instaview C interactive workstation is an intelligent graphics terminal which uses a high resolution color raster CRT display. With CADD54 software, it provides advanced graphic manipulation capabilities including instantaneous dynamic zooming, panning and 3D rotation. The addition of the DCU (Display Control Unit) image processor allows high-resolution full screen graphics capabilities. It provides a choice of three basic modes of operation: high linear resolution of 1280 x 1024 addressable points of image memory with a choice of 64 colors; high color resolution with 1024 colors displayed out of 250,000 shades and standard linear resolution; and the capability to superimpose a high linear resolution line drawing on a shaded picture. Additional features of the DCU in-

clude multiple bit maps for support of dynamic motion (the color terminal has 6 maps), and mixed mode which allows operators to use both line drawings and shaded images simultaneously. The monochromatic DCU is \$5000, the color version in \$10,000.

Computervision Corp., 201 Burlington Rd, Bedford, MA 01730.

Write 218

16-Color Raster Graphics

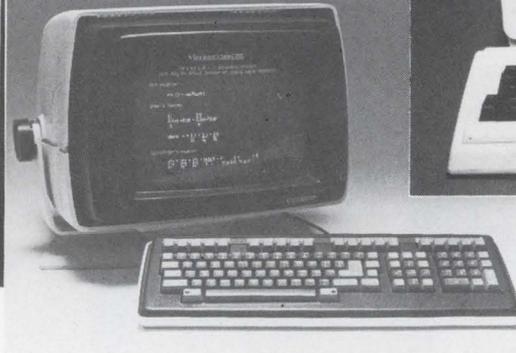
The Vision One/20-M8 equipped with the Graph-S option, can generate sophisticated raster graphics in 16 colors, with alphanumeric labeling capability. It is also a full-scale, real-time digital image processor. The system includes memory control logic, pipeline processors, D/A converters, chassis power supplies, vertical mount and system computer (LSI-11/23). Features include an image data base of 4096 x 4096 x 24 bits in real time; pseudocolor processing of 16 million colors; control by keyboard, data tablet, trackball or joystick; self-contained, firmware operating system; and real-time (1/30 sec.) roam, zoom and function memory processing. A variety of options are available. From \$41,500.

Comtal Corp., 505 W. Woodbury Rd, Altadena, CA 91001.

Write 219

Datamedia Corp.

Conrac Corp.



Data General Corp.

Computer Data/Graphic Applications

The 7200 series of raster-scan color monitors feature high resolution display of computer-based data. Precision In-Line (PIL) gun with 0.31 mm delta shadow mask gives high resolution display of 1280 horizontal x 960 vertical pixels at 1225 line scan rate on 19" CRT (1024 x 768 for 13" CRT). "Self-converging" PIL gun eliminates usual color convergence circuitry and simplifies maintenance for OEM and end user. Variable scan frequency feature allows one monitor to perform as four, at the cost of one. Specs include: RGB color image display accepts composite or non-composite video input; horizontal scanning frequency from 15.75 KHz through 36.75 KHz (interlaced or non-interlaced) may be selected by jumper plug location (any of four pre-set frequencies); and 40 MHz bandwidth accepts standard or high resolution EIA formats. Options include various CRT phosphors; differential video inputs; external vertical and horizontal drive; naked, rack slide or cabinet configuration. \$4900; qty. pricing available.

Conrac Corp/Conrac Div, 600 N. Rimsdale Ave, Covina, CA 91722.

Write 220

Color Alphanumeric Display

The Dasher D280C is a low-cost, 8-color alphanumeric display terminal for interactive applications. Two sets of user-definable characters provide 128 symbols in addition to the terminal's 128 U/L case ASCII characters. The host computer can define the shape of the characters in a variety of patterns. The user-definable characters can also be used to construct line and bar charts. The display measures 13" diagonally, and has a screen format of 80 columns by 24 rows. For international use, 7 alphanumeric character sets reside inside the terminal. The keyboard is configured in the language ordered by the user. This detachable keyboard contains a main keypad, 14-key numeric keypad, 12-key screen management keypad, 15 program function keys, \$3750 (\$3500 for the video display and \$250 for the keyboard).

Data General Corp, Rte. 9, Westboro, MA 01581.

Write 221

VT100 Compatible

The ColorScan 10 is an 80/132-column, 8 color display terminal which is compatible with the VT100. With its built-in line ruling set and 8 colors for both foreground and background informa-

tion, it is particularly appropriate for the emerging color business graphics market. The 8 displayable colors include red, blue, green, cyan, magenta, yellow, black and white. These colors are displayed on a non-glare 12" raster scan display in either an 80- or 132-column by 24-line format. As with all Datamedia terminals, the ColorScan 10's detachable typewriter-style keyboard with separate numeric pad provides greater operator convenience. Features include split screen, regional scrolling, smooth scrolling and double high/wide characters. \$3195; OEM discounts available.

Datamedia Corp, 7401 Central Hwy, Pennsauken, NJ 08109.

Write 222

Continuous Operation

The Barco CDCT series are high performance RGB color displays designed for continuous operation. The sturdy mechanical construction and extensive component cooling, along with all gold plated contacts and moisture and dust protected switches and potentiometers suit it for medium severe environments. The all plug-in concept guarantees and short MTTR. A wide choice of 3 scanning families, 3 picture tube sizes and 3 phosphor combinations allow meeting requirements in ras-

Elector



Florida Computer Graphics

ter-scan computer graphics and related applications. Features include plug-in modules, calibrated position on contrast and brightness controls, fast and slow horizontal sync time constant, and automatic and manual degaussing. The CDCT 4 features a newly designed video amplifier which boosts up the bandwidth to 50 MHz, ± 3 dB; improvements on convergence circuitry resulting in a typical max convergence error of 0.4 to 0.5mm anywhere on the scanned area; and typical power consumption with calibrated settings of 180W (max 210W).

Elector, 5128 Calle Del Sol, Santa Clara, CA 95050. **Write 223**

Ergonomic Design

The BEACON raster-scan color graphics system offers WP, DP and data communications capabilities that are easily integrated with graphics capabilities. The basic system includes electronics, detached keyboard and 13" color display (also available with 19" color, and 15" or 19" monochrome display). Features include: 16-bit bit-slice graphics processor with 48-bit microcode and 200 ns cycle time, 160 Kbytes memory expandable to 640 Kbytes; hardware vector, arc, circle and rectangle generation, and

other graphics functions and floating point arithmetic functions; an administrative processor aided by intelligent disk controllers, DMA channel access and other distributed processors for a high throughput; 7 communications interfaces; and ergonomic design. The BEACON offers 16 graphics and 16 alphanumeric color choices out of 256 available colors, or 32 gray shades on monochrome displays, with 640 x 480 pixel resolution. Memory organization includes 4 graphics planes, one cursor and one alphanumeric plane. From \$12,950; OEM discounts available.

Florida Computer Graphics, 1000 Sand Pond Rd, Lake Mary, FL 32746. **Write 224**

Displays 16 Simultaneous Hues

The G-6100 interactive graphics terminal utilizes a standard RS-232C serial interface or optional high-speed parallel DMA interface (available for most popular mini-computers). Specs include: resolutions of 768 x 512, 1392 x 1024, or 1536 x 1024 with 768 x 512 window; 60Hz refresh rate; color or monochrome; integer zoom (1 to 16 times); pixel scrolling; 19" CRT; high-speed Advanced Display Computer with 16 Kbytes PROM and up to 112 Kbytes RAM; and

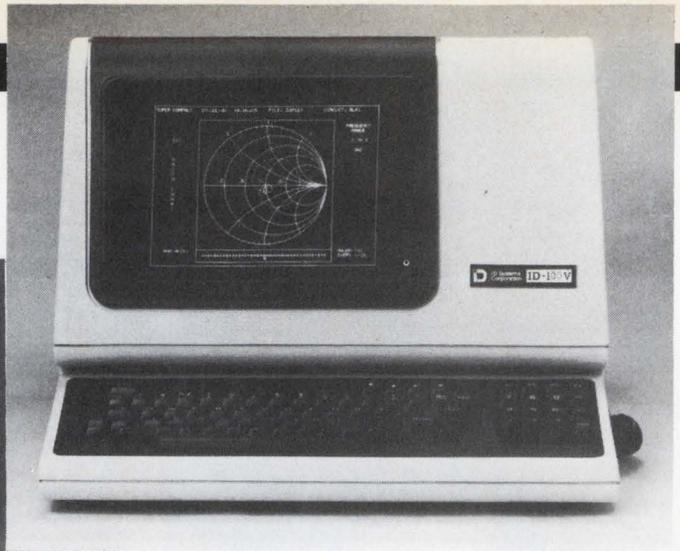
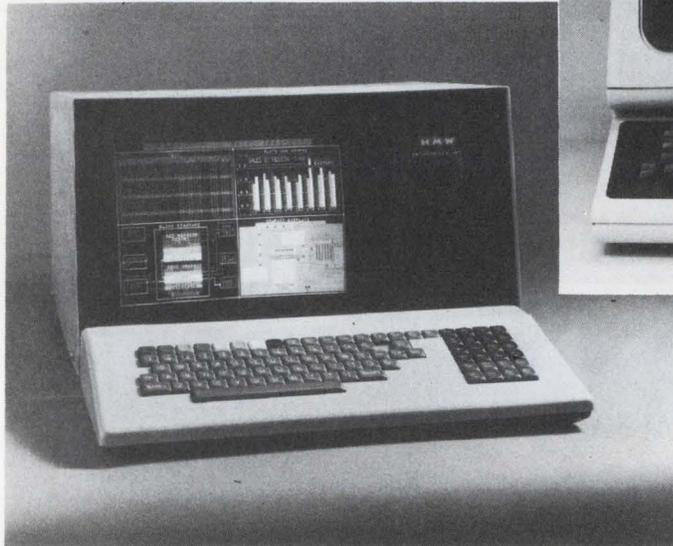
packaged in a standalone console. Options include 2 graphic overlays, graph tablet, hard copy compatibility, Fortran cross assembler, and Tektronix 4014 emulator. Bit mapped refresh memory stores high-resolution graphics with programmable color or monochrome lookup tables permitting a selection of 16 displayable colors or shades out of 64. \$23,250 to \$32,250; OEM discounts available.

Genisco Computers Corp, 3545 Cadillac Ave, Costa Mesa, CA 92626. **Write 225**

Variety of Configurations

The GMR 27 series high-speed graphic display system provides high speed graphics and imaging in a variety of resolutions, video refresh formats, and output video configurations. Modular design, wide range of options and semi-custom configurations provide for systems that meet customers' specific system requirements. They interface to a variety of computers; compatible with RS-232/RS-170/RS-343. Specs include: resolutions from 256 x 512 (60Hz), 512 x 512 (30 or 60Hz), 512 x 1024 (60Hz), and 1024 x 1024 (30Hz); pre-packaged systems include monochrome, greyscale, or RGB color with half-intensity blink. Options include

HMW Enterprises



ID Systems

special computer interface logic, character sets, zoom and pan, video digitizer (6-bit or 8-bit), video lookup table, image function video, quad cursor, joystick, trackball, keyboard, pre-wiring expansion, software package and monitors. \$9950 to \$21,000; OEM and qty. discounts available.

Grinnell Systems Corp., 2159 Berling Dr, San Jose, CA 95131.

Write 226

Industrial Quality

Model 9701 is a color terminal intended for demanding industrial and commercial applications. It features all metal construction, high resolution permanently converged CRT monitor, totally independent monitor and display generator power supplies, and a detachable solid state keyboard. Specs include: 80 characters by 48 lines; 64 special characters for diagram, plot and forms generation; 8 foreground/background colors; selective blink; character protect and size select; dual cursors; erase line and page; roll and scroll; and transmit full or partial pages. Communication is ASCII RS-232C or 20 mA compatible at 110 to 9.6K baud full or half duplex. \$3995.

HMW Enterprises, 604 Salem Rd, Etters, PA 17319. **Write 227**

DEC VT-100 Emulation

Available in either a 512 x 256 (240 visible) resolution or 608 x 480 with either short or long persistence units, the ID-100 terminals emulate the DEC VT-100 in the alphanumeric mode, but offer both color and graphics as well. They are compatible with ISSCO and Tektronix graphics software, and contain high level language graphic commands in firmware. Displays can be windowed with scissoring, scaled, and origin selected. Specs include: 65-key detachable keyboard with 18-key numeric keypad; 12" diagonal display, 60 or 30Hz; and 8 foreground/background colors plus blink, multi-cursor format, and full addressable cursor operations.

ID Systems, 4093 Leap Rd, Hilliard, OH 43026. **Write 228**

3D Shaded Graphics & Image Processing

The RDS-3050 is a color raster display system and graphics processor. It performs real-time 2D and 3D vector and polygon transformation and display, CAD/CAM, simulation, animation, image processing and research applications. Specs include: 512 x 512 x 24 (full color) or 1024 x 1024 x 6 (64 color) display; 32 bit graphics processor

(200 ns cycle); 2 million pixels/sec. vector rate, 64 million pixels/sec. max.; hardware transformation unit; and 68000 peripheral controller. Other features include software selectable display resolution, micro programmable display processor and matrix transform unit. Options available are a real-time video digitizer, voice crossbar switch, color monitors, trackball, joystick, switches, and image memory to 2048 x 2048 x 24. \$53,500, quantity pricing available.

Ikonas Graphics Systems Inc., 531 Pylon Dr, Raleigh, NC 27606.

Write 229

Multiprocessor Architecture

The IDT 2000 and 2200 color graphics terminal consists of a video generator, high capability color monitor and a multifunction keyboard. Specs include: graphics image size of 262,144 pixels, 512 x 512; character capability is 51 lines of 85 characters, 5 x 7 matrix in 6 x 10 dot field; 8 standard colors may be expanded to 64. The terminal's intelligence allows simplified programming using high level ASCII commands over a standard RS-232 serial interface requiring no special handlers or drivers. The system employs a pipelining hierarchical multiprocessor architecture which

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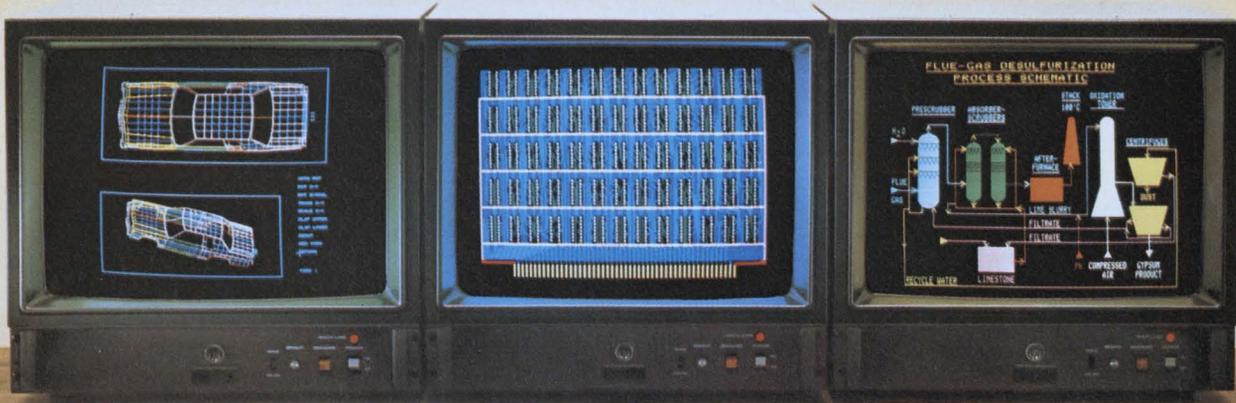
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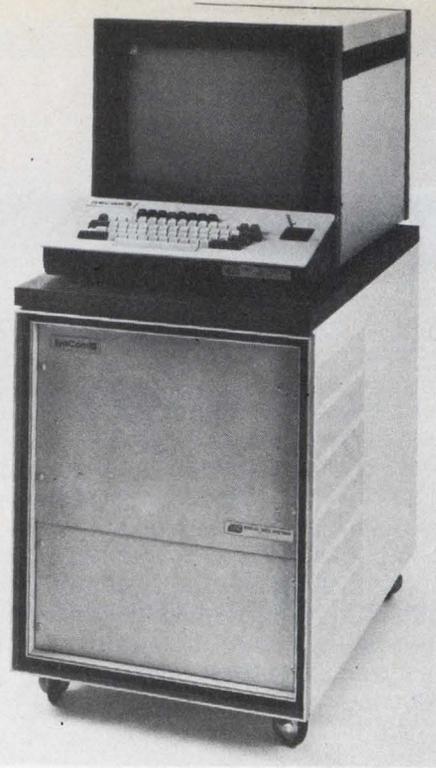
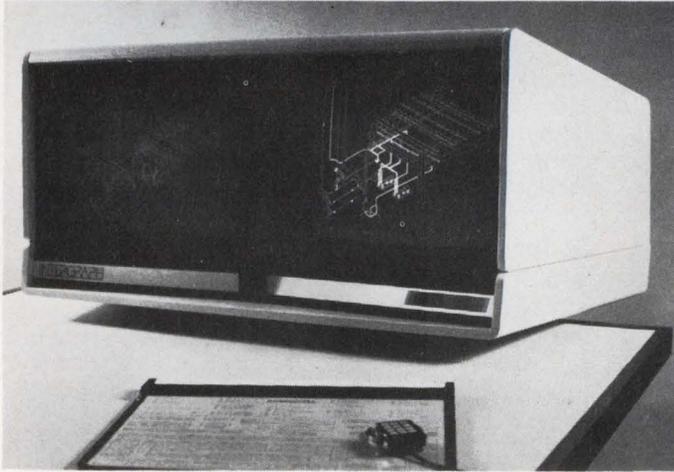
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Raster Displays

Intergraph Corp.



LogE/Spatial Data Systems

enables high speed dot writing and macroprogramming manipulation. This "building block" approach utilizes multiple processors with flexible and expandable memory and permits the user to select from many firmware and hardware options to meet specific application needs. From \$10,600.

Industrial Data Terminals, 173 Heatherdown Dr, Westerville, OH 43081. **Write 230**

Dual Raster Screens

The DSP037 is a high-resolution, flicker-free color graphics system. This fully compatible display system includes a 16-bit microcomputer, and dual 19" raster screens, one color and one monochromatic, which have a resolution of 1280 x 1024 pixels. Each screen can display full 2D and 3D graphics, plus operator prompts and messages, with independent hardware pan, zoom and drag for both screens. From a palette of 4096 colors, the user can select 128 active colors for simultaneous display. Additional memory planes allow the number of active colors to be increased as desired. A keyboard and a choice of digitizing tables, menus and cursors are available. Workstations can be directly linked at distances up to 6000' from the central site or

operated at remote locations over telecommunications lines. From \$60,000.

Intergraph Corp, One Madison Industrial Park, Huntsville, AL 35807. **Write 231**

Display Processor

The System 3400 is an intelligent peripheral device attached to a host minicomputer that reduces computer time required to perform display and image manipulation functions. Its separate programmable high-speed memory controller and μP provide 2 μ sec random updating and 60Hz memory refresh (non-interlaced). Eleven picture memories range from 256 x 256 pixels to 1280 x 1024 pixels, which displays flicker-free images. Users can choose from a scale of 4096 black-to-white tones to display 256 at once, or from a palette of 16.7 million colors to display 4096 simultaneously. Other features include lookup tables, a pan/zoom controller, blink controller, flexible overlay capabilities, 8 monitor options, alphanumeric keyboard, trackball or joystick, data tablet and modular design (over three dozen hardware and software options are available that allow tailoring the system to specific requirements.

Lexidata Corp 755 Middlesex Tpke, Billerica, MA 01865.

Write 232

Image Data Exchange

Model 330 EyeCom III is a real time image processing system with programmable architecture via the IDEX data exchange and pipeline processing of images at video frame rates. Features include spatial filtering, recursive filters, pseudocolor and true color with graphic overlays and programmable cursor, real time processing of video images, hardware architecture which is under software control, reconfigurable memories for different storage resolutions, very low noise analog signal conditioning permitting 10 bit digitizing. Specs are: 640 x 512 resolution, 8 or 10 bit gray scale, analog signal conditioning with 60dB S/N ratio, logarithmic or linear amplification and offset and range adjust under computer control, multiple image formats with panning, full A/N keyboard, 19" color display, and joystick cursor. DEC PDP-11 and LSI-11 compatible. Contains Unibus/Q-Bus interfaces with optional RS-232 and DMA interfaces to most other computers with operating system independence. From \$45,000.

LogE/Spatial Data Systems, 508 S. Fairview Ave., PO Box 978, Goleta, CA 93116. **Write 233**

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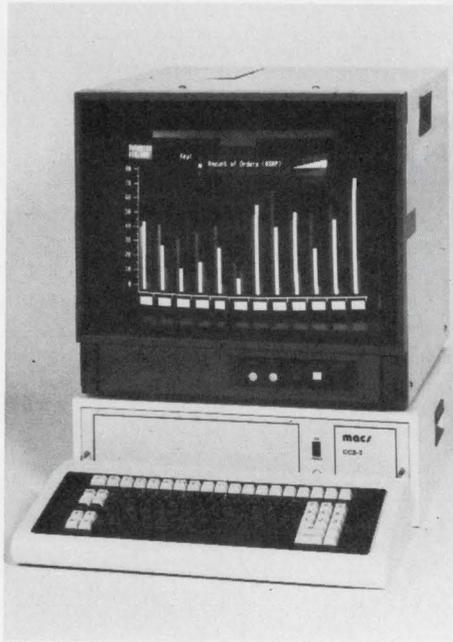


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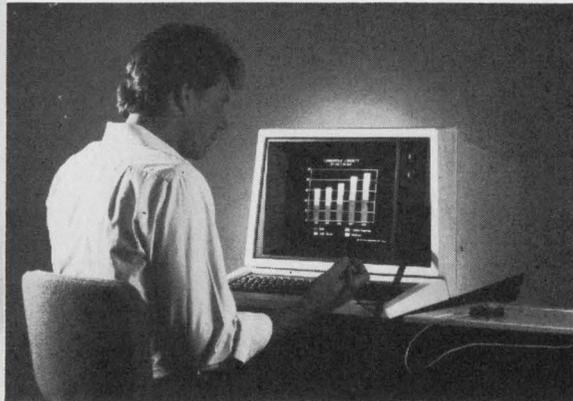
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Matrox Electronic Systems



Ramtek Corp.

Modular Design

The GF-18 is a modular color graphics terminal based on a building block technique for both hardware and software. Depending upon the configuration, specs include: modular color graphics, off-the-shelf components, software building blocks, emulates Tektronix 4010/4114 terminals, custom software, interfaces for a wide range of peripherals, 512 x 512 x 8 resolution, color overlay alphanumeric, 700 ns/pixel vector generator, 16 million color look-up table, 512 x 512 x 8 real time frame grabber, 12", 14" or 19" color CRTs, Multibus hardware standard, 8 bit (Z-80A) or 16 bit (8086) CPUs, 8 foreground/background colors, color alphanumeric overlay, 16 million color look-up table, and a 2 Mbyte disk storage option. From \$10,000 to \$20,000.

Matrox Electronic Systems Ltd,
5800 Andover Ave, Montreal H4T
1H4. **Write 234**

Dynamic, Interactive System

The Wizzard 7250 is a line drawing color raster display system standard with 12 bit (4K x 4K) virtual addressing. It supports up to 16 colors from a 4096 color palette, with separate color-lookup table for each 512 x 512 pixel resolution monitor. Standard features include hardware pan, true

binary zoom, full screen clipping, dynamics, distributed processing, software support, 60Hz non-interlaced output, 160 ns/pixel average pixel update rate, and tri-state dual bus architecture. Options include 3D transformations, surface processor, hard copy pick module with digital comparator, data tablet, keyboard and joystick. A basic system with 512 x 512 resolution, 8 color, single output, 19" display and graphics processor is \$30,500.

Megatek Corp, United Telecom Computer Group, 3985 Sorrento Valley Blvd, San Diego, CA 92121.

Write 235

Full Featured Desk-Top Unit

The RM-6211 colorgraphics terminal offers high-resolution raster scan color graphics. It is suited for business, process control, scientific data analysis and government and military applications. It communicates with any host computer via an RS-232C interface, and has a resolution of 640 x 480 pixels operating at 30Hz (interlace), with an option for 640 x 512 pixels at 60 Hz (repeat field). Other features include 13" monitor; four refresh memory planes controlled by a user-programmable video look-up table which permits simultaneous display of up to 16 colors from a palette of 64, or 8 colors plus either an alpha-

numeric overlay or a blink function; a variety of software packages; and more powerful graphics capabilities. Options include additional 16 Kbytes of RAM, interactive devices, color hardcopy (printer, camera), and formatted data I/O.

Ramtek Corp, 2211 Lawson Lane, Santa Clara, CA 95050. **Write 236**

Dual-Mode Image Array

Model One is a high-performance raster-scan graphics display system that offers software-selectable point addressability and 64K RAM-based image memory. The graphics controller installs between an existing host computer and color display monitor. It features advanced architecture, extensive graphics commands and comprehensive user-friendly operating aids. Also, it offers dual mode image-array selection—either 512 x 512 pixels or 1K x 1K addressable points—so users can perform both imaging and full-screen line-drawing tasks on the same display monitor. It gives a window or an entire full-screen 1K display on a standard video monitor so that users can switch, via software commands, from imaging to line drawing applications without having to change systems or display monitors. Other features include a 16 bit Z8000 processor; optional Direct Pixel Memory Access (DPMA) port with band-



Sigma Design West



Tektronix Inc.

width up to 3.75 Mbytes/sec; an optional overlay plane for alphanumeric data; and hardware pan and zoom functions. The Model One color graphics controller with 24 image memory planes that permit an unlimited number of simultaneously displayed colors is \$17,500.

Raster Technologies Inc., 9 Executive Park Dr, N. Billerica, MA 01862. **Write 237**

Automated Design Workstation

The Sigmagraphics workstation is a turnkey computer automated design workstation which includes a processor with two floppy disks and a micro Winchester, a 512 x 640 19" color raster tube, a keyboard with joystick, a touch sensitive menu with 256 positions for selecting commands and user programs, and a plasma display of 6 lines of 40 characters each which is used for operator communication. Multiple Sigmagraphics workstations can be attached to a Masterplex which allows them to communicate with and to share data and output devices. Workstation and Masterplex have a telecommunications capability to allow transfer of data over phone lines. Available as I/O are the following: three types of pen plotters, a printer plotter, two types of line printers, and three different sizes of digitizing tab-

lets. Included in the system price is a complete graphics software package for general drafting in 2D and 3D wire frame. Complete workstation prices from \$87,000 to \$120,000 depending upon configuration and software. B&W models are also available.

Sigma Design West, 7306 S. Alton Way, Englewood, CO 80112.

Write 238

Programmable Resolution

The CD-2 is a color raster display that attaches to the PGM via a CH-1 high-speed channel and affords the user with a programmable resolution RS170/RS343 RGB color video output capability. Its video output can be used to drive many different video devices such as video to 35 mm film units like the Dunn or Matrix cameras on large screen displays, in addition to the standard 19" monitor provided by Superset. The CD-2 consists of a channel interface board, a 393 Kbyte memory board, a video display board and a standard 48 bit Fortran processor. This provides the user, in effect, an auxiliary PGM available for Fortran processing when the video display is not actually in use. Other features are software operated cursor, software operated color palette (for selection of within 8 or 16 of 262,144 colors), blink any color and interface

to allow synchronization with external video for overlaying video on PGM generated graphics. The CD-2 and CH-1 are \$16,500; available 3rd quarter 1982.

Superset Inc., 11035 Roselle St, San Diego, CA 92121. **Write 239**

High Data Communications Speed

The 4113 is an intelligent color terminal with a 19" 60Hz non-interlaced raster display. Features include true zoom and pan, a 4096 color palette (with 8 or 16 colors simultaneously viewable), multiple viewports, local picture segments, 2D transforms, 4096 x 4096 addressability viewable in 640 x 480 blocks, 32K memory, and is available in desktop configuration. With host communications up to 9600 baud, 19.2K baud with flagging, the 4113 provides display speed suitable for a broad cross-section of CAD and mapping applications. Pictures and picture elements can be defined by MOVE and DRAW commands, then locally stored, recalled and manipulated with transmission of a simple segment identifier from the host. Optional 3-port RS-232C peripheral interface enables local control of plotters, printers and graphic tablets. Base price is \$16,500.

Tektronix Inc., PO-Box 500, Beaverton, OR 97077. **Write 240**

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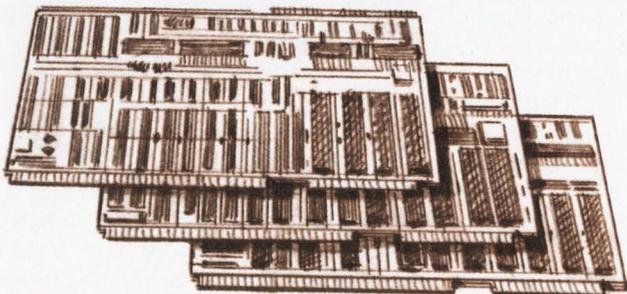
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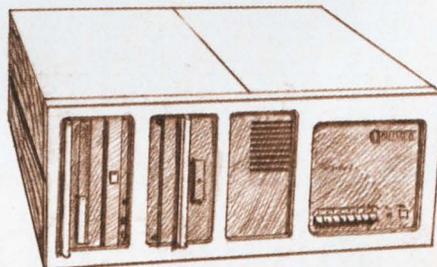
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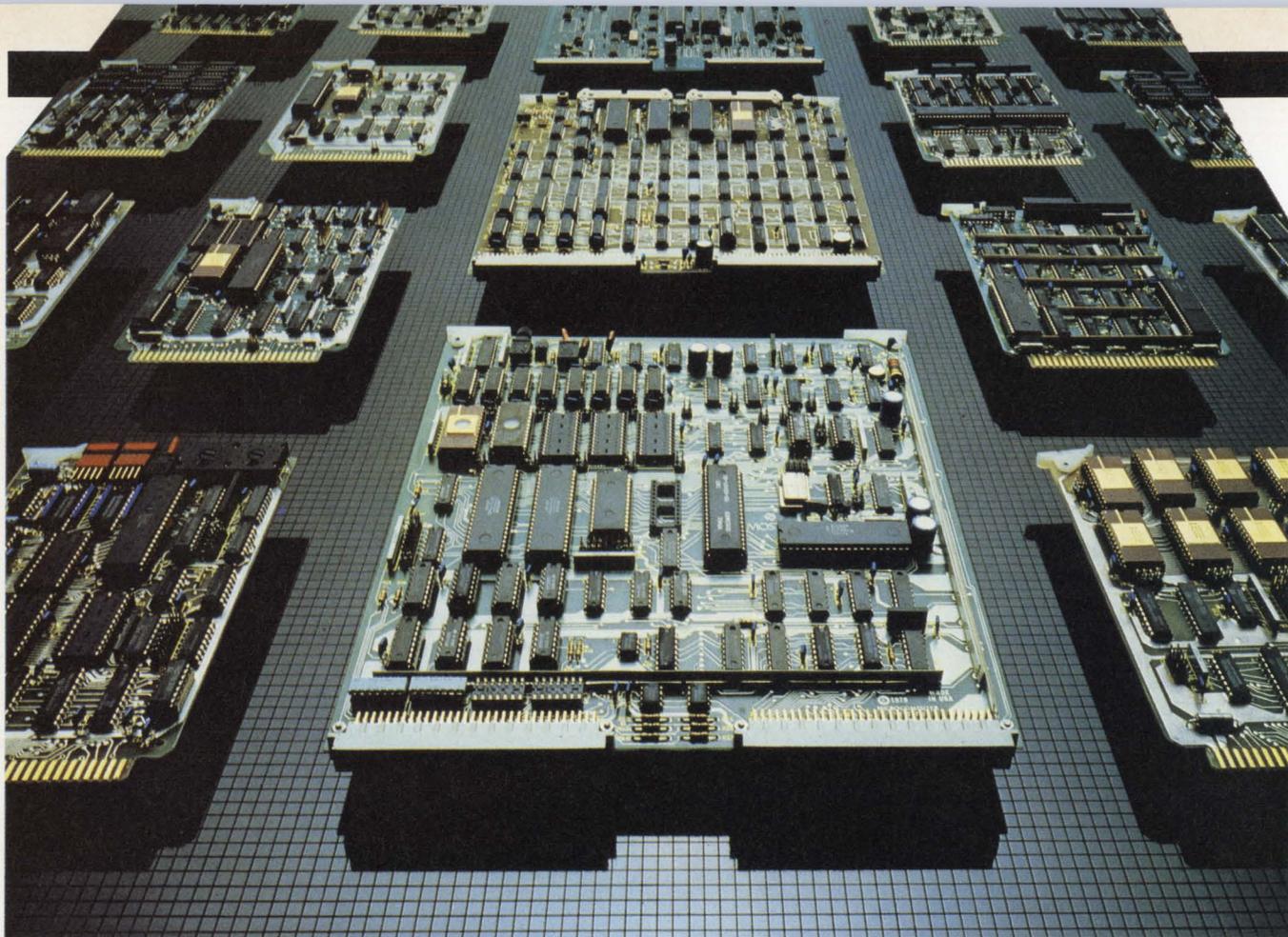
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Single Board Computers: Time And Money Savers For Some Unusual Applications

by Bill Groves

Single board computers (SBCs) are not for everyone, yet they fill thousands of applications for a lot less money than any component μ P design could touch. They also offer very quick turnaround, since the basic engineering is already completed. More time and effort can then be spent in tailoring the SBC to the specific tasks it will be required to perform. In some cases, even this step can be simplified if commercial software packages already exist.

Defining the application is the initial chore. Once this has been thoroughly developed, then the hardware can be defined. If the number of systems to be produced is low, then single board products

may be the only practical answer.

If the reader is considering producing a μ P-based system in quantity, the trade-offs between a components design versus purchasing a board level product can get much more difficult. Some of the major

SBCs fill thousands of applications for less money than component μ P designs and offer quick turnaround time.

considerations should include not only volume of product to be produced, but facilities and capabilities, engineering manpower availability, turnaround time, and real cost.

If you plan to build a lot of product, then you must know your own physical limitations. Do you have the man years of engineering talent available to design a system from the bottom up, debug it, and produce the operating system? Even if you have all of these capabilities, can you produce the board level products, either in-house or by subcontracting? Do you have to add production capability, space, new equipment, etc.? What are your real costs? In many companies, real costs are difficult to determine until you actually try to pro-

duce something. If you are confident that you can do it in-house at an acceptable cost, you should check some of the SBC suppliers (see list at end of article). They might be able to offer better prices, especially in the current market.

Consider also buying boards now and building in-house later when your volume gets larger. Many of the semiconductor companies recognize this problem and are willing to license companies to produce their board level products using their components.

You should also be very aware of other costs of development. Software can be a major time consumer. If you use your resources here, will you also have time for product development, production, and testing? The SBC suppliers offer development tools and documentation for their products. This is an added time saver. Commercial software packages already exist for many board level computers, and frequently these can be used as is or modified for an application.

Testing is another area that requires careful cost evaluation. A SBC product will have been tested by the manufacturer. Usually, the user only needs to test the complete system performance. This can save time and, more importantly, the cost of adding test gear.

If you have made all of these trade-offs and are considering a SBC, what is the next step? The application is the key. Only after the application is well defined should you begin to consider hardware. At this point, you will know if you need 2-4-8-16- or 32-bit capability. Then you can begin to narrow your choices based on physical environment, power consumption, bus structure, I/O capability and all of the other application-driven requirements.

Some Real Applications

Everyone's application of a SBC is unique. If this were not true, then the board level market would not exist. A few companies have agreed to share some of their experiences in using single board computers, and to pass along their

knowledge.

● *Thermco*. A leading manufacturer of diffusion furnaces for the semiconductor industry, Thermco is a company using TI SBCs in a unique way. Dick Dunn, the marketing director at Thermco, plans to use close to 2000 boards per year. His reasons for buying a SBC were turnaround time on design coupled with the fact that they cost less than what Thermco could build the boards for from scratch. Design time was a definite factor, but the real deciding factor, in addition to the board cost, was software. Thermco did not have enough in-house capability to generate all of the software it needed. TI and Thermco were able to work together to develop the software to match the application very quickly.

Earlier models of the diffusion furnaces relied on a minicomputer to control the four diffusion tubes

Thermco chose boards to solve the problem even though they have extensive in-house engineering and PC board manufacturing capability because the SBCs were just less costly than an in-house approach.

Thermco does modify the boards it receives from TI to protect some proprietary features of the furnace. This is a relatively easy modification that they have developed in conjunction with TI. Dick Dunn hopes to modify more than 50,000 older diffusion furnaces to this type of computer control in the future.

Thermco is a good example of a company that has selected a board level product to save time and money. They have also opened a new market in modifying older furnaces.

● *Highland Labs*. Paint tint dispensers for retail paint stores have been manually operated and prone to operator error for many years.

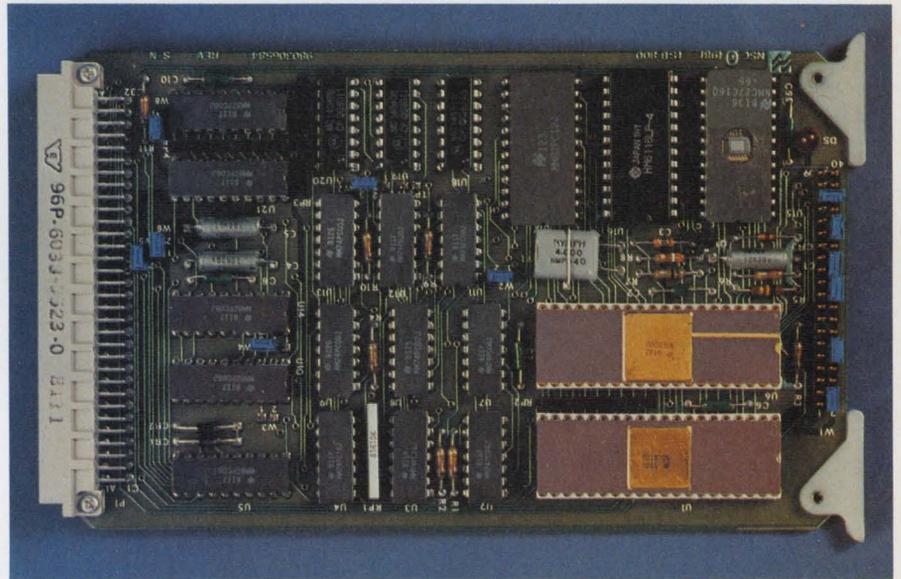


Figure 1: National Semiconductor recently announced a line of CMOS SBCs based on their NSC800 chip set. These low power SBCs have a -40°C to $+85^{\circ}\text{C}$ operating temperature range, making it possible to operate the μC in a sealed enclosure. This permits application in electrically noisy, explosive, and extreme temperature areas for many industrial process control applications. National also provides a full line of I/O, memory, and analog support boards.

in each furnace. When the mini went down, so did four tubes loaded with expensive wafers. Thermco decided that each tube had to be controlled separately. The solution was obvious—separate μP control.

Highland Laboratories in Ashland, MA is a leading manufacturer of colorant dispensers, and Highland's president, Jim Poitras, has directed his company's product toward computer control.

A most recent application was developed with S. Dyrup and Company, one of Denmark's leading paint manufacturers. Dyrup was concerned about adding color to its large variety of latex, vinyl, acrylic, and oil-base paints. Retail clerks made numerous errors copying tint

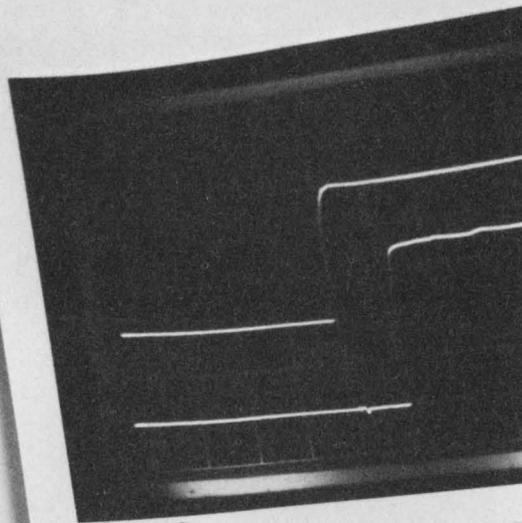
formulas from large color code books. Ability to make exact color duplicates of paint colors was very difficult because of operator variations on manual tinting equipment.

Highland reviewed the cost of computerizing its dispensers and

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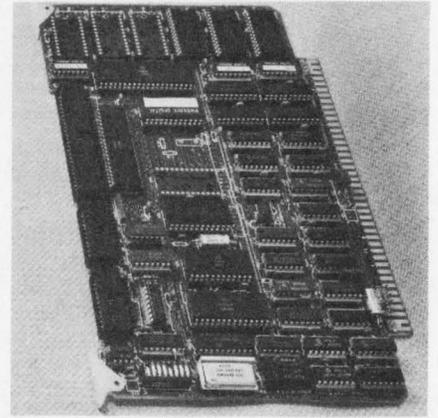


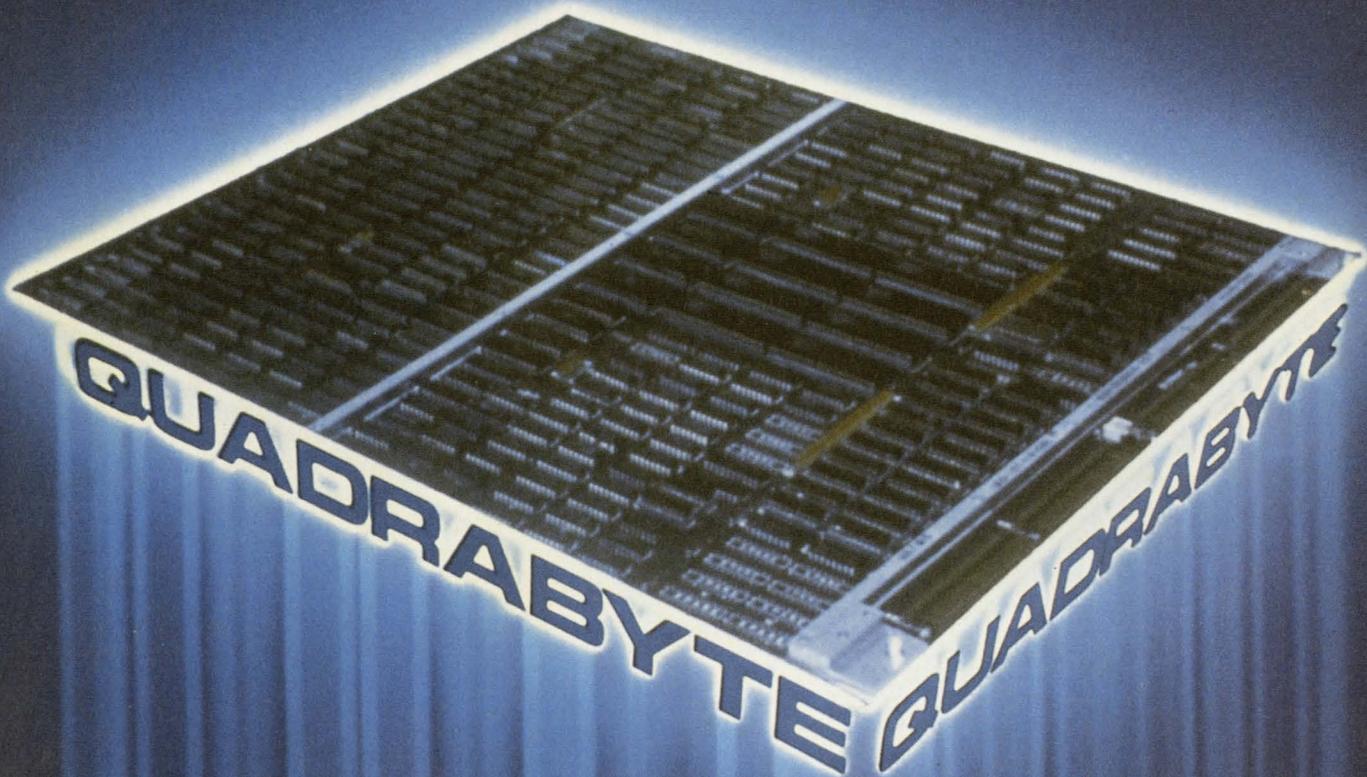
Figure 2: Phoenix Digital Corp. offers a very broad line of SBCs and support boards. The PCU-6809 series boards are designed for either single or multi-processor environments for a wide range of industrial control applications. It has a 4-year real-time clock/calendar with thousandths, hundredths, and tenths of a second, seconds, minutes, day of the week, month, year, and alarm outputs. It is software set, software controllable with its 16 registers, and is interruptible. It is available with 1MHz or 2MHz speeds. The PCU-6809 board, based on the 8-bit MC6809 μ P chip and its special multiphase clock generation circuitry, allows multiprocessor applications through the concept of shared memory. Operating simultaneously with an NCM-6809 Network Subsystem on the same bus, two processors can run at full speed but 180° out of phase with each other to double the throughput rate. Phoenix Digital offers a 0°-70° commercial version of the PCU-6809 and, for harsh industrial environments, a -40°C to +75°C version. Prices are under \$1000.

found cost was a major obstacle. Competitors were selling computer-controlled dispensers for about \$10,000 each—much too costly for most retail outlets, especially those that must tint paint rather than inventory a variety of colors.

Poitras found a solution in the AIM 65 SBC from Rockwell. He was able to interface the AIM 65 with a proven dispenser system. The processor, complete with keyboard and memory, retails for under \$500, and this enabled Highland to produce a computer-controlled dispenser for a price competitive with other electromechanical dispensers.

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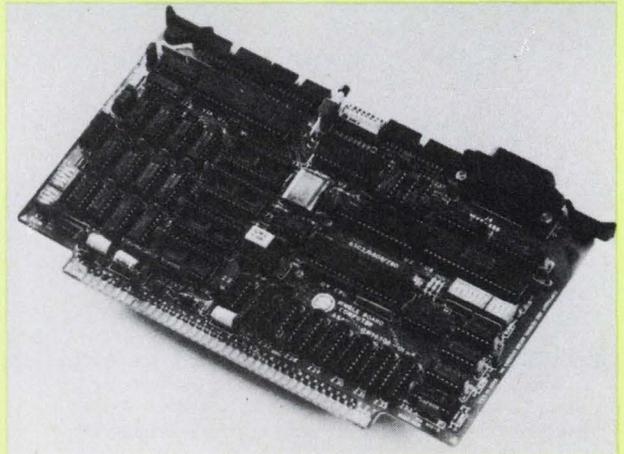
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General Micro Systems of Ontario, Canada, has developed a unique family of SBC modules offering interchangeable 6502, 6809, and Z80 μ Ps. Directly pin compatible with Motorola's EXORciser micromodule and Rockwell's System 65/AIM 65 buses, the modules offer up to 4K bytes of static RAM, 16K bytes of EPROM/ROM plus ACIA, IEEE-488, and printer ports. Each module also includes eight I/O lines, two 16-bit timers and two 8-bit shift registers with VUA/VXA and bootstrapping.

This single board module, when combined with a RAM memory expansion module and a floppy disk controller module, can produce a full 6502, 6809 or Z80 operating system. Other features include power-on reset, reset, base address, and enable/disable switches. All modules have fully buffered data, address and control lines, plus over voltage and polarity protection.

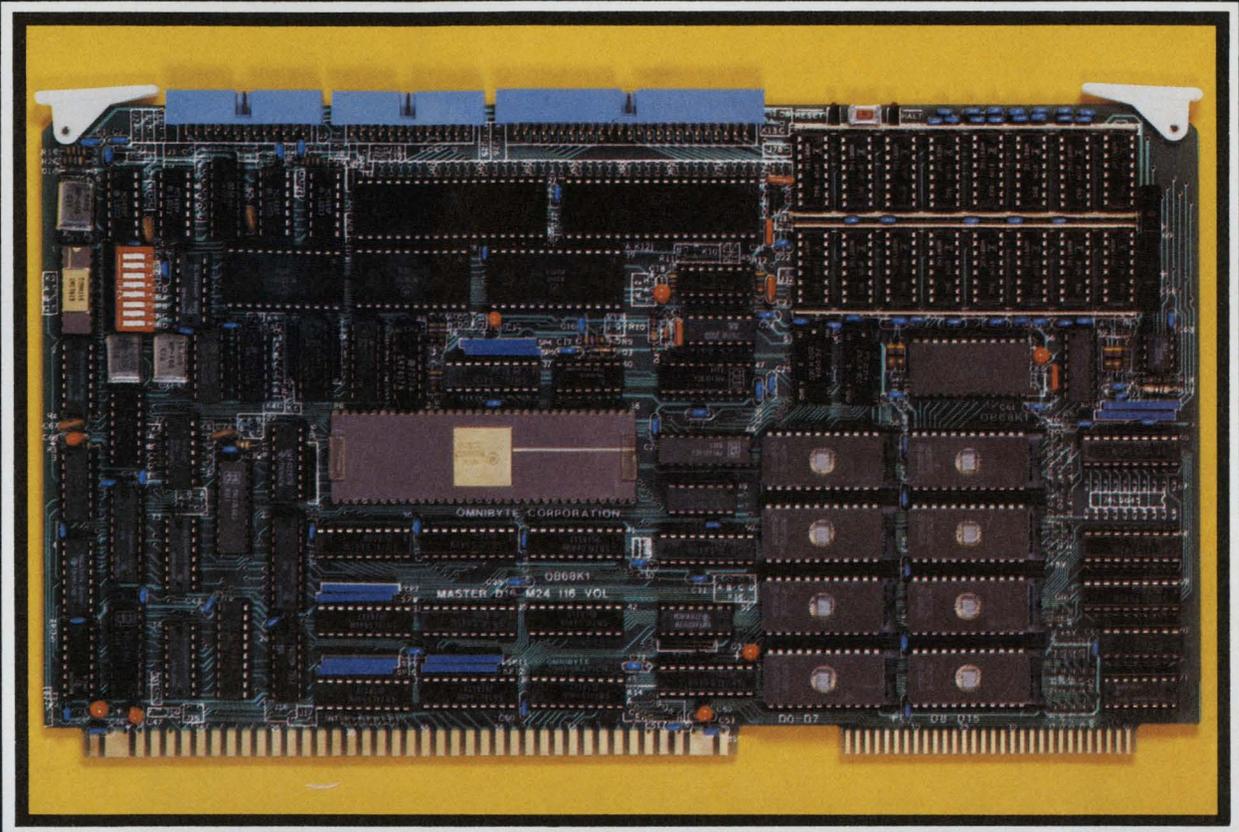
Using the basic General Micro Systems module, the changes needed to interchange processor chips are simple. Chip translators on the board let the different μ P chips be plugged in at any time. Crystal oscillators to match the 6502, 6809, and Z80 μ Ps are also available from General Micro.



Operating systems for the 6502 (basically the System 65 operating system), 6809, and Z80 families are available. Individual software packages for IEEE-488, ACIA and printer are also available. All of the General Micro modules are burned-in for 72 hours. Each carries a full year's warranty. The 6" by 9.75" boards sell for about \$500 each with quantity discounts available.

General Micro Systems' approach to interchangeable μ Ps could certainly be of value to users needing several different types of SBCs. Basic boards could be held in inventory until used, and at that point the choice of processor can be made.

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- ★ triple 16-BIT timer/counter
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The OB68K1 is designed to function in either a single or a multi-processor environment. All onboard memory is protected from access by other processors and devices, permitting multiple boards to run concurrently. Since the OB68K1 will address up to 16 megabytes of total memory, it is possible for several boards to access a common pool of memory and I/O devices within a shared bus system.

SOFTWARE SUPPORT

Because the board is configured with the same I/O arrangement as Motorola's MEX68KDM design module, any software developed for the KDM module, including the MACSBUG[®] monitor/debugger, will operate on the OB68K1. An off-the-shelf operating system is

currently available from Hemenway Corporation (Boston, MA) and high level languages are reported to be available from several major software houses by early fall.

For more information about the OB68K1, ask for our free summary sheet or send \$10 for a detailed technical manual. Contact Randy Cochran, Marketing Manager.



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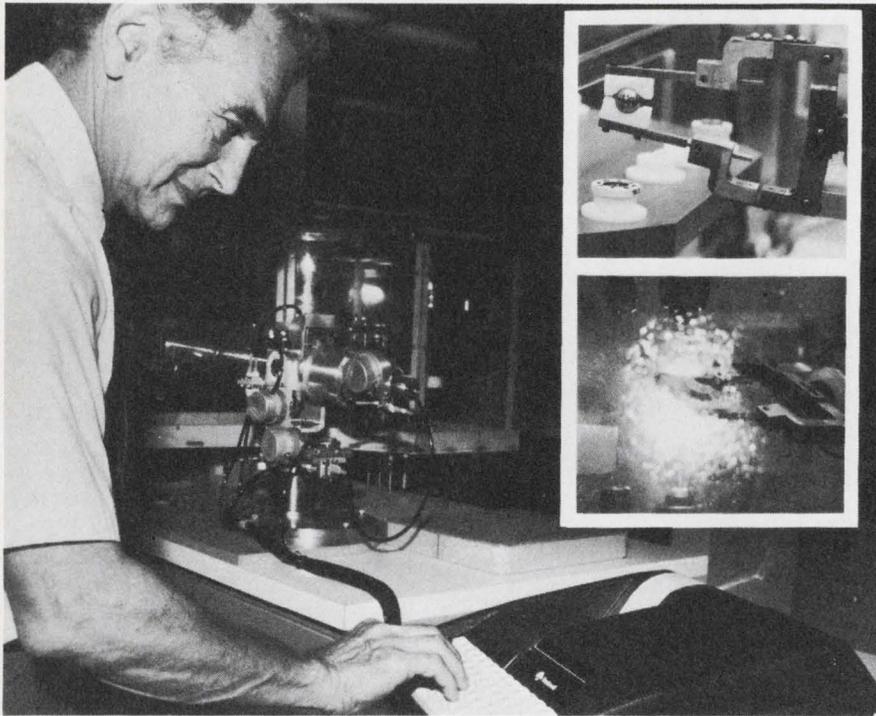


Figure 3: Rockwell's Antonetics Marine Systems Division uses an AIM 65 SBC to clean precision ball bearings for submarine gyros. The AIM 65 controls a robot moving on five axes in a pressurized nitrogen atmosphere. The robot cleans the bearings, round to within 4 mils, with filtered pressurized freon and dried nitrogen in about 14 minutes. The cleaning procedure cannot be accomplished by human operator without contamination. The Rockwell division designed this special purpose robot and then selected the lowest cost system capable of control. It turned out that the AIM 65 produced by another Rockwell division performed the control function for under \$1000.

Using firmware in the AIM 65, the retail clerk is prompted through the tinting process with an LED display. The only mechanical settings required by the clerk are the "dip-stick" like settings on up to 16 colorant dispensers, and he is told how to make the settings. The AIM 65 controls the dispensing and mixing operations. Exact color duplicates can be produced over and over again.

For Highland it meant putting a computer-controlled tint dispenser on the market at a price most paint retailers could afford. Highland was also able to get their product to market faster because they used an existing tint dispenser and added a SBC that even prints labels for the paint cans. Cost for the complete system went up by about 20% compared to the mechanical system, yet it stayed well below competitive computer-controlled systems. For the S. Dyrup Co., it means error-free tinting in its 175

retail outlets in Denmark.

Trends In SBCs

SBC products are serving two major markets. One is the general purpose computer applications where a small computer is imbedded into a system for control or data collection. This type of processor is also the most common one produced. Usually it operates on a proven bus structure, has I/O and communications interface, and

Figure 4: This 16-bit SBC from Motorola has been designed for the industrial and laboratory-automation markets. Based on the 68000, it offers Versabus interface, local bus extenders, two multiprotocol serial I/O ports, and 128K bytes of dual-port RAM with DMA. It also has a full line of support boards for peripheral interface, color graphics, and up to 512K bytes of dynamic RAM. With 128K bytes of RAM, it sells for under \$4000. It may be an attractive replacement for a minicomputer.

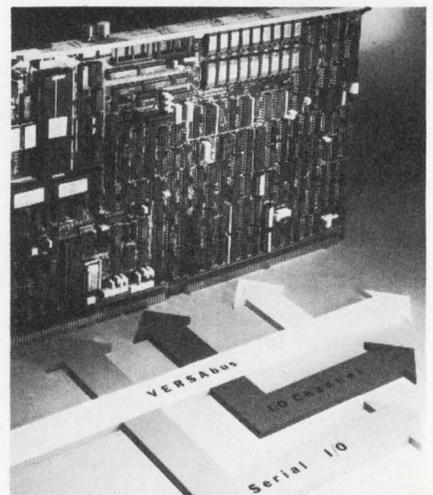
is readily adapted to a dedicated control function.

The second, and most rapidly growing market for SBCs is the truly dedicated function processor. RCA and National Semiconductor both produce tough single board processors for industrial control applications. National's new CMOS line is packaged in environmentally immune form that lends it to severe real world operating environments such as machine shops, oil refineries, steel mills, etc.

This more dedicated processor approach is more specifically tailored to industrial applications. Environmental considerations and packaging make these easier to use, but they do add to the cost.

Both the general purpose and dedicated SBC markets are growing because many users simply find it easier to buy a unit than to undertake development. Development dollars are often better spent on software and getting the product to market faster.

Many of the companies now using SBCs are fully capable of developing their own system, but because of cost and time they are electing to buy board products. The trend for the SBC makers is for larger markets. The users are not as easy to define. More sophisticated users are now taking the single board approach; however, at the same time, the number of first time computer users is increasing rapidly. Serving both ends and the middle of this market is a challenge to the SBC manufacturers. It will



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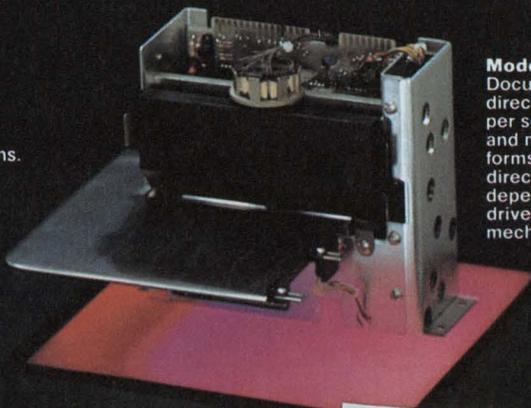
Model 420/421

Split paper feed printer. For receipt/audit applications. Prints two 18 character columns. Printheads available to match paper and printing speed/density requirements.



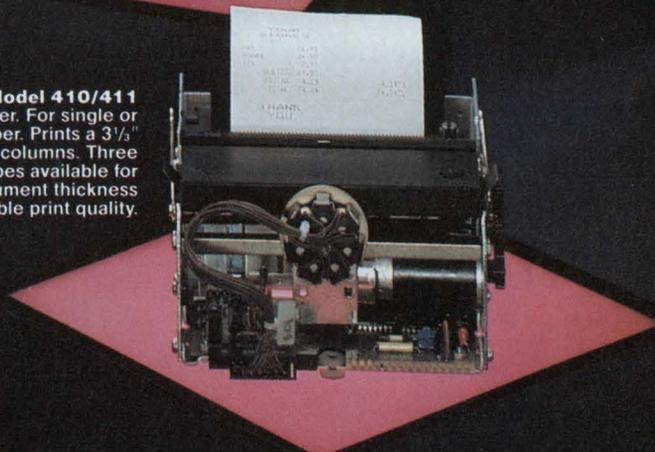
Model M-400

Document printer. Prints bi-directionally up to 3 lines per second. Handles single and multi-ply tickets and forms. Speed 3 lps bi-directionally. Has a quiet, dependable stepper motor driven paper advance mechanism.



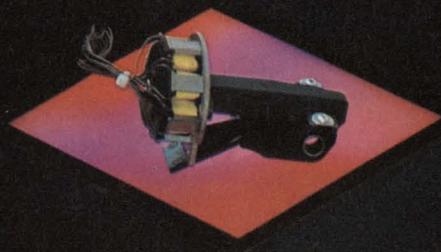
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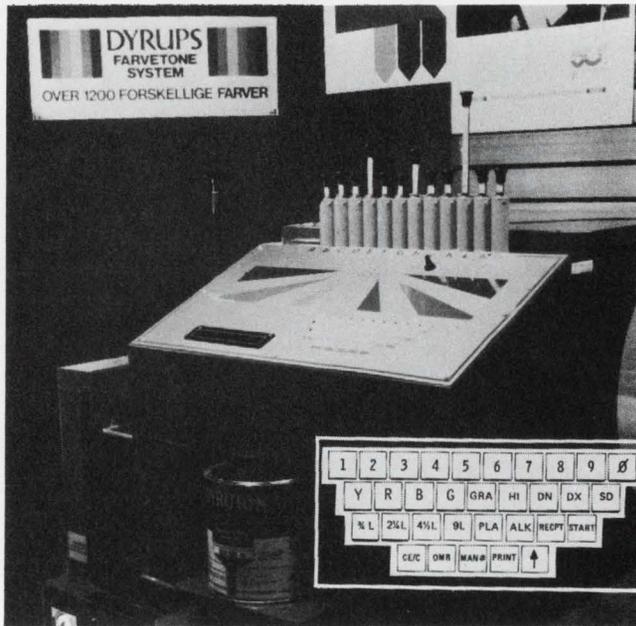


Figure 5: Automated Paint Mixing: Computerized paint colorant dispenser manufactured by Highland Laboratories automatically dispenses the correct amount of colorant and prints an identifying label. The computerized dispenser is successfully being used in over 175 retail stores in Denmark.

be interesting to watch them define their markets. Almost certainly, the first time SBC user will require the most hand holding support, and that may do some interesting things to prices. Product support may well be the key to success for the board manufacturers.

SBC Sources

Table 1 shows some of the sources

of SBCs. It is not intended to be a complete product directory, however, it is a guide to some of the products available. Since the processor chip type and the bus structure are key to any system, we have tried to show what chips and bus types are available. We apologize to the companies not listed and to the companies with new products not included.

Choices abound in the 8-bit SBC offerings. Something for everyone seems to be the way the 8-bit market has evolved.

For the 16-bit μ C boards, the choices are fewer and easier. Multibus is the dominant bus structure, but it is under great pressure from the Versabus. With the agreement of Motorola, Mostek, and Signetics/Phillips to standardize on the new VME Bus and the Euro-card format, Multibus may feel even more pressure.

The 16-bit μ P chip offerings are dominated by the 8086 and the 68000. The number of boards available based on these two chips is expected to grow rapidly. VME and Versabus do offer the 68000, a definite advantage over the other buses because they started out as 16-bit structures.

CMOS board level products will quickly find their way onto 16-bit boards, because the CMOS chips have extremely low power consumption. National, AMI, TI, Signetics, Harris and others should all be introducing 16-bit CMOS devices very soon. □

Table 1: Some of the currently available 16-bit and 8-bit SBCs currently available.

16-BIT μ COMPUTER BOARDS			
BUS	COMPANY	PROCESSOR	COMMENTS
MULTIBUS	AMD	AmZ8002	Eurocard
X-BUS	Data Applications Int's	8086	
PROPRIETARY	Data General	mN601	Large Selection
PROPRIETARY	Digital Acoustics	68000	
PROPRIETARY & LSI-II	Digital Equipment	LSI-II, F-II, T-II	Full Line of Board Products
MULTIBUS	Distributed Computer Systems	8086	
PROPRIETARY, MULTIBUS	Forward Technology	68000, 8086	IEEE-796 Bus Compatible Board
PROPRIETARY	Hewlett-Packard	2901	
MULTIBUS	Intel	8086, 8086-2	Full Line of Board Products
MULTIBUS	Microbar Systems	68000	
MULTIBUS	Matrox Electronic Systems	8086	IEEE-796 Bus Compatible Board
VERSABUS, VME	Mizar Designs	68000	
VERSABUS, EXORBUS, & VME BUS	Motorola	68000	IEEE-796 Bus Compatible Board
MULTIBUS	National Semiconductor	8086, NS 16032	
MULTIBUS	NEC Electronics	8086	IEEE-796 Bus Compatible Board
MULTIBUS	Omnibyte	68000	
VERSABUS	RCI/Data	68000	IEEE-796 Bus Compatible Board
PROPRIETARY	Stynetic Systems	CP 1600	
PROPRIETARY	Tau Zero	TMS 9900	IEEE-796 Bus Compatible Board
PROPRIETARY	Texas Instruments	TMS 9900, 74S481	
MULTIBUS, PROPRIETARY	Western Digital	8086, WD-9000	IEEE-796 Bus Compatible Board
FLEXBUS III	Xycom	Z 8001	
MULTIBUS	Zendex	8086	IEEE-796 Bus Compatible Board
PROPRIETARY	Zilog	Z 8002, Z 8001	

8-BIT μ COMPUTER BOARDS

BUS	COMPANY	PROCESSOR	COMMENTS
MULTIBUS	Advanced Micro Devices	8085A	
STD	Applied Micro Technology	Z80, Z80A	
STD or EXORBUS ¹	Applied Systems	6800	
STD or PROPRIETARY	" "	8085 or Z80	
MULTIBUS ²	Comark	8085	
EXORCISER ¹	Creative Micro Systems	6802, 6809	< Compatible with Motorola Exorciser Boards
EXORBUS	" " "	6809	
AIM-65 ³	Cubit	6502	
CYBERBUS	Cybersystems	6502, Z80, 8085	
DCE	Data Applications Int'l	8080, 8088, 6808 and Z80	All Eurocard Format
STD	Datronic	6809, 6800, 6804 and 6512	
STD	Desert Microsystems	8088	
PROPRIETARY & MULTIBUS	Digital Microsystems	Z80A	< Interface to Hi-Net Local Network
EXORCISER	Digitek	6800	Basic Compiler
MULTIBUS	Distributed Computer Systems	8080A, 8086, 8088	
MULTIBUS	Diversified Technology	NSC 800	CMOS - Low Power
MULTIBUS	ETI Micro	8085, 8088	
PROPRIETARY	Fairchild	3850	Communications Interface
MULTIBUS	Heurikon	Z80, Z80A	Some with IEEE 488 Interface
AIM-65	Industrial Micro-Systems	6502	Low Cost
MULTIBUS	Intel	8080A, 8085, 8085A, 8088	Large Selection
PROPRIETARY	Intersil	80C35, 6100	Key Pad and Display Included
S-100	Intercontinental Microsystems	Z80A	
CAMAC	Kinetic Systems	8085	< Built to IEEE-583 CAMAC Standards
S-100	Logical Devices Inc.	6809	
STD	Matrix	6809, 6803	
S-100	Measurement Systems & Controls	Z80A	
PROPRIETARY	Matrox Electronic Systems	Z80A	Can Be Customized
STD	Miller Technology	Z80A	
MULTIBUS	Monolithic Systems	Z80Z	
STD-Z80 & SDE	Mostek	Z80, Z80A	
EXORBUS	Motorola	6800, 6802, 6809	< Large Selection and Many Support Boards
S-100	MUSYS Corp.	Z80A	
EXORCISER	MRC Systems	6801	< Interfaces with Exorciser and Micromodule Buses
MULTIBUS, CIMBUS ⁴	National Semiconductor	8080, 8085, Z80A	< Some Alternate Source to Intel Boards
LSI-II & STD	Nortek	Z80A, 8088	< High Speed Peripheral Controllers for LSI-II
PROPRIETARY & STD	Octagon Systems	INS 8073, INS 8070	High Speed
PROPRIETARY & MULTIBUS	Omnibyte	6808, 6809	
SS-50	Percom Data	6809	
STD	Pro-Log	8085A, 6800, Z80, Z80A, 6809	Large Selection - High Speed
EXORCISER, RM65, EXORBUS	Phoenix Digital	6800, 6809	
PROPRIETARY	RCA	1802	CMOS - Low Power
PROPRIETARY	RC1/Data	6800, 6802, 6502, 6809	
RM-65 & PROPRIETARY	Rockwell International	6502	Low Cost
PROPRIETARY, MULTIBUS, SMP	Siemens	8085A	Eurocard Format
PROPRIETARY, SS-50	Smoke Signal Broadcasting	6809	
C-44 PROPRIETARY	Synapse	NSC-800, 6805 E2	Extremely Low Power
PROPRIETARY, KIM, EXORCISER	Synertek System	6502, 6800	
AIM-65	Systems Innovations	6502	
PROPRIETARY	Texas Instruments	TMS 9980	
MULTIBUS & PROPRIETARY	Western Digital	8085A, 8088	Alternate Source to Siemens
PROPRIETARY	Wintek	6800, 6801	
FLEXIBUS II & III	Xycom	8080A, Z80A	
MULTIBUS	Zendex	8085-2, 8088	
PROPRIETARY	Zilog	Z80, Z8-02	
STD	Ziatech	8085A	High Speed

¹ EXORBUS, EXORCISER, VERSABUS - Motorola Trademarks² MULTIBUS - Intel Trademark³ AIM 65 - Rockwell International Trademark⁴ CIMBUS - National Semiconductor Trademark

CP/M-86 vs. MS-DOS

by Neil Colvin

Comparisons are made on recently released versions of both operating systems in the following nine areas: program management and program control, memory management, serial I/O, disk I/O, file management, command processing, standard support utilities, CP/M-80 conversion effort, and reliability. Both Digital Research and Microsoft have announced future product upgrades which may address a number of these areas.

Program Management

Both CP/M-86 and MS-DOS support multiple program models for flexible control of the 8086's program/memory architecture. CP/M-86 supports three models: 8080, SMALL, and COMPACT. MS-DOS supports two models: 8080 (COM) and 8086 (EXE). These models generate different initial mappings of the program code on disk to the 8086 memory, and different initial settings of the 8086 segment registers.

Both operating systems use an 8080 program model that is derived in part from the CP/M-80 program model. In these models, the 8086 code, data and stack segments are one and the same, and code and data are intermixed in the segment. The code starts at 100H relative to the start of the segment, and low memory in the segment (0-FFH) is predefined in a manner similar to CP/M-80.

Both operating systems also have a program model that supports separate code and data/stack segments. Thus, additional memory can be automatically allocated for these segments and code segments can be shared in multi-tasking environments. MS-DOS, however, allows program relocation which cannot be done under CP/M-86.

Adapted from a seminar by Neil Colvin, President of Phoenix Software Associates Inc.

Not allowing for program relocation makes CP/M-86 inefficient because the 8086 architecture restricts a single segment to 64 Kbytes. Since one of the advantages of the 8086 is its large address space, programs that are larger than 64K are well suited to run in the system. While both operating systems allow multiple segments of code to be included in the program, only MS-DOS automatically relocates the inter-segment linkages (in the form of in-line FAR JUMPS and FAR CALLS and double word pointers) at the time of program loading. Under CP/M-86, in its third program model, the segment bases of these additional program segments are available in the memory image, but must be explicitly managed by the program code to produce FAR CALL and FAR JUMP pointers.

Memory Management

Memory management refers to the facilities within the operating system which can be used to obtain additional memory resources during the execution. The two operating systems differ greatly in their approaches to this problem.

MS-DOS uses an approach similar to CP/M-80 for its memory management. After a program is loaded, certain locations in its low data area contain the addresses of the top of the current data segment, and the top of all available memory. The program has access to all memory from the base of its code segment through the top of memory, and may manage it as it desires. One consequence of this technique is that MS-DOS only supports machines that have contiguous RAM memories.

CP/M-86, on the other hand, allows memory to be allocated out of the free memory pool, or at absolute memory locations (providing control over access to memory-mapped devices or other non-shar-

able memory resources). Specific size memory segments may be requested, or a request may be made for the maximum memory segment that is available. As a consequence, the available memory under CP/M-86 need not be contiguous, so that systems can handle memory-mapped devices and ROMs that may intrude upon the memory space.

In both operating systems, programs may be "stacked" in memory. This means that a program may request the operating system to load another program "above" it in memory, transfer control to that program, and be given control back when that program terminates. This process can be repeated by the new program.

MS-DOS also features a number of program controls during program execution that are not available in CP/M-86. These include:

- Programmable trap for CTL-C handling without program termination.
- Programmable trap to inhibit return of program to the operating system for any reason. This trap is stacked when a new program is loaded so that the termination of the program will always return to the original calling program, even if the new program has set

Serial I/O differences

MS-DOS

- * Expanded Console I/O System Calls
- * Interrupt Driven Keyboard Support
- * No List Status Call
- * No I/O Byte Type Support
- * Sophisticated "Buffered Console Input"
- * "File I/O" to Serial Devices "Device Independent" I/O

CP/M-86

- * Direct "BIOS" Calls for Serial I/O
- * List Status Call
- * I/O Byte Support—Dynamic Device Assignment
- * Simple "Buffered" Console Input
- * Serial and File I/O Totally Separate

Table 1: Serial I/O differences.

its own termination trap.

- Programmable trap for critical error handling. The program directly handles disk I/O errors and other errors which would normally cause program termination. Detailed error codes and error recovery options are provided for use by the error routines.
- Memory lock option leaves a program resident in memory after termination. A program can link into the interrupt vectors or device driver area, without vacat-

Disk I/O differences

MS-DOS

- * Blocking/Deblocking in OS
- * Multiple Sector Reads
- * Arbitrary Physical Sector Size

CP/M-86

- * Driver Does Blocking/Deblocking
- * 128 Byte Reads/Writes Only
- * Single Logical Sector at a Time
- * CP/M-80 Methodology

Table 2: Disk I/O differences.

ing the memory area until the next cold system start.

- Time and date support, with calls for reading and setting the system time, and internal support for a real-time clock.

Serial I/O Comparison

Many small serial-I/O differences exist between the two systems (**Table 1**). CP/M-86 provides direct access to the BIOS functions for serial I/O through a system call, whereas MS-DOS does not provide any direct access to the BIOS level I/O. MS-DOS does offer an expanded set of system calls for dealing with console I/O, including direct and indirect read without echo and flush keyboard buffer (for interrupt driven keyboards). MS-DOS does not provide any equivalent to the CP/M-86 List Status call to determine if the list device is ready to receive a character (a feature used by many programs with background print capability).

A second minor difference is in the I/O byte handling. Although both operating systems support four logical devices (console, list, reader, punch), CP/M-86 uses an I/O byte to assign up to 4 physical

devices per logical device. It also makes use of the STAT utility to change those assignments. MS-DOS provides no equivalent facility.

The third minor difference is in the "buffered console input" function. Both systems have editing capability while inputting data, but MS-DOS lets a user edit lines similar to the way Microsoft's BASIC interpreter's editor performs.

The major serial I/O difference between the two operating systems is support of a "device independent" I/O facility for serial devices which allows the standard file I/O calls (i.e. read and write) to be assigned to special file names (CON, PRN, NULL, and AUX) in order to access the serial devices. Thus, programs can be written in the fashion of a Unix operating system where serial I/O files and disk files cannot be distinguished from actual serial devices.

Disk I/O

CP/M-86 disk I/O is very similar to that of CP/M-80. A logical sector size is 128 bytes, and the blocking and deblocking is left to the system implementor. One logical sector at a time is assumed for all I/O operations, with the user having to interleave sectors.

MS-DOS takes a different approach. Hardware-dependent disk drivers need only concern themselves with reading and writing sequential physical sectors. No arbitrary restrictions are placed on physical sector size, and MS-DOS does all the necessary blocking and deblocking necessary internally. In addition, MS-DOS requests multiple physical sector reads and writes from the driver whenever possible, thereby making use of non-interlaced disk structures for maximum speed.

These differences in approach to basic disk I/O (**Table 2**) are reflected in the file management strategies of the two operating systems.

File Management

A list of some basic quantitative comparisons is in order:

	CP/M-86	MS-DOS
Maximum Allocation Block Size	1K/16K	32/2048K
Minimum Allocation Block Size	1K	1 sector
Maximum Physical Sector Size	?	16K
Maximum Allocation Blocks/Volume	8K	4K
Maximum Storage/Volume	8M	1024M
Maximum File Size	8M	1024M
Maximum Directory Entries	8192*	4080
(*CP/M-86—Max Alloc. Blk Size: 12)		
Maximum Memory Table Size/Volume	1K	6K

File management differences

- * Incompatible with CP/M-80 File Structures
- * Byte Stream Files
- * Arbitrary Logical Record Size
- * Byte End-of-File Pointer
- * Random Access to Byte Level
- * Multiple Record Read/Write
- * Time/Date Stamping of Files
- * 7 Byte Logical Record Allows File (=) Serial Drive I/O Independence
- * In-Memory File Allocation Table

CP/M-86

- * Identical with CP/M-80 File Management
- * 128 Byte Logical Records
- * Record Level End-of-File
- * Single Record At-a-Time I/O
- * Partitioned Directory (User Areas)

Table 3: File management differences.

These figures show two significant features. First, MS-DOS supports much larger volume and file sizes than CP/M-86. Second, MS-DOS uses more memory per volume than CP/M-86. This latter point is somewhat deceptive because MS-DOS makes a substantial speed vs. space tradeoff by using the additional memory.

As **Table 3** shows, the most important difference between MS-DOS and CP/M-86 file management is that they are based on entirely different file structures. MS-DOS media are not compatible with CP/M-86 media, and vice versa. CP/M-86 16-bit media are 100% compatible with CP/M-80 (8-bit) media however, and there lies the crux of the matter. Since CP/M-86 is constrained to the same file structures and file management as CP/M-80, there has been no improvement or enhancement of the access or management facilities. Under CP/M-86, a file consists of

128 byte records, with 128 records/logical extent. All file access is based on these records, and end-of-file detection is also done on a record boundary. All other management of the data within a file must be done by the program itself.

MS-DOS, by using a different file structure from the 8-bit operating system predecessor, has added many new file management facilities to the system. MS-DOS files are stored as one long string of bytes, with an exact 32-bit byte count end-of-file pointer maintained for each file. Files may be accessed in a way as if consisting of a set of records of some program determined size. But that size may be anywhere from 1 byte to 64 Kbytes. This logical record size may be changed from access to access (it is not stored internally in the file structure or between accesses), and all accesses to the file are based upon it, including read, write, and random I/O. Note that this allows random access to a specific byte in a disk file by using a 32-bit random key and a 1 byte logical record size. In addition, there are systems which allow the reading or writing of multiple records at one time. This allows entire files to be read or written with one system call, and is used internally by MS-DOS to provide high-speed program loading.

In addition, MS-DOS marks all files as to their time and date of modification. This provides a much needed capability to perform incremental backup of large capacity storage media (such as Winchester disks) based upon the actual usage of the files on that media.

Two performance notes concerning MS-DOS need attention. First, MS-DOS keeps the file allocations memory resident for ALL files on a given volume. This uses substantial amounts of memory (6K maximum/volume, as mentioned earlier, compared to the IBM personal computer's 0.5K), but provides very fast file access. CP/M-86 keeps its indexes on disk, and may require a directory search during a file access, especially a random one. This difference of file access

methodology can, in many cases, provide an order of magnitude or greater better performance for MS-DOS-based programs utilizing many common data access techniques, including ISAM and B trees. Both systems require directory searches during file opens and closes.

The second major difference in file management is that MS-DOS allows removable media to be changed at any time during program execution, as long as there are no currently opened output files on that media. CP/M-86 requires an explicit "reset" be issued to the drive after a media change has occurred if output is to be done to the new media, otherwise output is inhibited.

One of the major difficulties with the current MS-DOS is the lack of any form of directory partitioning. CP/M-86 provides for the partitioning of a single volume's directory into 32 different "user" areas. On volumes with large directories (greater than 128 entries), the lack of directory partitioning makes the use of large numbers of files difficult.

As a final note on the area of file management, both MS-DOS and CP/M-86 provide for "file-attributes." CP/M-86 provides two attributes: "read only," and "system," which inhibit directory listing of the file. MS-DOS also provides two: "hidden" and "system," which also inhibit directory listing of the file.

Command Processing

The command processors for both operating systems have been designed to retain the flavor of CP/M-80. CP/M-86's is almost an exact copy of the CP/M-80 CCP, with no additional features. MS-DOS has provided all of the CP/M-80 capabilities, plus some new ones:

- The COPY function (the PIP program in CP/M-86) is built into the MS-DOS command processor, allowing file transfers to be made at any time without having to load a transfer program first.
- The BATCH function (the SUBMIT program in CP/M-86) is built into the MS-DOS command

processor. Files with an extension (type) of .BAT are automatically submitted to the batch job stream when their file name is given as a command, in the same manner as a .COM or .EXE file would be. No explicit "submit" command is required.

- The batch file AUTOEXEC.BAT is automatically submitted to the batch job stream on a MS-DOS cold start. It may in turn execute whatever configuration or startup programs that are required, or start the execution of a turnkey application system.
- The entire command processor may be replaced simply by placing a new COMMAND.COM file on the system disk. Users can therefore easily install new interfaces to MS-DOS when required.

The DIR command lists not only the file name but also the file size and file modification date and time.

Standard Support Utilities

The system support utilities which are provided as part of the operating system releases are as follows:

CP/M-86

(*indicates provided in both 8080 and 8086 versions)

ASM86	* absolute assembler
GENCMD	* executable program builder
STAT	disk/file/device utility
PIP	file transfer utility
DDT86	machine language debugger
ED	character oriented text editor
SUBMIT	batch processing utility
LDCOPY	boot loader copy utility
misc	* system configuration and build utilities

MS-DOS

M86	relocatable macro assembler
DEBUG	machine language debugger
CHKDSK	disk utility
SYS	operating system copy utility

RDCPM	file transfer from CP/M-80 to MS-DOS
EDLIN	line oriented text editor
LINK	linkage editor
FILCOM	file comparison utility
TRANS	8080/Z80 to 8086 translator
EXE2BIN	EXE to COM converter
C86	cross reference utility
LIB	library manager

The CP/M-86 assembler uses mnemonics that are close to the Intel standard, with some minor variations, and generates only absolute (non-linkable) output. The MS-DOS assembler is 100% Intel-compatible, with a full macro capability, and generates relocatable and linkable output.

The debuggers provided with each system are similar, with some minor differences. CPM-86's DDT86 has the ability to do in-line assembly while debugging, while MS-DOS's DEBUG does not. DEBUG has a memory search option, and a direct disk I/O (by specific sector), while DDT86 does not.

Both systems' basic text editors are normally sparsely used, since many screen-oriented editors of much greater sophistication are available for both systems. MS-DOS provides a linkage editor for use with M86 as well as the many other Microsoft supported languages.

MS-DOS also has an 8080/Z80 to 8086 assembly language translator which accepts M80 compatible source files and produces M86 compatible ones. Digital Research markets a similar product, but it is only available at an additional cost.

One final utility that is unique to the MS-DOS system is FILCOM, a sophisticated file comparison utility that can locate the changes (additions, deletions and modifications) between two ASCII files, and report them. It can also do binary file comparisons.

CP/M-80 Conversion Effort

Probably the most intriguing com-

parison between the two operating systems concerns their respective "upward compatibility" from CP/M-80. The major issues in this area are disk compatibility, system call compatibility, memory image compatibility and performance.

MS-DOS disk structures are incompatible with CP/M-80's, while CP/M-86's are identical. This means that a conversion of all data files to the new format is necessary to convert to MS-DOS. A utility program, RDCPM, is provided to do this, but this conversion can be time consuming and difficult (especially with large data files).

The issues of system call and memory image compatibility are really only the concern of assembly language programmers. These issues are masked by the run time environment provided by high level languages. If, however, a company's software is written in assembler, this factor could be of great concern. Both systems maintain a high degree of system call compatibility. CP/M-86 does require that all CALLs and JUMPs to address 5H and 0H be changed to INT instruction. MS-DOS also uses the INT instruction as the preferred way of making a system call, but it does support a CP/M-80 compatible mode of system calls at locations 5H and 0H. The use of registers during system calls is similar on both systems, and does allow for easy mechanical translation from 8080 to 8086 code. It should be realized, however, that system calls constitute only a small portion of the total code in any given program.

CP/M-80 emulation calls are not perfect under either system, with slight inconsistencies present which could cause specific programs that worked perfectly under CP/M-80 to fail once translated, even though logically identical. This has been a minor problem to conversions done by Phoenix Software Associates programmers since the number of differences has been small, and the affected programs easy to identify.

Another incompatibility at the system call level is the absence of a compatible direct BIOS call capability by the use of locations 1H

and 2H in the memory image. CP/M-86 does provide a means by which its BIOS can be accessed directly, but the code to do so must be re-written. MS-DOS provides no direct BIOS access.

Both MS-DOS and CP/M-86 do emulate the memory image of a CP/M-80 system remarkably well. The reserved memory locations between 0H and FFH are used in the same manner as CP/M-80, including the command buffer at 80H, the default FCBS at 5CH and 6CH, and the top memory value at 6H-7H. Programs which rely on these locations can be converted with virtually no change.

The performance issues of conversion are interesting. Since CP/M-86 uses the same disk format and access techniques as CP/M-80, a converted CP/M-80 program should exhibit approximately the same I/O performance as was experienced under CP/M-80. MS-DOS, however, uses an entirely different disk access and blocking/deblocking technique. This results in directly converted programs that use CP/M-80 compatible I/O (128 byte logical records, one record at a time) to run 2 to 3 times slower than the equivalent CP/M-86 program. As the physical sector size of the disks was increased, the performance of the two systems became very similar. This performance differential is probably due to the fact that most MS-DOS implementations do not interleave the disk and instead optimize for the multi-sector reads. Larger physical sectors reduce the impact of the lack of interleaving, hence the noted result. The MS-DOS program will run 3 to 4 times faster than the CP/M-86 program if the converted programs are modified to use large disk buffers internally. This modification entails the CP/M-86 program doing multiple sequential 128-byte reads to fill the buffer and the MS-DOS program doing a single I/O call to fill the buffer. This performance increase due to multiple record I/O is automatically available to users of higher level languages because the run-time support for these languages under MS-DOS have been designed to use these features. □

The first 100mm removable Winchester offers high speed, low media cost, and low drive cost in an easy-to-integrate design.



100mm 5-Mbyte Winchester Solves Back-Up Problems

by Larry Sarisky

Winchester disc drives continue to be plagued by the persistent problem of media back-up in the under-50-Mbyte class of product. How does the user remove critical information from the sealed media to prevent a disc failure or a catastrophe from completely destroying his data base? Moreover, how can the user achieve this back-up at a reasonable cost?

Larry Sarisky is with SyQuest Technology, 44160 Warm Springs Blvd., Fremont, CA 94538.

SyQuest Technology, in introducing a 100mm 5-Mbyte removable Winchester disc cartridge, offers a fast back-up alternative (5 Mbytes can be offloaded in under 4 minutes), low cost (the cartridge will cost under \$30 each, while the basic disc drive will cost slightly more than a floppy drive), and a back-up solution that will fit right into existing designs without any changes in the controller or the basic system physical package (the removable cartridge form factor is half that of a minifloppy drive; SyQuest provides mounting hardware to compensate for mechanical differences).

Alternative Backup

To illustrate the significance of this solution requires first a description of the alternative solutions offered thus far: floppy discs, streaming, and start-stop tape. These will then be compared with the 100mm cartridge disc solution in terms of cost, operation, and impact on existing system design.

Floppy disc drives are the lowest cost means of back-up for hard discs. However, at present, the most one minifloppy can hold is 1 Mbyte. There are rumors of a 2-Mbyte minifloppy, but both media and drive costs should be consider-

ably higher than that for the 1-Mbyte unit. To dump a 5-Mbyte data base onto floppies with the current capacity requires 5 discs and about 2 hours of processing time. If the system's data base is changing a great deal daily, then back-up should occur frequently.

The alternative to backing-up the entire disc is to copy off onto floppy only the information that has changed since the last back-up operation. This can be accomplished at either the system level by adding back-up capability to the disc operating system software or by adding the functionality at the disc controller level. At the controller level, the design of the controller must incorporate a back-up command.

As shown in **Figure 2**, the typical hard disc track layout uses sectors with 512 or 256 bytes of data. To effect back-up of only the data that has changed requires the addition somewhere in the sector header or data, a byte that indicates whether or not the sector has had a transaction since the last back-up operation. Overhead bytes like address mark (AM), control field (FE_H), etc. already contain specific information that cannot be altered. Reducing the number of bytes of zeros on either side of the sector header means reducing the controller's tolerance to disc drive spindle motor variations. The last option is to reduce the number of bytes in the data field from 256 or 512 to 255 or 511, respectively. In the process, however, the system's disc operating system software is affected, since it must now accommodate a smaller data block on disc.

Assuming that one byte in the format can be used to indicate current activity within a sector, then a controller common for both hard disc and floppy can perform selective back-up. This would require additional functionality added to the controller, since now a back-up

operation must be able to scan each sector on disc looking for an activity byte that shows some current transaction. Finding a byte showing recent activity in the sector, the controller would then off-load the sector to floppy storage. The process would continue until each sector had been checked and offloaded, if necessary.

A more efficient way of doing selective back-up is at the disc operating system level. In a system using CP/M, one of the bytes in the file control block (**Figure 3**) could be configured to contain one bit that is set if the file has had activity since the last back-up operation. The differences in doing back-up at this level, rather than at the controller level, is that the file in a DOS system can contain many sectors on the disc. Thus, setting one bit in the file control block eliminates the need to write a bit in each sector on the disc level.

When it comes time to back-up the disc, an applications program written by the system's integrator is initiated. The program examines each file control block in the sys-

tem's file directory, looking for a set bit in the byte designated to contain the bit showing a current transaction. After the file has been copied from hard disc to floppy, the bit is reset for the next period of operation.

An alternative to setting a bit in the file control block is to create a file in main memory to contain the names of those files that have changed since the last back-up. Then, as before, an applications program developed by the system integrator can be called to store on floppy the contents of files whose names are contained in this back-up file.

Advantages to using either of these applications routines include faster back-up using a floppy. Also less information is stored away. The DOS, on the hard disc, for example, is already stored on floppy and is not copied each time a back-up occurs. The process of removing data from the hard disc to floppy is also a simple operation for the operator as well. Typically, he would need only to generate a single command, e.g., "BACK-UP", as the

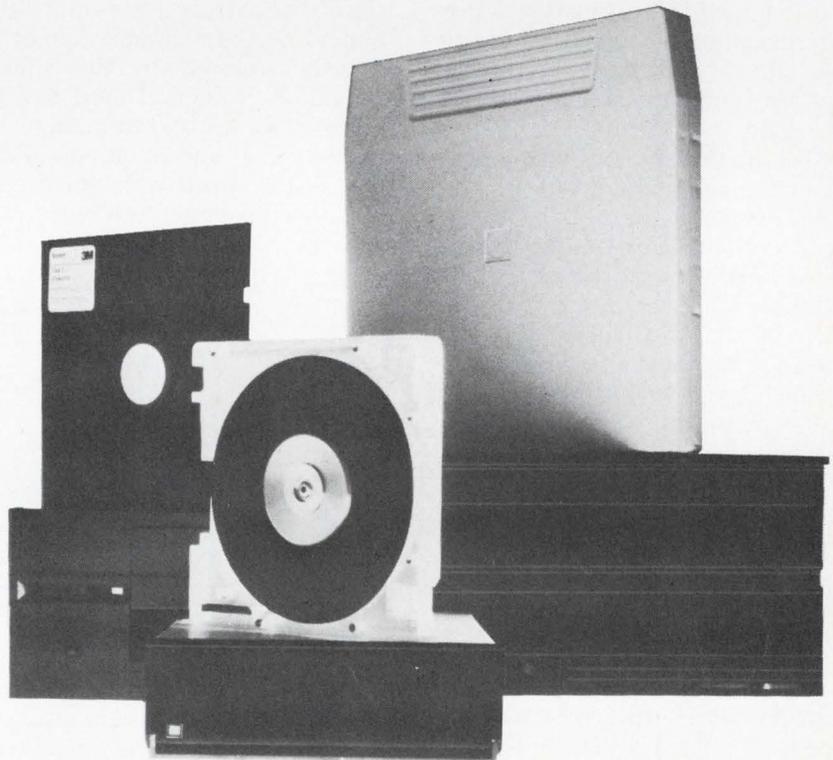


Figure 1: Winchester disk back-up technologies include a variety of disk media, including SyQuest's new microdisk, Shugarts minifloppy, and Data Peripherals' 8" Winchester cartridge.

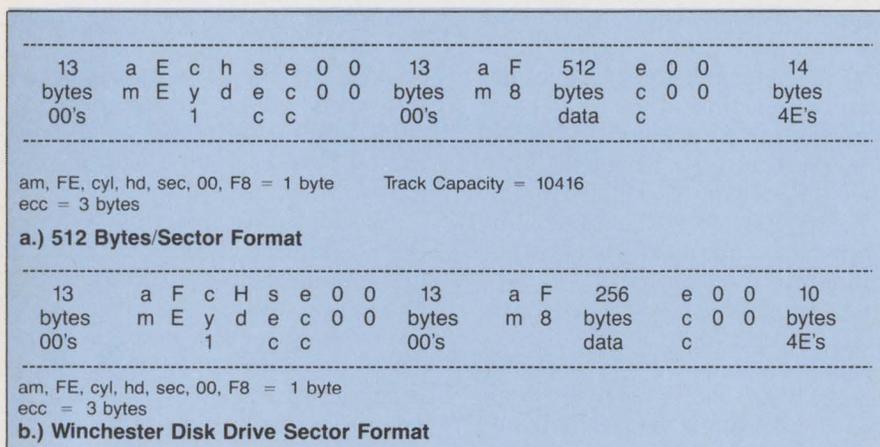


Figure 2: The typical hard disc track layout uses sectors with 512 bytes/sector and 18 sectors/track (a), or 256 bytes/sector and 33 sectors/track (b). Source: Data Technology Corp.

starting location and number of sectors to be copied.

Disadvantages to this approach, however, include cost. The system integrator must add additional software in the form of the applications program to do back-up. Moreover, the system overhead increases, too. In one instance, the file control block for each file in the system's directory is changed, and in the second case an additional file is being created and maintained. Another disadvantage is that the back-up information is dispersed among a number of floppy disc drives and must be reconstructed so as to recreate the intact data base.

Cost in the form of extra programming and additions to the system's overhead plagues the selective back-up approach, while added time is the extra cost of non-selective back-up. However, despite this cost disadvantage, the low price tag of the floppy disc itself makes it a very attractive solution when compared with tape back-up, which is much costlier. **Table 1** shows the system cost for both floppy and tape back-up implementations.

Tape Advantages

Tape offers strong advantages where storage capacities exceed the ability of floppy discs (over 20 Mbytes). Here the attraction of tape is its relatively low media cost (\$26/each for a 10 Mbyte tape car-

tridge) and its fast back-up time (about 5 minutes for up to 10 Mbytes). Moreover, the back-up can be an entire disc dump of only selected files. Even in these storage capacities where tape is cost effective and practical, there are some drawbacks. First the system integrator is faced with deciding between using tape exclusively for back-up or as a form of off-line storage as well. Choosing the former, he would probably opt to design in a streaming tape which records disc data as a first-in-first-out buffer. The data on tape cannot be directly accessed by the system computer. Rather, it must first be returned to disc and from there accessed. The appeal to streaming tape is the speed with which data can be offloaded—10 Mbytes in 5 minutes.

Using a start/stop tape drive, the integrator gets a device that can be accessed directly by the CPU. Data stored on a start/stop drive is clustered in blocks typically 4 Kbytes in size. Hence, a disc with 512 Kbyte sectors would store eight sectors to a block. While the attraction of this type of tape storage is that the system can access any of these larger blocks, the disadvantage is the added interrecord gaps between blocks which cut storage capacity and access speed considerably. Also, this type of device significantly increases system cost. A tape cartridge, when used on a streaming tape drive, can hold 17 Mbytes, but the capacity gets cut to 10 Mbytes when operated in start/stop mode. Also, there is a significant difference in speed between the two types of tape drives. Streaming tape runs at 90 inches per second (ips) while start/stop tape moves at a slower 30 ips. As a result, the 10 Mbytes stored away on streaming tape in 5 minutes takes around 20 minutes with a start/stop drive.

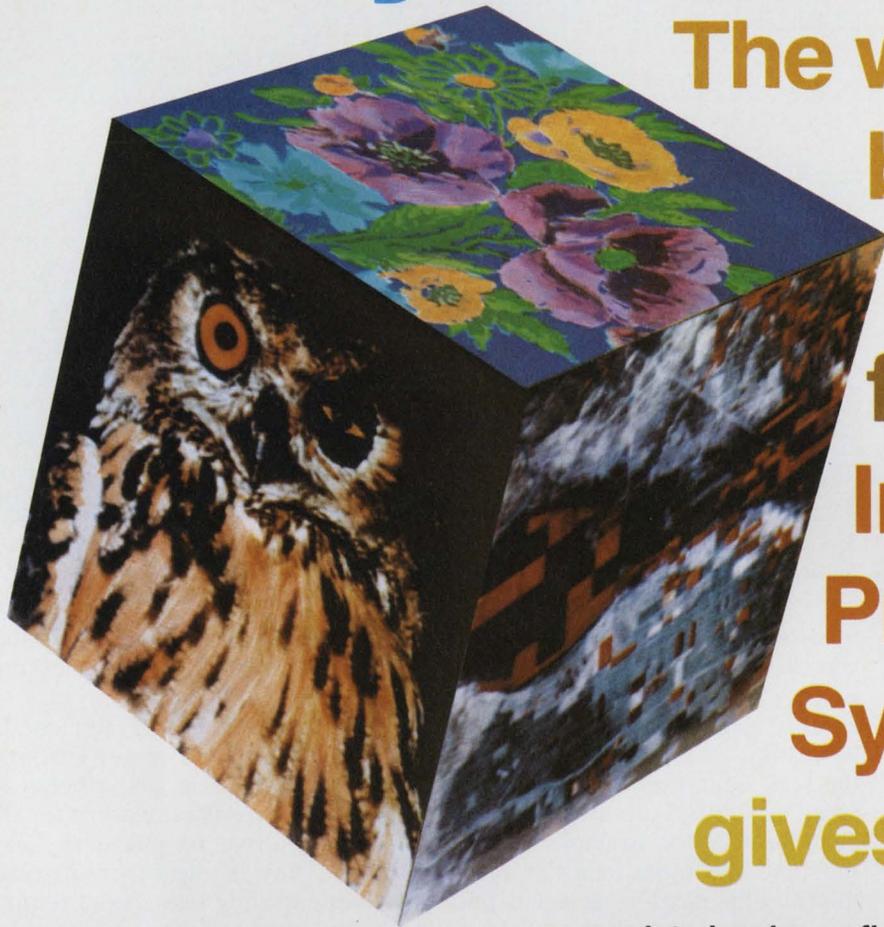
As with the floppy disc alternatives previously described, the back-up function for a tape drive can occur at the controller or in the operating system software. The task of incorporating a streamer or start/stop tape doing a dump from the disc, is simpler than that for a floppy or stop/stop tape drive doing selective back-up because there is no need to keep track of files that have been accessed since the previous back-up operation.

	FLOPPY	TAPE STOP/START	TAPE STREAMER	100mm CARTRIDGE	5.25" CARTRIDGE
DRIVE CONTROLLER	\$300	\$600	\$1200	\$400	\$995
CABLES	\$425*	\$925*	\$100*	\$300**	\$300**
POWER SUPPLY	\$40	\$40	\$40	\$40	\$40
SUBTOTAL	\$70	\$125	\$125	\$70	\$100
PRIMARY 5-1/4" HD MEDIA COSTS (5MB)	\$835	\$1690	\$2065	\$810	\$1345
	\$800	\$800	\$800	\$800	\$800
	\$2/ea \$10=5MB	\$26	\$26	\$30	\$60

* shared cost in dual function controller
** cost of single function controller with both drives daisy-chained

Table 1: Price comparison of floppy, stop/start tape, streaming tape, 100mm cartridge and 5.25" cartridge back-up alternatives.

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Low Cost Drive

Table 1 shows the relative cost of SyQuest's new drive when compared with tape and floppy discs. This savings comes from the low cost of the drive itself, as well as the media. Low drive cost results from a small parts count. Also, having a smaller diameter disc means a smaller, less expensive spindle drive motor and lower power consumption—thus less expensive power supplies. A general purpose μ C eliminates a great deal of electronic circuitry while at the same time adding functionality. It implements such features as high-speed buffered seek, a very inexpensive but very accurate servo scheme that easily accommodates track spacing of 435 tracks per inch (tpi).

Media cost is kept low by using a very simple but accurate servo mechanism in the removable cartridge. Larger disc cartridges use more expensive servo schemes in which servo information is stored between sectors of each track. This requires a more expensive servo writing process when manufacturing the disc cartridge, resulting in higher media cost. A typical 8" removable disc cartridge uses a scheme that requires 24 bytes of servo information and overhead between each sector in a track. In a track with 32 sectors, that is nearly 800 bytes of servo data on top of the general data format information for each sector. Not only is this added cost in manufacturing the disc cartridge, but there must be additional control electronics in the disc drive to process this servo information as well, adding to the drive's cost.

By contrast, for the 100mm cartridge, servo information is stored in a 64 byte wedge at index mark on each track of the drive. Not only is the servo information recorded in only one spot on a track, but it is recorded in an area already being used; the address mark, however, still functions to indicate the start of a track. This allows greater user flexibility as to different sector sizes.

The servo mechanism works as

dr fl f2 // f8 t1 t2 t3 ex s1 s2 rc d0 // dn cr r0 r1 r2	
00 01 02... 08 09 10 11 12 13 14 15 16... 31 32 33 34 35	
where	
dr	drive code (0-16) 0 = use default drive for file 1 = auto disc select drive A, 2 = auto disc select drive B, ... 16 = auto disc select drive P.
sl	reserved for internal system use, set to zero on call to OPEN, MAKE, SEARCH
rc	record count for extent "ex," takes on values from 0-128
fl ... f8	contain the file name in ASCII upper case, with high bit = 0
d0 ... dn	filled-in by CP/M, reserved for system use
t1, t2, t3	contain the file type in ASCII upper case, with high bit = 0 t1' = 1 = Read/Only file, t2' = 1 = SYS file, no DIR list
cr	current record to read or write in a sequential file operation, normally set to zero by user
ex	contains the current extent number, normally set to 00 by the user, but in range 0-31 during file I/O
r0, r1, r2	optional random record number in the range 0-65535, with overflow to r2, r0, r1, constitute a 16-bit value with low byte r0, and high byte r1
(All Information Contained Herein is Proprietary to Digital Research)	

Figure 3: In CP/M systems, a file control block byte can be configured to contain one bit that is set if the file has had activity since the last back-up operation.

follows: when the drive seeks to a track and its destination has been reached, it waits until the track's index mark is read before writing or reading in the track. If during the seek operation the drive heads come to rest 100 μ m off track from dead center, for example, during the time the index mark is read, this misalignment is detected and the corrected signal is generated. At the same time the index mark is read, the servo data in the wedge is simultaneously sampled by a sample and hold servo. The drive's on-board μ C determines the amount of misalignment, if any, and generates the appropriate correction signal to the drive's microstepping stepper motor, which moves the actuator one way or the other to correctly position the head over the track's center. The drive will not generate seek complete until it has correctly positioned the head. Once corrected, operation in the track occurs just as if the head had been positioned correctly all along.

Thin-Metal-Film Media

Another cost savings results from the use of thin-metal-film media, which provides much greater durability than that afforded by oxide media. As a result the user will

consume a great number of floppies before having to replace one cartridge.

The ruggedness of the media also gets rid of a minor inconvenience that users of other cartridges might suffer: waiting for the cartridge drive to purge the cartridge. Any of the other cartridge drives currently being used require the operator to insert the cartridge and wait for the drive to perform a purge cycle before heads are landed on the disc surface. Thereafter, the drive is brought up to speed and operation can begin. The purge cycle ensures that any particles that might have gotten into the cartridge are removed before loading the heads onto the media. The purge cycle means a wait of around 1½ to 2 minutes before the disc can be used from the time the drive is turned on.

With SyQuest's thin-metal-film media, there is no purge cycle required. The drive spins up to speed with heads on the disc surface as soon as the cartridge is inserted into the drive. The purge cycle occurs as the drive comes up to speed initially. Thus, the operator waits no more than he would for a fixed Winchester drive. Once up to speed, the drive is ready for operation. □

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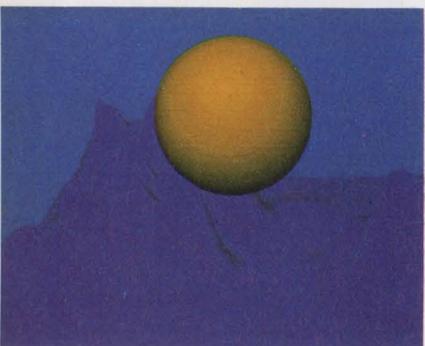
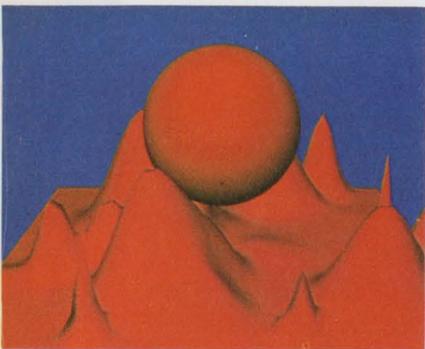
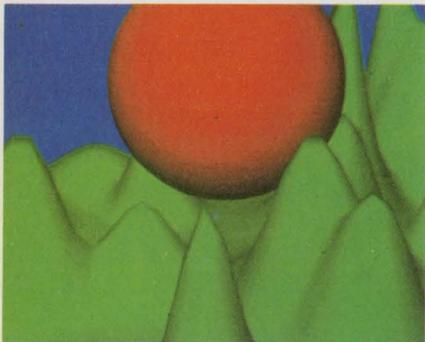
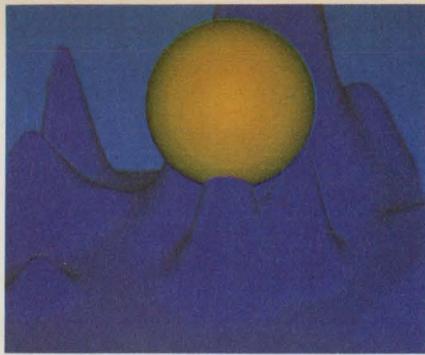


Figure 1: These mathematical functions were produced by the Nuclear Applications Group at Los Alamos National Laboratory using the CAMERA program (courtesy M. Preuitt, LANL).

SIGGRAPH '82

Highlights

This year's diverse program offers something for everyone, including designers of computer graphics systems, those involved in image synthesis, users of computer graphics, and even those who just like looking at them.

by Bob Hirshon

A variety of people attend SIGGRAPH for a variety of different reasons: engineers designing graphic systems attend the design seminars and technical sessions to keep abreast of the current technology; those involved in graphics generation home in on the sessions covering image synthesis techniques; users planning on purchasing a graphics system may find the vendor exhibition the most useful part of the show; and for the large non-technical contingent, the film, videotape and art shows are undoubtedly the highlights of SIGGRAPH.

New Intros

For those interested in keeping up with the latest graphics products developed by vendors, SIGGRAPH always has much to offer. Computer graphics companies, whose latest product might get lost in an NCC introduction, find SIGGRAPH an ideal forum to show their wares. In fact, some graphics companies have abandoned NCC altogether in favor of smaller shows, like SIGGRAPH and NCGA, that specialize in computer graphics.

"Now at the NCC a new company is lucky to be noticed at all," say Terry Hugley, chairman and

founder of Chromatics (Tucker, GA), a company manufacturing color graphics computers and displays. "We have been able to get much better results from smaller trade shows. Therefore, Chromatics will be concentrating this year on NCGA and SIGGRAPH and several regional shows which do a much better job in reaching the high-resolution color graphic customer." This trend lends more emphasis and importance to SIGGRAPH's vendor exhibition—and makes it far more interesting and exciting.

Drum Scanner/Recorder

Optronics International (Chelmsford, MA) will show their 40 × 40 large format drum system (**Figure 2**) which is a high resolution scanner/recorder with an intelligent microcontroller-processor. The system is designed for cartographic, LANDSTAT and aerial photography, computer graphics, and CAD/CAM applications. It operates at 1300 lines per minute (1pm) with a data rate of 960,000 pixels/second, and can do a full-frame 1:250,000 scale 30 × 30 satellite image in about two minutes.

The new unit performs as both an input scanner and an output plotter. As a scanner, it scans con-

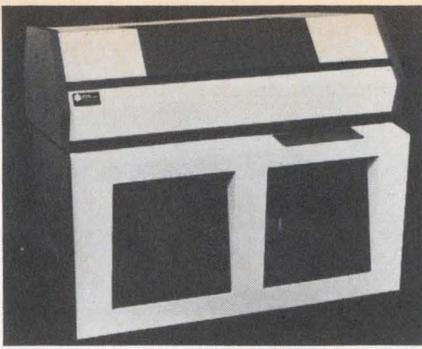


Figure 2: Optronics International's 40 x 40 large format drum system is a high resolution scanner/recorder with an intelligent microcontroller-processor.

tinuous tone and line art at resolutions up to 1000 lines per inch (1pi). In line art mode, the unit features automatic data compression, which allows easy insertion of large quantities of data associated with circuit art work, line art, engineering drawings and maps. The scanner also has color separation capability.

As a plotter, the drum system uses an argon laser to expose continuous tone, line and lithographic film. Line art can be plotted from compressed data or a bit stream.

Graphics Computers

The most noticeable trend regarding new product introductions is the sudden emergence of a variety of graphics computers and terminals offering greatly improved price/performance. The Beacon (Figure 3) from Florida Computer Graphics (Lake Mary, FL), uses a unique multi-processor architecture to create a color graphics system that is faster, brighter and more powerful than other systems in the under-\$20K price category. The Beacon uses an AMD 2901 16-bit bit-slice processor with 48-bit microcode and a 200 nsec cycle time to handle graphics generation and floating- and fixed-point arithmetic, and also incorporates three Z-80s: one which acts as the administrative processor and two others to manage commands from the keyboard and bezel keys. The multi-tasking these processors allow results in nearly instantaneous color graphics display generation.

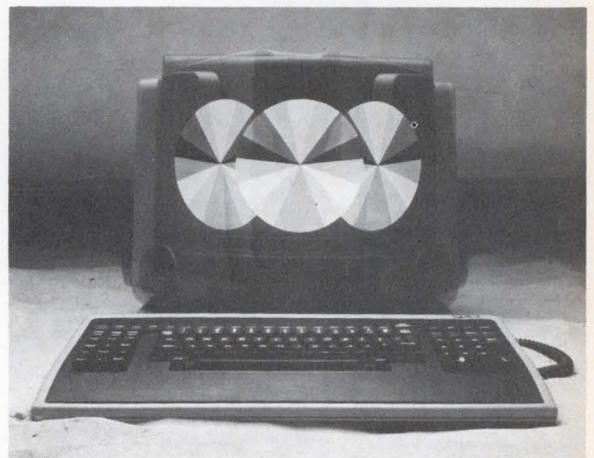
Florida Computer Graphics claims to have eliminated flicker and substantially increased brightness by means of a proprietary monitor they've developed and which they manufacture them-

selves. Although the total screen image is refreshed at 60 Hz, FCG claims that it is "augmented with advanced techniques that raise the apparent refresh rate far above the 80-85 Hz threshold at which flicker is noticeable." FCG claims that Beacon's bright image eliminates the need for hoods or dim room lighting.

Beacon features a graphics memory of 160 Kbytes (expandable to 640 Kbytes), shareable by the administrative processor, for a total of 890 Kbytes of main memory for large programs. It has hardware vector, arc, circle and rectangle generation, other graphics functions, floating point arithmetic and mathematics functions, programmable audio tones, resident self-diagnostics, anti-glare screen, full "zoom" and "roam" capabilities, and smooth vertical/horizontal scrolling and reverse-video callout for character graphics. Quantity prices for the Beacon start at \$12,950.

In this same price range, Cadline

Figure 3: This unretouched photo of the Beacon color graphics system demonstrates the display's brightness, made possible by a custom monitor and proprietary refresh technology.



(Chicago, IL) will be introducing a desk top graphic computer family of its own (Figure 4). The 68000-based system combines high-level performance with high-resolution bit-mapped graphics and features a building block system approach based on advanced industry standards. The system uses a UNIX operating system, C and Fortran software tools, the IEEE P-796 Multibus standard and Ethernet networking capability. As a result, Cadline claims to support both tra-

ditional stand-alone and host computer environments, as well as true distributed processing configurations.

Members of the new Cadline family feature a 1024 by 792 pixel landscape mode raster graphics display, an ASCII detachable VT-100-style keyboard, mouse pointing device and bit-mapped graphics controller.

The processor board features 250 Kbytes of zero wait state RAM with parity error checking, an 8 MHz 68000 processor, a two level segment page multiprocess memory management scheme that allows 16 concurrent processes, two serial I/O communications channels, a user programmable timer and an EPROM-based monitor.

One of the major reasons for computer graphics' tremendous growth recently is lower equipment prices. One price breakthrough evident at SIGGRAPH will be Colorgraphic Communications' MVI-100 color terminal (Figure 5), priced at about \$2000. The termi-

nal features 13" CRT, selectable page sizes of 80 x 192 or 160 x 96, vertical and horizontal scroll, baud rate range of 110 to 19,200, 87-key detached keyboard, double-high/double-wide characters, line and bar drawing character set, 4 independent screens, 6 menu selectable non-volatile monochrome emulations, insert and delete character and line, RS 232C plus auxiliary printer port, serial printer driver, and lower case characters with descenders.

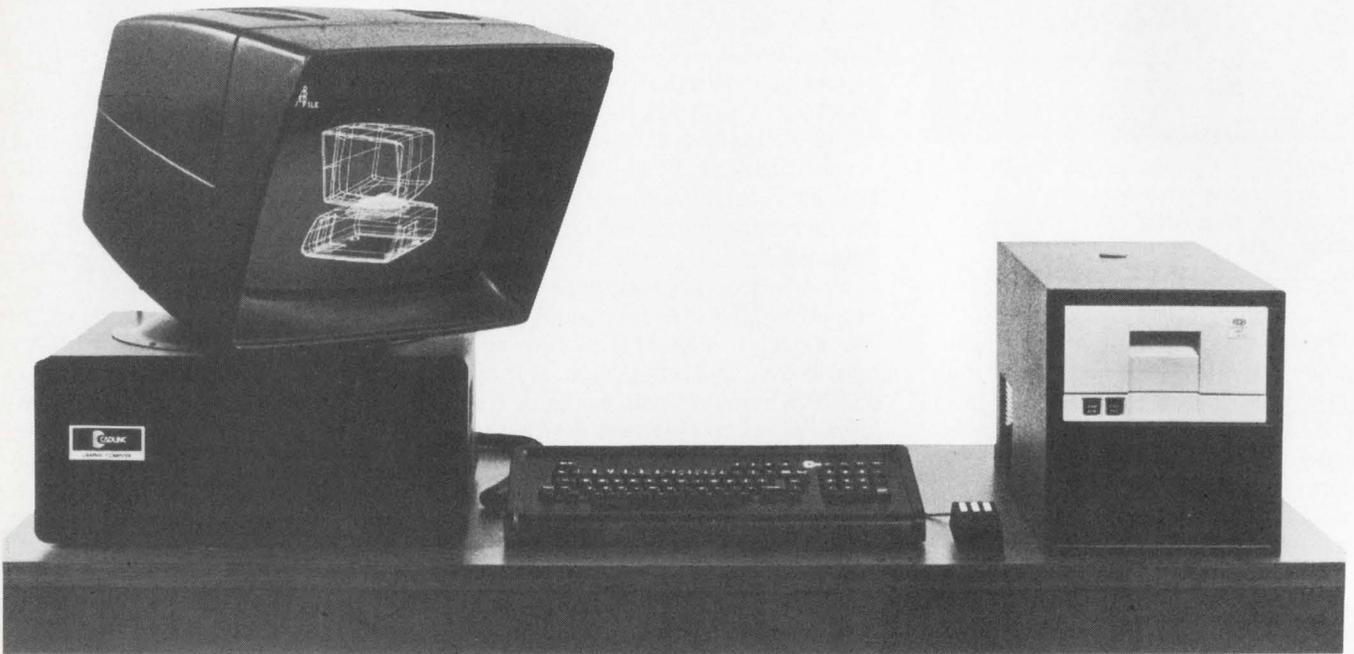


Figure 4: This 68000-based graphic computer system from Cadline offers a building-block approach based on industry standards.

Technical Sessions

For engineers involved in computer graphics research and development, SIGGRAPH's technical sessions are its main attraction. These sessions include panel discussions, as well as presentations of technical papers. Discussions will cover graphics standards, solid modeling, CAD/CAM, Videotex, business graphics, and other general topics upon which panelists from industry and academia will expound.

While the 37 technical papers being presented represent, in toto, a wide range of computer graphics applications, each is highly specialized, discussing whatever the author/authors have been working on for the past year or so. The sessions are designed primarily to help engineers specializing in graphics to catch up on their colleagues' work. Papers will include "Color Image Quantization for Frame Buffer Display," by Paul S. Hechbert of the New York Institute of Technology, "A Generalization of Algebraic Surface Drawing," by James F. Blinn, of the Jet Propulsion Lab, "A Contour Display Generation Algorithm for VLSI Implementation," by Michael Zyda of

Washington University, and "A Morphological Study of Nature's Form," by Yoichiro Kawaguchi of Nippon Electronics College.

Frame Buffer

Because of computer graphics' wide appeal outside the technical arena, and because even the most earnest engineers do not live on breadboards alone, SIGGRAPH also features events largely of artis-

tic interest. An art show of computer-generated works will be on display the entire week of the conference. The show will include a room of hard copy works, and another for film and video. A third room will be dedicated to a "frame buffer" show, which can best be explained by James Blinn, who started the idea last year:

"All of these pictures get made on computer displays: the people

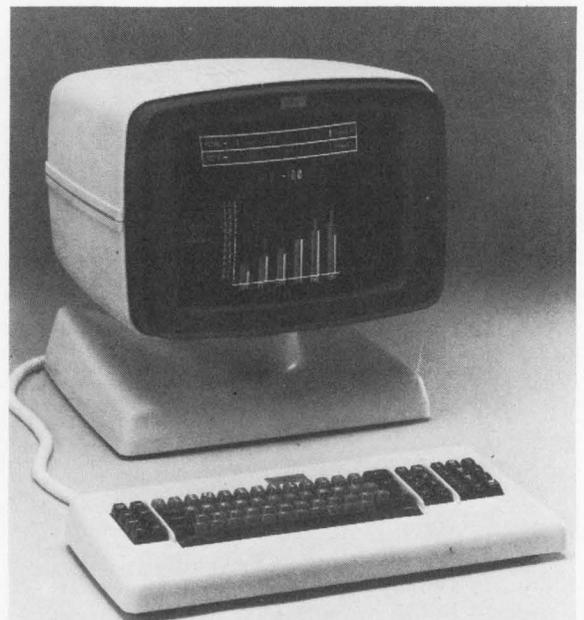


Figure 5: This \$2K color CRT terminal from Colographic Communications Corp. exemplifies the current trend toward low-cost color data terminals.

who make them tune the numbers, and the pictures look really nice on the tube. But when you show them to someone else, you have to take a photograph of them, or record them on videotape, which goes through NTSC, and the quality of the image always looks terrible compared to what you know it looks like for real. And so what I did last year, and what we're doing in a little bit more official-fashion this year, is to have a picture show on frame buffers.

We got some manufacturers to donate a frame buffer and some computer equipment, and I'm going to go around and scrounge up the actual digital data from various people who are making images of this sort. They'll be in a nice, pleasant room where you go in and sit down, and they'll be played back on a T.V. monitor, and you'll see (each image) in the same context in which it was made—it looks a lot better than photographs . . .”

Film And Video Shows

The film and video shows are where technical and non-technical attendees get together to “ooh” and “ahh.” Lou Katz, from the University of California at Berkeley, is running the shows. He says the films and videotapes will be arranged and presented for maximum entertainment value, rather than being grouped into technical or chronological categories.

There will be two shows: an “oldies-but-goodies” show featuring the best of computer graphics from throughout the history of the technology, including some works that have been seen at previous SIGGRAPH conferences; and a “latest-and-greatest” show focusing exclusively on works generated within the last year. In addition to the works produced by independent artists, the latter show will also feature excerpts from the major film studio's latest computer-assisted extravaganzas, including, in

all probability, “Tron” (Disney Studio's computer fantasy) and “Star Trek II.”

In all, SIGGRAPH is a highly technical, specialized conference that attracts a highly diverse, not-necessarily-technical computer graphics audience, by virtue of computer graphics' enormous popular appeal. SIGGRAPH combines the best and worst of scientific conferences—the open, exciting dissemination of ideas with the guarded suppression of propriety information—with the best and worst of artistic exhibits—the appreciation of artistic achievement with the high-brow criticism of anything new and different—to create a conference about which every attendee has a strong opinion. But while SIGGRAPH can no longer be everything to all of its attendees, it does offer something for everyone—and with the diversity of today's computer graphics audience, that's no small achievement.

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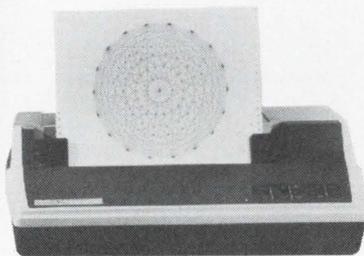
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Graphic Based Applications— Tools To Fill The Software Gap

by A. Rubel

Senior engineers may only be interested in using the computer as a tool. In graphics applications, they may realize their needs in engineering terms, but be unsure of how these relate to computer software terms.

A typical problem is one where the engineer may need to select and position symbols on a screen to represent a design, using a data tablet and pen as an input device to define connections and supply input signals.

It may be necessary to change the scale of the drawing and to execute some time and frequency domain analyses on it. On-line help also may be needed for training of new personnel.

The software engineer's solution comes in the form of two diagrams, the screen diagram and the menu diagram.

The screen diagram (Figure 1a) has a sketch of a display screen divided up into a working diagram area, menus of engineering symbols and program options, and a message area. The data tablet pen can be used to create and edit diagrams by selecting symbols and placing and connecting them in the working area. The "menu diagram" (Figure 1b) has several lists, each one a menu of program options. Various options are available at different times while using the program.

The software engineer will have gathered the necessary engineering analysis programs and created the graphics front end, as well as writ-

With new software tools, graphics applications programs will become easier to create.

ten the on-line help files and printed documentation.

Software Gap

One might expect applications like this to be in common use. Certain-

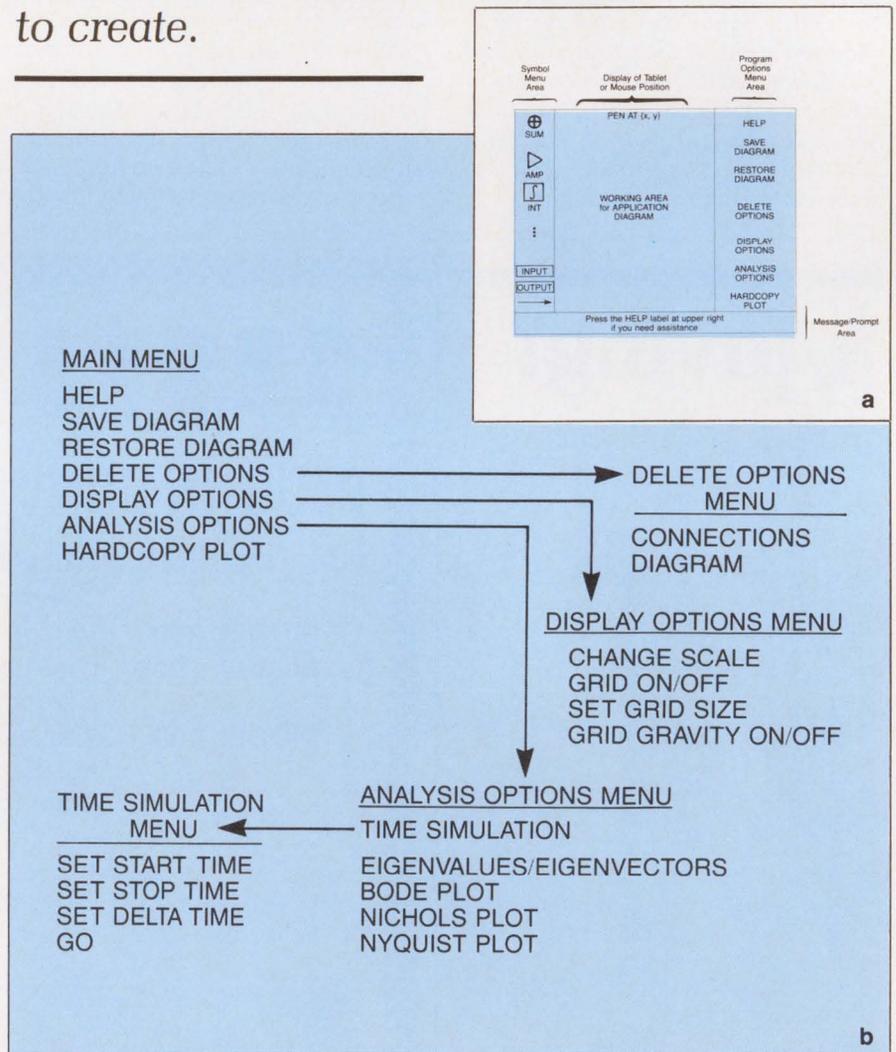


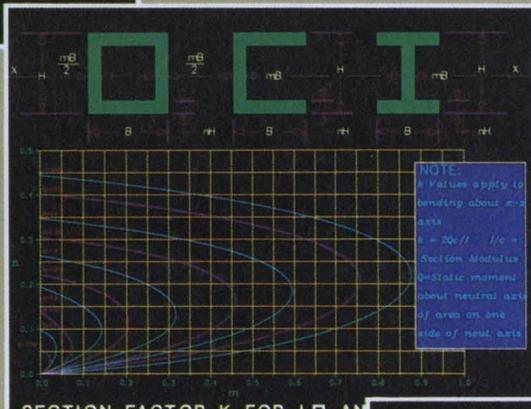
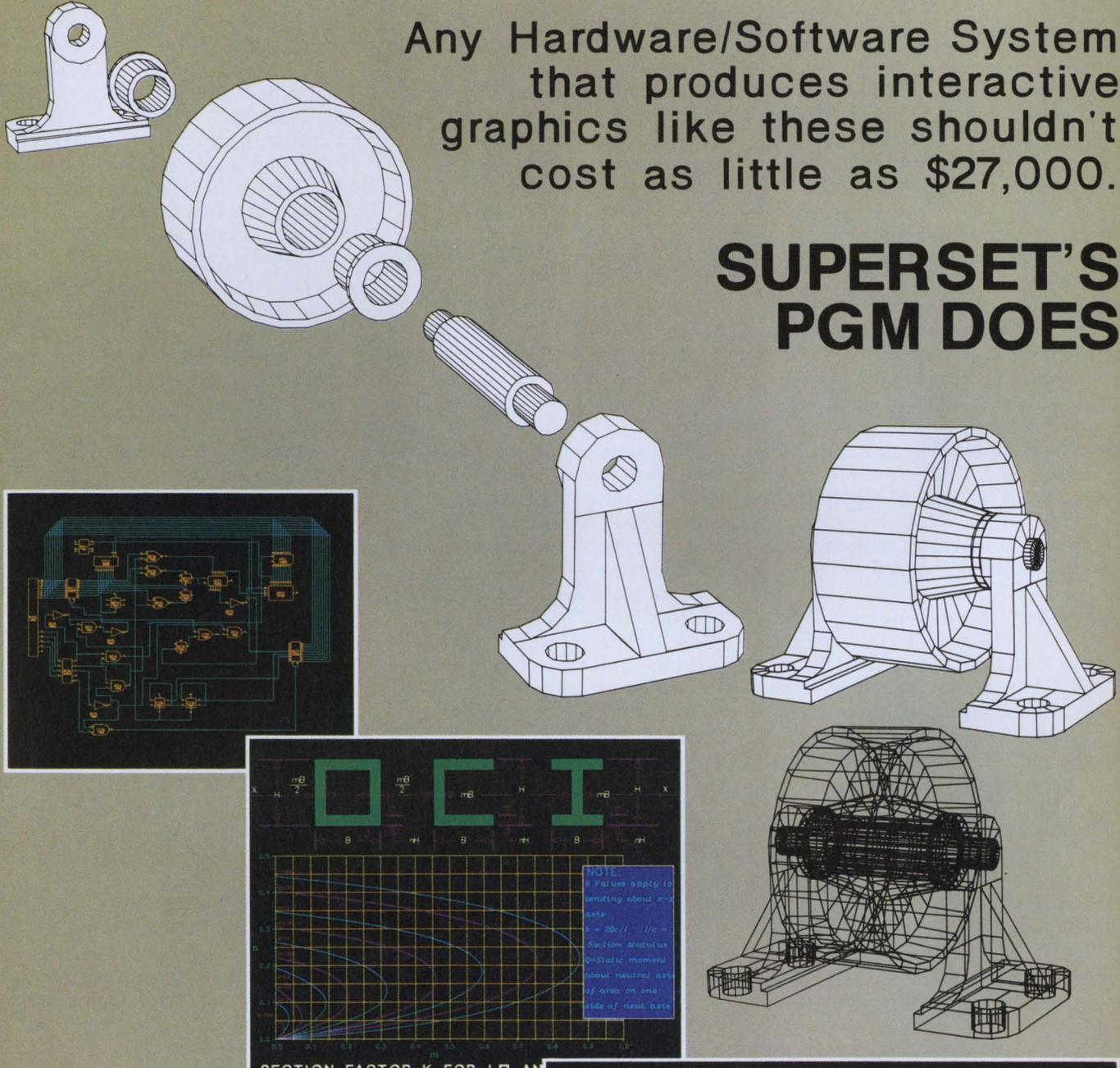
Figure 1: (a) Screen diagram. (b) The menu diagram is several lists of the program options. These are displayed along the right of the screen. A separate diagram specifies the symbol menu at the left. The lists are tree structured. When the label DELETE OPTIONS(*) is interactively selected, then the "Delete options" menu is displayed.

Andrew Rubel is with Rubel Software, 1 Soldiers Field Park 605, Boston, MA 02163.

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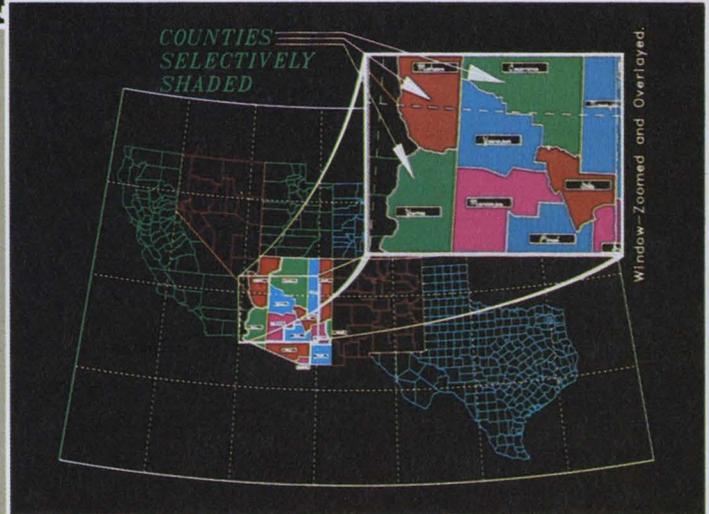


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ly the required hardware is available off the shelf as advertisements in this magazine will attest to. But the software to support this kind of application is another story. A number of software components are required, some of which are:

- menu display and control;
- retrieval and display of help text;
- common graphics and data base functions, such as display grids, scaling, saving/retrieving diagrams;
- graphics support library;
- input and editing of application data display;
- maintenance of application data base;
- hardcopy output of application data;
- application analysis computation;
- analysis output display.

The time needed to develop these software components and integrate them into an application is usually expressed in years rather than weeks or months. Such large costs preclude development unless the projected savings are even greater.

There are two major options for acquiring a graphics application: program it in-house or buy it. The "program-it-yourselfers" start with either bare hardware or a "graphics package," and create what is usually many thousands of lines of code for their custom application. The "buy-it-allers" pay a large sum of money for a packaged software application (and perhaps bundled hardware as well) which may not do exactly what is required or in the desired manner, but at least works and is available. Other "buy-it-allers" hire someone else to do the job, resulting in a more tailored, but expensive application.

Here lies the gap (Figure 2). On one side is the major custom effort of the "program-it-yourselfers" or custom contracts. On the other side is the expensive and not so custom job of the prepackaged software or bundled software/hardware. Packaged software is certainly an important commodity today, but only if a package approaching your needs is available and you can afford the price.

This gap points out the need for better ways to develop graphics applications. We can't close the gap completely yet, but we can make custom applications radically easier to produce, as in the earlier example.

Filling The Gap—BLOX Graphics Builder

What kind of software comes in between the graphics package and the full blown graphics application program? One approach is to try to make a subroutine library that is higher level or an application that is more general purpose. However, using that library will still require writing a lot of code and it is hard to imagine prepackaged applications so general that no more need be written.

Some possibilities for other kinds of tools are: (1) graphics programming languages; (2) incorporating graphics instructions into existing languages; or (3) graphics development tools separate from the programming language. With the idea that we have too many dialects of too many programming languages already, 1 and 2 are ignored here. *BLOX Graphics Builder* uses software tools to narrow the gap from both sides, but remains separate from any programming language. Software tools are gaining rapid acceptance today, typified by text oriented tools associated with UNIX or graphics tools inherent in the Xerox Star.

Basis Of The Tools

Many of the functions of the applications program example at the start of the article are completely

independent of the application itself. These can be specified and implemented independently of the application:

Function List:

- (1) different areas of the display for working, menus, and messages;
- (2) interactive menus to select symbols or options;
- (3) on-line help;
- (4) common graphics and data base functions like grid, scale change, save/retrieve, etc.;
- (5) low level graphics input and display (as a "graphics package"). Other features are more dependent on the application:
- (6) input and editing of applications data display;
- (7) maintaining application data base;
- (8) hardcopy output of applications data.

It is possible for functions 1-5 to be provided in advance of the applications development. A standardized data base representation of a line drawing, graphing, imaging, or network application, or a full DBMS will often provide the needed function for 6-8.

Other features of an application are completely dependent on the application itself and can't be done in advance:

- (9) analysis programs,
 - (10) display of analysis output.
- Fortunately, the application analysis programs (9 above) can be devoid of any graphics input/output as this is covered in the other categories. This makes them clearer and considerably easier to write. Display of analysis output (10 above) is aided by the availability of a good graphics package, but generally these must still be coded

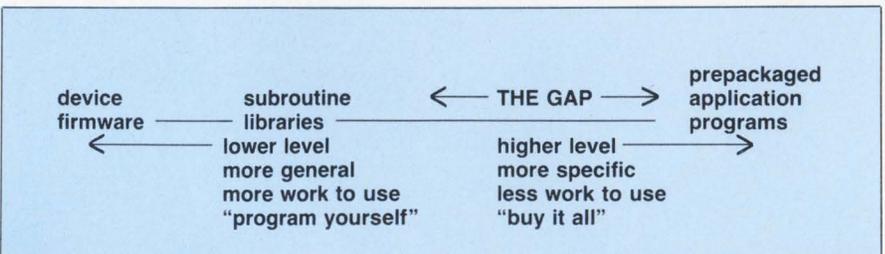


Figure 2: The gap. A spectrum of graphics software. Device firmware and subroutine libraries are low level development tools. Packaged applications are ready to run. In between is a gap, indicating the need for additional software development tools.

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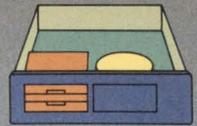
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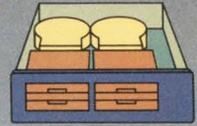
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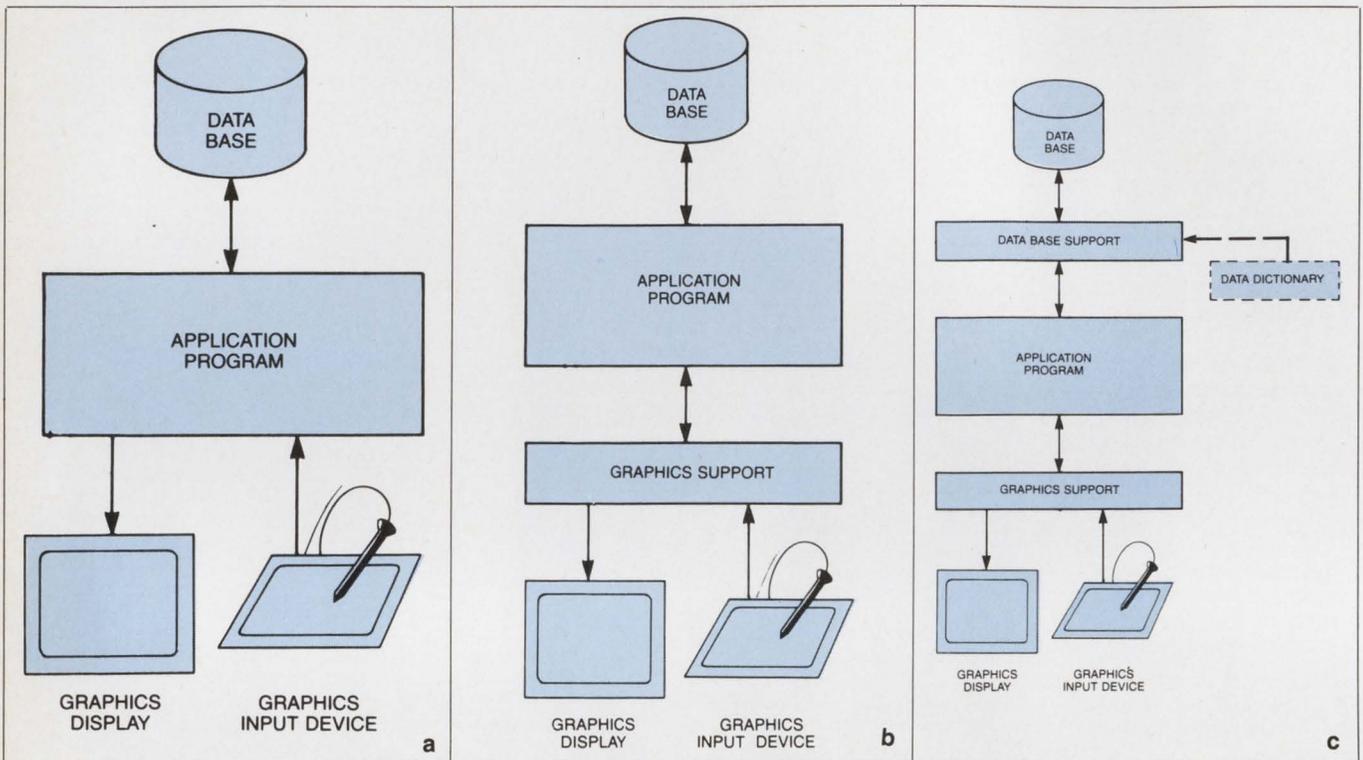


Figure 3: Progressive segregation of application from its application independent portions.

(a) Simplest model of a graphics based application. The developer is completely responsible for organizing and creating all aspects of the application, functions 1-10 in the above function list. Often because of time or other constraints, these portions are heavily intertwined. The dangers of this approach are costly development and large complex codes which are difficult to document, maintain and enhance.

(b) Separate graphics package supplies function 5 from function list independently of application code. This approach is widely used today. The graphics package may be supplied by the hardware vendor, a software vendor, or developed in house. The ACM Siggraph GSPC "Core Graphics" proposal now being considered by ANSI is already providing some standards for these packages. Even with a sophisticated graphics package, however, the developer is faced with a large amount of function to organize and code, as listed in function list 1-10 (excluding 5).

(c) Data base support also separated from application code, supplying #7 in function list. The data base may be written specifically for the application or may be more general and driven by a data dictionary.

(d) BLOX Graphics Builder separates interaction control and support from application dependent code (1-8 in func-

tion list). Control programs are driven by developer supplied "interaction tables", consisting of screen, menu, and finite state tables. This segregates almost all graphics programming from the application dependent "action routines." Interaction tables may be created with any text editor or with another tool, the BLOX table generator. The tables also

specify the modularity of the application routines, simplifying the creation of those routines which still must be coded. Although the developer no longer writes the highest level "calling program," he or she does specify the interaction tables which drive this program. These tables are easy to modify, hence so is the application interaction.

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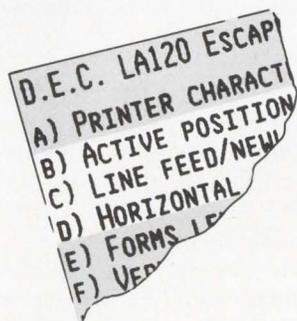


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SCREEN 1: WORLD.BOUNDS = 0,100,0,100						
Area #	Area Type	Area Bounds xmin, xmax, ymin, ymax	Grid On/Off	Grid Gravity	Grid Size	
1	WORK	10,85,10,100	ON	OFF	0.5	
2	MESSAGE	0,100,0,10				
3	MENU	0,10,10,100				
4	MENU	85,100,10,100				
5	PEN.AT	40,80,90,100				

Figure 4: Example screen table used for the application. The software engineer used the BLOX table generator with his sketch (Figure 1a) to create this table. World bounds describes the application coordinates of the boundaries of the screen. Lines starting with an exclamation mark (!) are comments. Area types in this example are work, message, menu, and pen.at (for pen location odometer display). Grid on/off, gravity, and size are meaningful only for work areas, and can be modified by the operator at run time.

MENU AREA 4:						
Level	Item Label	Item Type	Action Routine	Prompt/Other Params		
1	"HELP"	TEXT	HELP			
1	"SAVE DIAGRAM"	TEXT	SAVE			
1	"RESTORE DIAGRAM"	TEXT	RESTORE			
1	"DELETE OPTIONS"	TEXT	—	"Delete options:"		
2	"CONNECTIONS"	TEXT	DELETE.CONNECT			
2	"DIAGRAM"	TEXT	—	"Please confirm"		
3	"ABORT"	TEXT	—			
3	"CONFIRM"	TEXT	DELETE.DIAGRAM			
*1	"DISPLAY OPTIONS"	TEXT	—	"Display options:"		
2	"CHANGE SCALE"	TEXT	—	"Choose scale"		
3	"	1D.POT	SCALE	MIN = 0.1, MAX = 10, INIT = 1		
3	"DONE"	TEXT	—			
2	"GRID ON/OFF"	TOGGLE	GRID			
2	"GRID GRAVITY"	TOGGLE	GRID.GRAV			
2	"SET GRID SIZE"	TEXT	GRID.SET			
1	"HARDCOPY PLOT"	TEXT	HARDCOPY			
1	"ANALYSIS OPTIONS"	TEXT	—	"Analysis options:"		
2	"TIME SIMULATION"	TEXT	—	"Press GO to start"		
3	"SET START TIME"	TEXT	SET.START			
3	"SET STOP TIME"	TEXT	SET.STOP			
3	"SET DELTA TIME"	TEXT	SET.DELTA.T			
3	"GO"	TEXT	STARTSIM			
2	"EIGENVALS/VECTS"	TEXT	EIGEN			
2	"BODE PLOT"	TEXT	BODE			
2	"NICHOLS PLOT"	TEXT	NICHOLS			
2	"NYQUIST PLOT"	TEXT	NYQUIST			

Figure 5: Example tree structured menu table. Each line represents one menu "item" in a list. The column marked "level" specifies which list the item belongs to. All items at level 1 are on the main menu. The label appears on the display screen for each item. The action routine is the code to be invoked when that menu item is selected. Action routines may be BLOX or developer supplied. Parameters specify other features of each menu item.

for each application.

The key to BLOX Graphics Builder tools is segregation of application functions (9–10) from the graphics interaction and control (1–8). Just as a data dictionary is used in a DBMS to segregate an applica-

tion from its data base, interaction tables may be used to segregate the application from its interactive dialog. The progression of this segregation is shown in Figure 3a through Figure 3d. In Figure 3d, interaction tables are used to segre-

gate the application from its graphic interaction.

The Tools Themselves

The following are BLOX Graphics Builder tools: screen generator; menu generator; finite state interaction handler; table generator for creating needed tables; help and documentation generators; and commonly needed graphics and data base functions.

Because BLOX tools make a number of assumptions, they are limited to a specific conceptual world. This world contains a dynamic display, graphics input device, one or more push buttons (often tip of data tablet pen), a graphic cursor, and display areas for working, menu, and message purposes.

Screen Generator

The BLOX screen generator was the tool the software engineer had in mind in our example when he drew a sketch of the display screen divided up into different interactive areas for working, menus, and messages. That sketch was his concept of input to the screen generator for the engineer's application. The screen generator creates any layout or combination of: message areas for graphics/text output; menu areas for menu input; and working areas for display and editing of application data. The actual input the software engineer used for the screen generator appears in Figure 4. It consists of a tabular list of each area needed to be defined.

Menu Generator

The software engineer was thinking of the menu generator when he drew his menu diagram (Figure 1b). He used that diagram with the BLOX table generator to create the menu table of Figure 5.

When the user starts his application, the menu which he will see is the "main menu," consisting of all items at level 1. Should he select a menu option such as DISPLAY OPTIONS (marked with an asterisk), another menu will appear consisting of the level 2 items which appear under the DISPLAY

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At GE, we've developed a very basic philosophy . . . when an OEM speaks, we listen. It sounds simple, but just try talking to other suppliers.

The new GE 3000 family of serial printers is the perfect example. Compact, lightweight, and functionally styled, these tabletop matrix printers are specifically engineered for the OEM supplier.

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NOW YOU CAN SOLVE YOUR CUSTOMER'S NEEDS EFFICIENTLY AND EFFECTIVELY.

The GE 3000 family is designed to offer OEM's the advantage of single-design simplicity . . . without the application limitations of a single model product line.

The GE 3000 gives you configuration flexibility. Application flexibility. Design commonality and price/performance leadership.

OF COURSE, INNOVATIVE IDEAS ARE NOTHING NEW TO GE.

Our roots go back to Thomas Edison. It was in his tradition that in 1969 we introduced the first electronic data printer with modern LSI circuitry. Since then, we've continued in that inventive spirit, supplying OEM's with the finest in advanced printer solutions . . . longer than any other printer supplier.

General Electric. We're the industry leader in electronic printing. After all, we pioneered the industry in the first place.

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GENERAL  ELECTRIC

OPTIONS item. A number of menu item types may be used. Illustrated here are TEXT, 1D_POT

and TOGGLE. A TEXT item is simply a text string which may be selected by the operator. The 1D

_POT is a slide potentiometer used to change the scale of the diagram. A TOGGLE menu item is a simple toggle, or on/off switch.

The menu generator takes care of display and input using the specified menus. To create his application, the software engineer had to supply all the action routines specified in the menu table. Some of these, like HELP, SAVE, RESTORE, and the DISPLAY OPTIONS are provided in advance with a standard library. He had to code the application-specific routines (or find someone else's code) such as STARTSIM for start simulation. Of course he is free to re-code the library action routines as well if he wants them to function differently.

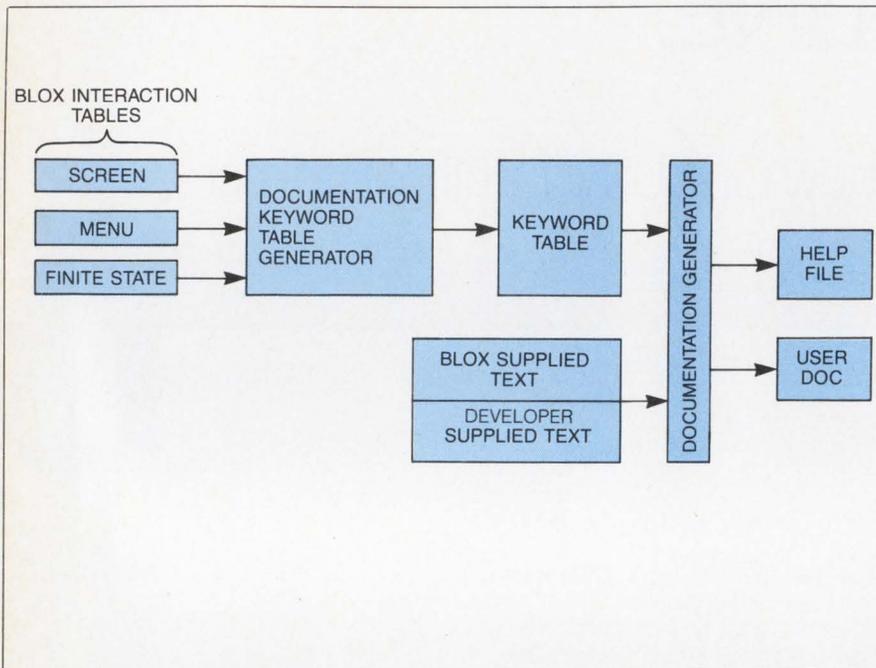
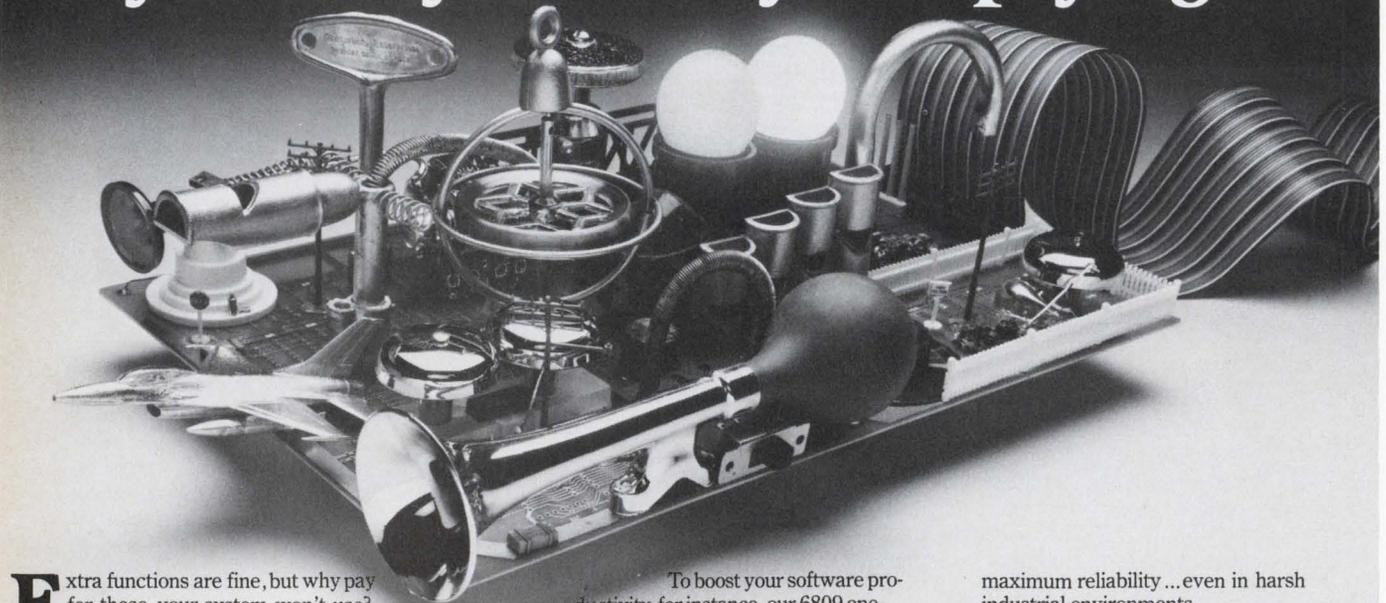


Figure 6: Documentation tools.

Finite State Interaction Handler

This tool controls the graphics interaction and action routines in the working area, used to input or edit

Do you really need all you're paying for?



Extra functions are fine, but why pay for those your system won't use? With our ModulasOne® micro-module family, you can specify only what you need — and skip the costly frills. That's because ModulasOne gives you a choice of twenty-eight 4½" x 6½" cards—all One-Bus compatible, all off-the-shelf. So you can simplify your system design, cut hardware costs, and get on-line much sooner.

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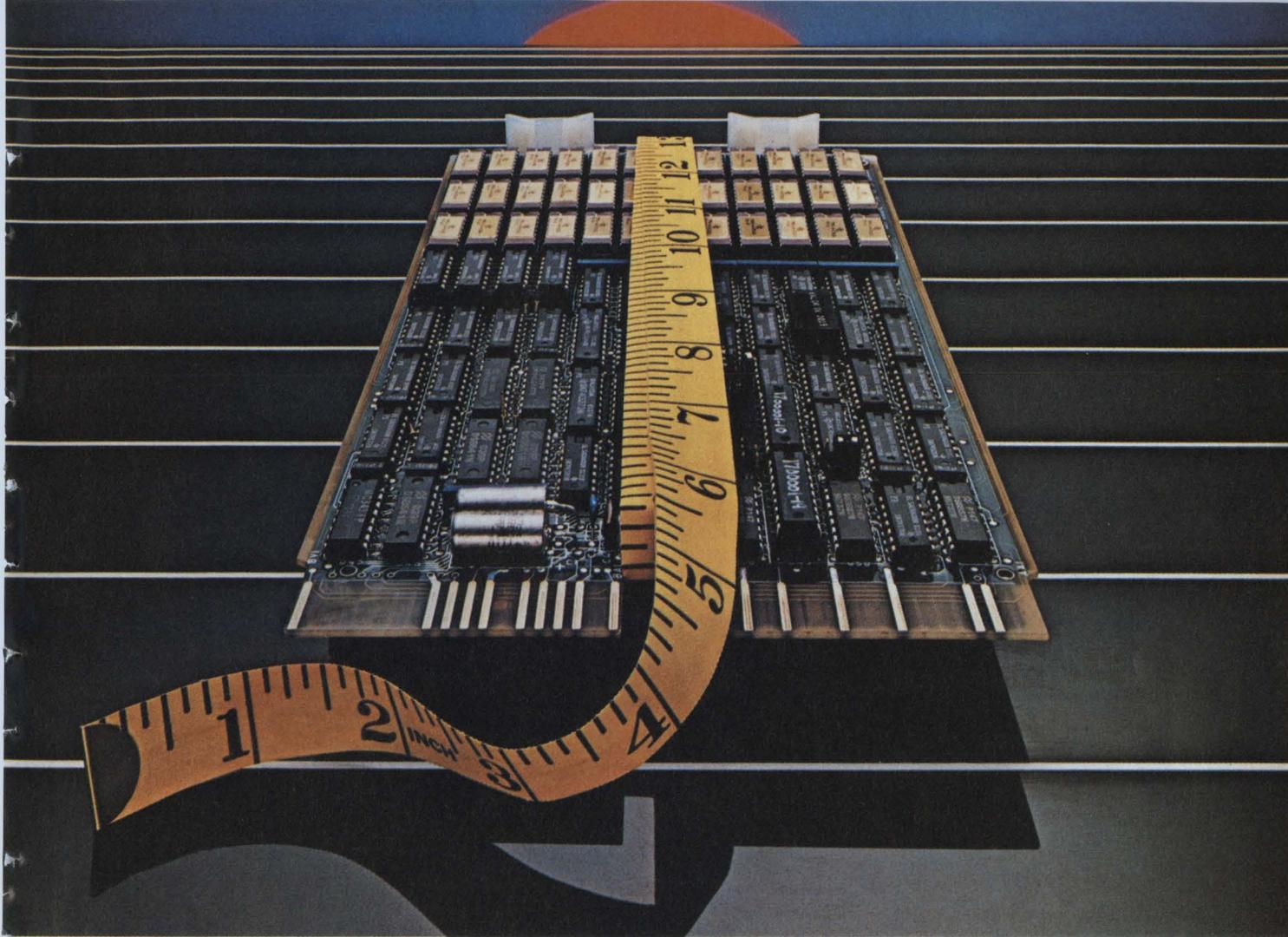
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System Shrinker.

Unique on-board controller makes parity controller boards obsolete.

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Protects and saves

The new TMM10010 memory board performs all parity functions. Its unique on-board parity controller signals when a parity error occurs, enabling the CPU interrupt to prevent operation with incorrect data.

Besides protecting the system, the TMM10010 eliminates the need for a separate parity controller board, which frees a slot for increased memory or extra I/O.

The TMM10010 can save you even

more money. It lets you add the parity feature to a backplane that's already full.

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It also provides 22-bit addressing

capability. High-density 128 KB and 256 KB capacity on a single "dual" board. And address space DIP selectable from 256 KB to 4 MB.

Custom boards, too

You can select from TI's standard boards. Or, we'll custom design boards for your specific applications.

TI boards offer you the latest in 64K DRAM technology. Highest packing densities. And lowest power consumptions.

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TI MEMORY BOARDS		BYTES/BOARD				
System	TI Series	64K	128K	256K	512K	1M
LSI-11*	TMM10010 ¹		X	X		
PDP-11*	TMM20000 ²			X	X	X
VAX*	TMM30000				X	X
Multibus†	TMM40010A ²	X	X	X	X	

¹Parity optional

²EDAC standard

Texas Instruments invented the integrated circuit, microprocessor and microcomputer. Being first is our tradition.

TEXAS INSTRUMENTS

INCORPORATED

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*Trademark Digital Equipment Corp.

†Trademark Intel Corp.

the application data. The finite state concept for describing interactive graphics has been with us for quite a while, but has not been used very extensively. The idea is that the application is always in some state. When an operator action is taken, such as pressing the pen down or moving it to a new area, then a specified action is taken and a new state entered. A state table consists simply of a list of states and state transitions, with an action routine and new state for each transition. Separate state tables for input and editing of specific applications data bases such as network, line drawing, graphing, and imaging, can be written in advance. Sophisticated application developers can modify these state tables or write their own.

Creating Tables

The three "interaction tables" that describe the graphics human interface are the screen, menu, and finite state tables, as described in the

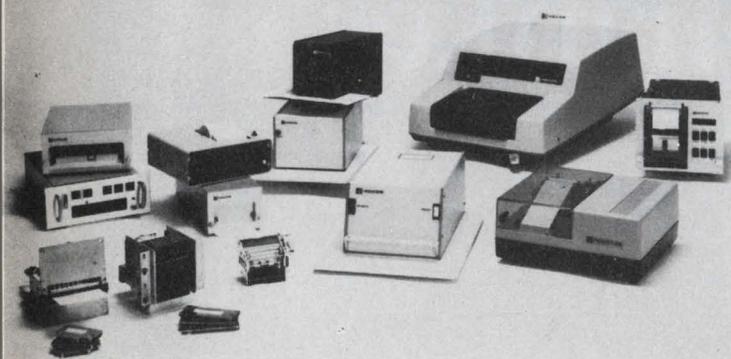
previous three sections. Each of these tables has a simple format and can be created with any text editor. But the application developer need not know so much about the screen, menu, and finite state tables. A separate design tool, the *BLOX* table generator, can be used to interactively create the required tables. All that is needed in advance is a sketch of the application screen and menus, as was created with the two design sheets. The software engineer referred to these sheets when using the table generator, which created the three tables for him. He asked the table generator to use a *BLOX* supplied finite state table for his network oriented application, rather than supply his own.

Documentation And Help

Quality documentation and on-line help are essential for complex application programs. Creating these is a big job. Tools for documentation provide a framework as well as

ready documentation for standard portions. To create his documentation, the software engineer used completed screen, menu, and finite state tables as input to a documentation generator. This tool created a keyword list from these tables. He still had the job of writing descriptive text for each keyword, but the *BLOX* supplied keywords had text already supplied. The help generator and manual generator were then used to create an on-line help file and formatted document pages. When the application is modified, he can generate a new keyword list (if necessary), edit his text, and generate a new help file and formatted documentation. This way he is saved the trouble of parallel development of text in help files and printed documentation. Since documentation is created from the same tables that drive the application, the correspondence between program and user documentation is also easy to maintain. This process is outlined in **Figure 6**.

The Little Printer That Didn't.



A technician anxiously approaches the test rack early on a Monday morning. Sipping his first cup of coffee, he looks expectantly at the tape for the results of the test run over the weekend. Blank. Eyes widening, he presses the "print" button. Silence. Frantically, he searches for a reason. Then he spots it. The printer... is not a Hecon.

Hecon has built quality printers that you can depend on for over a decade. We can supply Impact Dot Matrix, Thermal, Electrosensitive, and Modular Impact units. From one column to eighty columns. You can specify complete printers or OEM mechanisms. We also design and build custom units.

So the choice is yours—a printer that won't or a Hecon that will.

It's got to be good. It's a Hecon.



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• (201) 542-9200

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Moving?

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If mailing label is not available print your old Company name and address in this box

Please allow
6 weeks for
change to
take effect

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TITLE _____

COMPANY _____

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CITY _____ STATE _____ ZIP _____

3. Mail to: Circulation Manager
Digital Design
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Boston, MA 02215

BLOX Supplied Graphic And Data Base Functions

The support routines for all these tools consist not only of the usual "graphics package" for performing graphics input and display, but also of many high level action routines. These action routines provide on-line help, commonly needed display options like grids, and editing of display and data, using specific application data structures such as networks, line drawings, graphs, and raster images. *BLOX* supplied action routines are specified as an entry in a menu or finite state table, the same way that developer supplied action routines are specified.

Implementation

Most of the *BLOX Graphics Builder* tools described here have been implemented on a DEC VAX/VMS computer system, and are also being moved to a DEC PDP-11 computer using the RSX-11M

operating system. They currently use a refresh vector display; a raster version is being developed. The tables have the simple format indicated here and can be created with any text editor. A prototype table generator means that even learning their simple format is unnecessary.

Most of the graphics programming is done in advance.

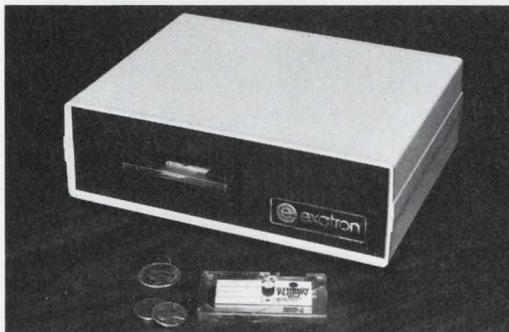
Summary

The development tools described here provide for screen areas, menu control, graphic input/editing, on-line help, and printed documentation. Many standard functions are provided by the tools. A simple method of specification allows the developer to combine custom coded application routines with presupplied functions. The

tabular specification of graphics interaction and action routines also makes the resulting application easy to modify. Most of the graphics programming is done in advance by the tools. The applications developer still must supply the application computation routines and possibly the data base support as well. The predefined conceptual world simplifies this job by specifying it as manageable, well defined action routines.

The image of a model in the mind of program designers and implementors serves as a framework upon which an application can be built. This encourages an organized building block approach and the reuse of previously defined portions. Even better than just a model is the inclusion of software tools based on the model. These types of tools have been found to make the creation of applications and their documentation easier, faster, more consistent, and more enjoyable. □

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Systems Approach to Off-The-Shelf Hardware Cuts Design Costs

Using standard off-the-shelf hardware may cost more per unit, but it can quickly make up for that increase with shortened prototype-to-market cycles and by eliminating tooling and design costs.

by Russell Petit

Early in the design cycle on selecting hardware for electronic equipment a decision has to be made whether to go to custom or standard hardware. The heart of most systems is the card rack, connector backplane, interconnect technique (i.e., wire wrap, multilayers, multiwire, stitchweld, etc.) plus cabling.

One of the advantages of off-the-shelf hardware is the elimination of any tooling and design cost; products are available in small quantities and delivery is quick. Also, prototype to market cycle is shortened by several months. The decision to buy a standard rather than custom product is made easier by asking the manufacturer to demon-

strate its product. That will quickly tell you if their packaging system meets your requirements. The disadvantage to the standard product is a higher unit cost, and the choice is limited to catalog items. However, review of these catalogs will surprise you with the large variety of packaging systems currently available.

Companies offering wire wrap panels have the largest variety of standard product because they have been around longer than companies involved with other interconnect techniques. Wire wrap packaging companies also offer system packaging that is compatible with a variety of interconnect techniques. It is common practice for example to mix wire wrap packaging panels and multilayer PCBs or wire wrap and multiwire boards in the same card rack. Normally wire wrap is used in the connector backplane.

There are many electronic and mechanical factors involved in selecting or designing IC packaging systems. Some of these are system speed, type of device (i.e., TTL, Schottky, ECL, etc.) noise suppression, voltage requirements, power requirements, I/O and IC density, cooling, type of connectors (i.e., card edge or two-piece post and box), Interconnect technique (i.e., wire wrap, multi-wire, multilayer, etc.). Is the system packaged in a desk top enclosure or 19" cabinet? Is this a one shot system, low or high volume production? Reliability and serviceability are major factors. Is it a bus-oriented system?

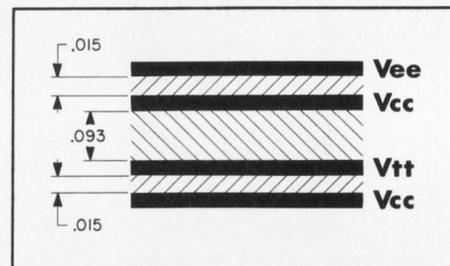


Figure 1: For systems requiring high speed ECL logic, four-layer multilayer wire wrap panels and connector backplanes are available.

All of these systems packaging problems are solved by the large variety of standard products currently available.

Speed is a major factor in system packaging. The layout of the interconnect panel and the connector backplane it plugs into goes a long way to improve on system speed. Four-layer multilayer wire wrap panels and connector backplanes (Figure 1) are available for systems requiring high speed ECL logic. These packaging systems handle the multiple voltage requirements and improve system speed, eliminate system noise through increased distributed capacitance between power layers, equalize current flow throughout the system via hundreds of plated through holes and offer both decoupling at each IC and power entry points and locations for plugging in SIP terminating resistors. Copper foil around each pin on both packaging panels and backplanes provide ground shield for signal wires. There are also a large variety of

Russell Petit is with Mupac Corp, 10 Mupac Dr, Brockton, MA 02401

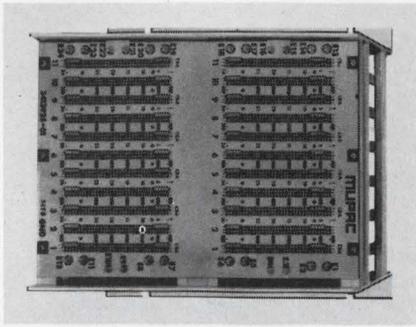


Figure 2: Using a single continuous backplane on double high and triple high card racks solves connector backplane power problems.

packaging systems available designed specifically for Schottky logic. These mostly involve three layer packaging panels, but more recently systems with four layer wire wrap panels have become available.

Connector backplane problems are solved by using a single continuous backplane (Figure 2) on double high and triple high card racks. This eliminates the need for a power bus between backplanes, plus the copper foil between the wire wrap pins equalizes current flow throughout the power bus system to help eliminate hot spots and voltage shifts. Slotted solder terminals on both ends of the backplane allow the use of heavy gauge bus bars and, therefore, remove some heat generated in the backplane. A large variety of backplanes are available to handle systems requiring multiple voltages.

Density is an important factor in the system approach to packaging.

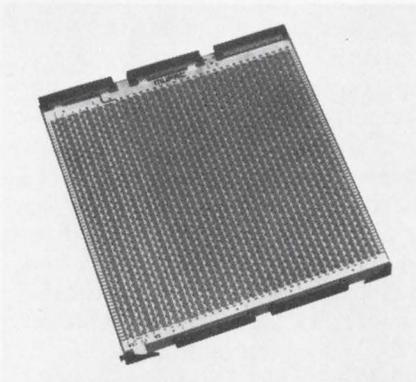


Figure 3: This panel, with its card rack, can be used for packaging large systems.

There are numerous standard packaging systems available to satisfy most any density requirement. The panel shown in Figure 3 in combination with its card rack can be used for packaging very large systems. It is a high density universal wire wrap panel for up to 469 sixteen pin ICs, plus it will package DIPS with any pin layout and 64 pin VLSI adapters. The ICs are closely spaced on a .100 inch pitch which keeps wire runs short and decreases crosstalk, ringing and propagational delay. The five 108 pin two-piece connectors will satisfy most high density I/O requirements. A variety of panels will satisfy multiple voltage requirements.

Bus oriented systems are very common today, but until recently

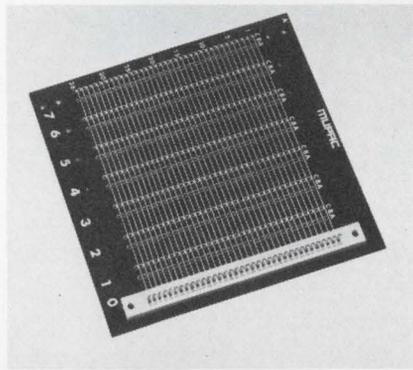


Figure 4: This backplane eliminates the need to wire wrap common bus signals between connectors.

have not been addressed by most standard packaging systems. The backplane shown in Figure 4 eliminates the need to wire wrap common bus signals between connectors. The I/O connector at the end of the bus makes it easy to take flat cable away from the backplane to other equipment. These bus oriented backplanes come in a variety of lengths and can be added to single, double and triple high card racks. There are also standard off-the-shelf packaging systems compatible with Intel's Multibus complete with terminators and Multibus connector backplanes (Figure 5).

Most of these off-the-shelf packaging systems have standardized on a connector spacing of 1.200" for plug-in wire wraps. However, the

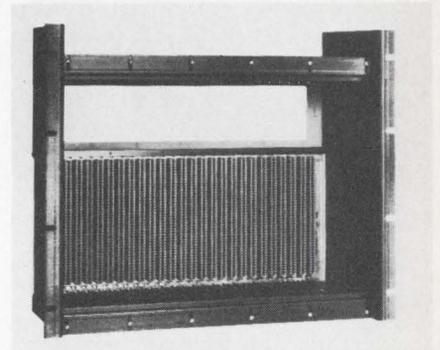


Figure 5: Multibus compatible packaging systems are available off-the-shelf, complete with terminators and Multibus connector backplanes.

manufacturer can add card guides and connectors on .600" spacing for plugging in PCBs. This is an ideal set up for the designer who prototypes and goes into small volume production with wire wrap, but wants to go to multilayer, multiwire or some other interconnect technique for high volume production. He can go straight from wire wrap into multilayer and use the same card rack, connector backplane card extenders, cabling, etc., or if any part of the design requires updating, the designer can mix wire wrap and multilayer in the same card rack, Figure 6. Having part of the design on wire wrap gives him the flexibility of change.

Off-the-shelf packaging systems

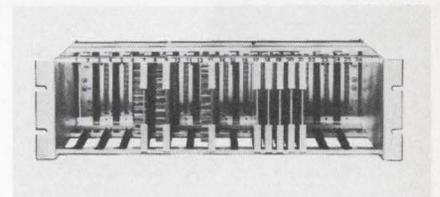


Figure 6: This packaging system allows designers to mix wire wrap and multilayer in the same card rack.

will handle TTL, Schottky, and ECL logic plus many μ C requirements i.e., Multibus, DEC, STD bus, Versabus, etc. Many of the packaging systems are offered in single, double and triple high card racks, full and half sizes, and may be mounted vertically or horizontally into desk top enclosures or 19" cabinets. □

3D Measurement Terminal

A new terminal for taking three-dimensional measurements from a pair of stereo photographs has been introduced by Matra Technology. A 3D image is projected from a pair of film carriages onto a screen. The 3D effect is achieved by using polarizing filters in the projection path, and viewing the resulting image through polarized glasses. An accuracy of 2-3 microns is obtained by using linear optical encoders to position the film carriages.



Figure 1: The Traster SST terminal.

The terminal, called the Traster SST (Stereo Satellite Terminal) is controlled by Intel 8086/8087 μ Ps which handle all the terminal's real-time functions. All applications-related code is written in Fortran and runs on a remote host computer. The biggest benefit of this approach, according to Reece Jensen, Matra's president, is that it saves the cost of a dedicated computer and its attendant software, maintenance and personnel costs. By using timesharing services, small companies can avoid getting into the computer business entirely, Jensen added.

Freeing the terminal from the need for a local computer has a number of other benefits, Jensen pointed out. The terminal does not need to be in the same room as the computer, so it can be located wherever it is most convenient to the user. If the user already has a computer, the termi-

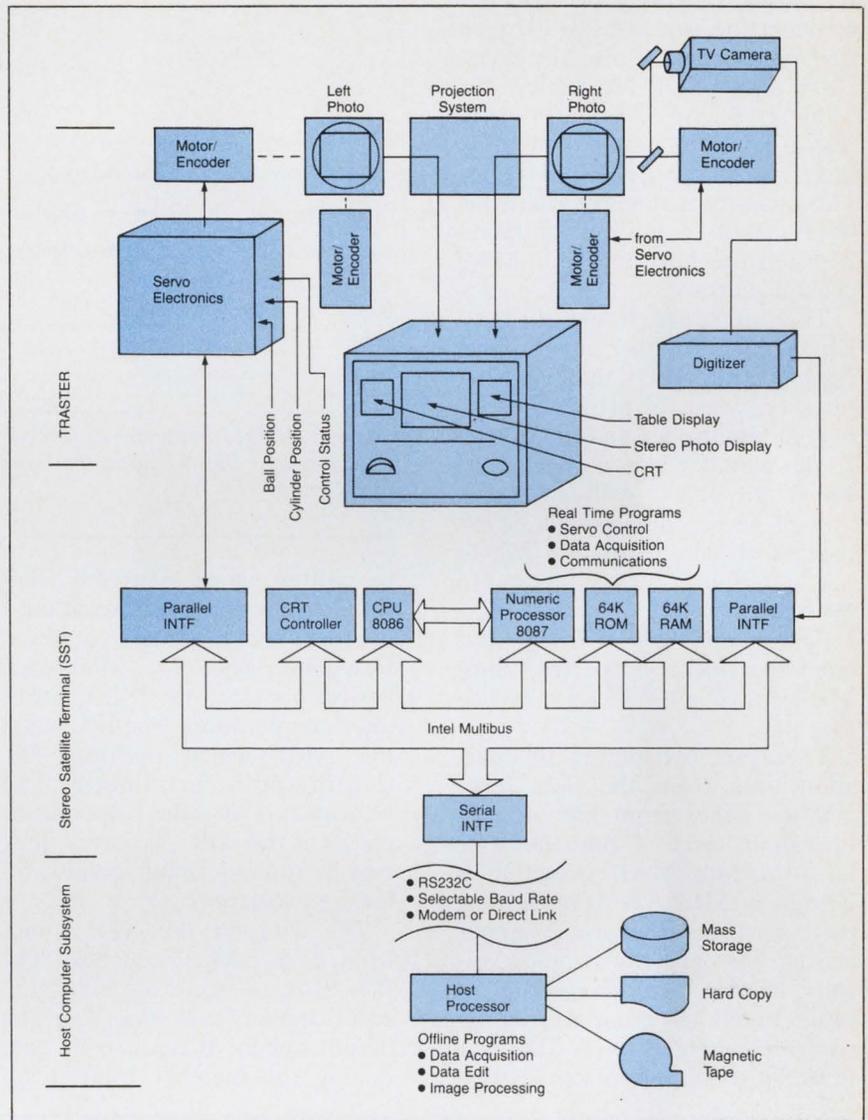


Figure 2: The Traster SST system is controlled by Intel 8086/8087 μ Ps which handle all the terminal's real-time functions.

nal will automatically have access to all the other peripherals on the system, such as plotters, and to existing data bases. Matra can perform diagnostics over a modem link to the user's facility, and software updates can be down-line-loaded. Data can be loaded directly into a CAD system without using intermediate tapes or disks.

Applications for the new terminal include any operation where 3D data is compiled. The most

common applications are expected to be in aerial surveying and mapping, civil engineering, utility mapping and as-built analysis of complex structures such as power plants.

The Traster SST costs \$150,000, with an optional plotting table available for an additional \$25,000. Delivery is on a 90-day schedule. *Matra Technology is located at 120 Albright Way, Los Gatos, CA 95030; telephone (408) 866-6606. Write 198*

4 Card Array Processor Fits In PDP-11 Backplane

The latest entry from CSPI into the world of array processors has come in the form of a 4-card set that plugs directly into the backplane of a PDP-11. Called the Mini-MAP, the 32-bit array processor features a shared memory interface to the PDP-11 Unibus. The memory is directly accessible by the PDP-11 and data transfers between the host and Mini-MAP are unnecessary.

The four cards consist of the 64 Kbyte memory, the Integer Processing Unit (IPU) that incorporates 4K words of program memory, the multiplier and the adder.

The memory is non-interleaved 16K static RAM with an access time of 250ns. Memory can be expanded in increments of 1 Mbyte per additional board up to 16 Mbytes.

Geoffrey Cohler of CSPI, outlined the operation of the Mini-MAP for Digital Design as follows:

There are two phases of operation, one from the user level and the other from the internal operation level. From the user level, a Mini-MAP program is written in MCL (Fortran Subset) that performs the user's application. This program would typically involve several calls to library functions along with some control statements. A PDP-11 FORTRAN Program would then

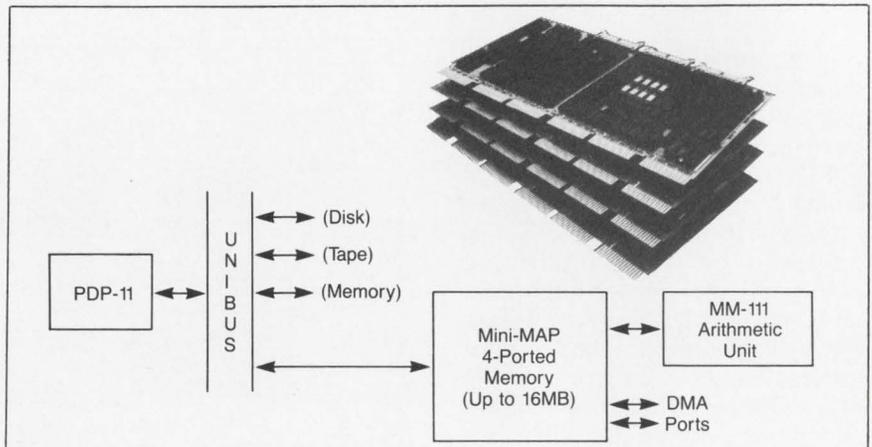


Figure 1: PDP/11 minimum system configuration and the 4-boards that comprise Mini-MAP.

be written which loads the Mini-MAP and controls its execution.

From the internal operation viewpoint, once the Mini-MAP has been started the IPU controls internal operation. The IPU starts the APU which performs the floating-point arithmetic. The Multiplier and Adder operate as pieces of the APU, however, they may be running simultaneously allowing overlap.

The data for the APU comes from and goes to queues. The IPU is responsible for filling the input queue and emptying the output queue. It does so by generating the memory transfer re-

quests in the order that data is consumed and produced by the APU.

Thus, the memory transfers and address calculations are done in parallel with the floating-point calculations. This functional parallelism is what allows the high speed to be achieved.

CSPI quotes a figure of 4.2 ms for the Mini-MAP to execute a 1024-point Real FFT.

In addition to the board set, Mini-MAP can be supplied with a wired PDP-11 backplane or a self-contained development system in a DEC compatible enclosure complete with power supply and Unibus cables. The 4 board sets are priced at \$16,200 in minimum quantities of 50.

CSPI, 40 Linnell Circle, Billerica, MA 01821. **Write 197**

Nonvolatile RAM Memory Board For The STD Bus

The advancements in EEPROMs have led to a number of board level designs incorporating this technology. The latest introduction in the field, from Acquis Data, of Irvine, CA, provides up to 4 Kbytes of nonvolatile RAM using Xicors NOVRAM devices. The NOVRAM-1 board performs read and write operations at a 4MHz rate, and storage into the permanent "area" of the entire 4K block takes only 10ms to

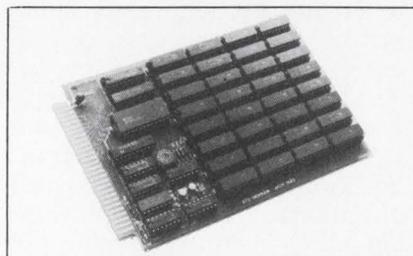


Figure 1: The NOVRAM-1 board from Acquis Data, provides 4 Kbytes of nonvolatile RAM using Xicors NOVRAM devices.

complete.

This storage speed is accomplished by using Xicor's "NOVRAM" technology which incorporates conventional static RAM overlaid bit-for-bit with EEPROM on the same device. Once data is stored into the nonvolatile area, power can be removed and the data is retained. A simple recall instruction loads the data into the RAM area providing instantaneous nonvolatile RAM that is

transparent to system operation. NOVRAM does not require any high voltage pulses or supplies; a single 5V supply is the only power source necessary. The high speed storage operation makes this

board suited for retention of data during power failures or brown-outs. Operating system boot information can be stored and changed at any time and will always be ready at power up. The

Addressing Mode is selectable on any 4K boundary by changing a single hex switch on the board.

Acquis Data, 18952 MacArthur Blvd., Suite 100, Irvine, CA 92715.
Write 199

1 Mbyte Memory Compatible With All Prime Computer Systems

A new line of Prime Computer-compatible memories, ranging from 256 Kbytes to 1 Mbyte, all on a single board, have been introduced by the EMC Corporation.

The new add-in memory line includes the E8 memory which provides 1 Mbyte of memory on a single board, the E7 memory with a capacity of 512 Kbytes, and the E6 memory with a capacity of 256 Kbytes. All three memories incorporate 64K RAMs.

They also include automatic error detection and correction circuitry, which detects and corrects

all single-bit errors and detects all multiple-bit errors. They support interleaving, and have a refresh and wide-word capability.

The 1 Mbyte E8 memory carries a single-unit price of \$18,000. EMC claims that Prime Computer charges \$36,000 for a comparable unit, and \$40,000 for four memory boards, each with 256 Kbytes of capacity.

EMCs 512 Kbyte memory is priced at \$11,250, and the 256 Kbyte memory is \$6,750.

EMC Corporation, 385 Elliot Street, Newton, MA 02164; Tel: (617) 244-4740.
Write 200

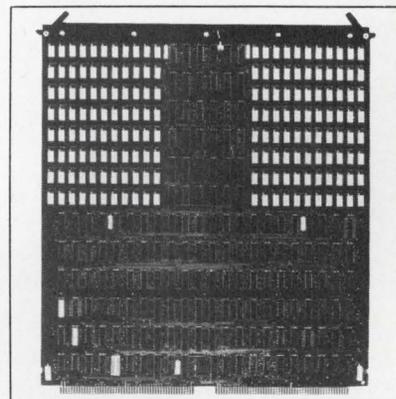


Figure 1: The E8 memory from EMC Corporation is one of three new add-in memories for Prime Computer.

The Canon 80K Byte Micro Floppy Disk Drive

Low cost - under \$100 in a 1000-piece lot ... includes electronics!

- Compact Light weight
- Highly reliable Write inhibit
- Random access Index signal
- Similar to standard 5¼" floppy interface

The compact high performance CMD 500 measures only 4½ × 6 × 2½ inches yet gives you a capacity of 80K bytes per side (double density) or 40K bytes per side (single density) unformatted on a 3.8" diameter double sided disk. Disks are packaged in a rigid plastic shell that protects them and permits rapid and safe disk changes.



Canon

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Write 32 on Reader Inquiry Card

IMAGE PROCESSING

UNIX-Based Workstations

The GRIDS systems give users a choice of Grinnell image processing hardware configurations and one of four, stand-alone DEC computer systems. Also included are a terminal, disk storage, and software for both image processing and the operating system. They are fully independent



workstations which reduce dependence on existing mainframe resources. A typical configuration is the GRIDS 23/1. It combines a Grinnell GMR 274 Image Processing and Display System with the UNIXCISOR computer system from IDS. The GMR274 has three 8-bit image memory banks, 512 x 512 resolution, four graphics overlays, two zoom and pan controls, a real time pipeline processor with 16-bit ALU, a 6-bit video digitizer and an image histogram generator. The UNIXCISOR system includes a DEC LSI 11/23, 256 Kbytes of RAM, parallel and serial interfaces, VT100 terminal, 30 Mbytes of Winchester disk storage, 1Mbyte of floppy storage and a binary license for the new SYSTEM III UNIX operating system from Western Electric. **Grinnell Systems Corp.**, 2159 Bering Dr., San Jose, CA 95131. **Write 152**

"C" CROSS COMPILERS

For Developing μ P Software On Timesharing Minicomputers

The first product in the family, C-Port 8086, lets programmers write and compile Intel 8086 programs in C on multi-user hosts, initially DEC minicomputers. With C-Port, users can take advantage of the host's full capabilities such as processing speed, large disks, tapes and printers. The compiled C programs can be downloaded to the target μ P, initially the Intel 8086, for execution as pure machine code. It supports all of the Intel 8086's 1Mbyte of memory space using

long (32-bit) pointers for code and data addresses. The code generated is optimized and intended for use in embedded ROM-based μ P applications. \$4500 including maintenance and support contract. **Intermetrics Inc.**, 733 Concord Ave., Cambridge, MA 02138. **Write 153**

CROSS ASSEMBLERS

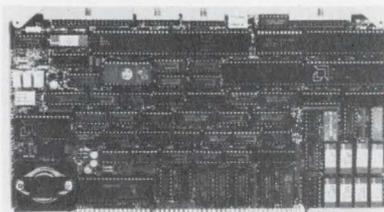
Generate Programs For Intel's 8048/49/41/35 μ P Family

Combined with a Millennium 9520 Development System, the cross assembler programs configure the system to facilitate hardware/software development for 8048/49/41/21/35 μ Ps. They can also be used with Systems' Analyzer (μ SA), MicroSystem Emulator (μ SE) or 9508 MicroSystem Emulator for program execution and debug. Programs with the cross assemblers include a MACRO assembler, a linking loader, a formatter/downloader, and equivalent Intel instruction mnemonics and MACROS. \$751. **Millennium Systems Inc.**, 19050 Pruneridge Ave, Cupertino CA 95014. **Write 196**

S100 BUS COMPUTER

With Memory Management

The Z80A Based Model CPZ-48000 features: 64 Kbytes of onboard dynamic RAM, two sync or async I/O channels, two parallel I/O channels, memory management of 16 Mbytes of system memory, a floppy disk controller for single/double density—one/two sided—5/8" disk drives, 8 vectored priority interrupts with Z80

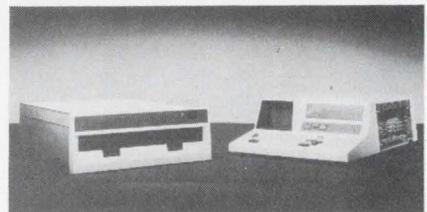


mode 2 interrupts chained in, and capacity for either 2 Kbyte or 4 Kbyte onboard EPROM. It can be used as a stand alone computer, network master, multiuser host and multiprocessor host. MP/M and CP/M operating systems are now available and Turbo-Disk is included in the purchase package. \$1095. **Intercontinental Micro Systems**, 1733 S. Douglass Rd., Suite E, Anaheim, CA 92806. **Write 154**

DEVELOPMENT SYSTEM

Provides Multi-User Support

The STEP-10/CDS provides multi-user support for real-time development of μ Ps, microprogrammed bit-slice computers, controllers and digital signal processors. The two unit system is composed of the FDC-480 Firmware Development Center, and the STEP-4/FITS Firmware Integration and Test Station. Software development proceeds on one or more terminals ports, while one or more STEP-4 instruments support real-time emulation on the remaining ports. A minimum 4 user STEP-10/CDS configuration including the FDC-480 with



208 Kbytes of RAM, 1 Mbyte of double density floppy disk storage, complete software support and a single STEP-4 FITS instrument is \$18,600. **STEP Engineering**, 757 N. Pastoria Ave., Sunnyvale, CA 94086. **Write 157**

COMPUTATIONAL NODES

Double Performance Of Domain Networked System

The DN400 and DN 420 computational nodes include floating point hardware with single and double precision and a high speed cache memory, a new horizontally oriented, 19" "landscape" display with touch pad control, and new operating system enhancements that include support for IBM 3270 communications protocol. The Domain Processing environment provides a 12 Mbit/sec token passing network that lets users share all their resources while simultaneously running their applications, all without affecting one another. Each user can run up to 15 concurrent processes on each Domain node. The Domain network can support hundreds of nodes each up to 1/2 miles apart. A typical DN 400 node, including a 32-bit central processor, 1 Mbyte of error checking and correcting main memory, and 15" B&W bit-mapped display is \$34,500. **Apollo Computer Inc.**, 19 Alpha Rd., Chelmsford, MA 01824. **Write 147**

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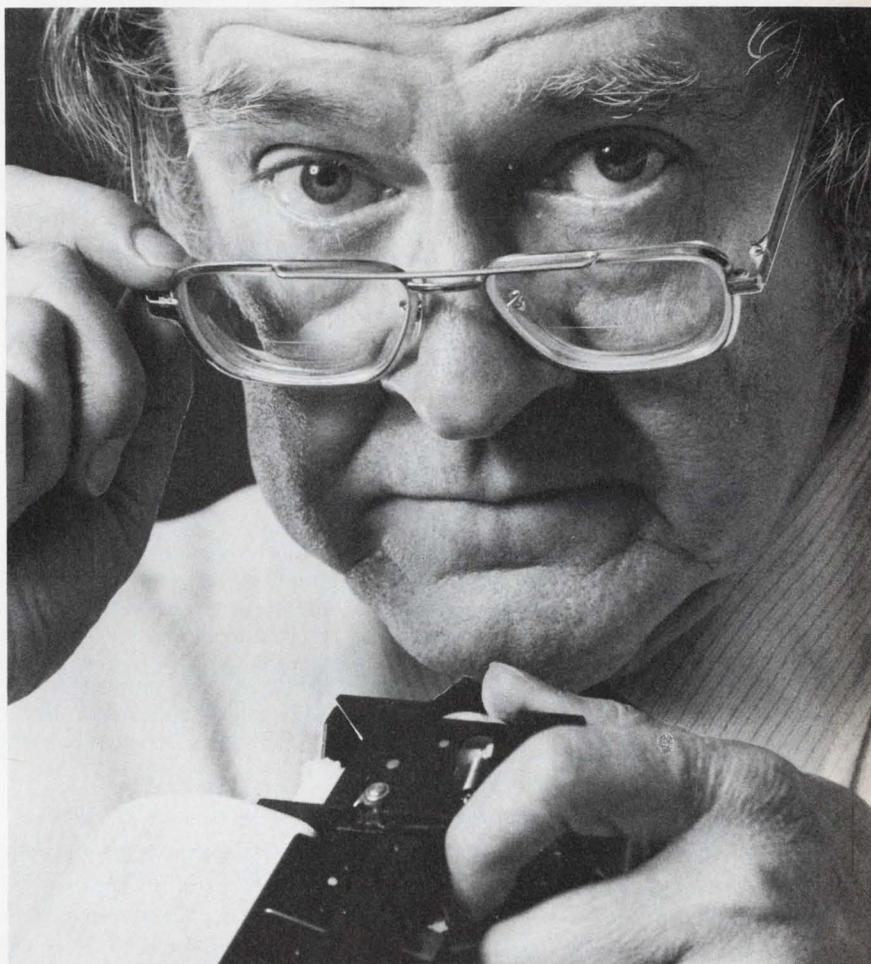
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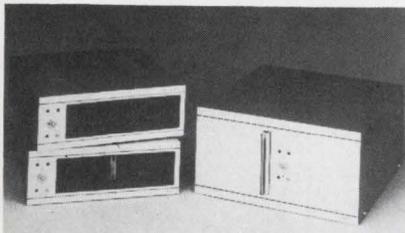
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COMPUTER SYSTEM

Single, 4, 8 and 16 User Systems

The single user and 4 user computers are 8 bit CP/M compatible systems. Models of these systems include dual floppy disk; 10 Mbyte hard disk with floppy backup; and a 10 Mbyte hard disk with a 20 Mbyte cartridge tape backup. The 4 user systems have 256K RAM. The larger 8 and 16 user systems are configured with a 20 Mbyte or 40 Mbyte hard disk and 20 Mbyte cartridge tape backup. A 16 bit, 68000 μ P is incorporated with an 8 bit processor to provide a unique system software compatibility with



CP/M and UNIX. **Access Matrix**, 1708 Stierlin Rd., Mountain View, CA 94043. **Write 148**

SYSTEM GENERATION PROGRAM

For Generating Customized M/OS-80 Software

MOSGEN gives the user an automated method of generating customized M/OS-80 software for different I/O devices and different RAM configurations. M/OS-80 is a CP/M compatible operating system for STD Z80 Bus-based computer systems. The console interface for the MOSGEN system generation program is either a UART or SIO STD-Bus card, and the list device control is a PIO or SIO interface. Drivers are supplied for single- and dual-sided floppy disks for both single- and double-density formats in 5¼" or 8" formats. The user may install his own customized handlers via the system generation program to adapt M/OS-80 software to a wide variety of other devices. \$1650 (1-9). **Mostek Corp.**, 1215 W. Crosby Rd., Carrollton, TX 75006. **Write 155**

SOFTWARE PACKAGE

For Data Acquisition Applications

DTBASIC combines the easy-to-use BASIC (RT-11 version) with powerful, real-time subroutines for controlling a wide range of sophisticated

data acquisition and control hardware. The real-time subroutines are written in MACRO-11 to achieve the



highest possible execution speed, yet are called with BASIC commands for ease of programming. It supports data acquisition hardware compatible with the LSI-11 Bus. Analog input interfaces allow digitizing up to 64 channels of analog data to 12, 14 or 16 bits of resolution at sampling rates up to 135kHz. Output interfaces provide up to 16 channels of analog data resolved to 12 bits. The language also supports up to 64 lines each of digital input and digital output. DTBASIC is \$1595. **Data Translation**, 100 Locke Dr, Marlboro, MA 01752. **Write 150**

COMPUTER SYSTEMS

Meet Office Automation Needs Of Multi-Site Corporations

A personal computer option, touch-sensitive screen, voice store and forward, broadband local area networking, and significant architectural enhancements highlight the new family of computer systems. The Series 5000 processors offer up to 6 Mbytes of memory, 2.2 Gbytes of disk storage, and support for up to 128 multi-function FASTRAK intelligent workstations with printers. The Series 5000 is comprised of three processors—the Systems 500, 700 and 800. A sample configuration of a System 700 consisting of a CPU, 3 Mbytes of RAM, 200 Mbytes of disk storage, a line printer, 16 character printers, 64 workstations and communications is \$475,800; can



be leased for \$18,000/month. Available first quarter 1983. **Four-Phase Systems**, 10700 N. DeAnza Blvd, Cupertino, CA 95014. **Write 151**

BOARD-LEVEL ECLIPSE

Based On microECLIPSE Chip Implementation Of The ECLIPSE Computer

Both models offer full I/O handling, floating point processing, extended memory addressing and full 16-bit real-time processing. Yet, the ECLIPSE S/20 and S/120 systems attain the advantages of DGs high-speed ECLIPSE computers, but at a price comparable with the smaller NOVA line. The S/20 offers OEMs and industrial/scientific end users components and systems capable of delivering full computer power to real-time, multiprocessing, multi-tasking applications. Beginning with a basic two-board, 128 kB CPU configuration, it may be expanded to include 512 kB of memory and floating point processor board. The S/120 offers similar features and processing power as the S/20, but in a single 15" board that is I/O compatible with the full line of ECLIPSE and NOVA peripherals. **Data General**, 4400 Computer Dr, Westboro, MA 01580. **Write 205**

PORTABLE μ C

Self Contained General Purpose Computer

Kaycomp II is packaged in a rugged low profile metal traveling case with



carrying handle. It includes a 9" display, two 5¼" floppy disk drives, and a typewriter keyboard with a 13 key numeric pad. It features a Z-80 central processor and CP/M operating system. The diagonal display has the standard 80 column by 24 row format, green phosphor screen, and high resolution characters. Interface accommodations include a printer output for 80 or 120 column printers, and an RS-232C interface for a modem or other peripheral equipment. \$1795. **Non-Linear Systems Inc.**, P.O. Box N, Del Mar, CA 92014. **Write 156**

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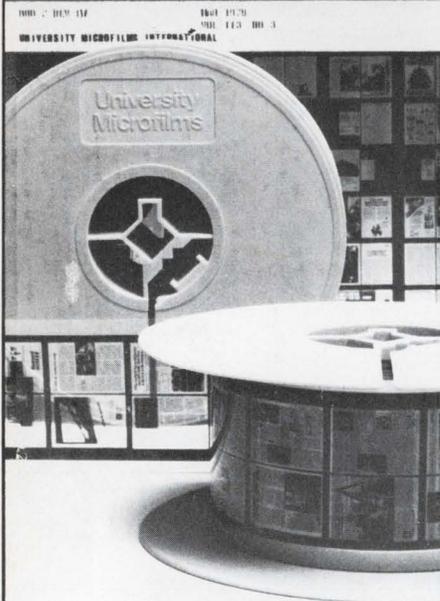
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Product Index

To help you find the products you need, we've compiled a subject index of the ads and new products that appear in this issue. Organized by general product area, the listings include the name of the manufacturer, the page on which the product appears and a write number for additional information on that product. Bold type indicates advertised products.

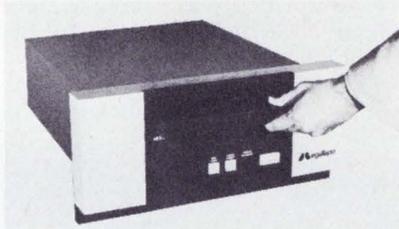
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WINCHESTER BACKUP

Start/Stop And Streaming Modes

The MegaTape 200 and 400 backup systems utilize 1/2" tape cartridges.



The 200 provides Winchester backup capacity of 200 MB (unformatted). Tape speed in start/stop mode is 50 ips, with a transfer rate of 40 Kbytes/sec. In streaming mode, tape speed is 200 ips, with a data transfer rate of 160 Kbytes/sec. The 400 provides over 350 Mbytes of storage. Start/stop tape speed is 50 ips, and streaming speed is 200 ips, with data transfer rates of 60 and 240 Kbytes/sec respectively. Both units use a serpentine-type recording technique, recording on 24 tracks. **MegaTape Corp**, 1041 Hamilton Dr, Duarte, CA 91010. **Write 131**

DOCUMENT PRINTER

Enhanced Forms Handling

Model 159 transaction document printer is capable of printing up to 5-part forms. This rugged printer allows tear-off within one inch of top of form, suiting it for invoice printing, inventory control, hotel management, wholesale/retail distribution and any business application where multi-part forms capability is essential. Standard features for this 80 column printer include compressed print, 150 cps bidirectional logic seeking printing, "clean



hands" ribbon cassette, and a variable forms length control. **Centronics Data Computer Corp**, Hudson, NH 03051. **Write 127**

MAG TAPE STREAMER

Includes Auto Threading

The DAM-1000 is a fully automatic, 45 ips start-stop and 100 ips streaming, 9 track 1/2" tape drive. It is designed with a µP driven embedded formatter and a novel digital servo. Automatic diagnostic capability is an

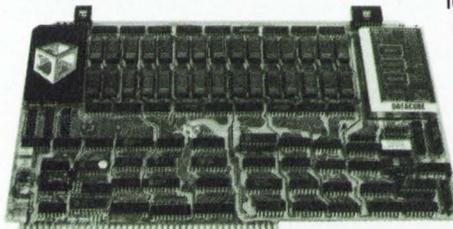
integral part of the system. ANSI compatible recording densities of 800/1600 bpi at 45 ips and 1600 bpi at 10 ips streaming is standard. The auto threading allows an operator to load all size tape reels as easily as inserting a disk or cartridge. From \$5000. **TDX Peripherals**, 148 New York Ave., Halesite, NY 11743. **Write 135**



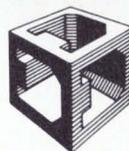
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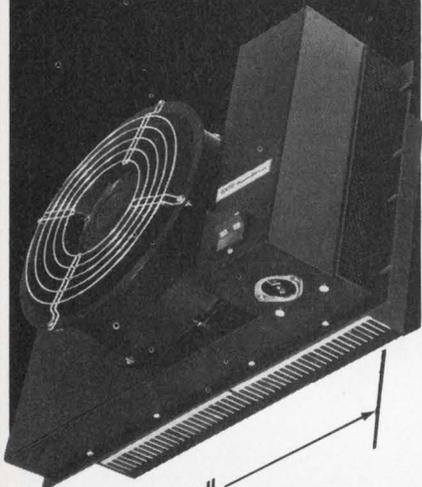
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WINCHESTER UPGRADE

For Floppy-Based Systems

This $5\frac{1}{4}$ " Winchester disk drive controller and subsystem is targeted at CP/M-based micros which have no current capacity upgrade path. The AS100 controller is a $5\frac{1}{4}$ " \times 11" circuit card designed specifically for $5\frac{1}{4}$ " Winchesters. Essentially it allows the user to "talk to" the Winchester as if it were a very high capacity floppy disk drive. This floppy-disk-emulation method minimizes installation time, product cost and the required system software modifications. The AS105 subsystem packages an AS100 controller, a 6.38 MB $5\frac{1}{4}$ " Winchester disk drive, power supply, cables and connectors with complete documentation and instructions for \$2495. The AS100 controller alone is \$595. **Alpha Systems Corp.**, 711 Chatsworth Place, San Jose, CA 95128. **Write 126**

$5\frac{1}{4}$ " WINCHESTER

Four Platters and Optional Data Separator

The "C" series of $5\frac{1}{4}$ " Winchester disk drives includes one to four platter models with capacities of 6.38, 12.75, 19.13, and 25.5 Mbytes (unformatted). Increasing track density from 270 to 383 tpi increases capacity per platter by 42% over earlier RMS models. Industry standard transfer rate of 5.0 Mbits/sec is unaffected.



An optional Data Express-II data separator increases capacities by another 50% (9.5, 19.13, 28.5 and 38 Mbytes) and uses a faster 7.5 MHz transfer rate. Another optional data separator, Data Express I, provides system integrators with standard MFM coding and 5 MHz data rates. From \$935 to \$1485 in 100 qty; Data Express I is \$197; Data Express II is \$250. **Rotating Memory Systems Inc.**, 1701 McCarthy Blvd, Milpitas, CA 95035. **Write 133**

DAISYWHEEL PRINTERS

35 CPS Print Speed

The Sprint 8/35 provides industry standard Qume parallel interface for word processing, and provides proportionally-spaced printing. The Sprint 10/35 terminal with an RS-232C interface offers high speed, letter-quality printing at prices compatible with microcomputer systems.



Both combine condensed, μP controlled, single-board electronics for increased reliability with Qume's MicroDrive mechanism for minimum mechanical stress and maximum print accuracy. Higher electrostatic discharge (ESD) immunity provides significant reductions in interruptions from environmental conditions. A complete line of plastic daisywheels plus a full complement of monospace and proportional space printwheels are available in over 100 typestyles. The Sprint 10/35 starts at under \$2000, qty. discounts avail. **Qume Corp.**, 2350 Qume Drive, San Jose, CA 95131. **Write 132**

DISK DRIVE

SASI-Compatible Intelligent Drive

The D145 incorporates all housekeeping functions at the drive level, totally independent of the host. This frees up the CPU for more productive data processing and database management tasks, and the SASI-compatible feature simplifies the entire system integration process. The drive combines 12MB of hard disk data storage and 12MB of disk-to-disk backup. It performs all error handling and protocol interface functions, without separate hardware interfacing or applications software changes. All seeks, verifications, error recovery and disk-control and data transactions are automatically handled in the drive without CPU or bus interaction. **Cynthia Peripheral Corp.**, 3606 W. Bayshore Rd, Palo Alto, CA 94303. **Write 128**

SYNTHESIZER

Professional Voice Quality

The Intex-Talker text-to-speech synthesizer is available as a stand alone peripheral or at board level. It can announce data transmitted at high speed over telephone lines or serve as an unlimited vocabulary audio interface for telephone transaction applications, and features 64 digitally programmable levels of inflection. Equipped with keyboard, it can function as a typewriter for the blind or as a communicator for the vocally impaired. The unit can recognize every ASCII character including punctuation as it is typed and can echo each character automatically. **Intex Micro Systems Corp**, 4758 Brafferton, Bloomfield Hills, MI 48013. **Write 159**

TAPE RECORDER

Portable Wideband Instrumentation Recorder

Storehouse is designed to handle the vast quantities of data gathered, stored and analyzed in modern research and development. Key features include Automatic Calibration and Equalization (ACE) and self diagnosis of performance. Extensive μ P control results in a recorder that does not require highly qualified staff for setting up and maintenance. It has a 42 track recorder with 15" coaxial reels compatible with 1/2" and 1" magnetic tape. An intermediate and wideband recorder, it can be used in any combination of the three standard data record/replay formats: DR (direct recording), FM (frequency modulated), and HDDR (high density digital recording). Set up time is reduced from several hours to less than 3 minutes. **Racal Recorders Inc**, 3830 Bee Ridge Rd, Sarasota, FL 33583. **Write 134**

COMMUNICATIONS PROCESSOR

Emulates Both IBM BSC and SDLC (SNA) Standard Protocols

When operating under BSC or SDLC protocols, the CA20 appears to the host as an IBM 3276 cluster controller. It interfaces CRTs to the host computer by causing the terminals to appear as 3278-type devices. Up to 8 unsophisticated async devices can be supported. Available with more than 32K buffer memory, the CA20 supports line speeds from 300 to 9600 bps. \$9700 with 10 ports. **ICCI**, 196 Broadway, Cambridge, MA 02139. **Write 160**

TAPE DRIVE

Includes Integrated Controller

Model 8020-2X houses two drives with an internal controller for a space reduction of up to 50% over long column drives. Two add on drives can be used with the basic 1x2 subsystem. An optional 1x8 feature allows four more add on drives to be attached. The 8020-2X operates with IBM 360/370 and 4300 CPU's. \$57,600 for two 6250 bpi drives and an integrated controller. Additional 6250 bpi drive models are \$18,900. **Telex Computer Products Inc**, 6422 E. 41st St, Tulsa, OK 74135. **Write 167**

TAPE SUBSYSTEM

92 MB of Backup for NOVA/Eclipse Minis

The DS12 combines a single-board tape adapter with Cipher's Microstreamer drive for backup of Winchester fixed-media disk drives. Utilizing 1/2" magnetic tape, the DS12 is available in rack-mounted or desktop versions and offers streaming capabilities at 100 ips; transaction processing is provided at 25 ips. It utilizes 9-track PE data formatting (ANSI- and IBM-

compatible), and is offered in either 1600 or 3200 bpi models. \$4995 in OEM qty for the 46 MB version, \$5385 for the 92MB model. **Datum Inc**, 1363 So. State College Blvd, Anaheim, CA 92806. **Write 129**

SONIC DIGITIZER

Meets OEM Requirements

The GrafBar GP-7-OEM is available for use in the design of all types of electronic data processing and data handling equipment requiring the digitization of 2D graphic data. A compact, 19" x 6" x 1 1/4" assembly, the digitizer incorporates two point microphones to eliminate the conventional frame microphone assembly, to unencumber the work area, to allow left hand or right hand digitizing, and to allow utilization of any work surface rather than a prescribed digitizing tablet. Active area is the largest, 18" x 24", of any low cost digitizing system currently available. Features built-in μ P conversion of slant ranges into cartesian (X-Y) coordinates. **Science Accessories Corp**, 970 Kings Hwy West, Southport, CT 06490. **Write 166**

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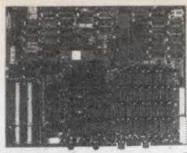
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Printer Products

A DIVISION OF CAPITOL CIRCUITS CORPORATION
24 DENBY ROAD, ALLSTON, MA 02134

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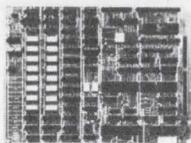
WAVE MATE SERIES 2000

The Series 2000 is a 2MHz 6800 based single board computer currently used in the TYPEMATE (Automatic Typesetting) and WRAPMATE (Wire Wrap) systems. The software available includes multitasking, 2 File operating systems, UCSD Pascal, Word Processing, Phototypesetting and Wire Wrap. Business packages are also available.

WAVE MATE INC.

14009 South Crenshaw Boulevard
Hawthorne, California 90250
Tel. (213) 978-8600. Telex 194369

Write 43 on Reader Inquiry Card



The WAVE MATE BULLET is a 4MHz Z80A, Single-Board-Computer that runs CP/M. The hardware and software were designed together to run CP/M as efficiently as possible.

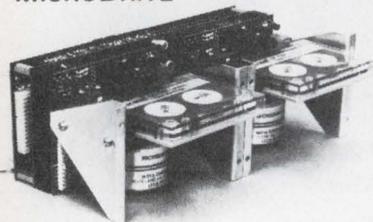
128 KByte of RAM with bank select—Single/Double density floppy disk controller for both 5 1/4 inch and 8 inch drives—DMA floppy disk operation with high speed RAM buffer—General purpose external DMA I/O—2 serial ports with transmission rates to 76.8 K baud—Centronics printer port—IMI or Corvus Winchester interface—Vectored interrupts—Real time clock—5 volts only—Full disk track buffering—Keyboard type-ahead—Disk write verification—Compact size—8 X 10.7 in.

WAVE MATE INC.

14009 South Crenshaw Boulevard
Hawthorne, California 90250
Tel. (213) 978-8600. Telex 194369.

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MICRODRIVE



DC100 CARTRIDGE DRIVE HAS SMART I/O

MicroDrive/OEM now features a micro processor based I/O. This unit performs all control and formatting for quick systems integration. A high level command set (22 commands) allows full peripheral status for the model 1251/O. Serial and parallel options are available priced as low as \$400 in OEM qty.

MOYA CORPORATION

9001 Oso, Unit B
Chatsworth, Ca. 91311
Tel: (213) 700-1200

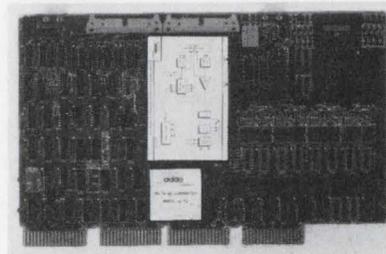
Write 42 on Reader Inquiry Card

New Products - COMPONENTS

A/D CONVERTER

\pm 40V Common Mode MUX
Protection

This 20 KHz standard size Unibus compatible board fits directly into a single slot of the mainframe of any

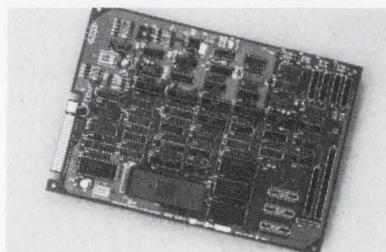


DEC PDP-11 minicomputer. High speed sample and hold is also a standard feature. The 12 bit Model 635/11AL can be populated with up to 32 fully differential inputs, or with up to 64 channels of single ended or pseudo-differential MUX input. Multiple strappable input ranges are standard. Programmable gain amplification, automatic zeroing, and provision for up to four channels of digital to analog conversion are optionally available. **ADAC Corp**, 70 Tower Office Park, Woburn, MA 01801. **Write 136**

DISK CONTROLLER

On-Board Error Checking And
Correction

This board-level controller for 5 1/4" and 8" Winchester-type disk drives, the WD1001, is based on the same proprietary chip set as the WD1000, expanded to include ECC as well as CRC (cyclical redundancy checking). The ECC is based on a 32-bit polynomial optimized for 5 1/4" and 8" Winchester drives, providing 5-bit burst error correction. The controller will interface up to 4 drives to a host processor, with drive signals based on the floppy look-alike SA506/ST1000 interfaces. Communications to and from the host processor are via an 8-



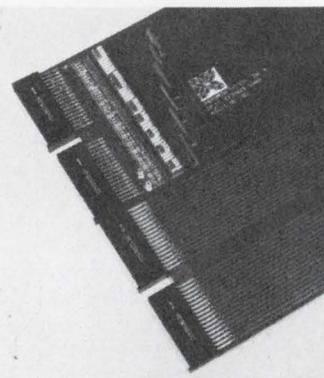
bit bidirectional bus. An on-board sector buffer allows data transfers to

the host independent of the actual transfer rate of the drive. The WD1001 is \$295 for 100-249 units. **Western Digital**, 2445 McCabe Way, Irvine, CA 92714. **Write 145**

Q-BUS EXTENDER BOARD

Is Active Participant In Debugging

In bus structured systems such as DEC's Q-Bus, the problem of isolating faults is often complicated by a balky board corrupting the bus. Model EB11 switchable extender board can isolate, through banks of miniature switches, each data and control line that makes up the Q-Bus. Pull-up resistors are provided on the card side of the switch to maintain a high (negated) state if the line is controlled by the system. The EB11 makes Q-Bus debugging more convenient and is available in quad widths (EB11) or



dual widths (EB11/2- includes both halves of EB11). \$250; qty. discounts avail. **Andromeda Systems Inc**, 900 Eton Ave, Canoga Park, CA 91304. **Write 137**

SINGLE CARD μ C

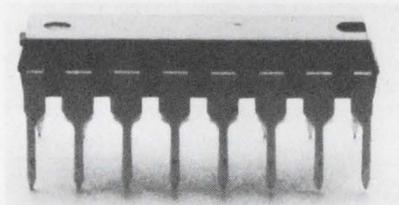
For OEM Applications

The DSTD-764 is designed to fit within the envelope of an 8" floppy drive and contains a Z80(A) μ P, 3 serial RS-232C channels, 1 serial RS-422 channel, two 8-bit parallel I/O ports, floppy disk controller with DMA, Hard Disk Host Adaptor, 64 Kbytes of RAM with parity, four 28 Pin Byte-wide memory sockets, 8 status switches and 8 status LED's, and a parallel port to interface to a video display controller daughter board. For added system flexibility the DSTD-764 also contains an STD BUS edge card connector and expansion drivers. **dy-4 Systems**, 888 Lady Ellen Place, Ottawa, Ontario K1Z 5M1. **Write 138**

16K STATIC CMOS RAM

Allows Easy Battery Backup

Available in three configurations to suit different applications, these silicon-gate CMOS devices feature low power dissipation (60 mA max. in active mode, 15 μ A max. in standby) and fast access time (120 ns for -12 parts, 150 ns for -15 devices and 200

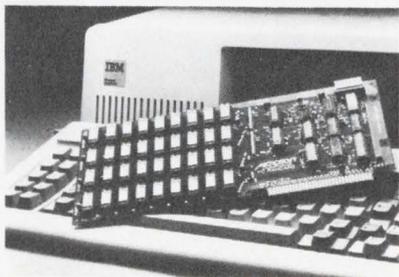


ns for standard versions). All three configurations operate from a single 5V power supply and all are fully static. The M5M5118P version incorporates two chip-select inputs to simplify battery back-up. Either input can place the RAM in standby mode and establish a high-impedance state on the chip's data lines. The M5M5117P version provides one chip-select pin and one output-enable pin. The output-enable is useful for bus contention control. The M5M5116P version offers faster chip access times by allowing only one of two chip-select inputs to switch the RAM to standby mode. **Mitsubishi Electronics America**, Semiconductor Div, 1230 Oakmead Pkwy, Suite 206, Sunnyvale, CA 94086. **Write 140**

MEMORY BOARD/RAMDRIVE

System For IBM Personal Computer

This expandable plug-in memory system for the IBM Personal Computer provides additional memory needed for large programs, plus disk emulation capability. The RAMCard system includes a board with up to 256



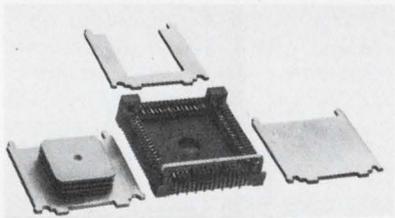
Kbytes of RAM; a diskette that enables the computer to use some or all of the memory as RAMDrive for disk I/O; and a systems manual written for

the computer novice. The RAMDrive feature is especially valuable for programs requiring repeated disk access, programs aren't bottlenecked while the disk drive is running. Available in 64, 128, 192 and 256 Kbyte configurations; from \$495 to \$1095. Up to three RAMCards may be installed at the same time. **Microsoft Corp**, 1901 Avenue of the Stars, Los Angeles, CA 90067. **Write 139**

68 LEAD CHIP CARRIER

Choice Of 3 Lid Configurations

The socket, designed to accept the JEDEC leadless "Type A" chip carrier package, offers the durability of a test socket while maintaining the low cost and small size essential to a high volume production socket. A choice of three lid configurations allows the socket to be tailored to specific applications. These configurations include a solid .050" thick aluminum lid for heatsink requirements not demanding



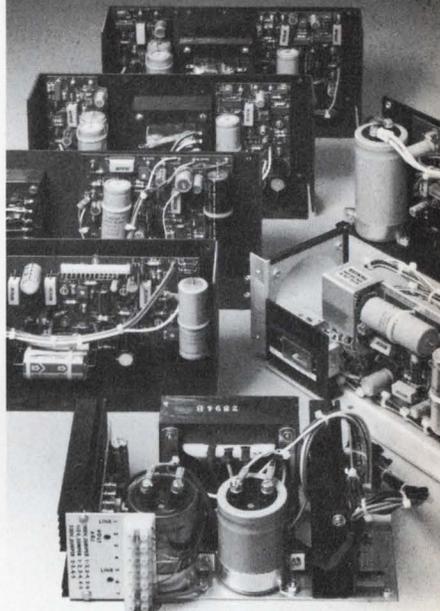
substantial cooling; a U-shaped lid for mounting a customer's heatsink; and, a lid with an external heatsink mounted as an integral part of the socket. With gold plated leads in 1000 qty, \$6.26 each, depending on lid configuration. **Textool Products Dept**, Electronic Products Div, 3M, 1410 W. Pioneer Dr, Irving, TX 75061. **Write 144**

DISK/TAPE CONTROLLER

Supports All Major 1/4" Tape Drives

The GYPSY can back up 20MB of disk data in less than four minutes, and allows any host to interface with a Priam Winchester disk drive. It communicates with the host via a simple parallel I/O port or through one of the company's host interface adapter boards. Other features include CRC error detection; offline backup and restore functions; the ability to control up to four 8" and 14" disk drives as well as four tape units; and multiple sector access capability. **Adaptive Data & Energy Systems**, 2627 Pomona Blvd, Pomona, CA 91768. **Write 170**

DISK DRIVE POWER BY XENTEK



Here are some of Xentek's 43 varieties of Disk Drive Power Supplies

Whether you use floppy or hard disks, or a combination—or disks with tape drive backup—chances are we've already designed and built the supply that matches your requirements. There are off-the-shelf models for many popular single and multiple 5 1/4" and 8" floppys, and OEM supplies for 5 1/4", 8" and 14" Winchesters.

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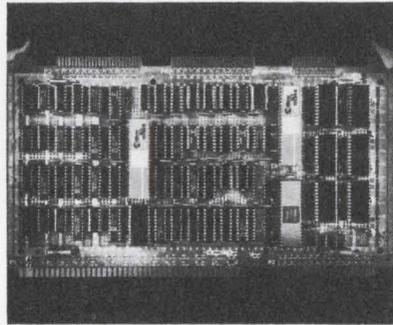
Contact: Bill Pryor,
Manager, Recruitment &
Classified Advertising,
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Publishing Co.,
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Boston, MA 02215
(617) 232-5470.

New Products · COMPONENTS

TTL μ P

Executes The USAF MIL-STD-1750A Instruction Set

The MKS1750/M single-board silicon-on-sapphire/TTL μ P executes 250 KIPS (DAIS mix) and dissipates less than 20W. It is logically and mechanically Multibus-compatible. A Development System was previously announced and an all-SOS version of the Processor Board is in the final development phase. The MKS1750/M is



suitable for 1750A applications which require MIL-E-5400 environmental conditions. MIL-E-5400 version is \$14,750; qty. 100 price is \$5950 each. Also available in a commercial package at a unit price of \$10,400; qty. 100 price is \$2300 each. **Mikros Systems Corp**, 3828 Quaker Bridge Rd, Mercerville, NJ 08619. **Write 141**

COMMUNICATIONS OPTIONS

For PC-8000 Personal Computer

A communications board (PC-8012A-COM1) offers two standard RS-232C ports, software selectable baud rates from 50 to 19,200 bps (up to 57,600 bps with sync software), and the option to address either Data Terminal or Data Communications equipment. Three sync communications packages include one that emulates an IBM transaction facility (BISYNC-80/3270), one that emulates an IBM file transfer facility (BISYNC-80/3780), and one that emulates an IBM multi-leaving workstation (BISYNC-80/HASP). All use the "standard" protocol IBM Binary Sync Communications (BSC). With the 3270 package, the PC-8000 can be made to emulate IBM 3271, 3275, and 3277 terminals, as well; while the 3780 package also emulates IBM 2770, 2780, and 3741. The communications packages run under the industry standard CP/M operating system. The communications board is \$250. The sync packages have a master license fee of \$995; an

async package, IE/Modem, is \$495. **NEC Information Systems Inc**, 5 Militia Dr, Lexington, MA 02173. **Write 175**

16-BIT MATH CHIP

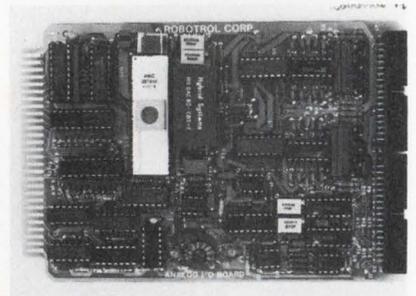
28 Multiply And 13 Divide Functions

The SN54/74S516 device is a bus organized multiplier/divider capable of performing 2's complement 16-bit calculations at high speed: 16/16 or 32/16 division in less than 3.5 μ s and 16x16 multiplication in less than 1.5 μ s. The commercial version, 74S516, has a maximum clock rate of 6 MHz; and the military version, 54S516, operates at 5 MHz. Both use a single clock. Among the 28 different multiply options the 54/74S516 can be programmed to perform are: positive and negative multiply; positive and negative accumulation; multiplication by a constant; and both single and double length addition in conjunction with multiplication. The commercial version is \$100 each in 100-lot qty. **Monolithic Memories Inc**, 1165 E. Arques Ave, Sunnyvale, CA 94086. **Write 142**

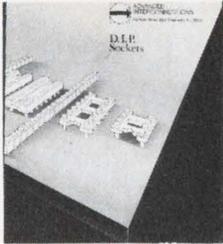
ANALOG I/O BOARD

STD Bus Compatible

The RSD-7728 has 8 differential or 16 single-ended analog inputs and 8 analog outputs. The resolution of all inputs and outputs is 12 bits. It features: 12 programmable modes, 6 output modes and 6 input modes with programmable interval timing; self test mode; 8 independent outputs; programmable gain amplifier with gains of 1, 2, 4 and 8; gain is also resistor programmable to accommodate low level inputs; Bus I/O may be memory mapped for specific I/O and

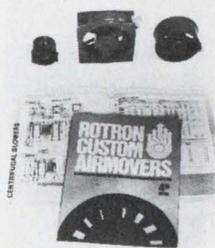


requires only 4 consecutive addresses; and vectored interrupt or polled program operation. The RSD-7728 operates with a Z80 or 8085 CPU up to 4 MHz and with a 6800 or 6809 CPU up to 2 MHz. \$360 (qty. 100). **Robotrol Corp**, 1250 Oakmead Pkwy, Suite 210, Sunnyvale, CA 94086. **Write 143**



DIP And μ P Chip Sockets. This brochure describes Hi-Rel sockets, detailing standard .125 thick sockets in 8 thru 40 pins. New super low profile (.50) thick open-frame sockets in 8 thru 40 pin configurations are also detailed. Data on 64 pin thru 289 pin μ p chip sockets included.

Advanced Interconnections Write 250



Custom Airmovers. This 286 pp. Custom Division Catalog includes the latest performance curves and acoustical data on Rotron's expanded line of equipment cooling fans and blowers for the military/aerospace and other high-reliability industries. The state-of-the-art ECDC motors and Hall-effect sensors, which monitor field rotation to warn against thermal runaway in the electronics systems being cooled are also described.

EG&G Rotron Write 258



Introduction to WordStar. Written by Arthur Naiman, this user-friendly guide is designed to teach anyone to use WordStar, a powerful word processing program. The beginner will quickly learn to edit copy, move and delete blocks of text, create and merge files, check copy for spelling accuracy, and even create special print effects. It contains a complete dictionary of all the commands used in WordStar, Spellstar and MailMerge. 220 pp., \$8.95.

Sydex Write 276



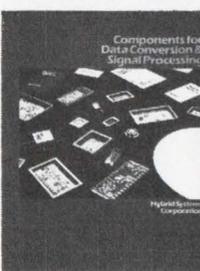
Telemetering Catalog. This 32 pp. catalog describes a line of telemetering products which includes: Voltage Controlled Oscillators, Oscillators, FM Discriminators, Frequency-to-DC Converters, Amplifiers, Analog Signal Isolators, Pressure Transducers, Power Supplies, Wireless Data Link and other products. All units utilize a miniaturized, ruggedized design and are recommended for military and industrial applications.

Solid State Electronics Write 275



Microcomputer Products. The 40 pp. catalog (821) from Electric Specialists presents their line of Microcomputer interference control products. Protective devices, Line Voltage Regulators and AC Power Interrupters are also included. Descriptive sections outline particular problems and suggested solutions. Typical applications and uses are highlighted.

Electronic Specialists Write 259



Data Conversion and Signal Processing Components. This 168 pp. catalog describes in detail a broad line of high performance monolithic, hybrid, and modular data converters. The product line encompasses many new state-of-the-art products from A/D and D/A converters to precision resistor networks. These devices are specifically designed for a wide range of measurement, control, and instrumentation applications.

Hybrid Systems Write 264

Wide Range Signal Measurement. Solutions to the problems inherent in such procedures as monitoring 0.01° changes in a furnace operating at 1000°, measuring small changes in ion concentrations, and variable frequency transducers are described. This 12 pp. brochure explains how the back-off signal balancing and calibration required in standard laboratory procedures can be avoided and a more reliable resolution obtained.

Chessell Corp. Write 253

Data Communications Products. The 48 pp. book lists the company's full product line, which includes a complete selection of data communications equipment. Their emphasis is on a fast, one-source supply for items that include modems, 4 and 8 channel statistical multiplexers/concentrators, cable and cable supplies, service and testing equipment, with a large inventory on hand to insure rapid shipment.

Data Communications Brokers Write 254

Lighting Guide. This 4 pp. short form, full line Product Lighting Guide (LG 1081), offers a broad overview of the Leecraft line while showing a full range of neon, incandescent and LED indicator lights. Also shown are a wide selection of Incandescent, Wedge Base and Halogen Cycle lampholders. The guide is streamlined for quick and easy design selection.

Leecraft Manufacturing Write 266

Digital Patching/Switching. This 14 pp. catalog covers Dynatech's extensive line of Mark II patching/switching/monitoring equipment. The Mark II series features low cost and versatility. The catalog covers the standard 24-circuit digital patching jacks, test/monitor modules and panels, digital A/B fallback and crossover switching, plus VF patching and monitoring equipment.

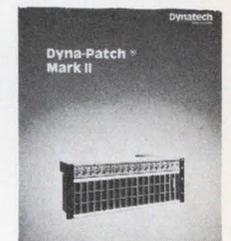
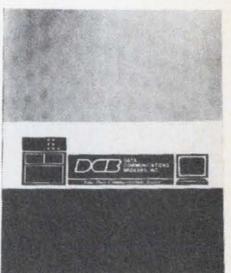
Dynatech Data Systems Write 255

Software Directory. This 108 pp. directory describes the broad range of applications and system software available for the entire family of Harris high performance super-minicomputers. The directory includes a large number of new CAD/CAM and graphics packages for the design and engineering marketplace. Included is the ANVIL-4000, an interactive graphics system for design, drafting, numerical control and management information.

Harris Corp. Write 263

ZEBRA Connector LCD Design Selector. This 16 pp. brochure assists Engineers in selecting the correct ZEBRA connector for mounting LCD's to PC Boards. Fifteen leading foreign and domestic LCD manufacturers are listed. Handy cross reference to ZEBRA connector assemblies enable readers to see at a glance what standard bezels and holders are available, eliminating the need of costly custom design and guesswork.

Tecknit Write 279



New Literature



CRT Display Filters. This engineering bulletin provides design data and specifications for non-glare, contrast enhancement CRT display filters. The bulletin can be used as a design guide by manufacturers of equipment with visual displays. It lists the most commonly used phosphors and the Homalite shade that meets specific light transmission requirements for those phosphors; and, describes various grades of filters available.

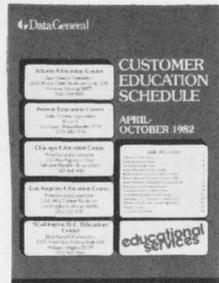
SGL Homalite

Write 274

Electronic Packaging Digest This 24 pp. edition, plus a 6 pp. product guide, features Bivar's complete family of over 2000 standard Electronic Packaging Aids for cost-effective solutions to costly PCB packaging and component mounting problems. Complete, dimensioned specifications, applications ideas, and prices are included. New products featured are available from distributor and factory stock.

Bivar

Write 252



Training Schedule The 16 pp. publication describes training services available to DGs OEMs and end-users through October 1982. It describes over 50 software, hardware and general lecture courses to be offered from April through October at the company's 5 U.S. regional training centers, and includes enrollment and pricing information on 22 self-paced instructional courses and the availability of on-site training at customer locations.

Data General

Write 257

Automatic Test Equipment Textbook. The 205 pp. text was compiled from course materials Test Engineering Solutions, Inc. uses in its Test Specialist Program. Subject matter includes: Why test (or why not)?; Elements of testing process; Types of failures and faults; Elements of an ATE; Elements of a test program set; Military vs. commercial use of an ATE; Test program development and much more. \$59.50.

Test Engineering Solutions Write 278



Electronic Wire Cable. This 208 pp. catalog is a comprehensive source of cable information and products for data communications, instrumentation, broadcast, computer and other electronics application. It describes standard product lines in indexed categories: multi-conductor cables; computer cables; molded cable assemblies; fiber optic cables; coaxial and broadcast cables; plenum cables; high temperature cables; and hook-up wire.

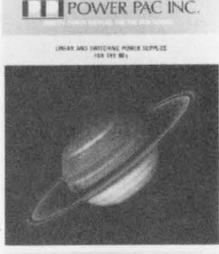
Belden

Write 251

Design Data Catalog. This 12 pp. brochure describes a comprehensive line of off-the-shelf power supplies for the OEM. It includes: general purpose single output and multiple output power supplies; disk drive and μ P supplies; modular supplies for industrial, OEM, and system applications; complete low cost power supplies on plug-in printed cards as well as custom power supplies for many more applications.

Power Pac

Write 271

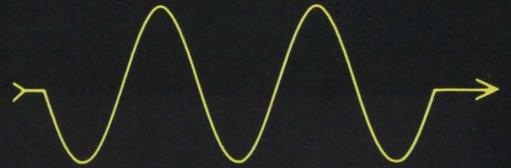
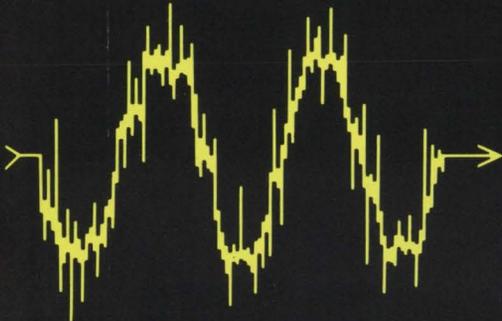


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And the probe takes care of clock, timing and signal interfacing so you don't have to worry about signal conditions.

Store your setups. The Dolch LAM 3250 lets you hold setups in a nonvolatile memory. Six files of menu and display configurations can be stored for up to three months without power. You don't have to reprogram every time you power up.

Don't settle for less than Dolch. The LAM 3250 is truly a universal logic analyzer with recording speeds of up to 50 MHz, sophisticated sequential triggering,

multilevel clocking, and 1 K-deep source and reference memories.

See a demonstration. You'll appreciate the difference in Dolch. For details on the LAM 3250, or any of our other trouble-shooting tools, write: Dolch Logic Instruments, Inc., 230 Devcon Drive, San Jose, CA 95112. Or call toll free: (800) 538-7506; in California call (408) 998-5730.

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